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electronics

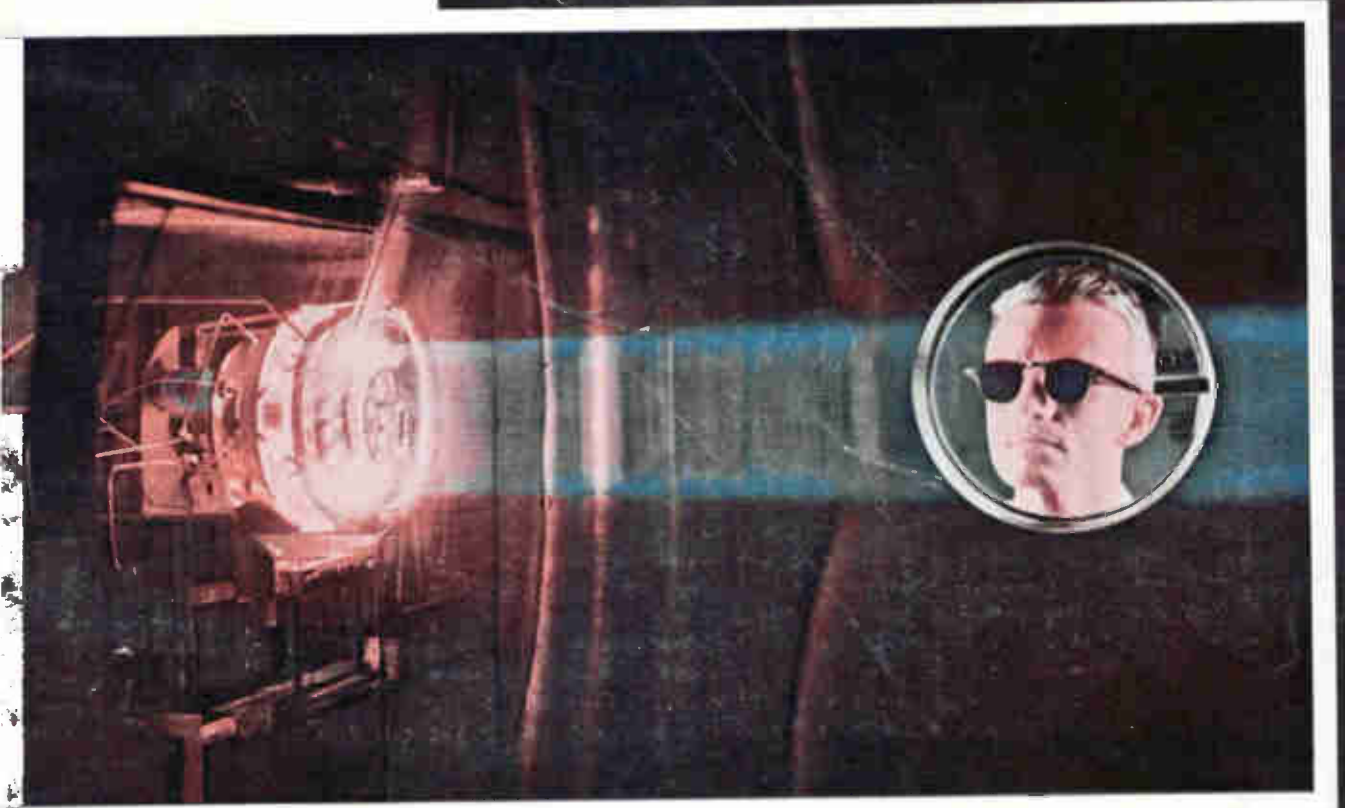
June 28, 1963

)PTO-TRONICS)N HORIZON

)ptical effects mean iew circuit tricks, p 32

THE IMPACT OF MICROCIRCUITS

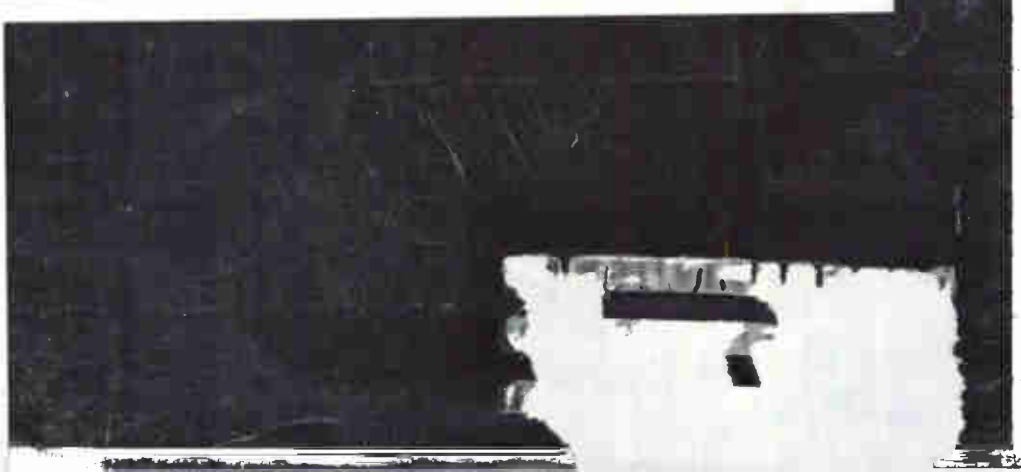
New techniques set to rock industry, p 51



ION ENGINE TEST COMING. *Can it get men to Mars?*

NEW PARAMP CUTS NOISE

Four-to-one noise reduction at S-band, p 57



in coaxial instrumentation from Hewlett-Packard

Instrument	Uses	Frequency, price ranges (dc · 10 mc · 55 mc · 215 mc · 450 mc · 500 mc · 940 mc · 1 gc · 2 gc · 3 gc · 4 gc · 10 gc · 12.4 gc)
Wavemeter 	Measure frequencies 960 mc to 4.2 gc with this reaction wavemeter, which indicates resonance by sharp output dip	536A ($500)
Dual Directional Couplers 	High directivity (> 30 db) makes these couplers especially useful in coax reflectometer uses; low insertion loss, high power handling capability make them suitable for permanent use in a transmission line for power monitoring; may be used to extend the range of hp power meters	774D 775D 776D 777D ($200)
VHF Detector VHF Bridge 	With suitable signal generator, (hp 608C, i.e.), permit direct measurement of impedance magnitude and phase, 2 to 2000 ohms, 0° to ±90°, avoiding bulk, awkwardness of slotted lines	417A ($475) 803A ($1000)
Slotted Lines 	Measure swr, determine reflection coefficient, return loss, mismatch loss, impedance	805C ($525) 805D ($600) 806B ($200)
Slide Screw Tuner 	Impedance matching device, ideal for maximizing power delivered to a load; less loss than single or double stub tuners, noninteracting adjustments	872A ($525)
Terminations 	For termination of 50-ohm coax systems in characteristic impedance for swr measurements and as production line impedance standards; the 906A sliding load permits its small reflection to be separated from other reflections in a system	906A ($250) 908A ($35)

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

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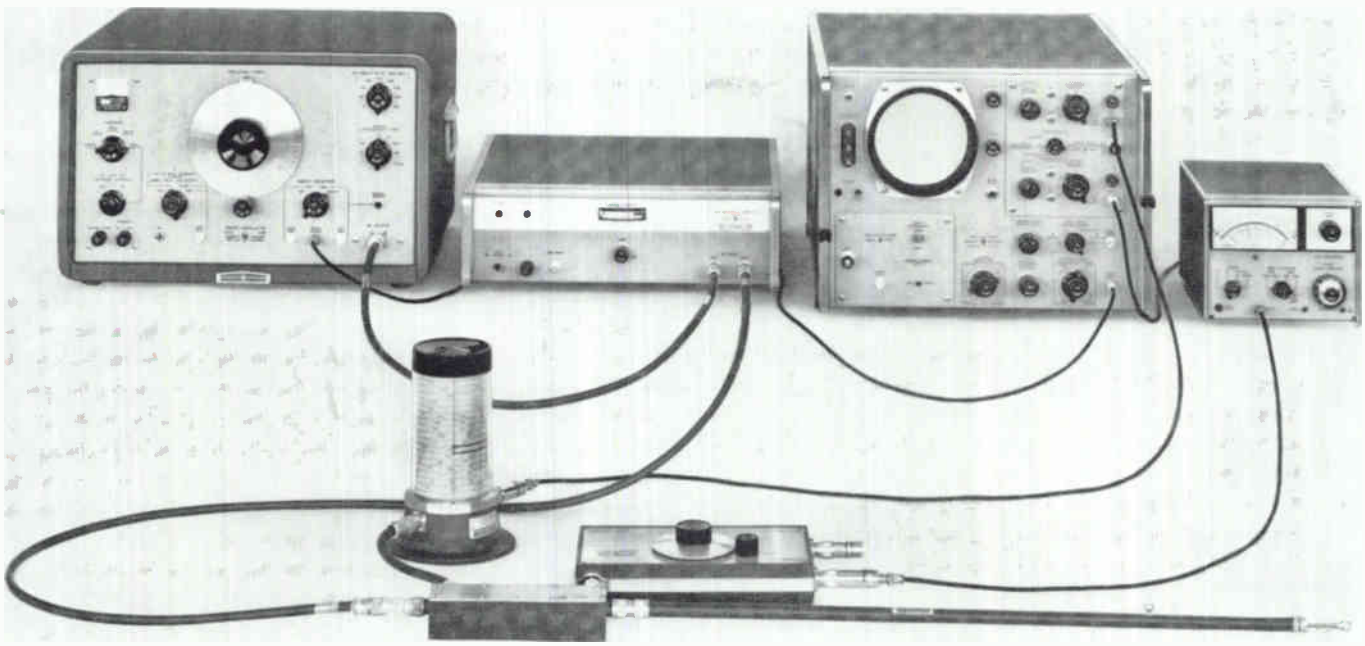
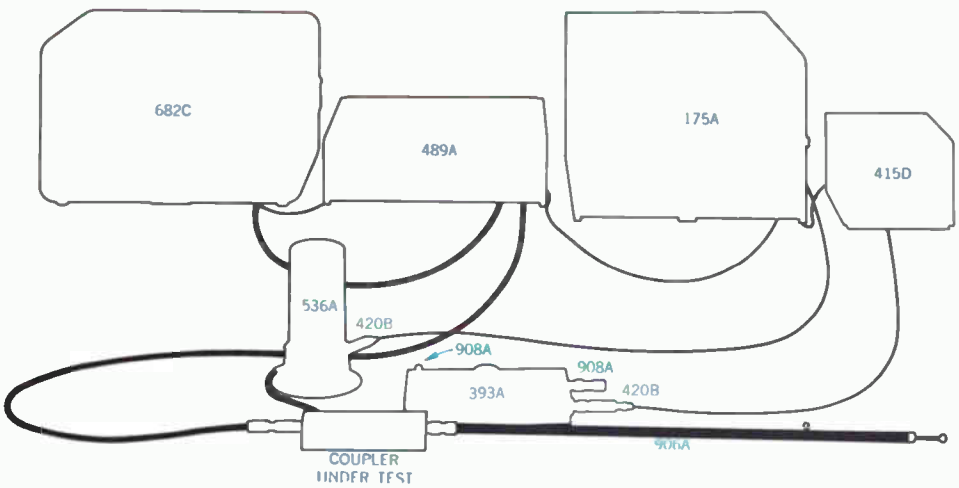
full-range tested



COAXIAL MEASURING INSTRUMENTATION

DC to 12.4 GC



from hp

Typical of the measuring setups possible with hp coaxial instrumentation is this arrangement for measuring directivity of the test coupler.

Turn the page for information on the wide array of precision coaxial measuring instruments available from Hewlett-Packard. Check the advantages of using compatible instrumentation from a single supplier offering high precision, maximum flexibility and top value.

COMPATIBILITY, PRECISION, FLEXIBILITY, VALUE

Measurements to 12.4 gc are convenient and easy with coaxial microwave instrumentation from hp. Compatible characteristics make individual instruments ideal for use in a variety of flexible setups for wide-range, accurate measurements. Using swept frequency techniques, hp tests each instrument over its entire frequency range, not just at random points. All hp instruments are warranted to conform with, or exceed, published specifications. Coaxial instruments are available for fast delivery at moderate cost. Complete information is available from your Hewlett-Packard representative.

Frequency, price ranges

Instrument	Uses	dc – 10 mc – 55 mc – 215 mc – 450 mc – 500 mc – 940 mc – 1 gc – 2 gc – 3 gc – 4 gc – 10 gc – 12.4 gc
Waveguide-to-Coax Adapters 	Designed for connecting coaxial cables and waveguide systems; available in these frequency bands (in gigacycles): S: 2.6 to 3.95 G: 3.95 to 5.85 H: 7.05 to 10 J: 5.3 to 8.2 X: 8.2 to 12.4	281A Series ($25 to $50)
Low Pass Filters 	Offering rejection of ≧ 50 db at 1.25 times their cut-off frequency, these filters effectively eliminate harmonics, provide pure signals to prevent erroneous readings or to mask a null in swr measurements	360A ($70) 360B ($60) 360C ($50) 360D ($50)
Attenuators  	Ideal for insertion loss measurements by the rf substitution method, in which power is fed through the attenuator to a detector and to a reference meter; replacement of the attenuator with the unknown permits determination of the difference in attenuation, and the insertion loss of the unknown; a sensitive detector (which may be a receiver) permits insertion loss measurements to 80 or 90 db; detector characteristics need not be known, since its input is constant	355C ($125) 355D ($125) 393A ($420) 394 ($420)
Detectors 	Basically, square-law devices for demodulation of rf signals; 423A has ± 0.5 frequency response; the 420B and 476A exhibit exceptional square-law properties, are particularly useful in reflectometer uses or for direct attenuation measurement with 415B,D SWR Meter or 416B Ratiometer	420A ($50) 420B ($75) 476A ($85) 440A ($80) 423A ($125)
Thermistor Mounts 	Used with the 430C and 431B Power Meters, to measure power in Type N systems; the 478A is temperature-compensated for measurements as low as 1 μw with the 431B	477B ($75) 478A ($145)

June 28, 1963

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SCHEDULED FOR FLIGHT TEST late this year, Hughes' ion engine opens up on the ground. Scout rocket may loft a capsule containing this engine and one developed in-house by NASA 5,000 miles for true space testing. *But bugs in the high-voltage power supply have engineers nervous about keeping on schedule*
COVER

HOT LINE—First Fruit of Disarmament Talks. U.S. and Soviet negotiators agree to emergency-only telegraph link between the two nuclear capitals. *Both sides will exchange equipment; the U.S. will provide the message encoders* 18

AREA CODE FOR SPACE. Command discrimination gear will prevent the newly launched Tiros 7 from getting Tiros 6's messages, and vice-versa. *Next: Tiros 8 and 45 ground stations* 18

MICROELECTRONIC LORAN-C WILL Fly Next Year. This new equipment was especially designed to use digital microcircuits. *Motors, gears, synchros are eliminated, weight is cut to 19 pounds* 22

NEW COLOR-TV TUBE Bows This Week. After two years and $4 million for development, 23-inch rectangular, 92-degree color-tv tube goes to work. *It's used in eight new sets* 26

WIRELESS MICROPHONES Get F-M Band. FCC says anybody can use them in the 88 to 108-Mc f-m band, with just a few limitations, for talking or telemetry. *Broadcasters don't like it* 26

PAPER PROTOTYPES Next for Command and Control. Future systems will be designed with Adam, a new programming concept, in a computer. *This technique is already being used to develop two systems* 28

OPTICAL SEMICONDUCTORS—Look at What They Can Do Now. Solid-state optical devices and optically coupled circuits are coming out of the lab. *Devices can now do logic switching, amplification, oscillation, rectification, and more* 32

NAVY PUSHES MICROCIRCUITS. Easy-to-repair systems will help solve technician shortage while boosting system effectiveness. *At R&D clinic, Navy also listed development it most wants* 34

THIN-FILM PROPULSION. Pulsed plasma system deposits metal films on wheel, then explodes it in spark gap. *Lightweight control system is another space development* 40

LOW-POWER DEVICES Are Going to Nanopower Levels. Experts see power cuts of 10 to 100. *Very promising: field-effect devices* 38

Contents Continued

electronics

June 28, 1963 Volume 36 No. 26

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

Executive, editorial, circulation and advertising offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Telephone Longacre 4-3000. Teletype TWX N.Y. 212-640-4646. Cable McGrawhill, N. Y. PRINTED IN ALBANY, N. Y.; second class postage paid at Albany, N. Y.

OFFICERS OF THE PUBLICATIONS DIVISION: Shelton Fisher, President; Vice Presidents: Joseph H. Allen, Operations; John R. Callaham, Editorial; Ervin E. DeGraff, Circulation; Donald C. McGraw, Jr., Advertising Sales; Angelo R. Venezian, Marketing.

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Subscriptions are solicited only from those actively engaged in the field of the publication. Position and company connection must be indicated on orders. Subscription rates: United States and Possessions, $6.00 one year, $9.00 two years, $12.00 three years. Canada: $10.00 one year. All other countries $20.00 one year. Single copies, United States and Possessions and Canada 75¢. Single copies all other countries $1.50.

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Audited Paid Circulation

CONTENTS continued

THE IMPACT OF MICROELECTRONICS. This week, electronics engineers of every stripe gathered in Chicago to hear industry and government leaders tell what lies ahead because of the microcircuit revolution. They spoke at a conference held jointly by ELECTRONICS and Armour Research Foundation (now ITT Research Institute). *Here's what they had to say* 51

NEW PARAMETRIC AMPLIFIER Approaches Noise-Figure Minimum. Completely packaged solid-state unit operates at S-band using a Ku-band pump. Noise reduction is better than four-to-one over early amplifiers. *Combining the latest design techniques optimizes the circuit.*
By P. Koskos, D. Mamayek, W. Rumsey, C. L. Cuccia, RCA, Electronic Tube Division 55

TUNNEL DIODES, Part III—Mixer and Converter Circuits. Practical circuits include a host of converter applications including mobile communications and television systems. *Circuits are compact, temperature stable and require minimal power expenditure.*
By E. Gottlieb and J. Giorgis, GE Semiconductor Products Dept. 61

DEPARTMENTS

Crosstalk. *One Customer Isn't Enough* 8

Comment. *Spare That Meter. Reliability Testing* 4

Electronics Newsletter. *DOD Awards Lag* 7

Washington This Week. *Experience—Not a Better Proposal—Wins Contracts. Russian Space Feat Helps NASA* 12

Meetings Ahead. *Electromagnetic Compatibility Conference. Plasma Phenomena and Measurements Symposium* 46

Research and Development. *Waveguide Telemeters Space-Chamber Data* 74

Components and Materials. *TWT Uses New Focusing Concept* 80

Production Techniques. *Electron Beam Welding Solves Relay Sealing Problem* 90

New Products. *Comparing Frequencies To 1 Part in 10^n* 100

Literature of the Week 110

People and Plants. *IRC Plans Advanced R&D Center* 114

Index to Advertisers 122

One Customer Isn't Enough

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such developing practices as:

Limiting competition on a project to just a few companies "best technically qualified." If a company doesn't win that title early, will it ever be able to compete? Can it maintain its competence without substantial military R&D funds?

• Breaking down R&D into shorter program stages. This has many advantages, but contract security is not one of them.

• Rapid disclosure and rapid dissemination of technical advances. This may be good for the military in general, but it decreases a major attraction of military R&D—getting a leg up, technically, on competition.

• Increasing use of military and not-for-profit R&D shops to plan, manage and build system prototypes. Even when these jobs are given to industry, the company is often barred from subsequent hardware contracting.

Military production contracting, too, is becoming more chancy:

• Equipment needs change rapidly today; military concepts and world politics are in flux. Only one major program need be cancelled to bring hard times to a cluster of contractors.

• Technology can take a radical turn, as it is now doing with microelectronics, and unprepared companies can quickly go in the ditch.

• System complexity and the "best technically qualified" criterion can lead to more prime contracting by fewer companies. If microelectronics forces radical consolidation of systems and components manufacturing—as some believe it in the next five to ten years—more and small supplier will be in difficulty.

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Spare That Meter

In your April 19 issue, article titled, Building A Si Transistor Tester (p 56), aut Montgomery has included a rath clever range-changer switching cir cuit. However, since banging the pointer against the stop-pin in any meter is a function that is normally shunned by those of us who must finance our own efforts and equipment, I would like to suggest that he change the meter portion of one switch referred to, so that the shunt resistor is in the circuit while the button goes down, and out when the switch bottoms. In this way the high-current range is within the first function of the switch, and the low-current range is arrived at in the second position. Thus the meter is spared abuse. Alteration of the switch is simple, with the meter portion being changed to a close-then-open arrangement.

HARRY ALDEN LYON
Lyonart Industries
Taos, New Mexico

Reliability Testing

This year's IEEE International Convention presented particularly interesting exhibits. The accent appeared to be more on applications and improvements in already familiar instrumentation.

An impressive exhibit by DuPont Company demonstrated the "inertness" of their new cleaning and degreasing agent, Freon-TF. This exhibit consisted of an operating television receiver chassis completely submerged in a transparent tank filled with Freon-TF. As this agent has the appearance of water, it was impressive to note that all electrical connections were immersed in this liquid with no evidence of electrical leakage.

Another point of interest regarding this exhibit, was the thin stream of bubbles arising from certain components. Evidently, these components generated heat, which vaporized the Freon-TF and formed the stream of bubbles.

Understandably, heat is usually an unwanted by-product in an elec-

tronic device. However, a circuit designer cannot always predict localized hot-spots in an electronic chassis. A design modification, may be an indication of component failure

Shrewsbury, Mass.

An inter for applications is already in checking. For tion, see the niques articles on 1963 and p 72, July

Edwin, not Edward

In the article, New Digit version Method Provides Na ond Resolution (p 55, May ? which I am co-author, my was spelled wrong.

Thank you for the excellent presentation of my article.

EDWIN JOHNSON
Edgerton, Germeshausen & Grier, Inc.
Santa Barbara, California

It may come as a surprise to author Johnson that his name is given as Edward on the manuscript we received.

Laser Modulation

In the article, Field Modulates Laser (April 26), you quote on p 26 some of our results (center column, bottom). There is an error. For 100-percent a-m with a few hundred megacycles bandwidth, only a *few watts* (not a few hundred watts!) are required. Furthermore, the paper presented at the Symposium on Optical Masers is co-authored by K. Gürs, rather than by myself alone.

R. MÜLLER
Siemens & Halske AG
Munich, Germany

SILICON FIELD EFFECT TRANSISTORS

2N2386 2N2794

These P-channel diffused silicon transistors embody all the desirable characteristics inherent in the field effect design – low input capacitance and high impedance. Use of an S-shaped gate configuration contributes to the exceptionally low capacitance ■ Tung-Sol's wide application experience with injection transistors and vacuum tubes – features of which are combined in the field effect transistor – is an important consideration for anyone seeking a competent source of this advanced semiconductor device ■ Write for complete technical information. Tung-Sol Electric Inc., Newark 4, N. J. TWX: 201-621-7977

TYPICAL ELECTRICAL CHARACTERISTICS (25°C)

	TEST	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
2N2386	Drain Current	I_{DSS}	$V_{DS}=-10V, V_{GS}=0$		3.0		mA
	Forward Transadmittance	Y_{FS}	$V_{DS}=-10V, V_{GS}=0$ f= 1Kc	1000		3000	μmho
2N2794	Drain Current	I_{DSS}	$V_{DS}=-10V, V_{GS}=0$	1.5		5	mA
	Forward Transadmittance	Y_{FS}	$V_{DS}=-10V, V_{GS}=0$ f= 1Kc	1000		3000	μmho

TUNG-SOL

CENTER LINE QUALITY

Red Tape Slows Up DOD Contracts

WASHINGTON—Barraged by industry complaints, the Pentagon has admitted that the volume of prime contracts will not come up to expectations for the fiscal year ending June 30. The slowdown was much discussed by representatives of the electronics industry at an EIA meeting here last week. Some firms reported layoffs because of the failure to land expected contracts.

The Pentagon says the awards will be several hundreds of millions of dollars less than the rate scheduled for the year, but insists "there are no policy reasons behind the delay." It attributes the lag to "mechanical reasons." DOD plans had called for placement of over $31-billion worth of new orders, about $2 billion more than last year.

One big reason for the delays, the Pentagon says, is the organizational overhaul the Army procurement agencies have been undergoing in the past year. The technical services were relieved of contracting responsibilities last year and a new Army Material Command set up to do all the Army's buying.

The Navy is also lagging. One reason may be Defense Secretary McNamara's decision to postpone building a $300-million aircraft carrier authorized in the fiscal 1963 budget. The Air Force, however, is pretty much on schedule, according to Pentagon experts.

Tungsten Bulb Pumps C-W Laser

C-W LASER pumped only by a tungsten bulb has been developed by RCA for the Air Force. Input power to stimulate the laser is only 15 w. The system has also been pumped continuously by the sun, Air Force said. The dysprosium-doped calcium-fluoride crystal can be as small as ⅛ inch in diameter and one inch in length and can operate in either a liquid neon or liquid nitrogen atmosphere.

To modulate the beam, a single crystal of cuprous-chloride is used (p 12, March 1). It is capable of 100-percent modulation of calcium fluoride crystal emission at 2.36 microns. Internal modulation of the energy levels within the crystal has also been accomplished using a very small magnetic field (p 26, April 26). The laser beam has been used as a carrier for audio frequency signals. The cuprous-chloride crystal and the magnetic field modulation technique were employed.

NYU Study Gives Hope Of Cancer Prevention

RESEARCH with organic semiconductors that last week was reported to be providing clues to causes of cancer (p 7, June 21) may also show the way to prevention of the disease. Dr. Walter Brenner, who heads the NYU group conducting the study, told **ELECTRONICS** that if a solid-state conduction process is involved in the start of cancer then it may be possible to take advantage of another theory.

This holds that the semiconduct-

Self-Service Credit Card

TELEMEMORY *punched-card control system installed by Motorola at automated Gulf Oil terminal makes sure right truck driver picks up right load, verifies credit and, with data-processing equipment, handles record-keeping and billing*

Learning Machine Winning Favor

EVANSTON, ILL.—Scientists are turning toward the learning-machine concept because of a growing realization that digital computers, with their dependence on precise and determinate programming, won't be able to handle in economic fashion highly complex tasks such as rapid interpretation of hundreds of thousands of photographically recorded 'events' taken from a cloud or bubble chamber, speech-handwriting conversions or translations.

Some feel that attempts to use digital computers as pattern recognizers is comparable to the engravers' trick of making a picture out of thousands of tiny dots. However, the cost of providing more and more 'dots', or memory cells, begins to rise exponentially as more and more information is required.

These were the impressions gained from speeches, both public and private, at a Computer and Information Sciences Symposium at Northwestern University here.

"The digital computer is too centralized in its concept; even if it works in nanoseconds it can accomplish only one computation at a time," said W. Ross Ashby of the University of Illinois. "There is no need to tolerate this type of organization when there is work to do calling for a simultaneous approach."

ing carcinogenous dyes used in the experiments prefer to form charge transfer complexes with substances other than living tissue and that it may be possible to introduce such substances into the tissue. The carcinogens would then not affect the tissue protein. At the Pasadena Foundation of Medical Research in Pasadena, Calif., scientists have found that living cellular tissue painted with a vinyl dye of low concentration is destroyed by laser beam radiation. Transparent cells are unaffected. Future applications in cancer treatment and research are indicated, researchers say, although the treatment has not yet been applied to humans.

Nuclear-Powered Missile Program Given A Push

DALLAS—Ling-Temco-Vought says it has been awarded a $10-million contract by the Air Force for "continuation of the technology for development of a nuclear-powered low-altitude supersonic vehicle (LASV)." This is "part of the AF's LASV program which includes consideration of both nuclear and chemical propelled vehicles," LTV says.

LTV has been working on a nuclear-powered ramjet project since 1958, and initiated studies on a project called SLAM (Supersonic Low Altitude Missile). It had invested some $3 million of its own in this program, but for the past 18 months or so, the project has been wrapped up in security—even the name SLAM was taboo.

Superconductive Memory Is 0.00012-Inch Thick

NEW YORK—Experimental, high-speed memory 120 millionths of an inch thick with a storage capacity of 16,384 bits was shown here this week by RCA's Sarnoff Research Center. Designed for computer and EDP applications, the memory has layers of tin, lead and silicon oxide deposited by evaporation on a 2-square-inch glass plate. Between the three layers are two conducting grids made up of 128 hair-thin strips of lead deposited at right angles to each other. A film of tin is deposited between the grids and the insulator.

Plasma Metal Junction Generates 29th Harmonic

PLASMA METAL junction harmonic generation is producing microwave outputs at frequencies of 1,015 Gc from a 35-Gc drive input. Even higher microwave frequencies than the 29th harmonic are expected to be produced in the next few months when the drive frequency is doubled.

Heart of the technique, developed by K. Froome of Britain's National Physical Laboratory, is a gaseous plasma in contact with a metal surface. Plasma density is such that it behaves electrically as a wire so that microwave energy fed in is conducted to the junction of the plasma and the metal electrode. By applying a d-c field to the region of intense positive ion space-charge at the actual point of contact, an electron emitting area —the cathode spot of a cold cathode arc—is formed, the electrons being extracted by field emission. Under simultaneous application of the d-c field and a microwave field, the cathode spot acts as a microwave rectifier generating harmonics. The microwave drive input power level is around 10 w at 35 Gc with a superimposed d-c current of 400-500 ma.

Talking Bird Stands By On Kennedy European Tour

WASHINGTON—C-97 "Talking Bird" stratocruiser plane carrying a complete radio station and 18 communication specialists was sent to Dublin this week as a backup for the President's radio link with the Pentagon Command Post here. The plane, a unit of the Oklahoma National Guard, is equipped with a Collins ARC-58 ssb 28,000-channel transmitter and receiver as well as uhf and vhf, teletype, cryptographic, coding and decoding and telephone switchboard equipment.

In Brief . . .

HOUSE Government Operations Committee has approved a bill providing for centralized management of government ADP (automatic data processing). It is claimed the plan would save $100 million yearly.

TV SET manufacturers are stepping up the tempo of their changeover to all-channel TV receivers, EIA says. Industry estimates indicate that 20 percent of black-and-white sets produced this year will receive both vhf and uhf.

COMPUTER SYSTEM with a capacity of 800 million characters of data is scheduled for installation in late 1964 at Randolph AFB.

IN A SECOND TRY, Relay I was used to transmit signals from the U. S. for the automatic setting of type in England (p 7, June 21).

CONTROL DATA Corp. and Itek have signed an agreement under which Control Data will produce principal digital elements for Itek's Digigraphic system. Control Data will also market the device.

GENERAL DYNAMICS, North American and Douglas have each been awarded a $500,000 Air Force contract to study a new piloted space plane. AF also wants Boeing to quote schedules and costs to develop pilot control of the Dyna-Soar booster.

LEAR SIEXLER has received a contract from NASA to study a system that would sense and record the various physical functions of an astronaut and his vehicle. First step will be development of a system mounted in the pilot's garment and headgear.

HAROLD S. GENEEN, president of ITT, has flatly opposed a suggestion by General Sarnoff, RCA chairman, that all international voice and record communications facilities be merged and placed under control of Communications Satellite Corp.

RUSSIAN SATELLITE was launched October 4, 1962 and decayed October 29, NASA says. Later reports indicated that 23 other pieces of the same unannounced spacecraft decayed between then and February, 1963.

One Customer Isn't Enough

SWEEPING and sometimes unpredictable changes in Pentagon procurement policies and practices make it more and more apparent that it is unhealthy for electronics engineers and electronics companies to place too great a reliance on military contracting as a source of work and profit.

The present administration is becoming more selective about the number and kinds of contracts it awards, and seems bent on setting new records for speed of cancelling contracts on going projects it wants to drop.

In the abstract, these are praiseworthy trends, but they are creating serious problems for companies and men heavily committed to military contracting. The descent from the pinnacle can be swift, the climb back slow.

Military electronics dominates our industry. It is our mainstay. Military R&D provides technical advances and income, military production is a prime source of profit. But it is the prospect for the individual company that the individual company must be concerned with, not this generality.

In military R&D, opportunities are being narrowed by such developing practices as:

- Limiting competition on a project to just a few companies "best technically qualified." If a company doesn't win that title early, will it ever be able to compete? Can it maintain its competence without substantial military R&D funds?
- Breaking down R&D into shorter program stages. This has many advantages, but contract security is not one of them.
- Rapid disclosure and rapid dissemination of technical advances. This may be good for the military in general, but it decreases a major attraction of military R&D—getting a leg up, technically, on competition.
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- Technology can take a radical turn, as it is now doing with microelectronics, and unprepared companies can quickly go in the ditch.
- System complexity and the "best technically qualified" criterion can lead to more prime contracting by fewer companies. If microelectronics forces radical consolidation of systems and components manufacturing—as some believe it will in the next five to ten years—more and more small supplier will be in difficulty.
- Profits are less sure. The trend is away from fixed-fee toward fixed or incentive contracts, and from negotiated to competitive procurement. This means more risks for the contractor.

For each of these negatives, a positive can of course be found. Certainly the electronics industry should not curtail its military electronics support. But it becomes increasingly obvious that companies, also, must be more selective in the military contracts they seek. And they must channel more effort into civilian electronics, too.

Civilian electronics has its ups and downs and competition. But the trends toward more automation in industry and toward greater use of all types of consumer and professional electronic equipment are long-term, with fewer hazards than a munitions industry faces.

Even if peace never breaks out, a more balanced mix of civilian and military electronics is necessary for greater stability and growth for the electronics industry and the men and companies which comprise it.

COMMENT

Spare That Meter

In your April 19 issue, in an article titled, Building A Simple Transistor Tester (p 56), author Montgomery has included a rather clever range-changer switching circuit. However, since banging the pointer against the stop-pin in any meter is a function that is normally shunned by those of us who must finance our own efforts and equipment, I would like to suggest that he change the meter portion of one switch referred to, so that the shunt resistor is in the circuit while the button goes down, and out when the switch bottoms. In this way the high-current range is within the first function of the switch, and the low-current range is arrived at in the second position. Thus the meter is spared abuse. Alteration of the switch is simple, with the meter portion being changed to a close-then-open arrangement.

HARRY ALDEN LYON
Lyonart Industries
Taos, New Mexico

Reliability Testing

This year's IEEE International Convention presented particularly interesting exhibits. The accent appeared to be more on applications and improvements in already familiar instrumentation.

An impressive exhibit by DuPont Company demonstrated the "inertness" of their new cleaning and degreasing agent, Freon-TF. This exhibit consisted of an operating television receiver chassis completely submerged in a transparent tank filled with Freon-TF. As this agent has the appearance of water, it was impressive to note that all electrical connections were immersed in this liquid with no evidence of electrical leakage.

Another point of interest regarding this exhibit, was the thin stream of bubbles arising from certain components. Evidently, these components generated heat, which vaporized the Freon-TF and formed the stream of bubbles.

Understandably, heat is usually an unwanted by-product in an electronic device. However, a circuit designer cannot always predict localized hot-spots in an electronic chassis. These hot-spots may require a design modification or more likely, may be an indication of an approaching component failure.

After viewing this demonstration, it seems to me that this technique, when used as a test procedure, can be a powerful tool for reliability, testing of electronic equipment. This procedure may be used as a final test in a production line, or as an aid in determining the reliability of a new circuit design.

W. P. CZERWINSKI
Shrewsbury, New Jersey

An interesting idea that may find applications. Infrared inspection is already in use for manufacture checking. For more on ir inspection, see the Production Techniques articles on p 62, June 14, 1963 and p 72, July 6, 1962.

Edwin, not Edward

In the article, New Digital Conversion Method Provides Nanosecond Resolution (p 55, May 3), of which I am co-author, my name was spelled wrong.

Thank you for the excellent presentation of my article.

EDWIN JOHNSON
Edgerton, Germeshausen & Grier, Inc.
Santa Barbara, California

It may come as a surprise to author Johnson that his name is given as Edward on the manuscript we received.

Laser Modulation

In the article, Field Modulates Laser (April 26), you quote on p 26 some of our results (center column, bottom). There is an error. For 100-percent a-m with a few hundred megacycles bandwidth, only a *few watts* (not a few hundred watts!) are required. Furthermore, the paper presented at the Symposium on Optical Masers is co-authored by K. Gürs, rather than by myself alone.

R. MÜLLER
Siemens & Halske AG
Munich, Germany

SILICON FIELD EFFECT TRANSISTORS

2N2386 **2N2794**

These P-channel diffused silicon transistors embody all the desirable characteristics inherent in the field effect design – low input capacitance and high impedance. Use of an S-shaped gate configuration contributes to the exceptionally low capacitance ■ Tung-Sol's wide application experience with injection transistors and vacuum tubes – features of which are combined in the field effect transistor – is an important consideration for anyone seeking a competent source of this advanced semiconductor device ■ Write for complete technical information. Tung-Sol Electric Inc., Newark 4, N. J. TWX: 201-621-7977

TYPICAL ELECTRICAL CHARACTERISTICS (25°C)

	TEST	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
2N2386	Drain Current	I_{DSS}	$V_{DS}=-10V$, $V_{GS}=0$		3.0		mA
	Forward Transadmittance	Y_{FS}	$V_{DS}=-10V$, $V_{GS}=0$ f= 1Kc	1000		3000	μmho
2N2794	Drain Current	I_{DSS}	$V_{DS}=-10V$, $V_{GS}=0$	1.5		5	mA
	Forward Transadmittance	Y_{FS}	$V_{DS}=-10V$, $V_{GS}=0$ f= 1Kc	1000		3000	μmho

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Red Tape Slows Up DOD Contracts

WASHINGTON—Barraged by industry complaints, the Pentagon has admitted that the volume of prime contracts will not come up to expectations for the fiscal year ending June 30. The slowdown was much discussed by representatives of the electronics industry at an EIA meeting here last week. Some firms reported layoffs because of the failure to land expected contracts.

The Pentagon says the awards will be several hundreds of millions of dollars less than the rate scheduled for the year, but insists "there are no policy reasons behind the delay." It attributes the lag to "mechanical reasons." DOD plans had called for placement of over $31-billion worth of new orders, about $2 billion more than last year.

One big reason for the delays, the Pentagon says, is the organizational overhaul the Army procurement agencies have been undergoing in the past year. The technical services were relieved of contracting responsibilities last year and a new Army Material Command set up to do all the Army's buying.

The Navy is also lagging. One reason may be Defense Secretary McNamara's decision to postpone building a $300-million aircraft carrier authorized in the fiscal 1963 budget. The Air Force, however, is pretty much on schedule, according to Pentagon experts.

Tungsten Bulb Pumps C-W Laser

C-W LASER pumped only by a tungsten bulb has been developed by RCA for the Air Force. Input power to stimulate the laser is only 15 w. The system has also been pumped continuously by the sun, Air Force said. The dysprosium-doped calcium-fluoride crystal can be as small as ⅛ inch in diameter and one inch in length and can operate in either a liquid neon or liquid nitrogen atmosphere.

To modulate the beam, a single crystal of cuprous-chloride is used (p 12, March 1). It is capable of 100-percent modulation of calcium fluoride crystal emission at 2.36 microns. Internal modulation of the energy levels within the crystal has also been accomplished using a very small magnetic field (p 26, April 26). The laser beam has been used as a carrier for audio frequency signals. The cuprous-chloride crystal and the magnetic field modulation technique were employed.

NYU Study Gives Hope Of Cancer Prevention

RESEARCH with organic semiconductors that last week was reported to be providing clues to causes of cancer (p 7, June 21) may also show the way to prevention of the disease. Dr. Walter Brenner, who heads the NYU group conducting the study, told ELECTRONICS that if a solid-state conduction process is involved in the start of cancer then it may be possible to take advantage of another theory.

This holds that the semiconduct-

Self-Service Credit Card

TELEMEMORY *punched-card control system installed by Motorola at automated Gulf Oil terminal makes sure right truck driver picks up right load, verifies credit and, with data-processing equipment, handles record-keeping and billing*

Learning Machine Winning Favor

EVANSTON, ILL.—Scientists are turning toward the learning-machine concept because of a growing realization that digital computers, with their dependence on precise and determinate programming, won't be able to handle in economic fashion highly complex tasks such as rapid interpretation of hundreds of thousands of photographically recorded 'events' taken from a cloud or bubble chamber, speech-handwriting conversions or translations.

Some feel that attempts to use digital computers as pattern recognizers is comparable to the engravers' trick of making a picture out of thousands of tiny dots. However, the cost of providing more and more 'dots', or memory cells, begins to rise exponentially as more and more information is required.

These were the impressions gained from speeches, both public and private, at a Computer and Information Sciences Symposium at Northwestern University here.

"The digital computer is too centralized in its concept; even if it works in nanoseconds it can accomplish only one computation at a time," said W. Ross Ashby of the University of Illinois. "There is no need to tolerate this type of organization when there is work to do calling for a simultaneous approach."

ing carcinogenous dyes used in the experiments prefer to form charge transfer complexes with substances other than living tissue and that it may be possible to introduce such substances into the tissue. The carcinogens would then not affect the tissue protein. At the Pasadena Foundation of Medical Research in Pasadena, Calif., scientists have found that living cellular tissue painted with a vinyl dye of low concentration is destroyed by laser beam radiation. Transparent cells are unaffected. Future applications in cancer treatment and research are indicated, researchers say, although the treatment has not yet been applied to humans.

Nuclear-Powered Missile Program Given A Push

DALLAS—Ling-Temco-Vought says it has been awarded a $10-million contract by the Air Force for "continuation of the technology for development of a nuclear-powered low-altitude supersonic vehicle (LASV)." This is "part of the AF's LASV program which includes consideration of both nuclear and chemical propelled vehicles," LTV says.

LTV has been working on a nuclear-powered ramjet project since 1958, and initiated studies on a project called SLAM (Supersonic Low Altitude Missile). It had invested some $3 million of its own in this program, but for the past 18 months or so, the project has been wrapped up in security—even the name SLAM was taboo.

Superconductive Memory Is 0.00012-Inch Thick

NEW YORK—Experimental, high-speed memory 120 millionths of an inch thick with a storage capacity of 16,384 bits was shown here this week by RCA's Sarnoff Research Center. Designed for computer and EDP applications, the memory has layers of tin, lead and silicon oxide deposited by evaporation on a 2-square-inch glass plate. Between the three layers are two conducting grids made up of 128 hair-thin strips of lead deposited at right angles to each other. A film of tin is deposited between the grids and the insulator.

Plasma Metal Junction Generates 29th Harmonic

PLASMA METAL junction harmonic generation is producing microwave outputs at frequencies of 1,015 Gc from a 35-Gc drive input. Even higher microwave frequencies than the 29th harmonic are expected to be produced in the next few months when the drive frequency is doubled.

Heart of the technique, developed by K. Froome of Britain's National Physical Laboratory, is a gaseous plasma in contact with a metal surface. Plasma density is such that it behaves electrically as a wire so that microwave energy fed in is conducted to the junction of the plasma and the metal electrode. By applying a d-c field to the region of intense positive ion space-charge at the actual point of contact, an electron emitting area —the cathode spot of a cold cathode arc—is formed, the electrons being extracted by field emission. Under simultaneous application of the d-c field and a microwave field, the cathode spot acts as a microwave rectifier generating harmonics. The microwave drive input power level is around 10 w at 35 Gc with a superimposed d-c current of 400-500 ma.

Talking Bird Stands By On Kennedy European Tour

WASHINGTON—C-97 "Talking Bird" stratocruiser plane carrying a complete radio station and 18 communication specialists was sent to Dublin this week as a backup for the President's radio link with the Pentagon Command Post here. The plane, a unit of the Oklahoma National Guard, is equipped with a Collins ARC-58 ssb 28,000-channel transmitter and receiver as well as uhf and vhf, teletype, cryptographic, coding and decoding and telephone switchboard equipment.

In Brief . . .

HOUSE Government Operations Committee has approved a bill providing for centralized management of government ADP (automatic data processing). It is claimed the plan would save $100 million yearly.

TV SET manufacturers are stepping up the tempo of their changeover to all-channel TV receivers, EIA says. Industry estimates indicate that 20 percent of black-and-white sets produced this year will receive both vhf and uhf.

COMPUTER SYSTEM with a capacity of 800 million characters of data is scheduled for installation in late 1964 at Randolph AFB.

IN A SECOND TRY, Relay I was used to transmit signals from the U. S. for the automatic setting of type in England (p 7, June 21).

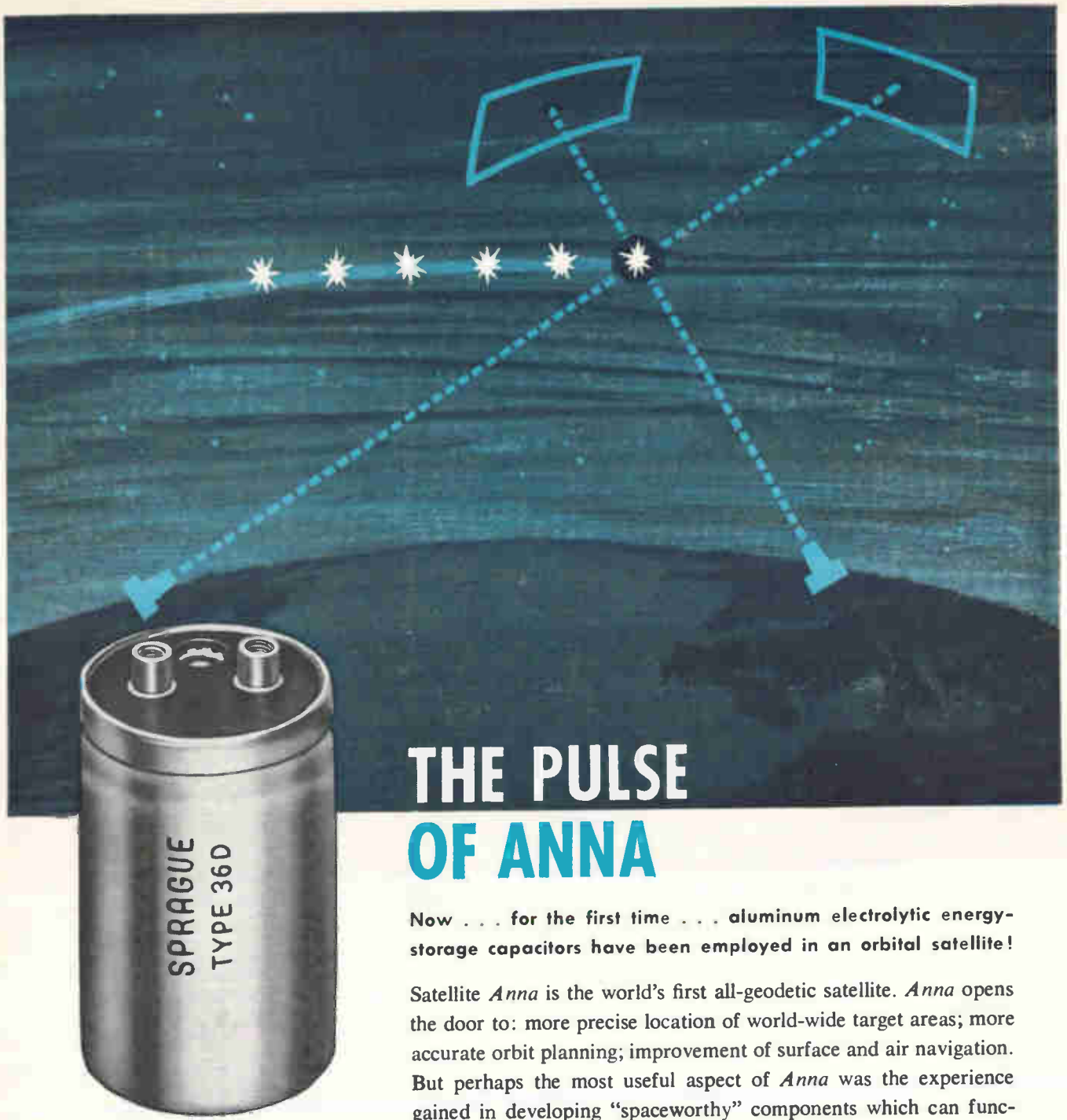
CONTROL DATA Corp. and Itek have signed an agreement under which Control Data will produce principal digital elements for Itek's Digigraphic system. Control Data will also market the device.

GENERAL DYNAMICS, North American and Douglas have each been awarded a $500,000 Air Force contract to study a new piloted space plane. AF also wants Boeing to quote schedules and costs to develop pilot control of the Dyna-Soar booster.

LEAR SIEXLER has received a contract from NASA to study a system that would sense and record the various physical functions of an astronaut and his vehicle. First step will be development of a system mounted in the pilot's garment and headgear.

HAROLD S. GENEEN, president of ITT, has flatly opposed a suggestion by General Sarnoff, RCA chairman, that all international voice and record communications facilities be merged and placed under control of Communications Satellite Corp.

RUSSIAN SATELLITE was launched October 4, 1962 and decayed October 29, NASA says. Later reports indicated that 23 other pieces of the same unannounced spacecraft decayed between then and February, 1963.



THE PULSE OF ANNA

Now . . . for the first time . . . aluminum electrolytic energy-storage capacitors have been employed in an orbital satellite!

Satellite *Anna* is the world's first all-geodetic satellite. *Anna* opens the door to: more precise location of world-wide target areas; more accurate orbit planning; improvement of surface and air navigation. But perhaps the most useful aspect of *Anna* was the experience gained in developing "spaceworthy" components which can function in the difficult launch and orbital environment.

Anna's optical beacon, developed by Edgerton, Germeshausen & Grier, Inc., flashes sequential strobe signals from satellite to ranging station. *The heart of this beacon is a bank of Sprague Type 36D Powerlytic® Capacitors.* Powerlytics were chosen for their high capacitance, their compact physical size, and their ability to withstand the stringent demands of outer space.

An electrolytic capacitor specialist will be glad to discuss the application of these capacitors to *your* projects. For application engineering assistance without obligation, write to Electrolytic Capacitor Section, Field Engineering Dept. For complete technical data, write for Engineering Bulletin 3421 to Technical Literature Service, Sprague Electric Company, 35 Marshall St., North Adams, Mass.

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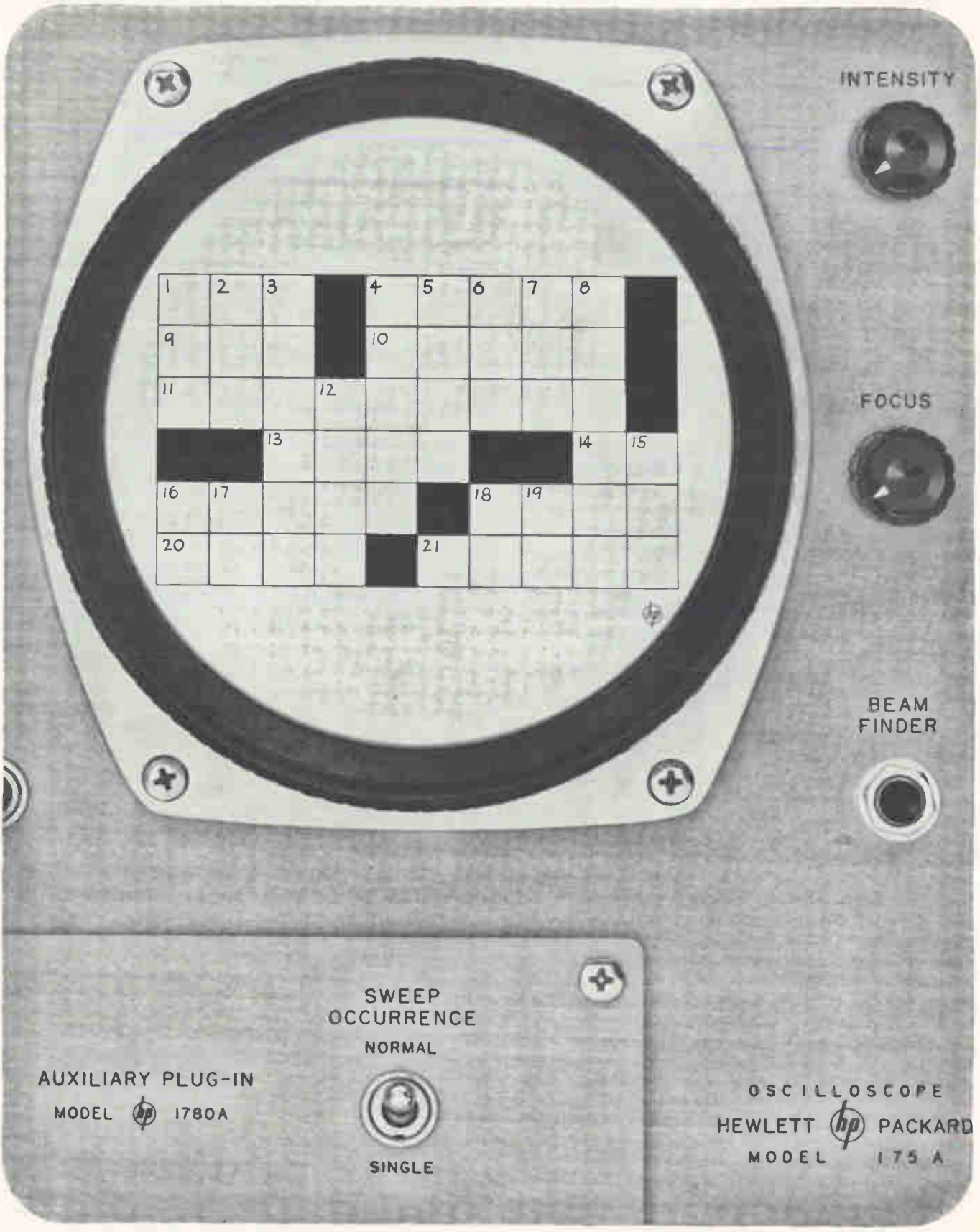
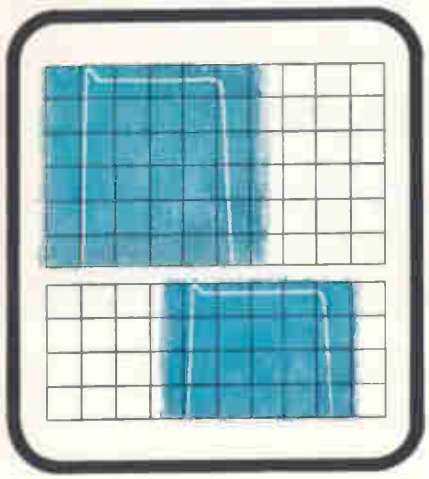
How much do you know about today's high-frequency scopes?



6 down, 10 across

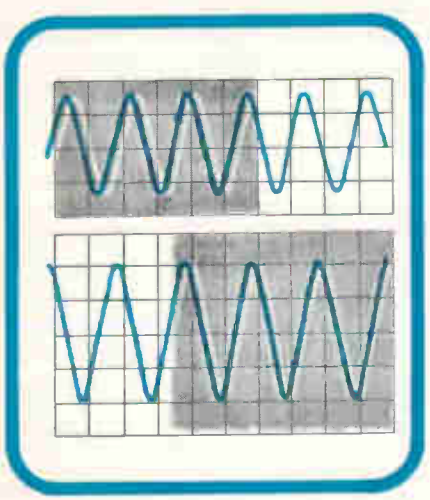
6 down, 10 across . . . solution:
Divide a 12-volt pulse by 6 cm. Now divide the same pulse by 4 cm.



Puzzle: Estimate the amplitude of the overshoot. Two answers, please . . . one for each graticule.

There's the significance of a 6x10 cm crt — obviously more accurate, easier to read with greater precision, easier, on the 175A, to measure pulses with rise times to 7 nanoseconds.

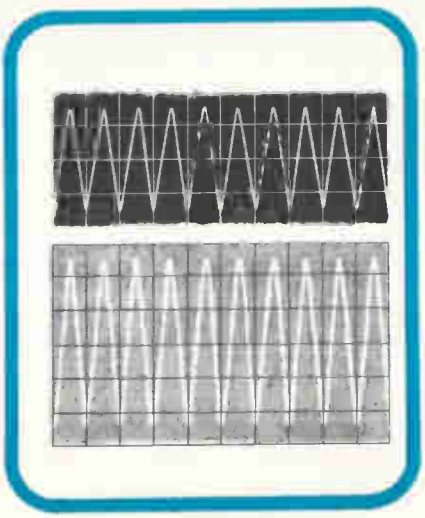
Whether you measure high frequency signals yourself or merely depend on measurements made by someone else, do you know the significance of parallax error? Here is parallax error (top) as contrasted with a no-parallax crt. (bottom):



Camera or eye can be as much as 5% wrong unless able to view every part of a scope trace from directly in front of the graticule line. Wide-angle viewing in conventional scopes is distorted by separation between internal trace and external graticule. With an *internal* graticule, in the same plane as the trace, parallax is non-existent. Check the 175A.

Of course you're familiar with the problems of glare. You've had to turn off overhead lights, turn your scope away from windows, use viewing hoods, dim scope pictures with filters . . . and you've still had to fight glare. If the trace were brighter, if the crt glass were non-glare, if . . . No such "ifs" with the 175A.

When you depend on scope photography, the comparison is simple: See the problems caused by black-and-white photo limitation, trace and graticule both white on black (top), especially as opposed to photo gradations, where trace, graticule and background are clearly separated (bottom). The 175A permits photos with trace, graticule and background of clearly different values:



So far, almost everyone who's looked at the picture on the crt of the hp 175A 50 MC Oscilloscope has been convinced . . . not only of the quality of the picture but also of what that quality, what special characteristics can do for him: Unprecedented accuracy, easier viewing. It concerns a 12 kv post-accelerating cathode ray tube developed by hp . . . sensitive enough to make a 6x10 cm presentation to 50 mc, equipped with an internal graticule to eliminate parallax error and permit more readable photographs, topped off with a specially etched non-glare faceplate.

Then, one step farther . . . something you may not have thought about on the crt in your present scope. The sensitivity of the 175A crt minimizes deflection defocusing, so that the conventional front-panel astigmatism control can be eliminated. No more jockeying between focus and astigmatism controls to get a legible picture. Easier to depend on others to make the important measurements for you . . . get the job done faster and more accurately.

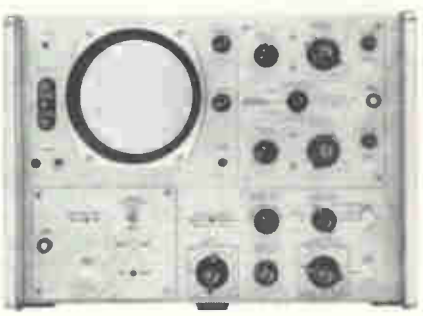
The man concerned with maintenance will be happy, too. The high sensitivity of the 175A crt eliminates the need for a complex distributed amplifier . . . and the service man knows how long it takes to adjust those, how a hairline turn of a trimming capacitor can force you to start back at the beginning . . . and how many tubes and mandatory adjustments are involved in trying to align any distributed amplifier.

We think it's a practical consideration . . . how to make the job easier, do it faster, make the results more dependable. And we didn't make the changes to be *different*. We made them to be *practical*.

Now consider these virtues: Horizontal and vertical plug-ins . . . such as dual- and four-trace and high-sensitivity vertical viewing, sweep delay and x-y recording capabilities . . . when, but not unless you need them. They're all available as plug-ins for the 175A Oscilloscope.

Positive preset syncing over the entire bandwidth, the easiest triggering and the most dependable triggering in scopedom. Plus fewer controls, easier to understand than anything you're used to. You can teach a novice to use the 175A in half the time it'll take him to learn the intricacies of other scopes.

And back to the maintenance story: The 175A uses only 7 tube types and 5 transistor types . . . none "selected." Keep a small maintenance inventory, and if you need to replace a tube, *any* tube of the type will do . . . without elaborate realignment. Add this to your comparison of basic alignment time. You'll make someone happy, yourself or your service shop.



You can't know how practical all this is until you've thought about it, item by item. You can't know how practical it is until you've given it your own critical comparison, set the 175A alongside any high-frequency scope you're using . . . fiddle with it, noodle it, try it. Until you've fiddled with the 175A you probably don't know as much as you should about high-frequency scopes. Until the 175A, we didn't either. hp 175A, $1325 (without plug-ins).

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

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1501 Page Mill Rd., Palo Alto, Calif., (415) 326-7000. Sales and service representatives in principal areas. Europe, Hewlett-Packard S.A., 54 Route des Acacias, Geneva, Switzerland; Canada, Hewlett-Packard (Canada) Ltd., 8270 Mayrand St., Montreal, Quebec.

WASHINGTON THIS WEEK

EXPERIENCE—NOT A BETTER PROPOSAL—WINS CONTRACT

CHANGING GROUNDRULES in military procurement were again spotlighted by the Senate inquiry into the X-22 VTOL plane contract award (ELECTRONICS, p 12, June 21). Though a Navy source selection board picked Douglas Aircraft, Bell Aerospace got the contract because of "past performance and relevant experience." Bell is experienced in vertical lift research, Douglas has not been active in the field.

Harold Brown, director of defense research and engineering, shed some light on the latest Pentagon view of contract proposals. Asked by Senator Goldwater why Bell's design proposal had been rated lower, Brown said the connection between a proposal and a contractor's capabilities is often "loose." This comment reflects growing DOD concern that too much industry resources and brainpower are going into salesmanship—the effort to get new contracts—rather than into actual development work.

As for the "relevant experience" emphasis in new contract awards, observers see serious deficiencies. The argument against this is that it would maintain the dominance of experienced companies and tend to discourage other firms from expanding into new fields of military technology.

BYKOVSKY AND TERESHKOVA—HAPPY LANDING FOR NASA, TOO

LIKE THE CAVALRY, the Soviet space twins arrived in the nick of time for NASA. U.S. space officials had $500 million and a year's free rein riding on the male and female nose cones. The feat put an exclamation point on NASA's contention that its $5.7-billion budget request is a bare minimum to keep the U. S. in the space race.

House budget watchers had determined on a 10-percent slash, were increasingly critical of the $50-million electronics lab assigned to Massachusetts. The Senate has NASA's free-wheeling methods under fire.

Congress has now moved from carping at the growing cost of the moon race to less-cutting issues. House members are taking exception to the personal frictions which led to the resignation of D. Brainerd Holmes (he gives other reasons, see ELECTRONICS, p 22, June 21). The Senate complains it wasn't consulted on minor program changes.

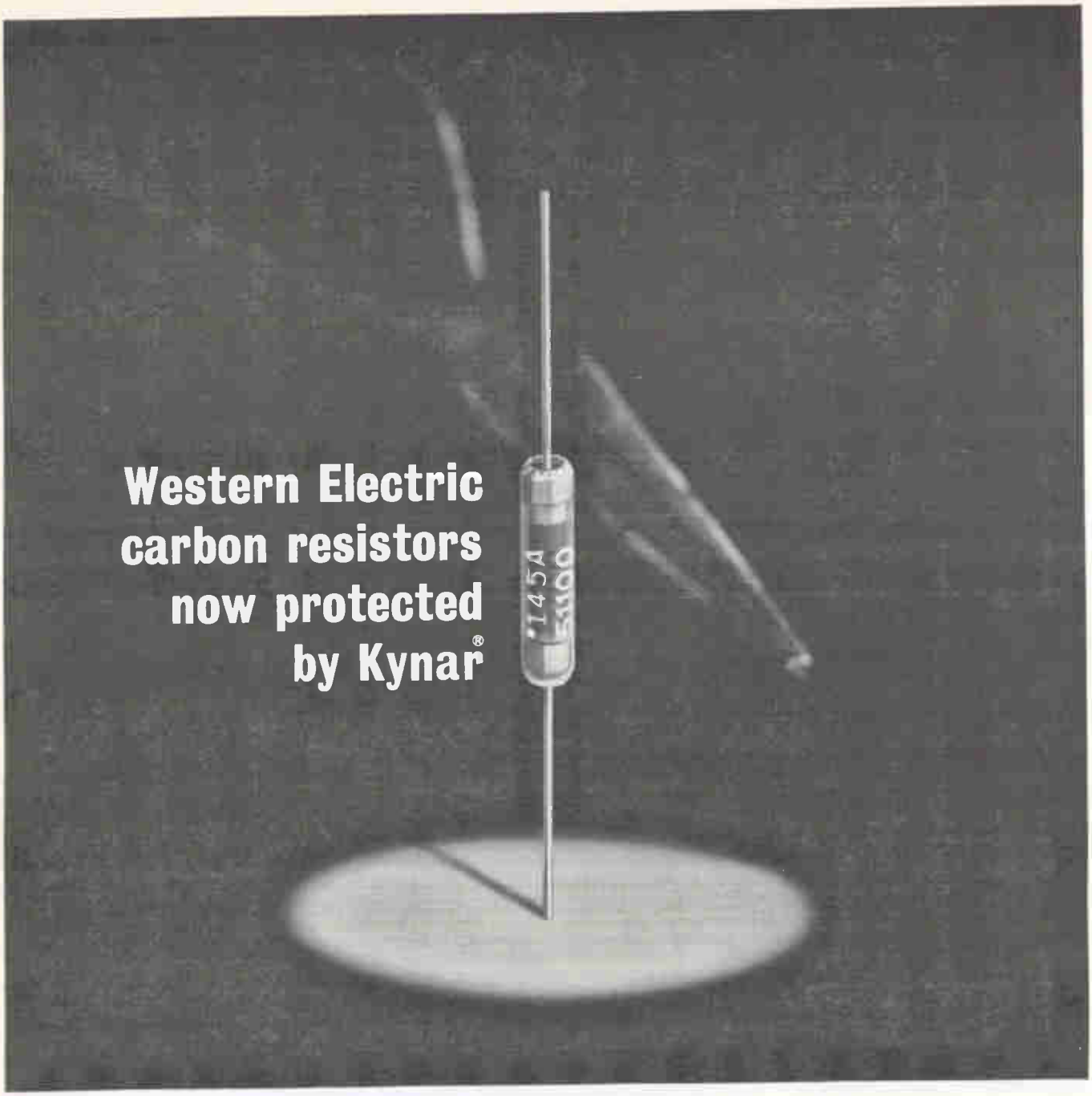
Still in trouble, though, is a $55-million item for space communications research. Clinton P. Anderson, Senate Space Committee chairman says the work should be done by the Communications Satellite Corp. NASA says most of the money—$40 million—is for the Syncom satellite, a research project, not a "working system" like Telstar.

BAMBI'S DEAD, MIDAS IS ILL

HOUSE HEARINGS on the defense budget, just released, confirm that the Defense Department has halted feasibility studies on the Bambi satellite-based anti-ICBM system (ELECTRONICS, p 26, May 3) and has sharply reduced work on the Midas early-warning satellite (p 7, May 31).

Jack Ruina, outgoing ARPA director, said to implement a Bambi system would cost $50 billion a year and require major advances in reliability, interceptor accuracy, discrimination of target signals from sunlit clouds and target assignment control. Bambi was to detect and intercept ICBM's during their launch phase.

Harold Brown said that about half the $423 million spent on Midas development was "wasted on premature system-oriented hardware." On his recommendation, Air Force's $190-million budget proposal was slashed 80 percent and the Midas project will move along more slowly next year.



Latest refinement in carbon film resistors made by Western Electric is a sleeve of Kynar,* Pennsalt vinylidene fluoride resin. Western Electric produces 30 million resistors of this type yearly for ANI (Automatic Number Identification) equipment.

Western Electric engineers selected Kynar for two principal reasons—strength and stability. Kynar won't melt, drip or burn, under the most severe overloads. Its superior stability assures freedom from degradation due to aging or environmental conditions. Kynar is completely compatible with high-speed production. Extruded tubing feeds readily through forming equipment, cuts cleanly, heat-forms easily, takes marking inks.

Kynar offers a unique combination of electrical strength, mechanical toughness and stability. If you have a problem where you need extra performance, write or call us for data. Plastics Dept., PENNSALT CHEMICALS CORPORATION, 3 Penn Center, Philadelphia 2, Pa.

Kynar...a fluoroplastic that's tough!

Pennsalt Chemicals

*Kynar is a Registered Trademark of Pennsalt Chemicals Corp.

3 New G-E Vidicons

High sensitivity, low lag, and more uniform photoconductive surfaces give broadcast-quality pictures in *any* television pickup function. New "Snow White" manufacturing facilities assure uniformity.

The GL-7038 vidicon is designed for televising live scenes and film pickup applications. Highly uniform photoconductive surface provides a uniform, high-quality picture across the scanned area. The GL-7038 will replace the 6198 and 6198A vidicons. Over-all length: 6¼".

The GL-7325's high sensitivity is ideal for televising live scenes, at lower light levels. The photoconductive surface provides low lag (20-30%) at these light levels. Over-all length: 6¼".

The GL-7226 is designed for transistorized camera chains. Featuring a low heater power cathode which operates at 90 ma, performance characteristics of the tube are the same as the GL-7325. Over-all length: 5⅛".

For specifications and data on the complete line of G-E vidicons and image orthicons, write to: General Electric Company, Room 8006A, Owensboro, Kentucky, or call your nearest G-E Industrial Tube Distributor, today!

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Launching ships is an old story in Baltimore, which has built them by the thousands. The busy shipyards here are still building them, too. But another kind of launching preoccupies many Baltimore-area plants today . . . with electronics for guidance systems, chemicals for propulsion, hardware for the space vehicles themselves. Space-age research and development, engineering and production are expedited by ideal sites, a profusion of specialized labor skills, major colleges and universities, proximity to NASA headquarters and Washington, D.C.

Added to these, in Baltimore and its neighboring counties, is fast, flexible transportation . . . by air, land and sea. Stable economy, too. When you want to think big, think BALTIMORE.

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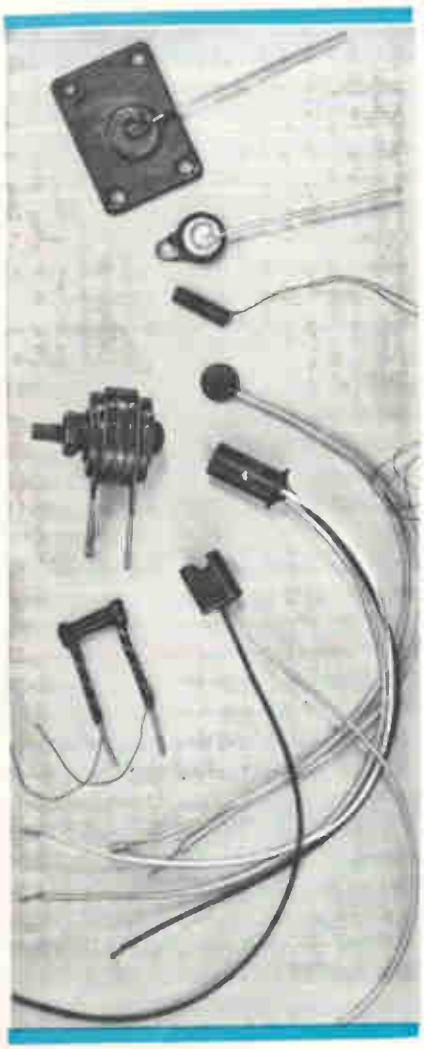
NEWS

Thermistors?—Nobody makes a wider variety than Carborundum.



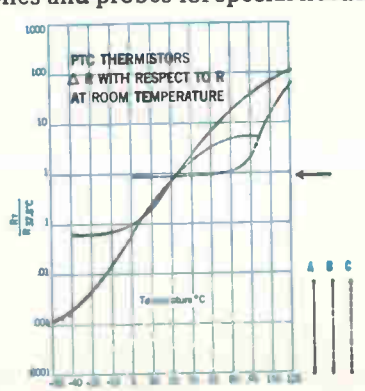
Carborundum is turning out thermistors in varieties undreamed of a short time ago—from sub miniature discs to complete assemblies.

Special assemblies can be manufactured to fit chassis and operating requirements. You can specify your electrical and dimensional needs and we'll design the assemblies to meet them. They meet precise tolerances for temperature coefficient, dissipation constant and resistance at reference temperature. Can be potted in epoxy. Provide long-term stability.

Discs and washers are available in sizes from 1/10" to 1" in diameter. We supply them soldered to mounting plates or with special terminals to solve assembly problems. They're made of high-stability compositions. Beta values range from 2700 to 4800.

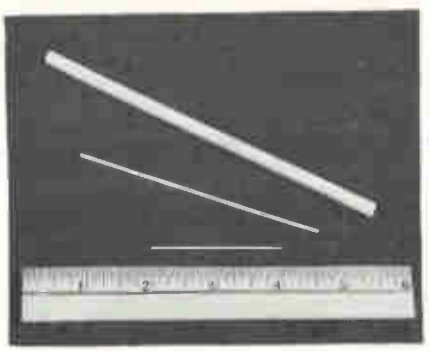
Rods can be purchased from Carborundum in the widest range of body sizes and temperature coefficients available to industry—in lengths from 1/4" to 12" and diameters from .05" to 1". Beta values from 1100 to 4600.

PTC Thermistors are new, positive-temperature-coefficient units with high sensitivity. Sensitivities as high as 12 percent per °C can be achieved. Use PTC's in combination with NTC's (negative coefficient units) and with linear resistors to construct an astonishing variety of temperature compensation curves for your circuits. We also manufacture PTC assemblies and probes for special needs.



The graph shows resistance of three different PTC thermistors over a range of temperatures as a multiple of resistance at room temperature.

For more information on this complete thermistor line, write to: Electronics Division, Globar Plant, Dept. ED-6T, Niagara Falls, N. Y.



Magnesium oxide crushable preforms now in longer lengths

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Washington and Moscow agree on duplex

HOT LINE: For

By ALEXANDER A. McKENZIE
Associate Editor

WARREN KORNBERG
McGraw-Hill World News

WASHINGTON — Radio Moscow simply said, "This line is to be used in case of emergency." And a U.S. spokesman added, "We hope it never gets used."

Both were talking about the hot line—a constantly open link between the two nuclear capitals. The agreement signed in Geneva last week is the first concrete result of the disarmament talks there.

The accord, signed by Charles C. Stelle, for the U.S., and Semyon K. Tsarapkin, of the USSR, calls for a full-time duplex teleprinter cable circuit between Washington and Moscow backed up by a radio circuit. Brig. Gen. George P. Sampson, deputy director of the Defense Department's Defense Communications System, handled technical details with Ivan Kokov, Soviet Deputy Minister of Communications.

Washington terminal of the line will be the National Military Command Center in the Joint Chiefs of Staff area of the Pentagon. From Pentagon to President existing techniques will be used, depending upon where the chief executive is located. Telephone will not be used. The Moscow terminal has not been announced but the Soviet end of the circuit would probably be handled through the Ministry of Posts and Telegraphs.

NO SATELLITES—Standard communications procedures can still be glamorous in an age of communications satellites, as is pointed up by details in the agreement's technical annex. Although much of the hot line's significance is political, symbolizing a mutual concern for accidental military action, the 24-hour operation of the line must be foolproof. So, engineers batted down exotic recommendations and are sticking to circuits that are already available or in daily operation.

WHAT COMPANIES?—Routes for the cable circuit are spelled out as Washington, London, Copenhagen, Stockholm, Helsinki, Moscow, and circuits over these routes do exist. What companies will be involved was not officially revealed at press time.

Long Lines officials of AT&T, for example, indicate that they are in the overseas telephone business, but that channels in their cables leased to others could be put to any use without their knowledge. Ruling out AT&T as an active participant, those companies remaining who use identical New York-London facilities are Western Union, American Cable and Radio, and RCA Communications. Western Union spokesmen denied knowing the choice, but communications people feel Western Union will get the nod.

Existing circuits from London to Moscow via Helsinki are identical for all services and it is expected that those of the Finnish-operated Great Northern Telegraph Co. will complete the loop.

Space Area Code Sorts

CAPE CANAVERAL—When the Tiros 7 weather satellite went up last week to joint its long-lived brother, Tiros 6, it made the sky a bit crowded. NASA asked RCA to build Tiros 6 for a 3½-month mission requirement, but it is still transmitting after 9½ months.

Both satellites use the same command frequency. The problem of a mixup in transmission, however, is being solved by command discrimination gear—something like the area code in telephony. With telemetry frequencies becoming overworked, this technique will probably become a much more common practice.

The launch marked approximately the mid-point in the Tiros program. The next move, starting with Tiros 8, will be the use of Apt (Automatic Picture Transmission Cameras) and the use of numerous ground stations to receive televised weather pictures. Apt transmits in real time.

Some 45 Apt stations, each costing $30,000, will be operating around the world when Tiros 8 goes up this fall. They are being bought by NASA, the Weather Bureau, the military, and other agencies and will later be offered to foreign countries.

Apt stations, built by Fairchild Stratos, consist of a 12-db gain antenna that can cover 35 degrees while stationary, and 136-Mc and facsimile receivers.

Tiros 9 will have two cameras, one an Apt, rotating on a wheel-type configuration to take alternate

COMPONENTS *of a Tiros are displayed at RCA plant*

teleprinter for emergency use

Cool Nuclear Decisions

Official announcement specifies a duplex radiotelegraph circuit via Tangier. RCA Communications has such a circuit in full-time operation serving both Tass, the Soviet news agency and the Soviet delegation to the United Nations.

In good position to furnish the backup circuit is RCA Communications.

LANGUAGE AND SECRECY — The language barrier will be partially overcome by having the Soviet Union send its messages in Russian and the U. S. in English. Sets of teleprinter equipment will be exchanged for installation at the far end of each circuit. Another sticky problem, that of not washing one's diplomatic linen on a public circuit, has apparently been solved by agreement of the U. S. to sell the Soviets four encrypting machines that use what is known as a one-time tape. The code is used once and then the tape is destroyed. The Russians will send us tapes showing which of our coding arrangements they are going to use, we slip these on our decoders and the Washington machine then spells out straight Russian text. We'll furnish decoding tapes to the Russians. Deadline goal for the hookup is 60 days.

Commands for Satellites

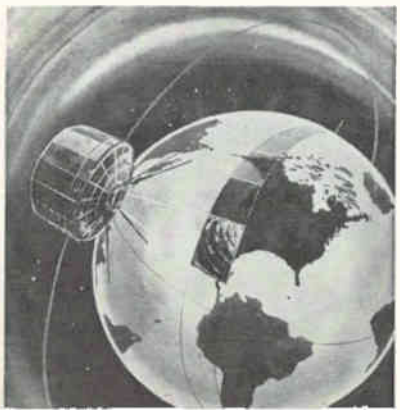
pictures (ELECTRONICS, p 7, May 31). Tiros 10 and 11 will provide information on possible synchronous-orbit weather satellites. Number 12 will go back to the wheel configuration and have an Apt and a picture-storing recorded. The last three will be regular types. They'll be used if earlier R&D types fail.

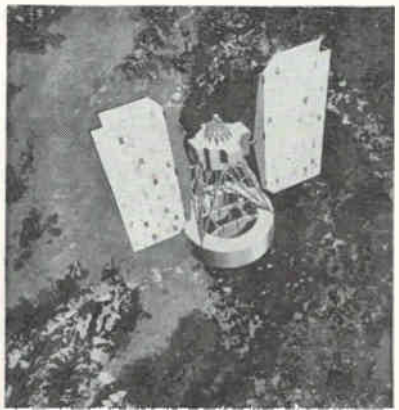
Then the Nimbus series of satellites will begin. Nimbus will not replace Tiros. Tiros is more flexible and will continue to be used to supplement the Nimbus program. Chief feature of Nimbus is that it will take larger-area pictures and continually look at earth.

One of the Nimbus development problems is that the organic bonding materials used in the lenses are fogged by radiation. The satellite will have to pass through the artificial radiation belts.

A Nimbus-type infrared recorder is being carried by Tiros 7, the first Tiros to make infrared measurements in space.

NEXT CONFIGURATION *for Tiros is a wheel, so cameras alternate in taking and transmitting pictures. Nimbus follow-on is sketched at right*





NEW MODEL 430A POWER SUPPLY

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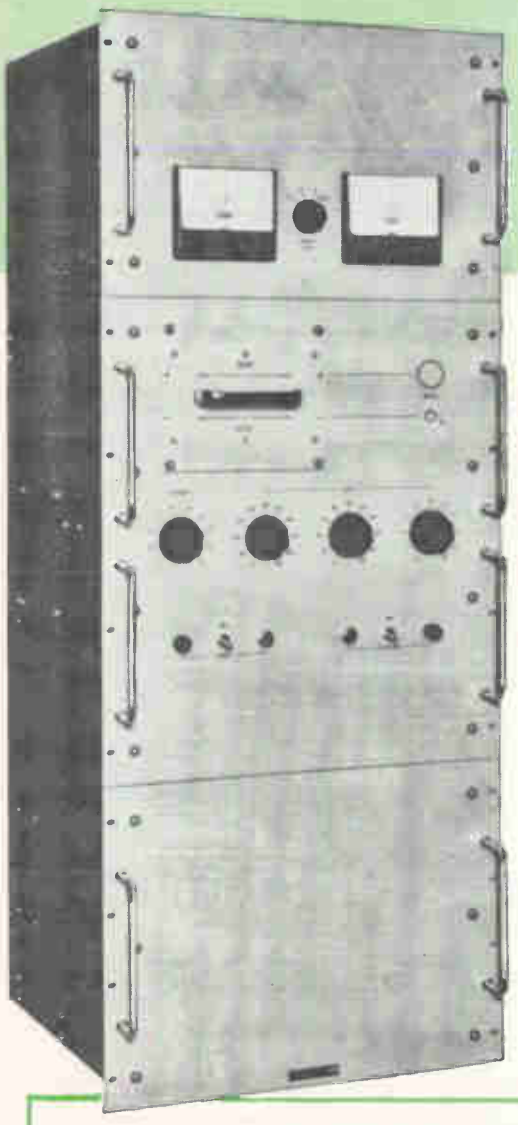

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Stability, 0.005%
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Acceleration and focusing in high resolution cathode ray tubes
Calibration of electrostatic voltmeters and high voltage dividers
Pressurized ionization chamber experimentation
High voltage research
Charging high voltage capacitor banks

Model 430A delivers calibrated DC from 10 kilovolts through 30.22 kilovolts, with an output current capability from 0 to 10 milliamperes. The supply may be operated with either a positive or negative output, with one side always grounded to the chassis. Polarity is easily changed by reversing a front panel polarity plug, which is interlocked for safety.

No oil-filled tanks and associated heaters and thermostats are used. The sampling string features stress-free encapsulation, reed relay switching and 100 millivolt resolution at any output voltage.

The high voltage output is developed from a conventional 50-60 cycle voltage doubler, free of interference associated with RF type supplies. Approximately 60 seconds after line power is switched on, the high voltage circuitry is armed, and the 430A is ready for use.

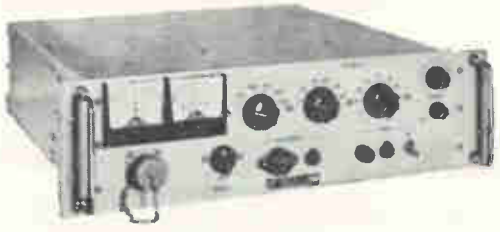
BRIEF SPECIFICATIONS

	MODEL 430A	MODELS 413C, 413D
OUTPUT VOLTAGE	10 KV-30.22 KV	0-3111 VDC
OUTPUT CURRENT	0-10 ma	0-20 ma
LINE REGULATION, for 10% line change	0.005%	0.001% + 1 mv
LOAD REGULATION, for full load change	0.01%	0.001% + 2 mv
STABILITY		
Per hour	±0.005%	±0.005%
Per day after warmup	±0.03%	±0.03%
RESOLUTION, full range	100 mv	2 mv
RIPPLE	5 mv RMS	150 uv RMS
CALIBRATION ACCURACY	±0.25%	±0.25%
SIZE	48" high x 19" wide x 18" deep	19" wide x 5¼" high x 16" deep
WEIGHT	260 lbs.	50 lbs.
PRICE	$3900.00	$695.00—413C $595.00—413D

Models 430A, 413C and 413D may be used over a wide range of environmental conditions

OPERATING TEMPERATURE RANGE	0°C to 50°C
TEMPERATURE COEFFICIENT, 10°C to 40°C	±0.002%/°C
STORAGE TEMPERATURE RANGE	—20°C to +60°C
HUMIDITY	0 to 80%
ALTITUDE	0 to 10,000 feet

Other new Fluke power supplies:



MODEL 413C, shown above, offers 0-3111 VDC; ±0.001% line and load regulation; front panel polarity switch; virtually complete absence of noise; low ripple; no voltage overshoot, and high resistance to mechanical shock and vibration. Same specifications apply to Model 413D (with front panel polarity plug; without meters).

Before specifying any type of power supply, check the full range of Fluke models. Write for new Catalog Digest 3-63 showing complete line of Fluke test and measurement instruments, or ask your Fluke sales representative for complete technical data or demonstration.

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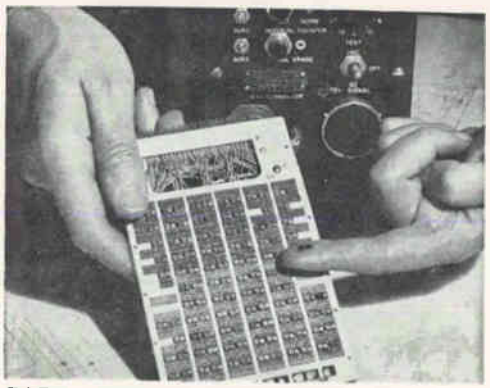


CARD HOLDS *silicon microcircuits for receiver unit*

ENGINEER *Robert Hudelson points out readout display on mockup of ARN-76 control indicator. Below are antenna coupler and receiver, at left is Sperry's operational airborne Loran-C receiver weighing more than 100 pounds*

Reliability and accuracy are increased in new 19-pound receiver

Microelectronic Loran-C Will Fly Next Year

AIRBORNE Loran-C receiver using digital microcircuits will be flight-tested early next year. The 19-pound AN/ARN-76 receiver is expected to provide position fixes accurate to within a few hundred feet almost anywhere over the Northern Hemisphere.

Sperry Gyroscope Co. is developing the receiver with support from the Navy Bureau of Weapons. Containing more than 25,000 components and occupying 0.47 cubic foot, it is one of the first complete electronic subsystems designed specifically for microcircuits.

INTEGRATED CIRCUITS — The package is made up of an antenna coupler, receiver and control indicator. Ninety-five percent of the receiver circuits are silicon integrated circuits while the remainder (r-f amplifier, power supply and magnetostrictive delay line) are cordwood.

Sperry expects the digital ARN-76 to be an airborne replacement for bulkier analog Loran-C receivers in use on ships and planes since 1958. The ARN-76 will be one-fifth the size and weight.

Receiver reliability is being hiked by using only five different types of microcircuits, and eliminating gears, motors, fans, and synchros, Sperry says. First tests of the microcircuits have shown that receiver mtbf will be more than 1,500 hours.

The five basic circuits are flip-flops, NAND gates, AND gates, dual AND gates and dual NAND gates. They can handle 1-Mc clock rates and are mounted in banks of 100 or more on postcard-size plug-in cards.

APPLICATIONS — ARN-76 has been in development for over a year and is intended for use where size, weight, operational simplicity and minimum power consumption are critical considerations. Range is 2,500 miles. Where existing receivers have a fix accuracy of 1,000 ft at 1,000 miles from the nearest transmitter, ARN-76 has an accuracy of 600 ft (0.1 μsec).

In contrast to previous systems the 2.4-pound control indicator is the only component that has to be in the cockpit—remainder of the equipment can be located up to 100 feet away, permitting installation in small single-seat aircraft. Operator controls have been reduced from 29 to 5; operators can be trained in 15 minutes. A simplified time-difference display provides quick numerical readout in in-line decimal form. Fully automatic search of less than one-minute duration under signal-to-noise conditions of 1:1 or better is provided. Automatic receiver operation can be maintained under s/n of 1/10, and also with c-w interference up to 35 db greater than the received Loran-C signal.

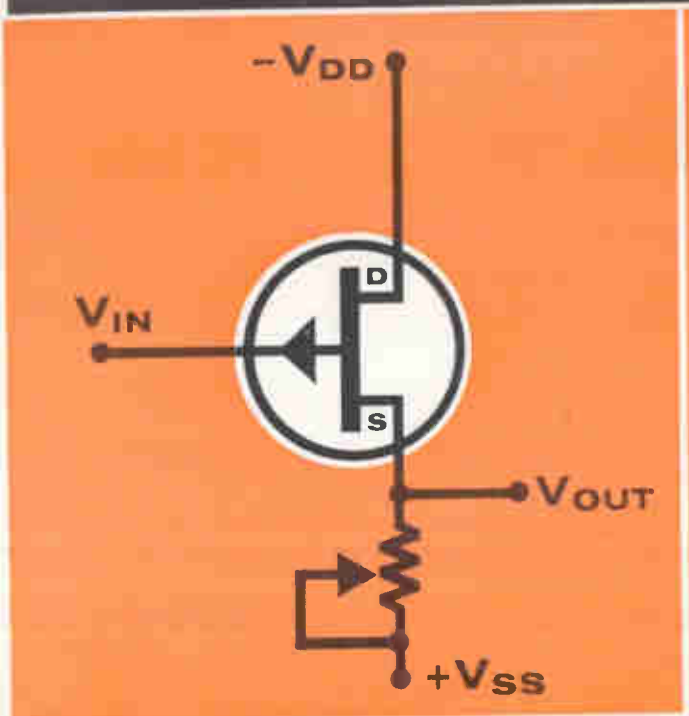
Other specs are: receiver sensitivity, nominal signal level 5μv at antenna; agc and gain balance range, 132 db; antenna, effective height less than 15 inches and capacitance of 100 pf minimum; input power, 155 watts.

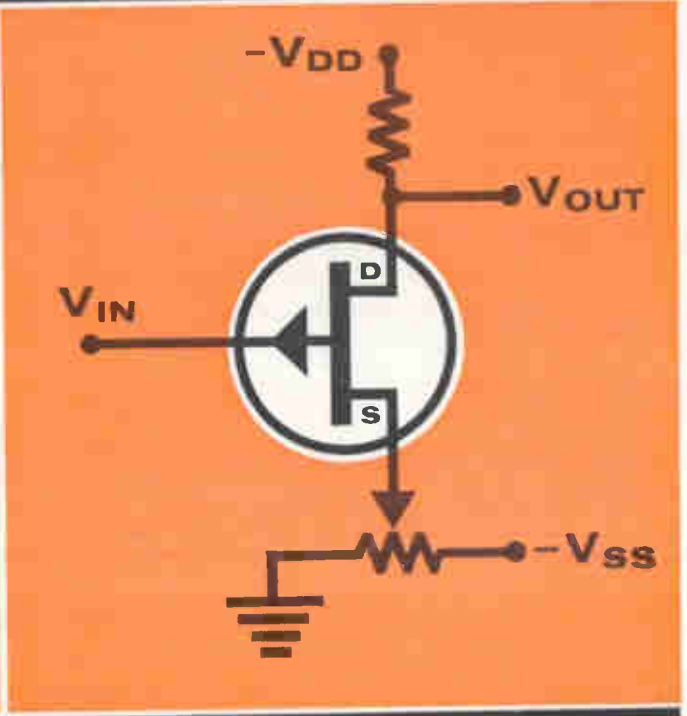
Designed by Sperry several years ago as a world-wide radio navigation system, Loran-C now covers the sea-land areas of the North Atlantic, North Pacific and Arctic Oceans and Bering and Mediterranean Seas.

Position fixes are calculated with the aid of the receiver which measures the time interval between the arrival of 100-Kc pulses broadcast from chains of strategically-located transmitters. Matching these measurements to special Loran map coordinates, the navigator then pinpoints his position.

The ARN-76 is expected to be used in long-range patrol aircraft, photo reconnaissance, counter-insurgence aircraft and antisubmarine warfare. Research is underway to evaluate its capability for tracking missiles and satellites. Sperry is also working on a microcircuit shipboard unit.

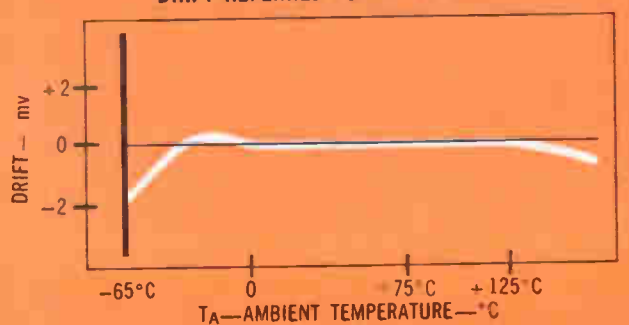
How to put Siliconix UNIFETs* to work . . .



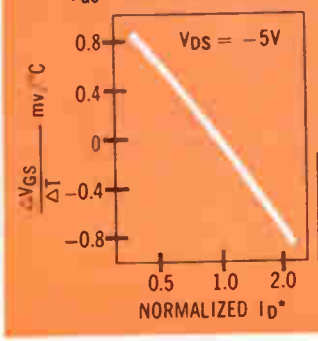


DRIFT – LESS THAN 1 mv/100°C

DRIFT REFERRED TO THE INPUT



VGS TEMPERATURE COEFFICIENT vs NORMALIZED ID



Typical Values of I_D and g_m for zero temperature coefficient of V_{GS}.

	I_D (μa)	g_m (μmho)		I_D (μa)	g_m (μmho)
2N2606	10.5	40	2N2841	14.0	50
2N2607	30.0	120	2N2842	40.0	140
2N2608	95.0	370	2N2843	125	450
2N2609	300	1100	2N2844	400	1300

*Multiply scale by typical I_D above

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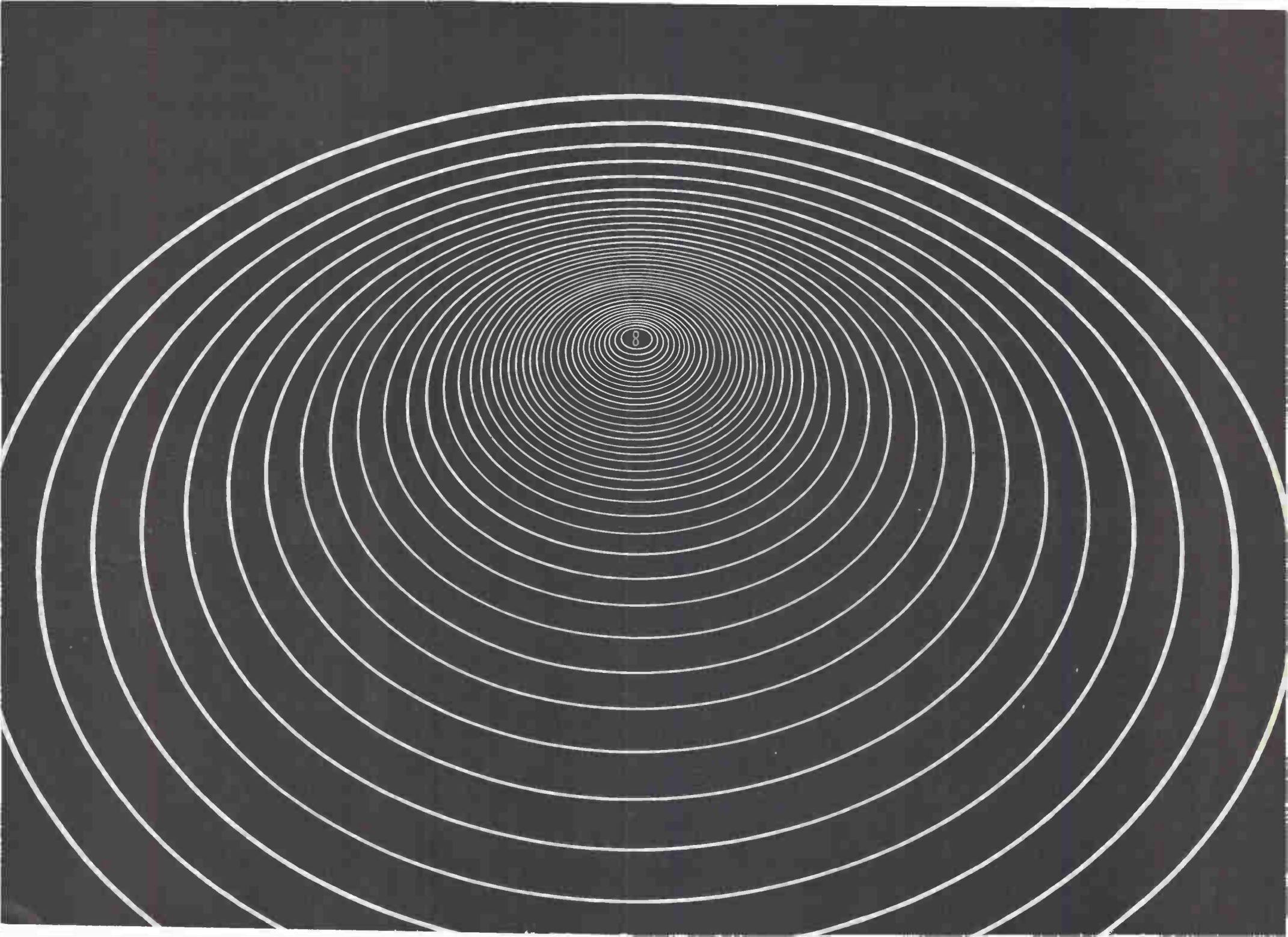

SCIENTISTS AND ENGINEERS:

From undersea navigation equipment for test on the research vessel Trieste to the development of non-inertial systems for deep space rendezvous, Motorola performance spans the broad spectrum of environments in advanced systems. In the area between, current programs include: advanced random access communications and side looking radar surveillance systems for the Army... air-to-air missile guidance and digital command systems for the Navy... data transfer and high speed teleprinting systems for the Air Force... satellite tracking, telemetry and instrumentation for NASA... and extensive company funded R&D projects. Scientists and engineers interested in joining an electronics company with versatile interests unbounded by narrow specialization write today describing your background and training in:

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92-deg rectangular tube

By CLETUS M. WILEY
Midwest Editor

CHICAGO—Hottest news at the IEEE's Chicago Spring Conference on Broadcast and Television Receivers last week was the extra-curricular leak of Motorola's plans for introducing the 23-inch rectangular, 92-degree color tube, under development for the past two years.

An RCA representative commented "that 92-degree deflection will be a neat trick, if they can manage it."

Admiral board chairman Ross Siragusa provoked chuckles as he welcomed others to enter the color field where "profit margins offset lower averages from portable B & W sets." Just last month Siragusa's company cut the price of its basic color model to $399.95.

COLOR TUBE—Motorola's long-awaited color set was to be introduced to dealers in New York and Chicago this Tuesday, June 25 with [illegible] of Motorola's color introductions use the newly developed rectangular tube, allowing sets to be nearly six inches shorter than other color models. Three use RCA's 21-in. round, 70-deg tube.

Price of the rectangular tube models starts with a $650 consolette, round-tube sets at $450.

Advances in technology over past two years—while company's investment increased from more than $100,000 to $4 million—has mainly been in refining tolerances, assuring reproducibility and tooling up for production with supplier, National Video Company, tv engineer Garth Heisig told ELECTRONICS.

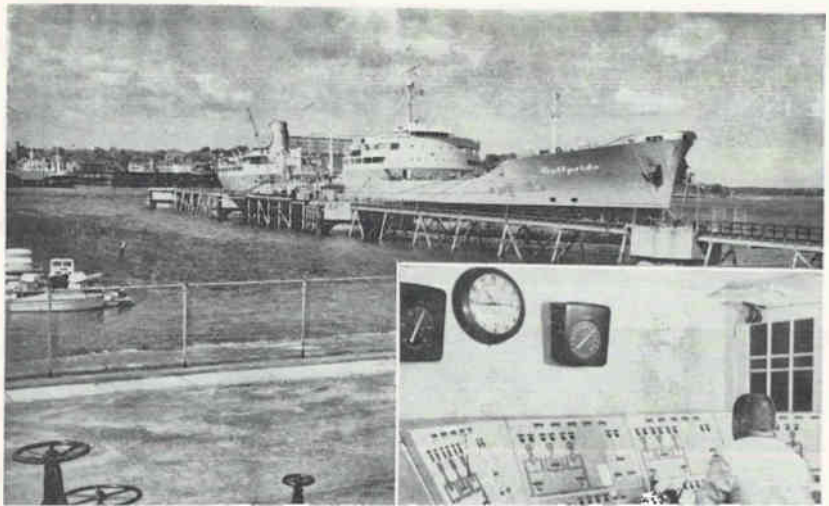
New rectangular tube still starts with a basic black-and-white type shell. Special deflection coils have been developed with Advance-Ross, Burlington, Iowa, to fit the smaller 1⅛-inch neck of this tube. Convergence circuits have been adapted for smaller color guns. A "dynamic pincushion" circuit straightens arcs at edges of the raster and a precision lens has been developed for the "lighthouse" which controls dealers in August, with "some sort of rationing appearing inevitable."

Company says it has not even started to think of making its new tube available to other firms.

TRANSISTOR TV—Cost crossover will make silicon transistors for consumer applications within the next couple of years, predicted L. A. Weldon, of Philco. Non-hermetic passivated packaging will help lower costs and will be adequate for consumer applications.

Transistor tv will never achieve large, efficient volumes until both price and performance compare with existing tube receivers, reported R. A. Santilli, of RCA. San-

Oiling Montreal the Easy Way



Wireless Mikes

EFFECTIVE JULY 1, the Federal Communications Commission is relaxing Part 15 of its Rules and Regulations, to let wireless microphones operate anywhere in the 88 to 108-Mc f-m band. By the same action, the band is also opened up to telemetering.

No licenses will be required, but manufacturers will have to have their equipment type-approved. The microphone or telemetering signal must stay within a 200-Kc band. Power will be limited to a field strength of 50 μv/meter at 50 feet. Custom-built devices for experimental use by educational institutions need not be type-approved, but the nearest FCC field office must be notified and the user must certify compliance with technical regulations.

Since there are plenty of inexpensive f-m broadcast receivers, the new service can be expected to prove popular with the public.

tilli and C. F. Wheatley cited circuitry from a 19-inch 114-degree line-operated all-transistor tv to illustrate development of two families of low-cost transistors. These included a germanium dot diffused mesa with low feedback capacity for tuner, picture, sound and i-f amplifiers, and a high-voltage diffused-collector graded-base power transistor for horizontal driver and vertical and audio output.

Glen Snyder, of GE, introduced a high-production flat-sided epoxy-housed silicon transistor for a-m radio and audio. It is designed to meet germanium competition.

R. L. Osborn, of Oak Mfg. Co., introduced a 4.14-cu-in. uhf tuner designed to keep pace with tv receiver evolution toward even more compact sizes. A stamped circular inductance ring whose tapering radial width provides straight-line frequency tuning is a central feature of the design.

Get F-M Band

posal, but will sit back to see what interference develops. They are happy that at least two-way conversations are forbidden and say maybe it won't be as bad as the Citizen's Band (at last count, 430,-124 CB authorizations were issued, not counting limited-power kid-CB sets).

Because of the capture effect, whereby the desired, stronger, signal takes complete control of an f-m receiver, it is expected that a minimum of mutual interference will occur between the new service—with its weak signal—and f-m broadcasting. If there is trouble, the wireless mike must go off the air.

MARKETS—Potential users include clergymen, public speakers, nightclub entertainers and others who must talk or sing and move about unrestricted by wires. Telemetering devices should get a play from both industry and professions like medicine.

Besides an f-m receiver, the user will need a transmitter. Since technical requirements are lower than for existing wireless microphones, it is expected that tiny, battery-powered microphone-transmitters can be made cheaply.

For Command & Control: Paper Prototypes Next

Future systems will be designed with Adam, a new programming concept

AIR FORCE command and control (C&C) systems will be designed more quickly in the future. They will cost less. And they will be capable of changing themselves as they operate, in response to any new user need that might emerge.

Responsible for this progress is an Advanced Data Management system called Adam, devised by the Mitre Corp. at Bedford, Mass. Using a 7030 Stretch computer, one computer program will serve as the experimental prototype system for future C&C L systems. In the past, each new L system required its own prototype.

The 7030 and its auxiliary equipment will be installed in the new System Design Laboratory (SDL) at Hanscom Field, the Air Force Systems Command's Electronic Systems Division. It will be operational by December.

An early version of Adam, developed in conjunction with Mitre's 473L Experimental Air Transport Planning Model, has already proved its usefulness by permitting Mitre to go into experimental operation of its 481L Paccs (Post-Attack Command and Control System) development with the same program used for the 473L model. The 481L model in Adam was in operation approximately one year earlier than a new computer program to do the same job could have been.

SYSTEM FUNCTIONS — Adam will consist of data-management functions common to almost all C&C systems plus an evolutionary capability of modifying itself while it is operating. With these capabilities it will be able to change dynamically to meet the specific requirements of many C&C experimental models.

Functions common to almost all systems include: planning, maintenance of forces, drills, alerts, force commitments, monitoring of activities, replanning and recommitment. These common command functions, in turn, can be equated to a limited set of data-management functions, including: creating and updating a collection of data, querying these data, processing messages, reporting, displaying and controlling formats. Adam generalizes these common data management functions by performing them as functions, independent of the data form or content specific to an individual system.

SYSTEM MODELS — Because Adam can modify itself, it can accept the specifications for data form and content for a particular system and operate with them, thereby modeling the system. As the specs change, additions can rapidly be made to Adam. It provides for user specification of input and output data formats, reports and displays, for changes in message processing, and for inserting computer routines for calculations or processing specific to a particular system being modeled.

The design of Adam comprises data-structures, a pseudo-program technique, operator language, and dynamic computer-storage allocation.

Adam will be used for experimental modeling and design of C&C systems at Mitre. Design proposals and decisions for a system, rapidly inserted into Adam long before the system acquisition has begun, can be verified, changed and restudied under experimental operation. Adam will also be used to study Adam techniques for application to operational systems.

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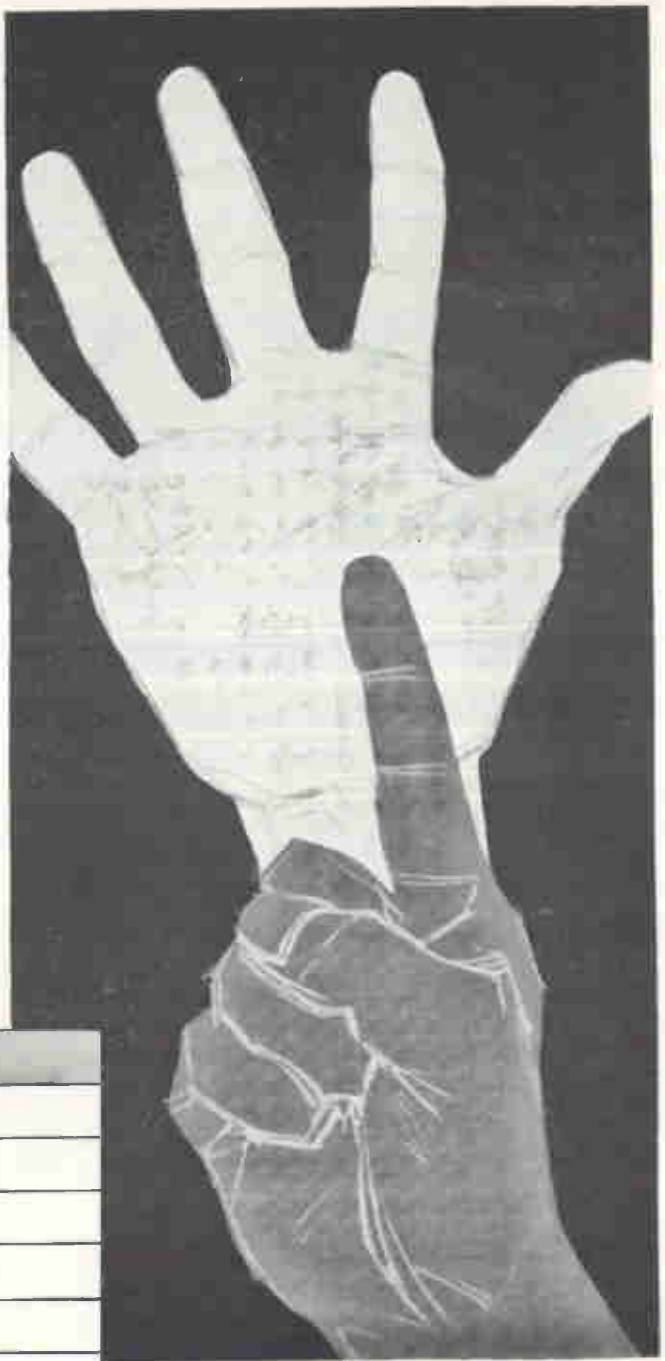

NO. 1	64.2%
NO. 2	11.7%
NO. 3	7.7%
NO. 4	4.6%
NO. 5	2.2%
NO. 6	1.9%
20 OTHER MAKES	7.7%

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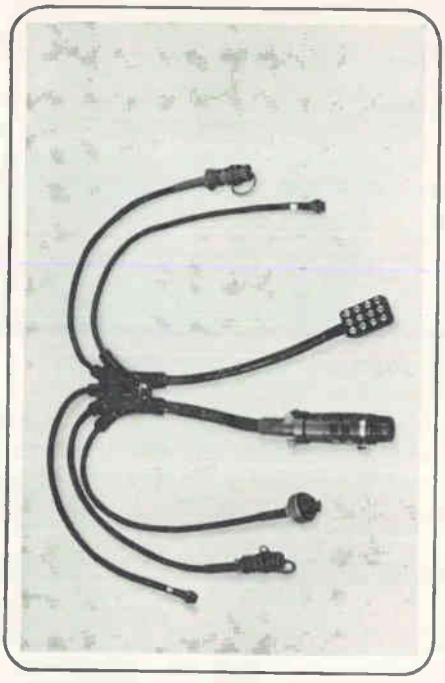

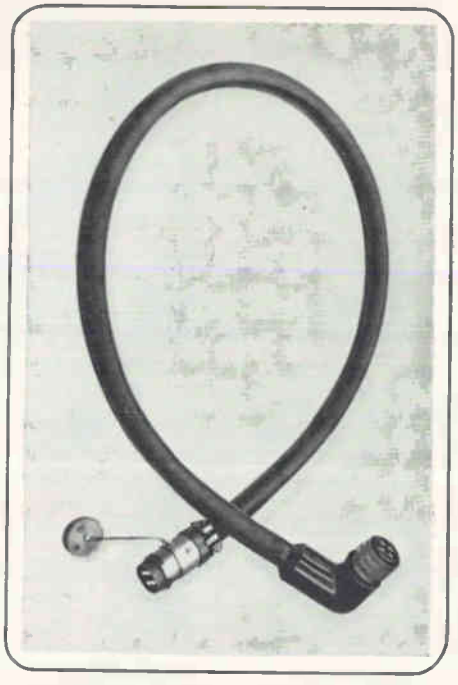

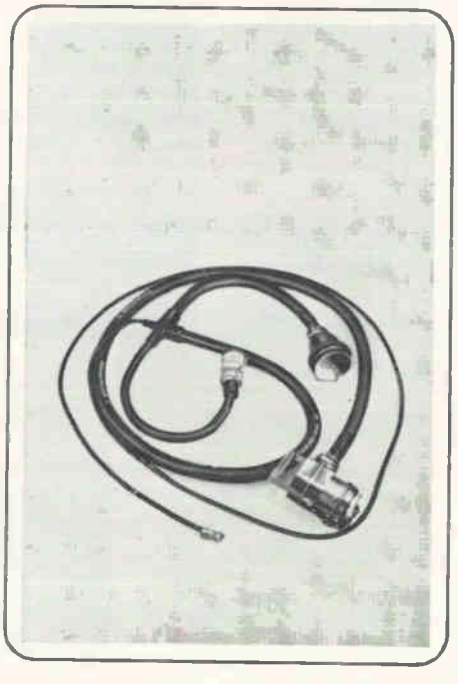

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Look at What Optical Semiconductors Do Now

Logic switching, chopping, amplification, oscillation, latching and rectification

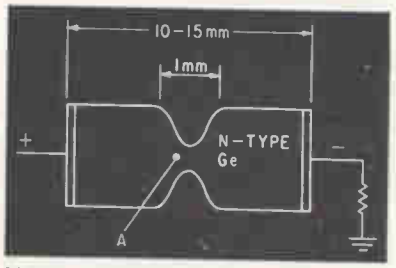
By MICHAEL F. WOLFF
Senior Associate Editor

EAST LANSING, MICH.—New developments in optoelectronics indicate this 10-year-old field may soon assume a significant role in solid-state circuit design. Several papers at the Solid State Device Research Conference (ELECTRONICS, p 24, June 21) revealed both new optical devices and circuit applications of optical coupling.

It's a good bet that this is only the top of the iceberg—a lot is going on that is not talked about.

DIODE DOMES—Three applications of gallium-arsenide diodes to integrated circuits were described by E. L. Bonin, of Texas Instruments, Inc. These are four-terminal, multichip devices that use 30-mil-diameter gallium-arsenide hemispherical domes placed a short distance above a semiconductor device in a single header. The diodes convert an electrical input to an infrared output with 2 to 3 percent efficiency at room temperature.

First application is the four-terminal transistor shown. It uses a silicon phototransistor and has unity current gain with currents typically exceeding 7 ma. Transistor rise and fall time is 6 μsec and the device is considered a useful building block for logic circuits. OR fan-ins exceed 100 (even at elevated temperatures), AND fan-ins are about 30, and fan-outs greater than 10 can be obtained. Various logic configurations have been demonstrated, including a two-input EXCLUSIVE-OR circuit. Advantages in logic circuits include flexibility of inputs and ability to perform parallel logic.

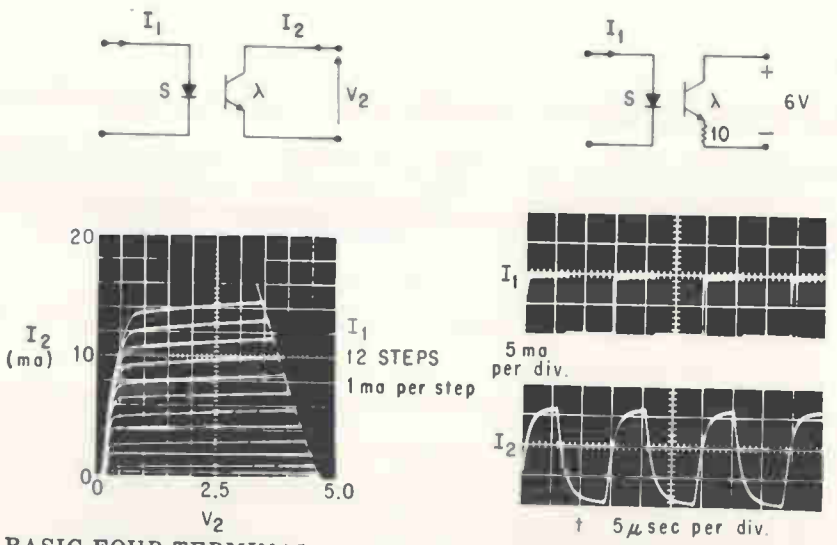


NEW SEMICONDUCTOR *oscillator developed at Electrotechnical Laboratory, Tokyo*

Second application is to use the diode with a double-emitter transistor as a transformerless miniature chopper. For a 100-ma bias on the light source, transistor offset voltages are less than 1 μv, impedance between the emitters is approximately 60 ohms and the maximum chopping current is 1 ma. Speed is determined by total circuit impedance: for 1 K it exceeds 5 Kc.

Power rectifiers and flexible small-signal logic elements are considered feasible if the gallium-arsenide diode is used to trigger a silicon *pnpn* switch. Forward standoff voltage of the switch can be reduced from several hundred volts to a few volts with less than 10 ma diode current. On special headers these transistors can switch currents approaching 1 amp.

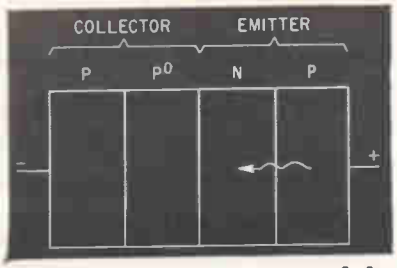
These four-terminal devices are considered to be possibly the most promising application for semiconductor light sources. In emphasizing their potential for c-w operation at room temperature with high efficiency and power, Bonin reported that with 1-ampere bias c-w outputs of 10 to 20 mw had been obtained from experimental power diodes. These diode domes have 72-mil-diameter bases with 20-mil mesa *pn* junctions.



BASIC FOUR-TERMINAL *transistor developed at Texas Instruments is shown with its V-I characteristics at left. At right is circuit for measuring the switching characteristics, and waveforms for input and output current*

OPTICAL TRANSISTORS—Construction of a three-terminal optical transistor using *pp°n* gallium-arsenide diodes (ELECTRONICS, p 88, April 12) was reported by R. S. Levitt, K. Weiser, A. E. Michel and E. J. Walker, of IBM Watson Research Center. The device is constructed as illustrated; *p°* represents a *p*-type region with excess carriers (in this case holes) frozen out onto manganese acceptors.

Typical current gains are five percent, and collector capacitance is 1 pf. This compares to 43 pf for the *pnp* optical transistor previously reported (ELECTRONICS, p 82, March 22). The low capacitance is



OPTICAL *transistor reported by IBM has 1 pf collector capacitance*

due to the wide p° region (40 microns) and would suggest a potential for faster operation. However, nothing definitive can be said about speed until the internal effects in the transistor are evaluated. Currents on the order of 1 ma can be switched.

When the collector is forward biased the device will switch currents on the order of hundreds of milliamperes and then latch, switching back only when bias is removed.

Both devices operate at 77 K. Thus they might eventually find application in circuits required for space environments. Similarly operating devices could be developed for room temperature operation.

THE SOGICON—Light can trigger a new type of solid-state plasma device called the Sogicon (Semiconductor Oscillation Generator by Injection and Constriction). This semiconductor oscillator (see illustration) was described by M. Kikuchi and Y. Abe, of the Electrotechnical Lab., Tokyo.

The oscillator is a germanium device in which a voltage pulse above approximately 100 v will cause the current measured across the resistor to break into a coherent and stable oscillation. Frequency of oscillation ranges from several hundred to several thousand kilocycles and amplitude modulation can exceed 50 percent.

This oscillation can be enhanced by illuminating the channel with visible light at point A; that is, the light will cause it to oscillate when the pulse input is just below oscillating strength.

These effects occur at room temperature, and oscillation is enhanced by raising 10 deg above room temperature. At present, only pulsed operation is possible but it is hoped that an understanding of the operating processes will lead to ability to use the device as a d-c to

a-c converter.

The applied pulses range up to 1 Kv with pulsewidths of 30 to 100 μsec and repetition rates of 10 pps. Lower voltages are possible in silicon but here the device must always be intensely illuminated.

THE FLEXODE—Light can also control switching in the flexode. Operating mechanism of this reversible semiconductor rectifier (ELECTRONICS, p 16, Aug. 24, 1962) was explained by J. Blanc, J. O. Kessler and M. S. Abrahams, of RCA Labs. They said its ability to convert from a resistor to a rectifier when heating current is applied is due to field-controlled lithium precipitation. Lithium is used to dope the *p*-type germanium and particles in the lithium precipitate move to short out the junctions when the electric field varies.

Switching time from resistor to rectifier is on the order of minutes; however, light can cause it to switch in the reverse direction in approximately 1 sec. Light generates an increase in saturation current which heats the device and allows large currents to pass.

Navy Pushes Microcircuits, Reason: Technician Shortage

COLUMBUS, OHIO—Systems effectiveness will be the controlling element in future Navy contracts, Col. Arthur Lowell, of the Bureau of Naval Weapons, told the nine-state Great Lakes Navy R&D Clinic at Ohio State University June 13 to 15.

A comprehensive plan defining systems effectiveness — composed of maintainability, reliability and serviceability—will be issued by BuWeps in the next three months.

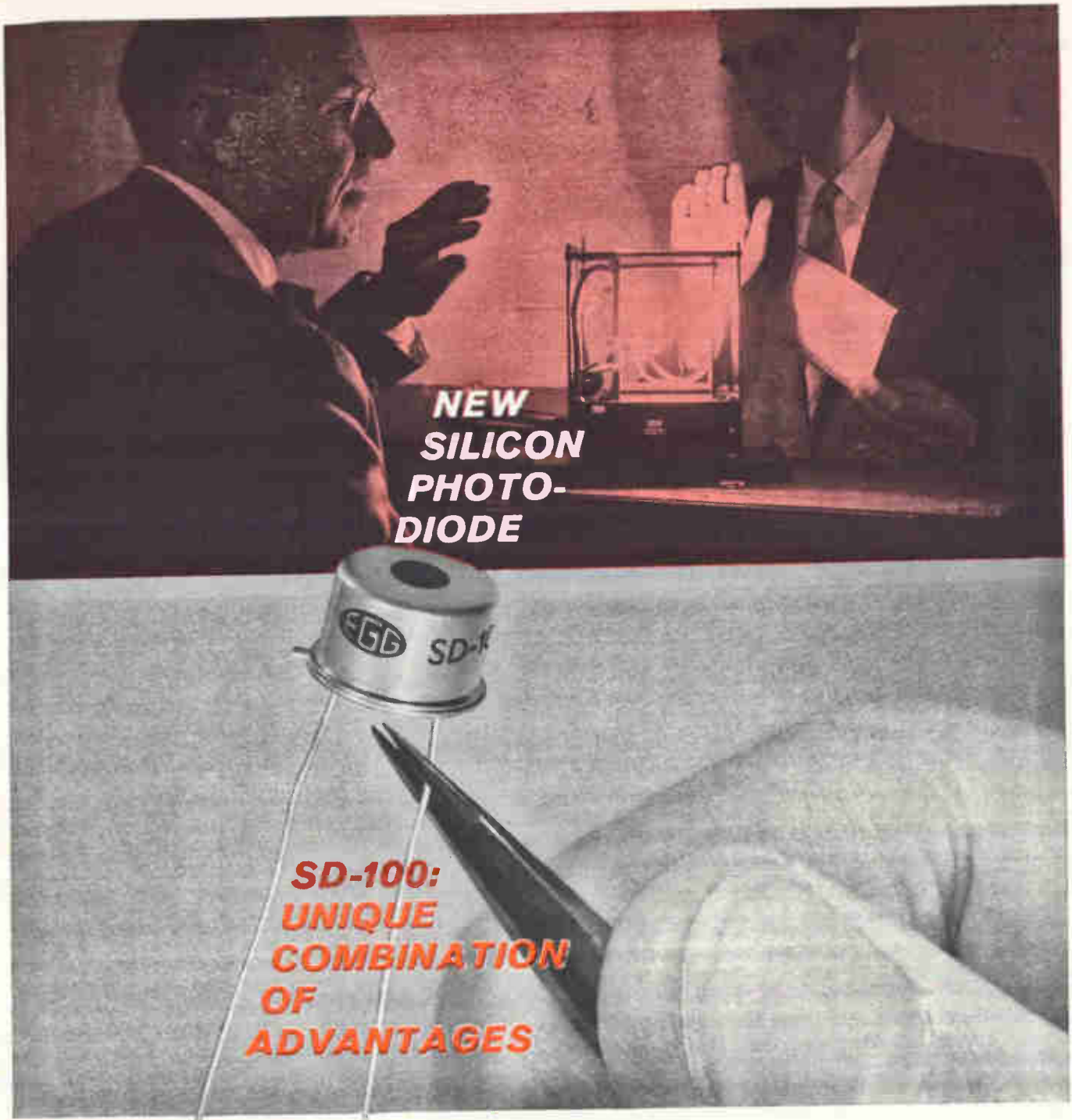
Explaining Navy's interest in microelectronics to boost systems effectiveness, Lowell said eight F4H's are required today to keep two operating at all-weather capability.

SHORT ON TECHNICIANS — With electronics maintenance requirements escalating 5 to 6 percent a year, Navy is now getting only half the technical skill levels it needs, he said. Only 10 to 30 percent of skilled technician requirements are expected to be available to the service by 1965 he said.

MEETAT (Maximum Improvement in Electronics Effectiveness Through Advanced Techniques) Program (ELECTRONICS, p 37, May 3) emphasizes solid-state reliability and go-no-go indicators at malfunction points for operators with minimum skills. Micromodules with fewer interconnections, redundant and disposable units are expected to save from $1 billion to $10 billion over the next 10 years.

NEEDED EQUIPMENT—Among Navy's most urgent needs listed by Rear Adm. E. E. Fawkes, assistant chief for research, development test and evaluation, were:

- All-weather passive system for tracking air and surface contacts, without radiating energy from the control ship
- System that would accept direct-sampled data output from a general purpose digital computer, to drive a high-precision analog illuminating radar or missile launcher, without any intervening moving parts
- Novel, economical techniques and equipment to detect and classify submarines
- Device to indicate by flashing light or aural alarm when preselected radio-frequency field intensities are exceeded. The unit should be small, lightweight and low cost
- 10,000 hour solid-state gyros needed for ship and aircraft stabilization, and contactless potentiometers are on the components wanted list.



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(3) High sensitivity — 0.25 microamps per microwatt

(4) Low noise — 1×10^{-12} watts • $(cps)^{-1/2}$

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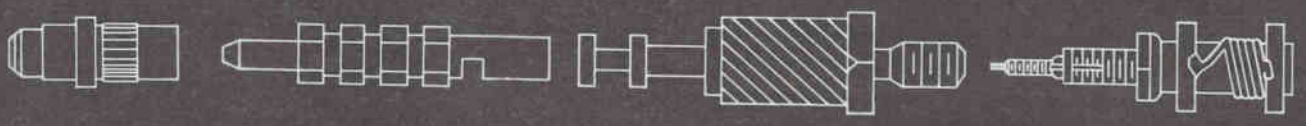

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Announcement to the trade

Eastman Kodak Company, Special Products Division, Rochester 4, N. Y., announces with pleasure and anticipation its success in pushing up to 7 inches the maximum diameter for disks of hard, clean, heat-resistant, shock-resistant, non-cold-flowing, moderate index (2.4), 1μ-to-20μ-transmitting, polycrystalline zinc selenide KODAK IRTRAN 4 Optical Material. Buy some. Absorption bands now eliminated!

Name your rare-earth chelate

The division mentioned above also offers KODAK Neodymium Glass Laser Rods (non-silicate). These are getting bigger and bigger while reports of low beam-divergence, low threshold, and high output grow more startling. Inquiries invited.

We think we are also getting involved with organic lasers but are not ready to boast of general expertise about them. All we say is: 1) business in europium chelates that customers could conceivably be dissolving in various plastics has suddenly flared up at Eastman Organic Chemicals Department, Distillation Products Industries, Rochester 3, N. Y. (Division of Eastman Kodak Company); 2) at the latter division further inquiries for any organic compound of europium or any other rare earth that a clever customer can think of will receive prompt and courteous attention.

Stick fast fast

EASTMAN 910 Adhesive came along a few years ago and then it was no longer silly to think of constructing serious equipment by simply *sticking* metal parts together, to say nothing of sticking organic materials together. The adhesive sticks so fast (in both senses of that word) and so little goes so far that $5 for a half ounce only *sounds* high.

It has proved a boon to scientific and industrial mankind, but sometimes it doesn't work. Maybe the mating surfaces are not clean. Maybe they do not fit close enough. Maybe too much adhesive has been applied. That is bad for the same reason that a bad fit is bad: little pools are bad. The adhesive should form a very thin, uniform film.

On some materials, polyolefins in particular, surface pretreatment is desirable. Some polystyrenes dissolve a little in the 910 monomer. The dissolved polystyrene sort of slows polymerization. We have also been politely informed that in the case of certain dissimilar or pickled metals a speedup would help.

All right, we'll tell you what to do in these cases. Apply EASTMAN 910 Adhesive to only one surface and wipe the other with a (non-aqueous) solution of phenylethylethanolamine, which we call EASTMAN 910 Surface Activator.

WATCH OUT NOW. For work where you have been getting along well with EASTMAN 910 Adhesive up to now and just want to hurry it along, forget you read this ad. What good would it do to have the bond form before the surfaces can be properly lined up?

So ubiquitous has the little bottle of EASTMAN *910 Adhesive become that it is reasonable to broadcast here an offer of a one-ounce sample of* EASTMAN *910 Surface Activator, with directions. Address Eastman Chemical Products, Inc., Kingsport, Tenn. (Subsidiary of Eastman Kodak Company). If you find we exaggerate the ubiquitousness, please so indicate and enclose $5.*

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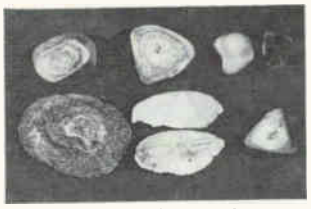
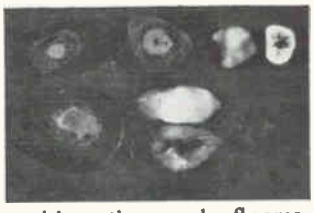
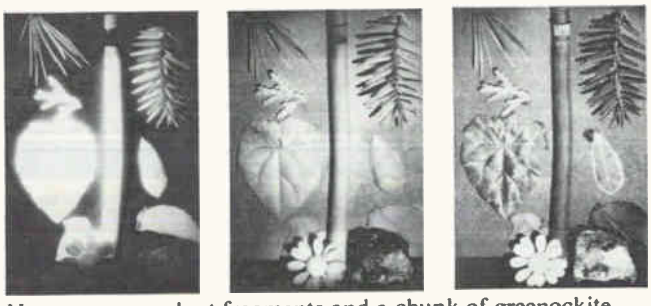
Fluorescence in the infrared



Here is an ordinary photograph of gallstones



and here they are by fluorescence in the near infrared.



Here are some plant fragments and a chunk of greenockite by infrared fluorescence, infrared reflection, and visible.

Illumination for the fluorescence shots was blue-green light with all the infrared filtered out. In front of a KODAK RETINA Reflex Camera loaded with KODAK High Speed Infrared Film, a KODAK WRATTEN No. 87 Filter passed only radiation longer than 740mμ. To record infrared reflection instead of infrared fluorescence, we removed the blue-green-passing, infrared-absorbing filter from the lamp, left everything else the same, and cut exposure time 20,000 times.

A man at Eastman Kodak Company, X-ray Sales Division, Rochester 4, N. Y., is the expert on this. His name is H. Lou Gibson. Write him if you like.

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This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

Micropower Devices Are Going to Nanopower Level

Speakers in NATO's road show see cuts of 10 to 100 in power levels

PARIS—NATO's nine-man team of micropower missionaries pinned down the state of the art and pulled back the curtain slightly on possible future developments at the team's first stop in the Agard (Advisory Group for Aeronautical Research and Development) sponsored four-country tour (ELECTRONICS, p 22, June 14).

More than 100 French engineers and scientists attended.

Digital circuits dominated the conference, chairmanned by American Bosch Arma's Edward Keonjian, pioneer in what he termed the fight against tyranny of power.

Already the fight is far enough along to allow CBS Laboratories' W. W. Gaertner to report on analog-to-digital converter integrated circuits requiring less than 10 μw each (ELECTRONICS, p 8, June 21). Gaertner predicted that technology improvements would one day cut consumption by a factor of anywhere from 10 to 100 compared to levels in today's micropower equipment. As a potential solution to the problem of stray capacitance—a concern that popped up often throughout conference—he suggested three-dimensional filamentary geometry.

A. T. Watts, of England's Mullard Radio Valve Company, told how a digital integrator using 1,000 transistors had its power appetite tamed from 1.8 w to less than 50 mw by refinements in the direct-coupled-transistor-logic circuit (p 8, June 21). The module is 2 × 3 cm, with passive elements evaporated on a glass substrate and transistors mounted in holes cut out of glass.

A shift from germanium to silicon transistors shaved consumption to 600 mw for the three-channel integrator, which operates at a 100-Kc clock rate and has a package size of 17 cu in.

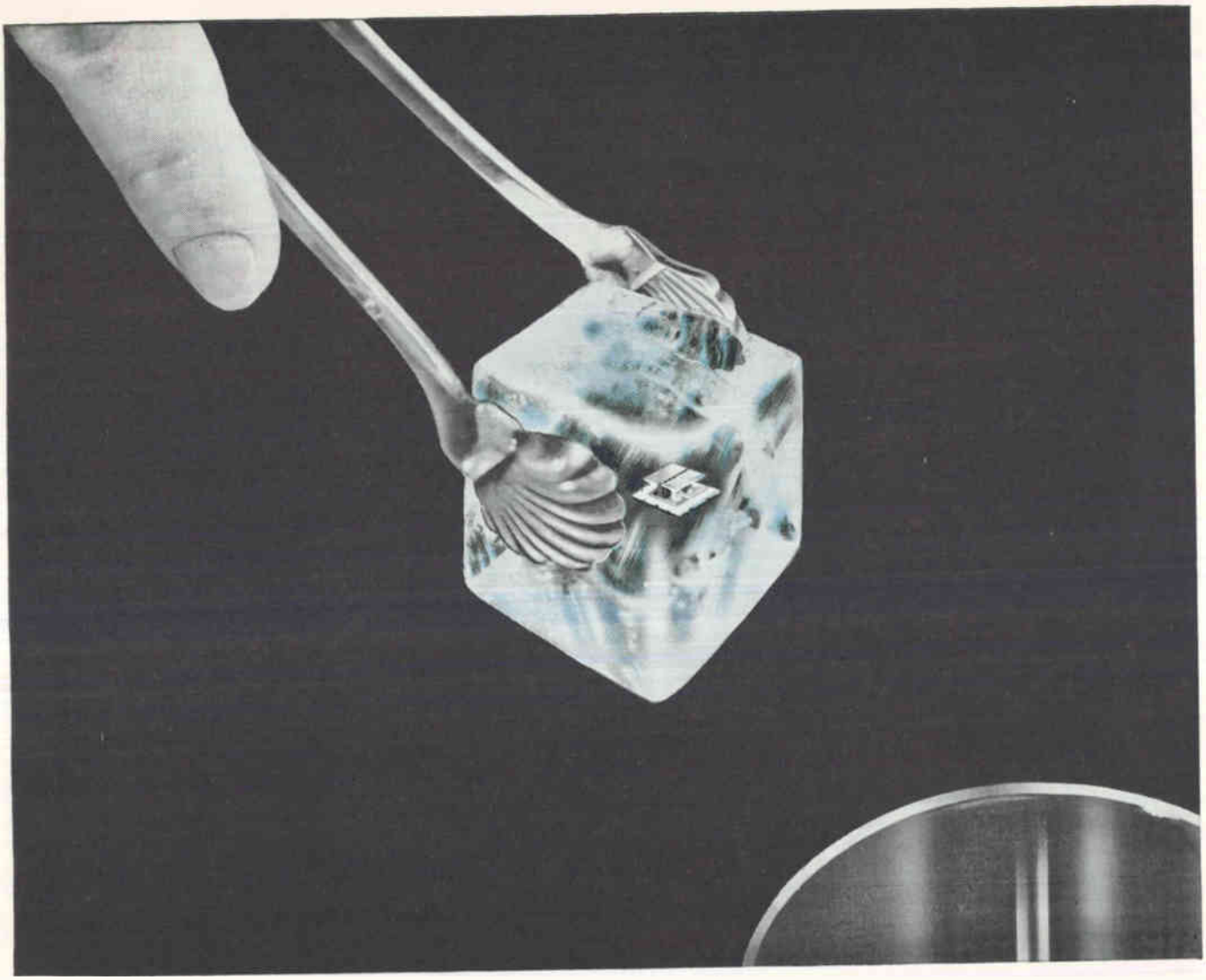
FIELD EFFECT DEVICES—The conference highlighted the bipolar junction transistor's advantages in micropower digital circuits. But a spate of other devices is forthcoming. G. E. Moore reported on insulated-gate field-effect semiconductors under development at Fairchild Semiconductor. The device acts as a planar silicon diode with no gate voltage. So standby power runs only 1 mw per stage. Switching time is 10 nsec.

Arrays of insulated-gate devices point the way to nanowatt memories, Moore said. As many as 2,500 memory units could be diffused into a wafer 1 inch square. Although Fairchild Semiconductor still has not fabricated one, integrated circuits based on the devices are possible. In fact, Moore maintained, interconnections between wafers is a bigger problem than developing devices themselves. No one dissented.

J. W. Moll, of Stanford University, discussed problems and limitations in micropower transistors. He described 100-Kc field-effect devices operating at 10 μw, feels devices can do 100 times better than people are now getting for low power levels at highly repetitive frequency rates.

Electronic Ticker Tape

STOCK MARKET *display system developed by Ultronic Systems uses Nixie tubes to show quotes. Six-bit ticker code is input to display*



WHAT TEMPERATURE IS A BREAKTHROUGH?

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The project was initiated under Company sponsorship, then quickly given an additional push by Government support. Breakthroughs come in many temperatures. They almost always have this kind of complex, cross-disciplinary history.

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Sparking Thin Films Drive Plasma Engine

LOS ANGELES—Electric propulsion system that uses vapor-deposited, thin metal films to achieve pulsed plasma propulsion was described last week by General Motors at the Institute of Aeronautics and Astronautic's summer meeting. In experiments at Allison division, the accelerator's efficiency peaked at 50 percent.

Metal vapor from a resistance-heated boiler is deposited on a rotating wheel. As the film moves between rail-type electrodes in a capacitor-discharge circuit, it is exploded electrically. Velocity of the resulting plasma is in a single direction only.

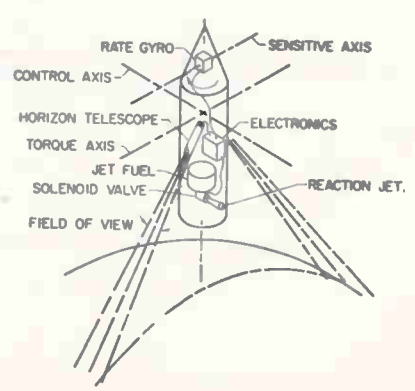
Allison representatives said that the feed system for applying the propellant is unique.

In session on guidance and control, NASA representatives discussed an extremely simple control system for spin-stabilized vehicles.

Control logic and electronics requirements for the system are held to a minimum. A flight-tested version of the system used a total of only 13 transistors and two moving parts—a rate gyro and a solenoid valve. Total weight of the system was less than 18 pounds.

Control system uses horizon-detecting telescopes for absolute attitude reference. A single reaction jet provides control torque for two axes and the required stability augmentation (see diagram).

Called Miniguide, the lightweight control system is inexpensive and has high degree of reliability, says NASA.



MINIGUIDE *space control has only 2 moving parts*

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SANGAMO 480 SERIES

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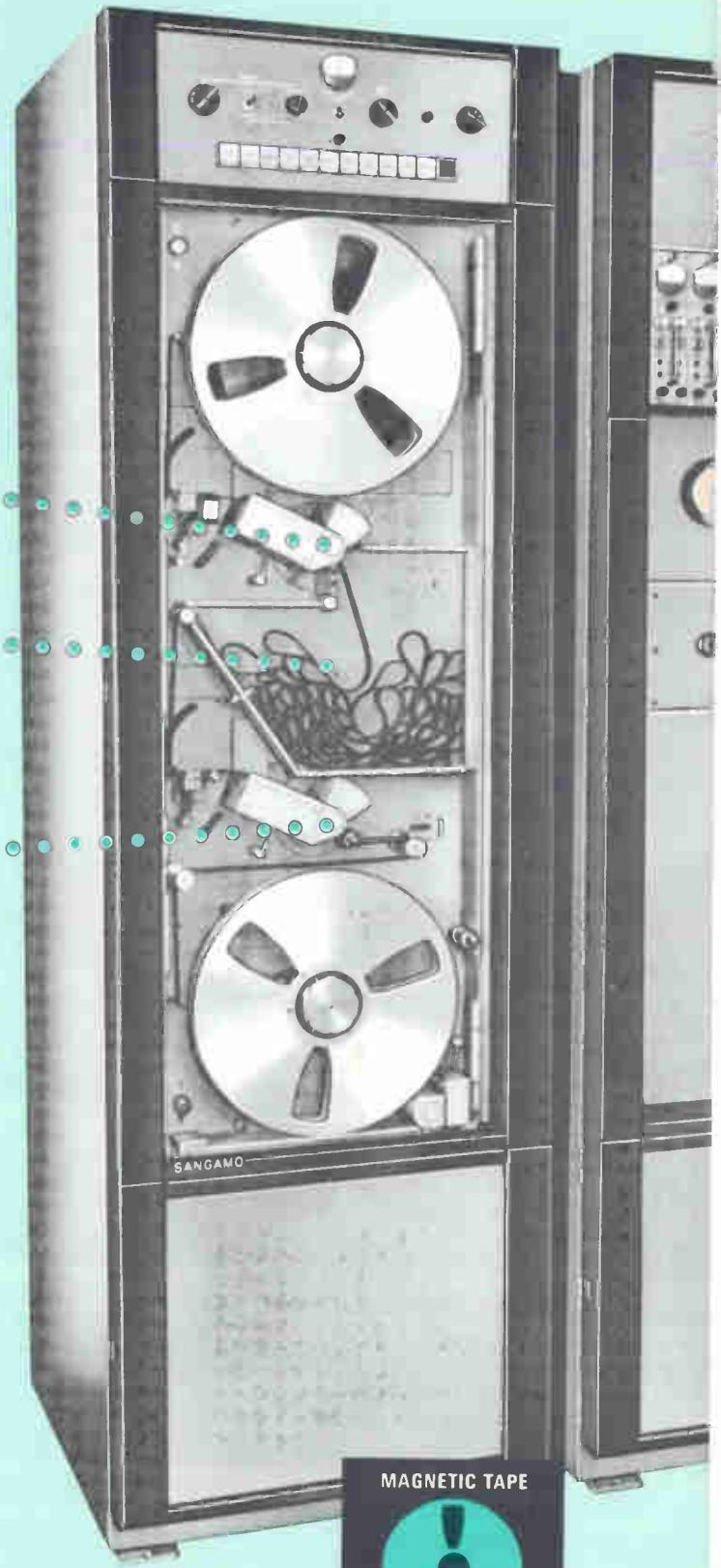

RECORD HERE
(or reproduce) with automatic switching of 4 speeds of FM or Direct electronics . . . 7 to 28 channels of data.

DELAY HERE
in buffer storage bin with capacity of 125 feet, providing fixed or continuously variable delay up to 12 minutes . . . recording simultaneously at both head stations, then reproducing, you can achieve delays as short as *zero* seconds—even *negative* time delays.

REPRODUCE HERE
(or record) with time-delay accuracies varying from .0004% to a maximum of ±25 microseconds . . . record or reproduce at first head station, with simultaneous delayed reproduce or record at second station . . . speed ratio between capstans may vary as much as 16:1 for time-base expansion or contraction while continuing to record.

FIXED OR VARIABLE TIME DELAY

The Sangamo 480 Series Recorder/Reproducer offers a totally new kind of application flexibility and reliability to the instrumentation field. The Model 480 is essentially two independent magnetic tape recorder/reproducers with a time-delay tape storage bin between the two capstans. Fixed or variable time delays can be achieved in either reel-to-reel or continuous loop applications.

Loop storage bin permits up to 250-foot loop for monitoring of infrequent data. Loop bin provides time delay between second capstan and first, in addition to providing any necessary delay to allow readout equipment to reach operating speed. Tape is continuously erased prior to passing the first head station.

Some operating features are shown above, but there's much more to tell. Write, wire, or phone us for the complete story.

MAGNETIC TAPE
INSTRUMENTATION

SANGAMO ELECTRONIC SYSTEMS

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

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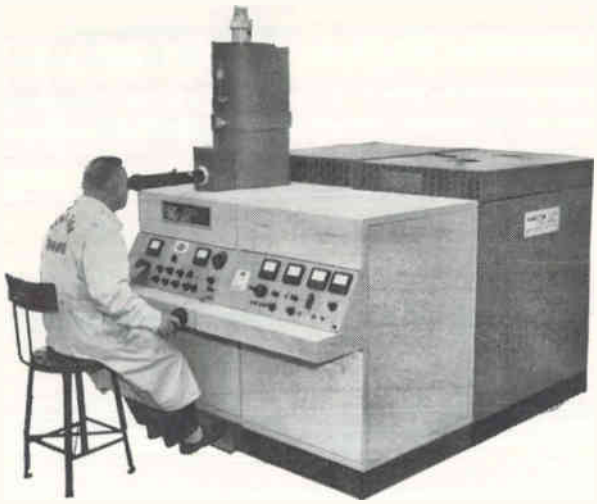
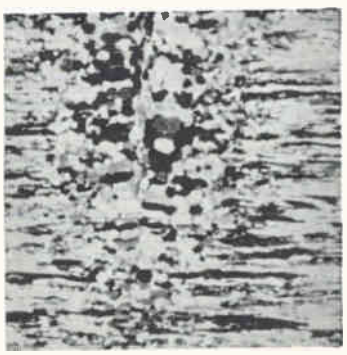
SEE "impossible" welds in the making by electron beam...



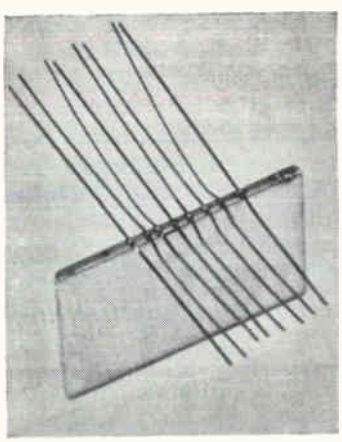
EXCLUSIVE OPTICAL VIEWING SYSTEM permits the operator to sight down the center line of the electron beam column and see a magnified view of the exact position of the beam on the work piece.

Welds that were once "impossible," like those shown, are now everyday occurrences—wherever Hamilton-Zeiss high energy-density electron beam welding machines are at work. These Hamilton Standard machines provide flexibility, repeatability, reliability. You can solve fabrication problems involving refractory materials, unequal thicknesses, deep penetrations, and hard-to-reach locations, with an ultraprecise electron beam focused through an exclusive magnetic optical system.

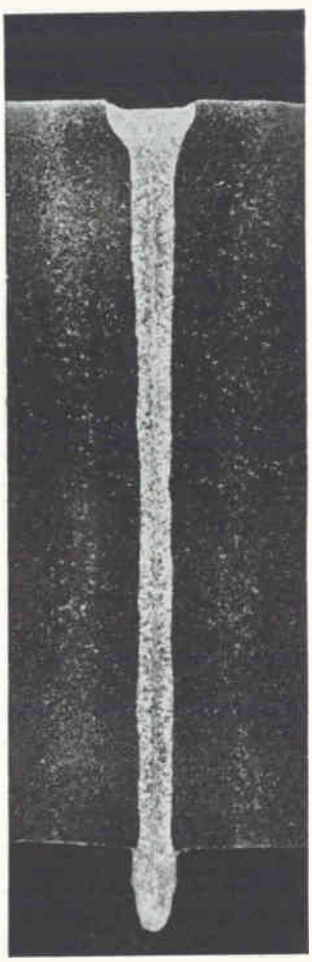
Hamilton-Zeiss electron beam machines produce welds in a vacuum, thereby eliminating contamination. Additional advantages include close control of dimensions and penetration, and low thermal distortion. Supporting metallurgical reports are available for your inspection. For complete information about Hamilton-Zeiss Electron Beam Welders, write or wire: Sales Manager, Electron Beam Machines, Hamilton Standard Division of United Aircraft Corporation, Windsor Locks, Connecticut.



Weld on 0.1" tungsten shows no contamination, minimal grain growth. Reasons: welding time is extremely short, heat is localized, impurities are vaporized, no filler is used.



Copper ribbon wires (0.002" x 0.01") welded to edge of nickel-plated ceramic substrate. Shows wide range of thicknesses and materials which can be joined on the same machine.



High energy density permits deep weld through 1" stainless steel with over 20:1 depth-to-width ratio. Weld is as strong as base material.

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION

←CIRCLE 42 ON READER SERVICE CARD

CIRCLE 43 ON READER SERVICE CARD

THERMAL DELAY SWITCHES

STC Thermal Delay Switches can be used for delaying the application of h.t. voltage to valves requiring preheat of cathode; are suitable for use with heavy duty relays to switch 3-phase circuits from star to delta arrangement for starting induction motors; for short circuiting surge limiting resistors; and for automatically reclosing a circuit breaker after a temporary surge has caused it to trip. These applications are described fully in booklet MS/117 available on request.

EXTENDED DELAYS can be obtained by cascade connexion. A circuit technique which sums closing and opening delay times yields an overall delay independent of normal heater voltage variations.

AMBIENT TEMPERATURE COMPENSATION Variations of ambient temperature within the range −35° to +70°C do not affect greatly the delay time since the 'stationary' strip is also bimetal and its contact shifts with the active contact.

Abridged Data

Type	Delay (seconds) at 20°C min.	Delay (seconds) at 20°C max.	V_h(V)	Contact Rating (V d.c.)	Contact Rating (V r.m.s.)	Base
S102/1G	44	66	6·3	220	100	B7G/F
S102/1K	44	66	6·3	220	100	B7G
S103/1K	36	54	27	220	100	B7G
S104/1K	25	35	6·3	220	100	B7G
S105/1K	20	30	27	220	100	B7G
S106/1K	44	66	19	220	100	B7G
S107/1K	8	15	6·3	220	100	B7G

Send for data sheets

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ITT

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Today, 20-second units are available in production runs in the new HI-AC series of data transmission resolvers and synchros . . . 0.01% functional accuracy in the HI-AC compensated computing resolvers.

These instruments permit the design of highly accurate, yet greatly simplified, data transmission systems. Elaborate two speed synchro systems, or equally complicated digital encoder systems, can be dispensed with, because the desired accuracy is inherent in the HI-AC synchros themselves. Reliability is immeasurably improved, maintenance cut to a minimum; and space, weight and cost greatly reduced.

The Reeves HI-AC Series are the only Size 23 Resolvers and Synchros currently available in production quantities with this high order of accuracy. For complete information, write for Data File 106.

Qualified engineers who are seeking rewarding opportunities for their talents in this and related fields are invited to get in touch with us.

REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America, Roosevelt Field, Garden City, New York

MEETINGS AHEAD

INFORMATION THEORY IN SCIENCE & ENGINEERING SEMINAR, Dartmouth College; at Dartmouth, Hanover, New Hampshire, **July 1-12.**

ADVANCED CONTROL THEORY AND APPLICATIONS, Massachusetts Institute of Technology; at MIT, Cambridge, Mass., **July 8-19.**

ANTENNAS & PROPAGATION INTERNATIONAL SYMPOSIUM, IEEE-PTGAP; National Bureau of Standards, Boulder, Colo., **July 9-11.**

MEDICAL ELECTRONICS INTERNATIONAL CONFERENCE, IFME, University of Liege, Liege, Belgium, **July 22-26.**

ELECTROMAGNETIC MEASUREMENTS & STANDARDS SEMINAR, National Bureau of Standards; NBS Laboratory, Boulder, Colo., **July 22-Aug. 9.**

AEROSPACE SUPPORT INTERNATIONAL CONFERENCE & EXHIBIT, IEEE, ASME; Sheraton-Park Hotel, Washington, D. C., **Aug. 4-9.**

INTERNATIONAL ELECTRONICS CIRCUIT PACKING SYMPOSIUM, University of Colorado, et al; at the University, Boulder, Colo., **Aug. 14-16.**

WESTERN ELECTRONICS SHOW AND CONFERENCE, WEMA, IEEE; Cow Palace, San Francisco, Calif., **August 20-23.**

AUTOMATIC CONTROL INTERNATIONAL CONGRESS, International Federation of Automatic Control; Basle, Switzerland, **Aug. 27-Sept. 4.**

INTERNATIONAL ASSOCIATION FOR ANALOG COMPUTING, AICA; Brighton College of Technology, Lewes Rd., Brighton, England, **Sept. 14-18.**

PHYSICS OF FAILURE IN ELECTRONICS SYMPOSIUM, Armour Research Foundation and Rome Air Development Center, Illinois Institute of Technology, Chicago, **Sept. 25-26.**

ADVANCE REPORT

ULTRASONICS SYMPOSIUM, IEEE-PTGUE; *Marriott Motor Hotel, Washington, D. C., Dec. 4-6.* **Aug. 15** *is the deadline for submitting 3 copies of 200-word abstracts to: T. R. Meeker, Technical Program Chairman, Bell Telephone Laboratories, 555 Union Boulevard, Allentown, Pennsylvania. Contributed papers are sought in any of the various specialized areas of ultrasonics with microwave ultrasonics receiving particular attention.*

ENGINEERING IN MEDICINE & BIOLOGY CONFERENCE, IEEE, ISA; *Lord Baltimore Hotel, Baltimore, Md., Nov. 18-20.* **Aug. 1** *is the deadline for submitting a 2-page digest manuscript. To properly do this, authors should write immediately for "An Application to Present Paper" to: 16th Annual Conference, Jenkins Hall, Johns Hopkins University, Baltimore 18, Md. Two fields are of special interest: creative evaluation of patient monitoring systems and operation details of analog-to-digital conversion systems.*

Easily replaced circuits—great advantage of ITT Kellogg's new Electronic Telephone Exchanges—made possible by THIOKOL PANELYTE Copper-Clad laminated sheets

ITT Kellogg's new Electronic Telephone Exchange Systems represent one of the great advances in modern telephony. If a malfunction occurs in any one of the circuits, an office secretary can handle the necessary maintenance. All that's required is the manual removal of the faulty circuit board and quick plug-in replacement with a handy spare.

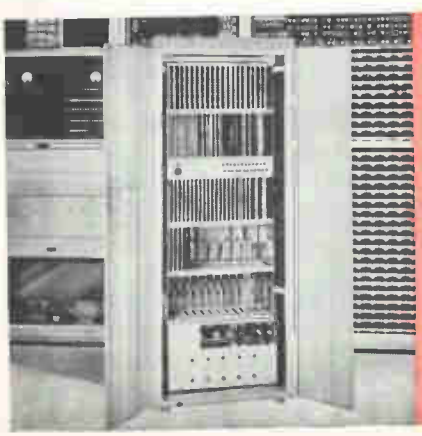
ITT Kellogg selected Thiokol Panelyte Copper-Clad circuit board for this unique and vital application. Reason: Panelyte Copper-Clad combines the high electrical and physical properties required. The glass epoxy G-10 Thiokol Panelyte Grade 1635 flame retardant chosen provides both the insulation strength and solder resistance specified by ITT Kellogg. This Panelyte grade is one of 10 special copper combinations engineered for special requirements.

Panelyte Copper-Clad and other electrical grades meet NEMA and government specifications. For full information write to Panelyte. Or see Sweet's Catalog.

Thiokol
PANELYTE
INDUSTRIAL

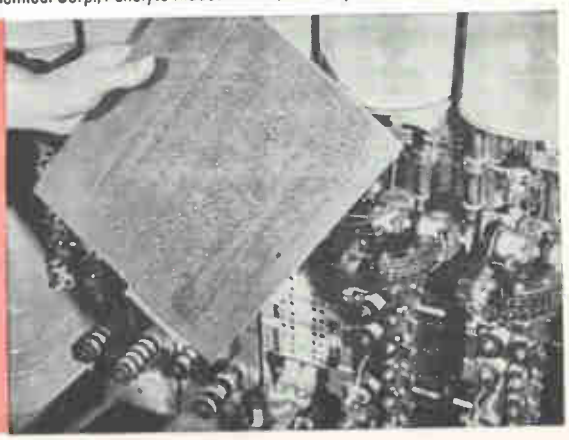
Laminated Sheet, Rod, Tube, High Pressure Moldings, Elastomeric Compounds and thin copper-clad laminates for multi-circuit application.

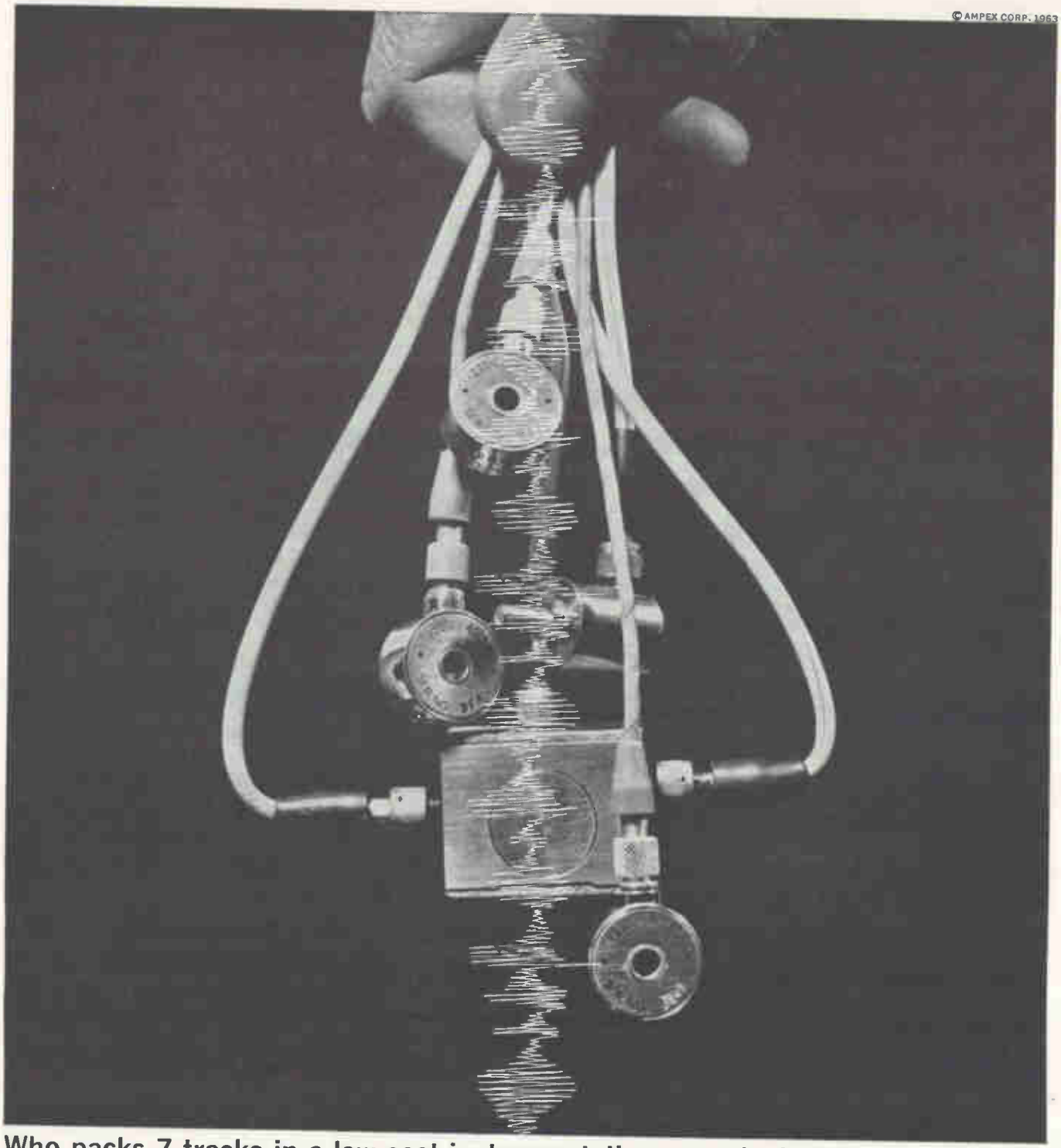
Thiokol Chemical Corp., Panelyte Industrial Div., N. Enterprise Ave., Trenton 4, N.J.



Through use of transistors, other electronic inventions, and Thiokol Panelyte Copper-Clad printed circuit boards, ITT Kellogg has reduced to file cabinet size and to 425 pounds the private automatic telephone exchange. Shown here: KELEX compared to conventional electro mechanical system.

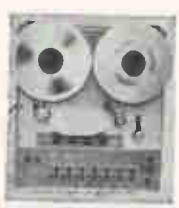
To the right is the ITT Kellogg printed circuit board made from Thiokol Panelyte Copper-Clad Sheet in comparison to the electro mechanical equipment which it replaces.





Who packs 7 tracks in a low cost instrumentation recorder? AMPEX

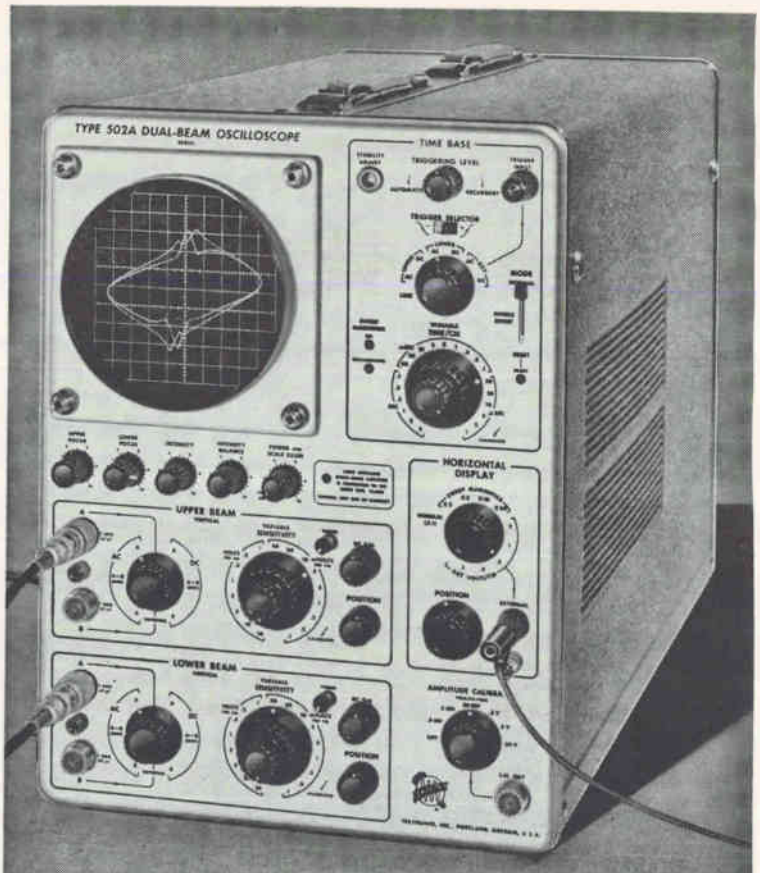
Not long ago we introduced the 4-track SP-300—a portable recorder with true instrumentation performance. It gave modest-budgeted research operations the precision needed at a reasonable price. But we wanted to offer more data handling capacity without sacrificing performance—and still keep the price low. Now we can: the SP-300 gives you up to 7 tracks of true instrumentation recording. And the price? Under $7000. No other instrumentation recorder on the market does so much for so little. Along with simultaneous recording of up to 7 separate tracks, the SP-300 gives you 4 speeds with electrical switching of both transport and electronics by a single control. It records FM at low frequencies from DC to 2500 cps. It records Direct at higher frequencies from 50 cps to 40 KC. It comes with built-in calibration and erase. It has printed circuit wiring and harnesses for greater reliability. And it uses the most thoroughly proved of all tape transports—specifically adapted for precise instrumentation applications. What about quality? Ampex through and through. For information about the 4- or 7-track SP-300 write to Ampex Corp., Redwood City, Calif. Term financing and leasing available. Worldwide sales and services.



Tektronix
DUAL-BEAM
Oscilloscope

fits many scientific and industrial applications

Type 502A



Here is a dependable laboratory oscilloscope you can use for medical, mechanical, many other applications. It is especially useful for dual-beam displays on linear times bases and X-Y presentations with either or both beams.

This dual-beam oscilloscope with 100 μv/cm basic sensitivity offers many convenient features for quick and easy waveform analysis. Some of these features include: *differential input at all sensitivities*—for cancelling unwanted common-mode signals . . . *single-sweep operation*—for facilitating waveform photography . . . *push-button beam finders*—for indicating relative trace position when deflected from CRT screen . . . *intensity-balance* control—for equalizing trace intensity or identifying upper or lower beam when superimposed for comparison.

Main Performance Characteristics Include:

- Passbands from dc-to-50 kc, minimum, to dc-to-1 Mc maximum.
- Calibrated Vertical Sensitivity in 17 steps from 100 μv/cm to 20 v/cm, both amplifiers
- Calibrated Sweep Range in 21 rates from 1 μsec/cm to 5 sec/cm
- Variable, Uncalibrated, Sensitivity and Sweep Range Controls
- 2X, 5X, 10X, or 20X Sweep Magnification
- Flexible Trigger Facilities
- Amplitude Calibrator
- Electronically-Regulated Power Supplies

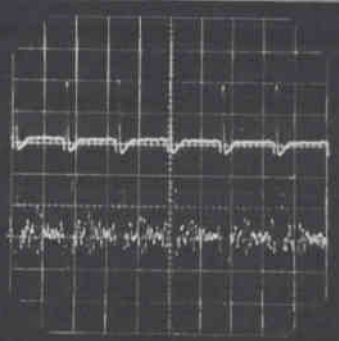
Type 502A Oscilloscope $1050

U. S. Sales Price f.o.b. Beaverton, Oregon

FOR A DEMONSTRATION, PLEASE CALL YOUR TEKTRONIX FIELD ENGINEER

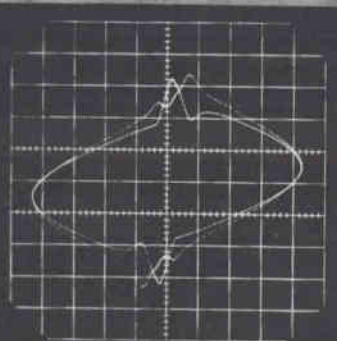
Typical Applications of Type 502A

1. Comparison and measurement of stimulus and reaction on the same time base.
2. Comparison and measurement of two transducer outputs, such as pressure vs. volume.
3. Comparison and measurement of phase angles and frequency differences.
4. Comparison and measurement of X-Y curve-tracing presentations.
5. Comparison and measurement of general-purpose or special-purpose low-level displays.



BIO-MEDICAL APPLICATION

Typical dual-beam display shows presentation of ECG (upper beam) vs. heart sounds (lower beam) of patient.



QUALITY-CONTROL APPLICATION

Typical dual-beam X-Y display shows comparison of E/I loops of two transformers in a production run.

Tektronix, Inc. / *P. O. BOX 500 • BEAVERTON, OREGON / (Area Code 503) Mitchell 4-0161 • TWX: 503-291-6805 • Telex: 036-691 • Cable: TEKTRONIX • OVERSEAS DISTRIBUTORS IN 27 COUNTRIES*

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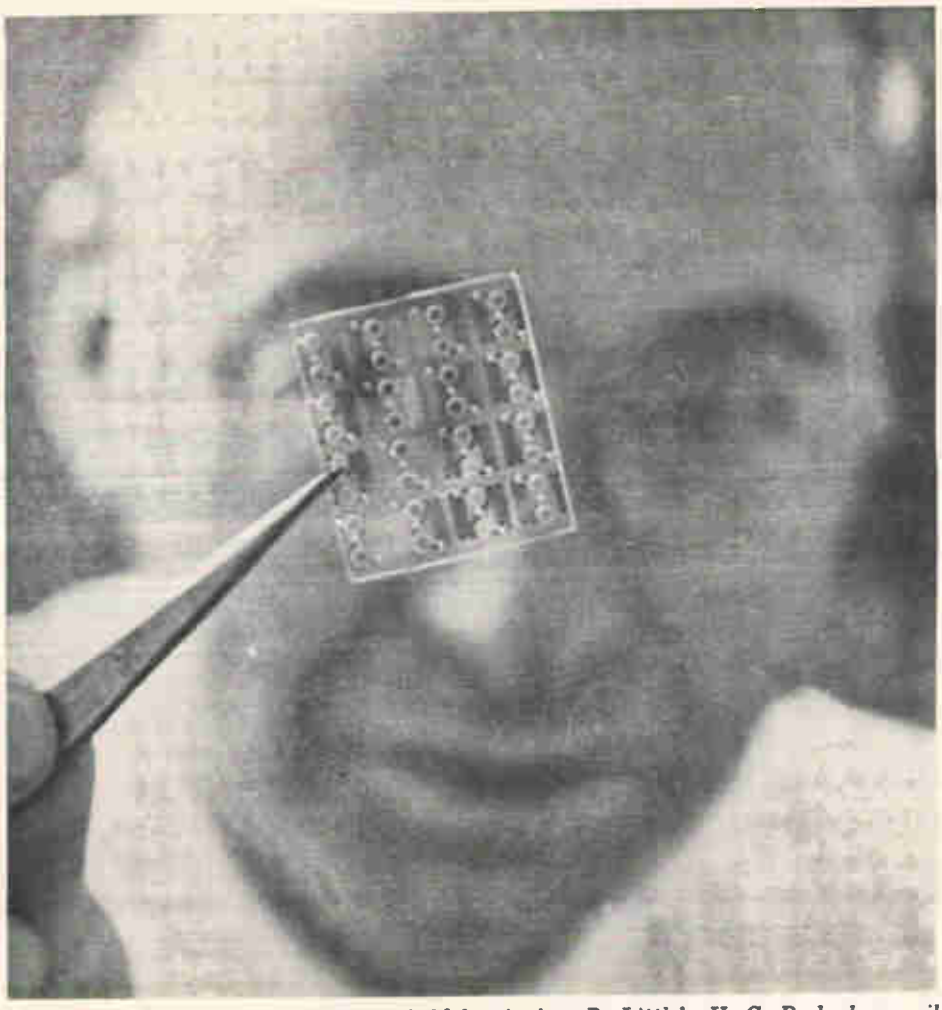
electronics
A McGraw-Hill Weekly June 28, 1963



MICROCIRCUITS *such as this one held by Arthur D. Little's H. G. Rudenberg will change more than the size and shape of equipment. The industry itself is changing*

THE IMPACT OF MICROELECTRONICS

Some call it revolution, others evolution, but almost everyone agrees that microelectronics will profoundly affect our traditional way of doing business

An ELECTRONICS staff report

DEEP AND LASTING changes in the electronics industry are slated to take place in the next decade as a result of the growth of microelectronics. That was the consensus of industry leaders gathered in Chicago this week to discuss the "Impact of Microelectronics" at a conference sponsored by ELECTRONICS and the Armour Research Foundation of the Illinois Institute of Technology.

The extent of the changes is still under dispute, but opinion appears unanimous that the influence of the new technology will be felt across the board, and

BRIDGES: "A comforting thought . . "

NOYCE: "Five times the money you think you need . . "

will affect the industry's traditional way of doing business, not only with its biggest customer, the government, but eventually all purchasers of electronic equipment, large and small. Specific areas certain to be changed in scope and technique are:

- Circuit and system engineering
- Product specification and standardization
- Marketing methods
- Recruitment and training of technical people

Thus, virtually the entire economic structure of the industry may be overhauled in response to changes in the product and in the market place.

According to George T. Jacobi, Assistant Director of Electronics Research at ARF (now IIT Research Institute), the depth of the changes can be appreciated by considering the present relationship between the electronic component vendor and purchaser. "Under the present system," says Jacobi, "a purchasing agent is provided specifications by his engineering group. The quantities needed are determined by sales and issued by manufacturing control. The buyer now shops around for a vendor who can meet the specifications. They are based on price, delivery date and quality assurance. The final decision on purchase involves engineers, inspection personnel, quality control and cost accountants."

Under the present system, this procedure, involving systematic documentation of component performance, in brochures, catalogs, spec sheets, purchase orders and the like, works well. But in the era of microelectronics, Jacobi points out, no manufacturer will have such detailed data available, nor list prices for the more complex and perhaps lower volume items which replace conventional components.

"If the traditional vendor-buyer relationship were maintained, systems design would almost literally originate in the office of the buyer," states Jacobi.

But the traditional relationship is not likely to survive. Under strong pressure from government procurement agencies, more and more companies are becoming committed to microelectronics. And these organizations are definitely not limited to those with a background of semiconductor manufacture. They include conventional component manufacturers, systems and equipment manufacturers, and a relatively new development, the small company devoted exclusively to microelectronics. With this new lineup, systems suppliers are bolstering their component manufacturing research and facilities, component manufacturers are seeking entry into the systems and subsystems fields, while the microelectronic specialist company must also fight for its place in the sun.

PREDICTS REDUCTION—Jacobi foresees a reduction in the number of companies able to participate in the electronics market, particularly in the area of military electronics. He predicts that the survivors will have in common an expansive R and D program, large sales volume and a modest return on the sales dollar.

According to James M. Bridges, Director of the Office of Electronics, Office of the Director of Defense Research and Engineering, Department of Defense, just such a "shakedown" in the industry may be necessary in order to realize the potential reductions in integral circuit costs.

While the advantages of microelectronics in reliability, and reduction in volume and weight of complex systems are cited most often as justifying the

SPREADING THE WORD

The conference on "The Impact of Microelectronics" held this week in Chicago resulted from the deeply held conviction on the part of ELECTRONICS staffers and Armour Research Foundation scientists that, while the technological aspects of microelectronics were being adequately exposed in the literature and

SPRAGUE: "We are materials processors . . "

feverish activity in this field, the substantial reduction in costs potentially afforded by the new technology is a prime mover in obtaining government support for microelectronics. Bridges likes to quote statistics from an industry source which estimate that by 1970 the government will be buying annually some $10 billion worth of electronic equipments and systems. Of this, about one quarter, or $2.5 billion, involves electronic circuits that could employ microelectronics. If microelectronics can be produced for one-half the cost of present electronics, the government would save $1.25 billion in its electronics bill. "A comforting thought," says Bridges, "and I suspect that it may be reasonably true. Let me point out, though, that these reductions in integral-circuit costs will probably not be realized unless their production is concentrated in a few companies so that it will be economically feasible for them to spend the sums of money necessary to develop the methods and processes and purchase the automatic machinery needed for low-cost manufacture."

A reduction in manufacturing costs is by no means the total possible savings that are intriguing government procurement agencies. According to Bridges, even more important will be the savings from lower logistics and maintenance costs.

SPARE PARTS—Equally significant will be the impact on the traditional system of stocking spare parts for electronics equipment, lucrative for the contractor, often a headache for the agency. Bridges looks forward to the day when all spare modules needed for the life of an equipment will be furnished as an integral part of the equipment when it is originally produced.

"Some calculations recently made by a contractor for the Air Force, reveal some interesting results," Bridges says. "If an equipment must have a life of, say, 10,000 hours of continuous operation (more than a year) and it has, say 10,000 circuits of 500 different types, each having a failure rate of 0.0001 percent per 1,000 hours, then there is a 99 percent probability that no failure will occur—*so no spares would be needed.*" The required failure rate has not yet been achieved, Bridges is quick to point out, but he says there is every reason to believe that it will come about as more is learned about failure mechanisms and process controls.

Despite this emphasis on reduced stocking of spares, Bridges is firmly opposed to standardization of microelectronics, and he appears to be speaking for the Department of Defense, in this matter. "Many of us in Defense and in industry who have carefully studied microelectronics in relation to Defense applications are firmly convinced that any effort to bring standardization into microelectronics now would be premature, with the possible exception of early standardization of descriptive terms and common testing methods and characteristic methods."

Bridges holds that the characteristics of microelectronics make the values of standardization objectives used in conventional electronics quite different. These traditionally have been to limit the numbers of different types in the supply system, increase the quantities of each item produced to reduce costs and improve reliability, and to provide uniformity in military equipment design. But with the advent of microelectronics, it appears that the cost and the reliability are going to depend on the development of manufacturing processes and automatic production machines and the manufacture of large quantities of *similar* circuits rather than large quantities of the *same* circuit.

Bridges is emphatic on this point. "We just will not know the answers to these questions until we gain more experience with microelectronics. Until that happens, we feel strongly that we should oppose any kind of standardization."

The government is deeply conscious of the impact on industry of microelectronics, according to Bridges. "It is evident that this impact will depend

at technical meetings, little attention was being devoted to the possible changes that might be wrought in the industry itself by the "new circuits". These changes could affect all of us, from the most highly placed decision maker, to the freshman entering engineering school. The conference was designed to provide a forum to discuss the problems sure to accompany these changes.

This article was derived in part from comments made by participants in the conference, and in part from interviews conducted by ELECTRONICS editors in the field. Coordinated by Senior Editor Samuel Weber in New York, contributions were made by Midwest Editor Cletus Wiley, New England Editor Tom Maguire and Ed Addeo of the McGraw-Hill San Francisco News Bureau

to a considerable extent upon the policies of the government, particularly with respect to such things as specifications, standards, and the support of manufacturing facilities. For this reason, the government must be most careful in developing those policies," he says.

Dr. E. R. Jervis, of ARINC Research Corporation agrees that the impact of microelectronics on maintenance and logistics will be very great if the potential reliability figures of a mean time to failure in the region of 10^4 to 10^5 for even relatively simple equipments of 100 or fewer components is achieved. "In fact," says Jervis," this is the dream come true of all people struggling with the present problems of maintenance and logistics; that of an equipment that outlasts its useful life and on the average, does not need replacement, while the few equipments that break down don't require maintenance but can be disposed of."

However, Jervis points out that most equipments still are electromechanical and mechanical components, and the reliability will be limited in the final analysis by these. Moreover, more complex equipment, operating for longer time will still require maintenance. He therefore supports as an intermediate step (between present logistic methods and the ideal no-spares no-repairs condition) the logistic self-support method, which depends on each equipment carrying sufficient replacement parts for the expected life of the equipment. This plan has many advantages, according to Jervis, including the minimization of replacement problems due to mismatching of equipment, a relaxation of the need for strict specifications and standardization of replacement parts, standardization of circuits within the equipment with consequent simplicity of design, and adaptability of equipment to self-healing systems in which failing components are automatically switched out of the system and new components replaced. "But successful development of these concepts will require a broad knowledge of failure modes and failure rates of the various components used," Jervis cautions.

GALVIN: "Component makers should effervesce . ."

INDUSTRY'S VIEW—What do industry leaders think will be the impact of microelectronics on the market and on the industry as a whole? Robert N. Noyce, general manager of Fairchild Semiconductor, agrees with some recent studies which project the microelectronics business in the next five years into the hundreds of millions of dollars range. "Right now we're in the tens of millions category, so microcircuitry will continue to grow much faster than transistors did," he told ELECTRONICS.

"The big point to consider, though, is that the near future in this field will bring the opportunity for many firms to realign themselves as more and more firms dig into the market and claim their own chunks. Each firm's share of the market will surely change, some more, some less. Each manufacturer must watch the market closely in the next few years and be ready to realign himself to his best advantage."

Here is another allusion to the coming structural change in the industry. But Noyce doesn't think integrated circuits will drive out the conventional components business, either his own or the industry's as a whole. "Conventionals still have their own purpose," he says, and it will be quite a while before microcircuitry gets into all applications."

Is Fairchild concerned about its own conventional components business? "Well, microcircuitry is effecting our own business, yes, but then it's our policy here to consider microcircuitry over and above what we would be doing otherwise. Microcircuits have had less than a 10 percent effect on our conventional sales, so we're not worried about that point at all."

There will be definite shifts in personnel, Noyce predicts. "There will be more emphasis on fabrication personnel, as opposed to assembly personnel," he says. "This will come about in a gradual upgrading of the type of personnel required for microcircuitry, in terms of experience and training, because this business has an ultra-sensitivity to error. The yield factors because of all the individual steps involved, are fantastically high. You need almost 100 percent in all stages, or else you'll get nothing out at the end

PROJECTED SALES OF ELECTRONIC PARTS AND GROWTH RATES

(in $ millions and in percent)

	1962 (Actual)	Growth Rate 1959–62 (%/yr.)	1967 (Proj.)	Growth Rate 1962–67 (%/yr.)	1972 (Proj.)	Growth Rate 1967–72 (%/yr.)
Discrete Active Elements	$1,252	10.9	$1,490	3.5	$1,755	3.3
Discrete Passive Elements	897	9.5	1,205	6.1	1,455	3.8
Filters and Networks	47	16.4	95	15.1	170	12.3
RCL Modules	16	9.9	23	7.5	30	5.5
Functional Assemblies	37	19.8	125	27.6	200	9.9
Microelectronic Circuits:						
Thin-film	5	....	75	71.9	200	21.7
Semiconductor	10	....	225	86.4	800	28.9
	$15	....	$300	82.1	$1,000	27.2
Electrochemical and other parts	1,076	9.4	1,432	5.9	1,835	5.1
Total Circuit Parts	3,340	10.2	4,670	6.9	6,445	6.6
TV Picture Tubes	175	(0.9)	205	3.2	265	5.3
Antennas, Loudspeakers, etc	195	(0.2)	235	3.8	290	4.3
Grand Total	$3,710	8.8	$5,110	6.6	$7,000	6.5

(Courtesy Sprague Electric Co.)

of the production line."

On custom versus standard modules, Noyce thinks that as advance systems come into being, they will probably become standard right away. "Most customs from here on will probably be retro-fit jobs, jobs to re-fit systems that have already been designed." Fairchild's business now is about 50-50 in dollars, but about 75-25 (standards to custom) in unit volume. This is because there is a one-to-three ratio in price.

Noyce doesn't look for much competition from new firms coming into the market. "The innocents have vastly underestimated the difficulties of getting into this business successfully," he says. There are probably four things needed to make it: five times the money you think you need; a reasonably healthy knowledge of the semiconductor industry; lots of experience in very tight control of manufacturing, and some good research behind you. And after five years, I'd list them in reverse order."

COMPONENTS CHANGES—In some quarters, microelectronics has been regarded as the death knell for the components industry as we know it today. Robert C. Sprague, Chairman of the Board and Chief Executive Officer of Sprague Electric Company emphatically disputes this view. At the Chicago conference this week, he explained some of the reasons why he believes that the radical changes in relationships among companies in the electronics industry, as forecast by some observers, may not come about. According to Sprague, people outside the components industry tend to look upon the components maker as a fabricator of bits and pieces by essentially very simple processes.

"Nothing could be further from the truth," says Sprague. "We are essentially in the materials processing business, in such fields as electrochemistry, metallurgy and solid-state physics; we use a wide variety of highly sophisticated processes such as controlled etching and plating, film deposition, diffusion, pressing and sintering and many others, most of which require very heavy capital investments." Sprague's implication is clear—who else is better prepared to meet the challenge of microcircuitry than the old-line components maker? In his view, for the component maker who has a broad base in all the important technologies of electronic circuits, assembled or integrated, the opportunities to share in the future growth of electronics are very good indeed. "To do this, however," Sprague told the conference, "he will have to be in a position to spend substantial sums of money on development work covering the entire spectrum of electronic materials and processes, and he will have to know enough about circuit design to work intelligently with the circuit developers in the systems field."

Sprague's own firm is heavily involved in microcircuits now, with 64 engineers and technicians directly involved in microelectronic circuitry R&D. But based on the projected figures derived by his market researchers, there will continue to be a market for discrete components for many years to come. (See Table) These figures show that the projected growth of microelectronics is part of a continuing evolution in the components area, and that while microelectronics will increase rapidly in volume, they will still not represent the dominant part of the total ten years from now.

VAN POPPELEN, JR: "The custom vendor is a subcontractor . . "

INTEGRATION—Sprague disagrees with those who say either that the major systems supplier will have to integrate downward in order to avoid complete loss of his design prerogatives, or that the component manufacturer will have to integrate upward to the systems level. "I believe present well-established working relationships between the systems manufacturer and his suppliers will be maintained to the advantage of both, what ever physical form the circuit elements may take. I say this with confidence, because such relationships are already being established between my own company and certain system suppliers."

He looks upon the specialized supplier active in the field of microelectronics as a special kind of component maker, facing the same requirements for successful operation as the broad-based components maker, including the large investment needed in highly skilled personnel and elaborate processing facilities.

Robert Galvin, youthful president of Motorola, agrees with Noyce and Sprague that microelectronics will have little effect of consequence on conventional component manufacturers in the next five years. But he looks for new kinds of discrete conventional components—preserving the advantages of simplicity, low price and high volume—within ten years.

Galvin told ELECTRONICS, "A lot of component makers are going to be disturbed within the next ten years unless they can 'effervesce'—through parallel development of improved conventional components.

BARDEEN: "Countermeasures against becoming obsolete . . "

For those who can, a big chunk of the market should remain. The general market should increase absolutely."

According to H. Gunther Rudenberg of Arthur D. Little, Inc. these parallel improvements in conventional components may be "forced" by the potential high reliability and low cost of microelectronics.

"Just as transistors forced improvements in tubes," he says, "They've become better and smaller and cheaper and use less power since transistors came in."

The advent of microelectronics, says Rudenberg, has already forced changes in the point of view of circuit designers. "Microminiaturization has shown them how to get rid of large expensive capacitors. Under its impact, some designers have designed ingenious circuits within the framework of conventional electronics to reduce size, improve reliability, lower costs, and in general use components more imaginatively."

CUSTOM VS. STANDARD—As vice president for marketing of Signetics, one of the few smaller firms specializing in semiconductor integrated circuits, F. J. Van Poppelen, Jr. holds that the buyer-vendor relationship depends on whether marketing of microelectronics goes one of three ways, which in his classification include the custom circuit, the customized circuit, and the standard circuit. He defined these as follows:

(1) The custom circuit—designed to the buyer's unique specifications starting from circuit analysis and proceeding through all stages of development, mask fabrication, diffusion, metalization and the rest.

(2) The customized circuit—a design to the buyer's circuit but based on a configuration of diffused components already being used by the vendor in the fabrication of his standard circuits.

(3) The standard circuit—an off-the-shelf circuit designed by the vendor to a set of specifications that represent his own best judgment on what circuit or circuits will find the greatest acceptance and widest application.

Van Poppelen is betting on the standard circuit as having the major short term impact in microelectronics because he believes the standard product approach is the most economical in terms of cost and customer engineering. "Where custom circuits are concerned," he says, "the vendor is essentially a subcontractor—not a component supplier—and the preparation of a responsible bid on a custom integrated circuit is costly. It involves preliminary design and process evaluation, and may tie up a considerable amount of engineering time and talent—so much, indeed, that there is an increasing reluctance to bid on custom circuits for which the production potential is either small or indeterminate." The major weakness in the custom circuit approach, he feels, is the shortage of engineers competent in both circuit design and diffusion technology.

The customized circuit offers concrete advantages over the custom circuit in terms of cost, because the final product uses the same masks and diffusion steps as the vendor's standard product line up to the metallization step.

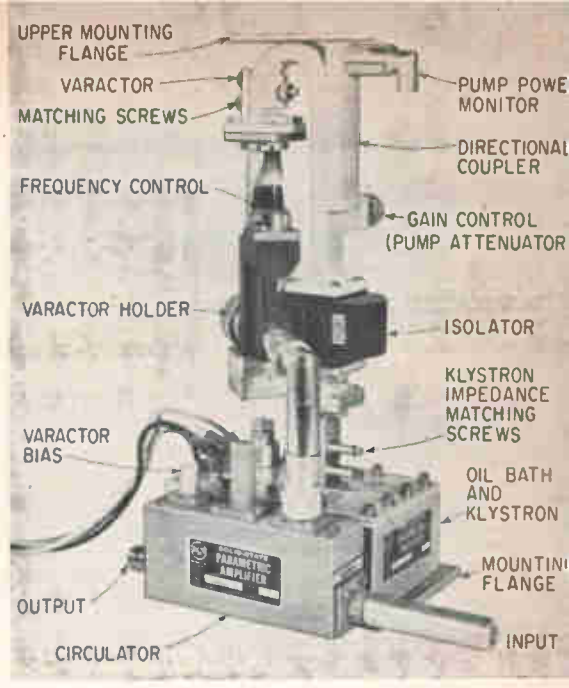
"Where time and volume production are concerned," says Van Poppelen, "the outlook for custom integrated circuits is quite favorable. But until process improvements are made, the short term solution to the buyer's need for small quantities of custom circuits lies in the customized circuit."

But the customized circuit still demands a cost premium and extra customer and vendor engineering time to achieve the optimum interconnection design. That's why Van Poppelen feels that the vendor with a good, extensive line of standard circuits will be in an advantageous position over the next two or three years.

EDUCATION—One of the chief effects of microelectronics on the engineering curricula will be a trend toward more basic science education for engineers—even at the expense of some current state-of-the-art courses. This was outlined to ELECTRONICS by Prof. John Bardeen, Nobel Laureate, co-inventor of the transistor, and now at the University of Illinois. The advent of microelectronics also emphasizes need for more interdisciplinary training for engineers and for closer interaction between industries and universities, according to Bardeen. "These would be countermeasures against becoming obsolete amid fast-changing technologies," he says.

Engineers in successful companies of the future will have to move knowingly among biological sciences, optics, physics, nucleonics, physical chemistry and metallurgy as well as in electronics, Bardeen predicts. Evolution of microelectronics is making materials research one of the most significant new trends in engineering promising growth potential for a whole new electronic generation over the next quarter century. "Understanding the nature and composition of materials has proved to be an essential foundation for breakthroughs in technology—particularly in electronics."

Bardeen calls for closer cooperation between industry and educational institutions to meet the demands imposed by the new technology. He suggests that updating should probably be a joint undertaking over the next decade, resulting in closer association between industrial and university research, including the exchange of information between both groups.



SOLID-STATE *amplifier of unitized construction bolts directly to heat sink*

S-Band Paramp Approaches Noise-Figure Minimum

Combining latest techniques produces better than four-to-one noise reduction over early parametric amplifiers and more than two-to-one improvement at 3 gigacycles over recently developed equipment. Amplifier also has a stable 2-percent bandwidth

By P. KOSKOS, D. MAMAYEK, W. RUMSEY and C. L. CUCCIA
Radio Corporation of America, Electron Tube Division, Los Angeles, California

PARAMETRIC AMPLIFIERS under development in several divisions of the Radio Corporation of America have been described in the literature[1-9].

Signal-frequency amplification in the present developmental paramp is conventional. The device conforms basically to the classical three-frequency nondegenerate model in which an r-f signal frequency and an r-f pump frequency are applied to a varactor in a circuit structure that also supports a difference or idler frequency across the varactor. A signal frequency of 3 gigacycles is used, a pump frequency of 17 gigacycles, and an idler frequency of 14 gigacycles. Because both idler and pump frequencies are in Ku band, the circuits use Ku-band waveguide. The signal circuit at 3 gigacycles uses a coaxial-line structure.

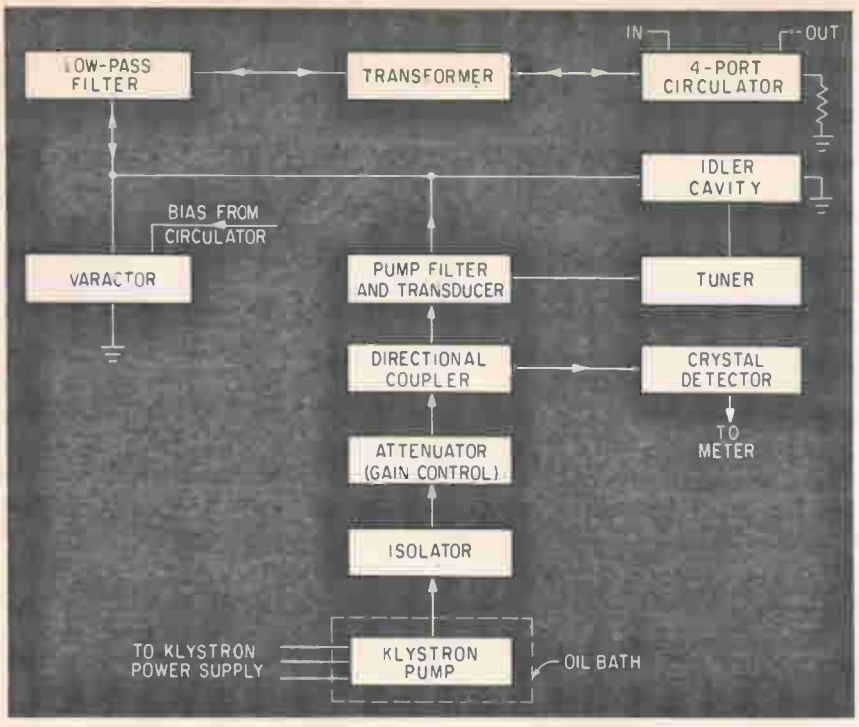
Excluding the pump-circuit power supply, the structure is suitable for installation in an enclosure only 6 by 6 by 11 inches. The pump circuit includes a klystron, immersed in an oil bath on which the parametric amplifier is mounted.

The general circuit of the amplifier structure is shown as a block diagram in Fig. 1. The pump circuit includes a Ku-band klystron, a Ku-band isolator, an attenuator, directional coupler and crystal used to measure pump power. The pump filter and transducer couple the pump to the varactor. The idler circuit comprises a 14-gigacycle cavity resonator and tuner. The varactor is positioned at an optimum match point to enhance transmission of the pump signal through the cavity to the varactor.

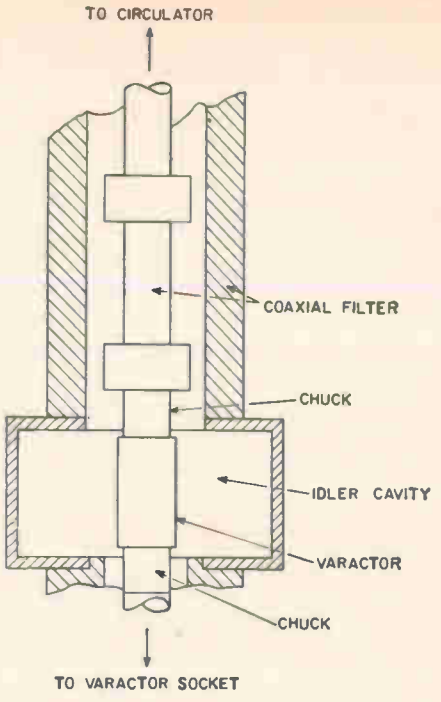
A FOUR-PORT CIRCULATOR of special design is included in the in-

IMPROVEMENTS ADD UP

Noise figures are not reduced by quantum jumps—not even in parametric amplifiers! Improvements generally come in a series of small steps. Early parametric amplifiers had noise figures from 4 to 5 db at S-band, owing to lossy circulators, inadequate varactors and excessively complex circuits. Reproducible noise figures in the range 2.5 to 3.5 db resulted from circuit-design and component improvement. The developmental parametric amplifier described here further reduces the operational noise figure to the 1.5-2 db range at 3 gigacycles—close to theoretical minimum. Such performance, achieved over substantial bandwidths, is obtained with a low forward-loss garnet circulator and a Ku (17 gc) band pump, optimum circuit design, and excellent coupling to the varactor at signal, idler and pump frequencies



LOW NOISE AND STABLE BANDWIDTH *are accomplished through a combination of improved techniques shown in block diagram—Fig. 1*



DISK-LOADED COAXIAL LINE *prevents leakage of idler and pump energy into input signal circuit. Chuck permits rapid insertion of varactors—Fig. 2*

put-signal circuit. The amplifier is coupled to the second port of the circulator through an impedance transformer and pump filter. The circulator includes a d-c block that allows bias voltage to be applied to the varactor. The circulator has a forward insertion loss in the order of 0.1 db. This low-loss performance, together with high reverse-insertion loss, is an important factor in the ultralow-noise characteristic of the parametric amplifier.

The input-signal circuit includes a coaxial low-pass filter described by Cuccia and Hegbar[7] and by S. Cohn[8] during the 1940's. This filter comprises a disk-loaded coaxial line with a cutoff frequency sufficient to prevent leakage of idler and pump energy into the input signal circuit. The use of this filter in association with the varactor in a parametric amplifier, shown in Fig. 2, was first proposed by R. Kurzrok[9] at the RCA Surfcom Laboratories in 1959.

A ten-turn vernier dial tunes the idler cavity to change the frequency of amplification. This adjustment is the only tuning required.

VARACTOR DIODE replacement is facilitated by a large knurled knob opposite the coaxial input line. When the knob is unscrewed, the diode and its spring-chuck mounting can be removed. The parts are designed to insure positive seating and locking. The entire amplifier structure is bracketed together for rigidity, and can be bolted to a heat-transfer surface that is in contact with the flanged bottom of the oil bath.

The parametric amplifier requires only the klystron power supply for stable, reliable operation at ultralow-noise figures substantially below 2 db at 3 gigacycles. Design of the amplifier permits operation at other frequencies in the range from 1 to 5 gigacycles.

OIL-BATH IMMERSION of the klystron, which operates at approximately 17 gigacycles with a power output of less than 50 milliwatts, stabilizes klystron frequency and power to the extent indicated by the graph in Fig. 3.

VARACTORS with extremely high cutoff were not required. This fact was evident after the design had been optimized and excellent matching to the varactor had been achieved in the signal, idler, and pump circuits of the parametric amplifier. Double-ended cartridge-type varactors that were used had cutoff frequencies in the order of 70 gigacycles at zero bias and capacitances of approximately 0.8 pf.

NOISE FIGURE of a parametric amplifier depends upon the insertion losses of the circulator and input circuit and also the noise contributed by the varactor and idler

NOISE FIGURE IS A TOTAL

Forward insertion loss of input port to the paramp port of circulator	0.15 db
Excess idler noise (from equation)	0.85
Input filter loss	0.10
Idler cavity wall loss (approximate)	0.05
Varactor resistive loss (approximate)	0.05
Miscellaneous connector losses in input circuit	0.05
Total (paramp theoretical noise figure)	1.25 db

circuit. These losses, in the order of one db, add to the fundamental minimum theoretical noise figure established by the ratio of idler frequency to signal frequency.

The lowest noise figure, NF that a parametric amplifier can provide when operated at ambient room temperature and with a lossless input circuit, circulator, and idler cavity can be calculated from the equation[1]

$$NF = 1 + \frac{W_s}{W_i}$$

where W_s and W_i represent the signal and idler frequencies, respectively. For a signal frequency of 3 gigacycles and an idler frequency of 14 gigacycles, the noise figure of the lossless parametric amplifier has the value

$$NF = 1 + \frac{3}{14} = 1.214\ (0.85\ \text{db})$$

This value is the excess idler noise. For a practical parametric amplifier circuit, the losses and noise that contribute directly to the noise figure are listed in the box.

Thus, the 1.3-to-1.9-db noise figures measured for the parametric amplifier, when the varactor is at room temperature, approach the theoretical optimum.

PERFORMANCE of the amplifier was measured with the three different varactors listed in the table. Gain measurements were made with a swept-frequency system in which the gain-frequency characteristics were displayed on the calibrated face of an oscilloscope.

Noise figure was measured in a circuit in which the parametric amplifier was used to drive an S-band low-noise traveling-wave tube. The traveling-wave tube was operated at substantial gain to minimize noise-figure deterioration in the stage following the parametric amplifier and to provide the amplifier with a stable load. Noise-figure was measured with a Hewlett-Packard Model 340E noise-figure meter operated with a calibrated noise source. The test setup was calibrated with ultralow-noise traveling-wave tubes having noise figures accurately determined by the hot-cold load method.

With the signal and idler circuits single-tuned, bandwidths in the 45-to-70 megacycle range were measured. The bandwidth was extremely stable for normal operating temperatures of 40 C. With the amplifier heated to 70 C, no gain change was observed, and the shift in center frequency was less than 3 megacycles. During repeated tests of several models of the amplifier, valid single-channel noise figures as low as 1.3 db were measured under highly stable operating conditions with the amplifier operated for many hours.

OPERATING CONDITIONS FOR THREE VARACTOR TYPES

Varactor Number*	Center Frequency in gc	Bandwidth in mc	Gain in db	Noise Figure in db	Varactor Bias in volts
685	3	53	17	1.9	+0.7
710	3	45	17	1.5	+0.7
709	3	60	17	1.5	+0.5

Varactor Number	Klystron Beam volts	Klystron Beam ma	Reflector volts	Pump Frequency in Gc	Pump Power in mw
685	570	52	175	17.05	40
710	570	52	175	17.05	40
709	570	51	175	17.05	15

* Manufactured by Semiconductor Devices, Inc., Newport Beach, Calif.

When double tuning was used in the signal and idler circuits, bandwidths as great as 100 megacycles were observed without increase in noise figure, and bandwidths as large as 200 megacycles were measured with the noise figure still in the 2 db range. The latter measurements, obtained with a pill type varactor, indicate the capability of the amplifier.

The writers acknowledge the aid of A. Solomon and B. Bossard.

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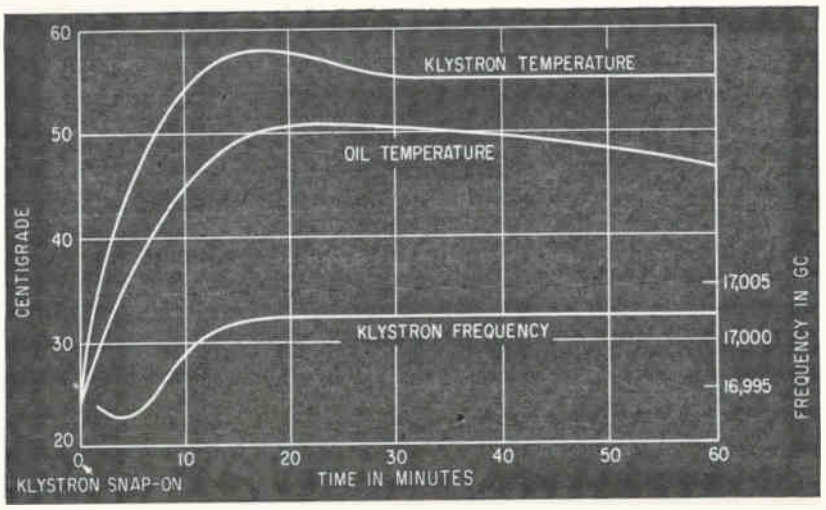


KLYSTRON FREQUENCY STABILITY *is insured by oil bath—Fig. 3*

TUNNEL DIODES Part III

Mixer and Converter Circuits

Here tunnel diodes enter the highly competitive fields of mobile communications, t-v systems and related uses. Advantages of using tunnel diodes lie in the compactness of their circuits, wide operating temperature range, plus months of useful life from flashlight batteries

By ERICH GOTTLIEB AND JOHN GIORGIS
Consultants,
GE Semiconductor Products Department, Syracuse, New York

TUNNEL DIODE oscillator and amplifier function's may be combined and the device used as a frequency converter.

The amplifier section (Part II) shows that if the tunnel diode oscillates or is externally driven, its "time-average" or "large signal" conductance is made considerably smaller than its small signal value. Thus the converter gain will in general be smaller than the amplifier gain. As a result one cannot expect to obtain as low a noise-figure in the converter as in the amplifier, but at best, one can hope to approach the amplifier noise figure.

There are several ways to use the tunnel diode as a frequency converter, each having its distinct advantages and disadvantages. These configurations are

- Self-oscillating (autodyne) converter.
- Positive input-impedance driven-mixer.
- Negative input-impedance driven-mixer.
- Passive driven-mixer.

SELF-OSCILLATING — Needing only one active device, the self oscillating converter is the least expensive of the converter circuits. All other approaches use two active devices, one for the local oscillator the other for the mixer.

The tunnel diode, when biased in its negative conductance region, can oscillate, mix, and amplify simultaneously, and can therefore operate as an autodyne (self-oscillating) converter with gain. Frequency conversion is achieved by the nonlinearity of the g-V characteristic with the diode biased at points A, B, C, or D, Fig. 1A. The requirement of self-oscillation, however, eliminates bias point A since the diode must be biased in the negative conductance region to oscillate. Furthermore, since the slope of the region A-C is steeper than C-D, greater conversion gain and better oscillator stability can be obtained at point B than at point D. Operation at C yields a great deal of second harmonic output, hence this point is generally chosen for harmonic conversion.[1]

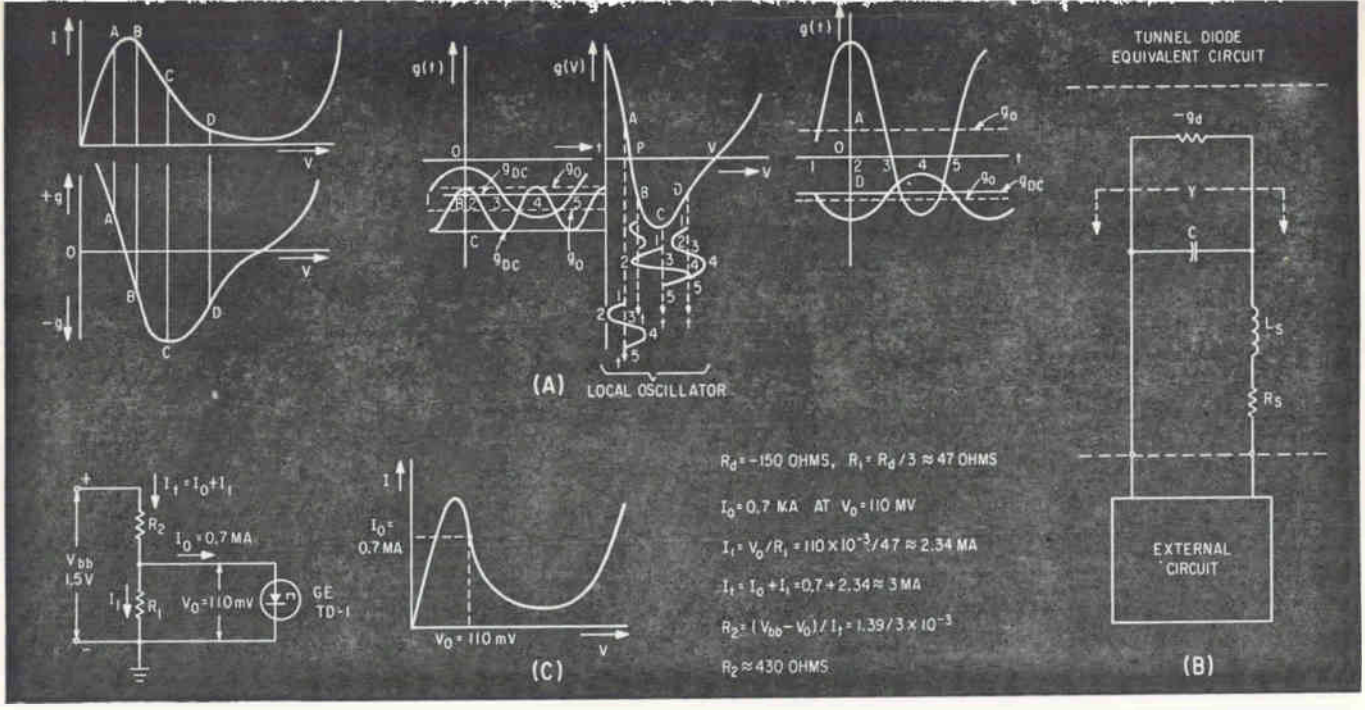
As the diode oscillates at the local-oscillator frequency, it swings over a large part of its nonlinear negative conductance characteristic. Mixing can thus take place if an r-f signal is fed into the circuit. Remarkably, while the diode oscillates at the local oscillator frequency, it can simultaneously amplify at both the r-f and i-f frequencies. Furthermore, since the tunnel diode conductance is "time-averaged" by its oscillator swing, small signal amplification can be accomplished more stably this way than in the straight tunnel-diode amplifier. However, frequency-stable conversion is the prime objective and amplification can therefore be kept small.

A single tunnel diode can provide stable performance in the simultaneous functions of r-f amplifier, local oscillator, mixer and i-f amplifier.

Mathematically this imposes certain requirements[1] on the relation-

WHY A TUNNEL DIODE CONVERTER

Parametric amplifiers may have poor noise figures in "down converter" circuit; tunnel diodes work fine whether converting downwards or upwards. To detect high-frequency signals in the gigacycle range beyond reach of vacuum tubes, a crystal mixer is usually provided with output from a klystron or traveling-wave-tube local-oscillator. Tunnel diodes can do all this in one unit. The same tunnel diode acts as the local oscillator and mixer and throws in a little overall gain for good measure. Its noise figure is good too. Specially constructed tunnel diodes, known as backdiodes, offer very low forward resistance making them ideal for low-level and video detectors



TUNNEL DIODE *characteristic curves are used to determine best bias conditions for frequency conversion (A), generalized tunnel diode circuit pertaining to converter operation (B), derivation of bias circuit components from characteristic curve and operation conditions (C)—Fig. 1*

ship of the external circuit to the equivalent circuit of the tunnel diode as seen in Fig. 1B.

Table I shows that the converter circuit will generally consist of three tank circuits resonating at the i-f, r-f and l-o frequencies respectively. The real termination or loading of these tank circuits must be satisfied in the following manner.

- At the l-o frequency the real part of the circuit admittance Re (Y), (including the parasitic parameters C, L_s and R_s of the tunnel diode) must be equal or smaller than the absolute value of the negative tunnel diode conductance at the bias point ($-g_{d1}$).
- At the r-f frequency, the real part of the circuit admittance, Re (Y), (including the parasitic diode parameters) must be larger than the time average negative conductance of the tunnel diode $|g_o|$.
- At the i-f frequency, the real part of the circuit admittance Re (Y), (including the parasitic diode parameters) must be larger than the time average conductance $|g_o|$.

CONVERTER DESIGN — Basic parameters: the r-f and i-f frequencies, are established by application considerations. From these frequencies the l-o frequency is determined. If, however, the i-f frequency is small compared to the r-f, the l-o frequency would be awkwardly close to the r-f frequency. For example, if the r-f frequency is 500 Mc and the i-f 10 Mc, then the l-o frequency would normally be either 510 Mc or 490 Mc. In a simple circuit like the autodyne converter, tank circuits resonanting so close to each other would cause a great deal of tuning-interaction, oscillator pulling, and loss of gain. Therefore, when the r-f and l-o frequencies are too close, harmonic conversion can be used. This means that the l-o tank circuit is resonated at half its desired frequency, thereby removing it far from interference with the r-f tank circuit. The tunnel diode is then operated at its inflection point, generating a great deal of second-harmonic output for mixing with the r-f signal. After all operating frequencies are determined, the diode can be selected.

Choice of diode starts with selection of the diode package. If the converter is to operate in the microwave region, a pill-type unit with inductance in the 0.1-0.4 nh region should be selected. For frequencies at or below uhf, higher-inductance housings can be tolerated, but from a stability standpoint it is always preferable to keep this inductance as low as possible. Even an inexpensive general-purpose tunnel diode should exhibit low inductance typically: 0.5nh for an axial package and 0.1nh for a sandwich package. Choice of the tunnel diode housing will determine the shape and make-up of the mount.

Once the tunnel diode package is determined the converter design will be derived from the operating parameters. For instance, if the circuit must handle source and load impedances of 50 ohms, the negative resistance of the diode must be high enough to abide by the stability criteria in Table 1. Secondly, for stable, low-noise performance, the resistive cut-off frequency (f_{r0}) should preferably be at least three times the operating frequency. The self resonant frequency (f_{r0}) should also considerably exceed the operating frequency.

When the diode is chosen, typical values and tolerances of negative conductance gd, capacitance C, inductance L_s, series resistance R_s as well as I_p, I_v, V_p, V_v and V_{fp} will be defined. This knowledge permits the bias circuit to be designed.

A 1 ma tunnel diode, biased at operating point B, Fig. 1A, implies a voltage of approximately 110 mv at a current of 0.7 ma. At this operating point it exhibits a negative conductance of 6.6×10^{-3} mho, or negative resistance of –150 ohms, so that the parallel combination of R_1 and R_2, Fig. 1C, may never exceed 150 ohms. The lower the series equivalent resistance the stiffer the voltage source. Unfortunately current consumption increases as this series equivalent resistance decreases. The numerical value of

equivalent resistance R_{eq} is given by $R_{eq} = (R_1 \times R_2)/(R_1 + R_2)$ A compromise value for R_{eq} is about one third of the negative resistance.

EXAMPLE—The bias network resistors, of Fig. 1C are calculated using a tunnel diode having a negative resistance at the operating point of −150 ohms.

The next step is to design the oscillator tank circuit, with its L/C ratio selected for resonant impedance at all times larger than its effective negative resistance. (see Part I on oscillator design). The question of required frequency stability must also be considered. Is the inherent stability of the tunnel diode oscillator adequate for the application or must the oscillator be crystal controlled? The frequency stability of the simple oscillator can be made better than ±200 parts/million by compensation. To ensure this or better performance, crystal control should be used.

Now the r-f must be coupled-in and the resultant i-f coupled-out. Some operating conditions are:

- Absence of appreciable reduction in oscillator stability.
- No undesirable oscillation at r-f, i-f, or spurious frequencies.
- Some stable r-f and i-f amplification.
- Lowest possible noise figure.

It was established in Part I that when the tunnel diode oscillates (or is externally driven) the resulting average conductance (g_o) and time average conductance (g_{dt}) become a function of the oscillation amplitude. Therefore, in a converter circuit, the conductances seen at both r-f and i-f frequencies are a function of oscillator amplitude.

It had also been established that the magnitude of these average conductances g_o and g_{dt} are reduced as the oscillator amplitude increases. Therefore the smaller the oscillation amplitude the closer g_o gets to the small signal conductance at the operating point (g_{dt}). On the other hand if the oscillation amplitude is large (as can be in a driven mixer) g_o can even become positive. Thus, depending on oscillator amplitude, the r-f and i-f impedances exhibited by the tunnel diode can go from somewhat above r_{dt} (normally around −150 ohms for a 1-ma tunnel diode) to infinity and even become positive.

To obtain r-f and/or i-f amplification it is necessary to match the input and output terminations to the oscillator-dependant average conductance g_o, without introducing instability. Hence, the real value of admittance must be greater than $|-g_o|$, when the imaginary part of $Y = 0$ to obtain stable gain. Unfortunately the average conductance is not given by the manufacturer as the measurement is involved and uses specialized equipment. Several papers have treated this subject.[2, 3, 4, 5, 6]

Basically data could be approximated from a graphical analysis of the diode characteristic. Here again, exact tunnel diode g-V curves are not conveniently available and it is generally more practical to derive these parameters experimentally. For a rough estimate of a g-V plot, the oscillation-amplitude and bias operating point will indicate the expected results.

Assuming a conductance g_o of −0.002 (equivalent $r_o = 500$ ohms) the r-f and i-f terminating impedances will have to be somewhat smaller than +500 ohms and require adjustment in the r-f and i-f transformer turns ratios to present such impedances to the diode. If the reflected terminating impedances are too high, the oscillator will switch modes from l-o to r-f and/or i-f oscillations; conversely, if the reflected terminating impedances are too small, low gain can be expected. It is best to start from

CONVERTER CIRCUITS—A Civil Air Patrol converter[7] can be designed in a small dashboard-mounted-box operated by a single flashlight cell. It is connected between the car radio antenna and the receiver and receives CAP frequencies (4.465 Mc) and converts

CONVERTER OPERATING CONDITIONS—TABLE I

Operation	Requirements
Oscillation at f_{l-o}	Re $(Y) < \|-g_{dt}\|$ Im $(Y) = 0$
Stable Amplification at f_{r-f}	Re $(Y) > \|-g_o\|$ Im $(Y) = 0$
Mixing	Proper bias point choice and sufficient oscillator swing to provide large conductance change
Stable Amplification at f_{i-f}	Re $(Y) > \|-g_o\|$ Im $(Y) = 0$

PERFORMANCE DATA FOR TUNER, FIG. 2G—TABLE II

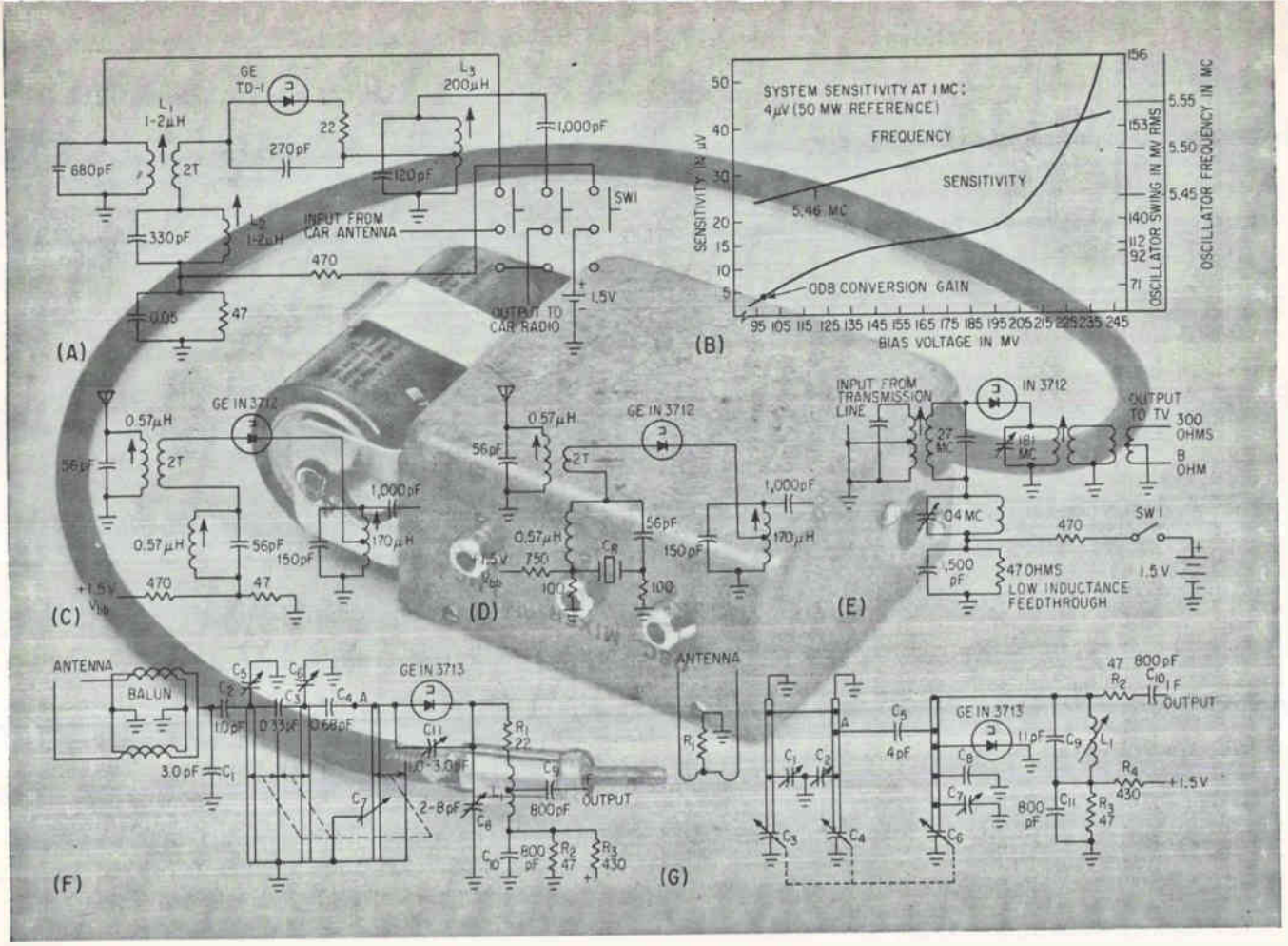
Frequency	Sensitivity	Noise Figure	Band Width	Overload Characteristics
	20 volts p-p, 400 cps at crt			Distortion and Sync. Clipping Across 300-ohm balun
850 Mc	10.3 μv	15.5 db	6 Mc	
820 Mc	8.8 μv	14.5 db		at 25 mv
700 Mc	8.1 μv	14.2 db	6 Mc	at 20 mv
500 Mc	5.9 μv	13.6 db	6 Mc	at 20 mv
470 Mc	6.9 μv	13.9 db		
Dynamic range to approximately — 27 dbm				

COMPARISON OF BACKDIODE CHARACTERISTICS—TABLE III

	R_b	C	R_b	13.5 Gc β at 1 μw power	13.5 Gc M Calculated	6.0 Gc β at 1 μw power	6.0 Gc M Calculated
	ohms	pf	ohms				
MA408B No. 5	42	0.23	35,000	0.2	37	2.0	370
MA408B No. 6	32	0.32	20,000	0.2	28	2.0	280
BD No. 5	10	0.30	730	2.7	45	11.0	180
BD No. 7	8	0.50	880	2.4	47	7.5	145

β = short circuit current sensitivity of the diode
R_b = video impedance of the diode
R_A = equivalent noise resistance of the video amplifier

And M is a figure of merit, where $M = \frac{\beta R_b}{\sqrt{R_b + R_A}}$



CIVIL AIR PATROL *converter (A), performance curves (B) set against background photo; citizen's band converter (C), crystal controlled version of the citizen's band converter (D), tunnel diode "up converter" for community t-v (E), tunnel diode tuner (F), uhf tunnel diode tuner with capacitance tuning (G)—Fig. 2*

them to the broadcast band. The circuit of this converter is shown in Fig. 2A, its performance in Fig. 2B and the finished converter in the background photograph.

The data, Fig. 2B, shows that 0-db conversion-gain can be obtained at close to 100-mv bias. In the range of 100 to 135-mv bias, the gain is less than unity but since this conversion loss is generally of little consequence.

Two types of citizens band converter circuits were investigated[7]. The first is straightforward, and by ganging the r-f and l-o circuits, the converter can be made to tune over a moderate frequency band. The second converter circuit is crystal-controlled at fixed frequency.

The simple converter uses the same design procedure as the CAP version and is shown in Fig. 2C; its performance is similar to the CAP type.

The crystal controlled converter, Fig. 2D, differs only in the oscillator section, which uses the crystal controlled circuit discussed in the oscillator section, Part I. The resonant resistance of the crystal R_{CR} reduces the oscillator amplitude, which in turn reduces the average negative resistance R_{av}. Consequently, the turns ratio on input and output coils is increased over the values shown in Fig. 2C.

FIRE DEPT. CONVERTERS — These automobile-mounted units enable volunteer firemen to get to the fire without first reporting to the station for information.

Some of these Fire Department converters operate in the 46-Mc range and thereby present an additional design problem. Operating at 46 Mc with a 1 Mc-i-f having a few kilocycles bandwidth puts a great burden on the frequency-stability of the oscillator. This is especially true for converters placed in a car, since they must operate stably over wide temperature ranges. Such applications require crystal control for best results. Although the transmitters are generally frequency modulated, slope detection in the car radio yields intelligible reception.

When operating at about 10 times the frequency of the CAP converter, both L and C may be divided by 10, thereby keeping the same L/C ratio at the new operating frequency. If this makes the input capacitance too small, the L/C ratio can be slightly altered.

COMMUNITY TV—In many poor-reception rural areas, community t-v service organizations provide a remote master antenna located in a suitable reception area. A master subchannel converter converts the vhf channel frequencies down to lower frequency (subchannel) carriers for cable-transmission and distribution. Wide-band amplifiers keep the signal levels up along the way. In the individual subscribers home an "up-converter" returns the signals to their former channel frequencies. One such type of circuit is illustrated in Fig. 2E.

UHF CONVERTERS — Two versions of uhf television tuners were designed[8] with performance ap-

proximately equal to their tube counterparts, as shown by Figs. 2F and 2G and Table II.

MICROWAVE CONVERTERS — Before tunnel diodes came along, the conventional microwave converter consisted of a crystal mixer driven by an oscillator using such tubes as lighthouse or klystron types. Mixers generally exhibited less than unity gain (−6 to −10 db) and system noise figures ran in the 8 to 15 db range.

More recently, the parametric converter has provided useful gain and hence lower noise-figures. The parametric converter, however, can be an elaborate and complex circuit requiring an external oscillator (pump), refrigeration, extensive power supplies, and other auxiliaries.

The tunnel diode provides a simpler, smaller, and less expensive means of achieving conversion with gain above unity and hence reasonably low noise-figures. In the self-oscillating converter, for instance, no external pump (oscillator) is needed and the only power required is the small supply voltage and current for the tunnel diode, typically 0.15 volt and 1 to 3 ma.

L BAND CONVERTER—A 1 Gc converter, with 30-Mc i-f was designed with the following results: gain = 25 db, noise figure = 10 db, bandwidth = 3 Mc, saturation level ≈ −30 dbm and image rejection = 21 db.

The tunnel-diode converter gain was around 0 db but the converter assembly contained one stage of i-f with 25 db gain (noise figure ≈ 4 db). This arrangement had the added advantage that the first i-f stage served as a built-in buffer between the converter and the external i-f amplifier. The circuit is illustrated in Fig. 3A and 3B.

CIRCUIT—The circuit consists of a half-wave signal stripline shorted at both ends and serving as r-f pre-selector. Radio-frequency energy is coupled in at a low-impedance point *A*. It is then coupled by a movable arm to the open ended quarter wavelength oscillator stripline. The tunnel diode is seated at a high impedance point, such that it can oscillate stably, while the i-f energy is coupled out at the local oscillator null. This i-f signal is then amplified by the low-noise buffer-amplifier transistor.

3 Gc CONVERTER — Another converter, Fig. 3C, was designed for $f_{r\text{-}f}$ = 3,150-Mc, f_{osc} = 3,090-Mc, and $f_{i\text{-}f}$ = 60-Mc. The built-in i-f amplifier buffer stage had the characteristics: power-gain ≈ 18-db, bw ≈ 20-Mc, NF ≈ 4.0-db.

The converter i-f amplifier combination had a power gain of about 13-db, BW ≈ 15-Mc, NF ≈ 11-db and an image rejection of about 10-db.

A paper on a complete solid state s-band receiver[10] discusses a tunnel diode circulator reflection amplifier and a self-oscillating tunnel diode converter. In this receiver, covering a range from 2.0 to 3.0-Gc, the down-converter had noise figures in the range of 12 to 15-db.

POSITIVE IMPEDANCE—Tunnel diodes, when biased in the positive conductance region or subjected to the large-swing oscillations (producing positive average diode conductance) can exhibit a positive input impedance. If the conversion conductance g_1 is made negative at the same time, conversion gain greater than unity can be obtained.

A low-gain tunnel diode converter[4] has claims for exceptional stability with variations of input impedance. This circuit exhibits lower conversion losses, lower noise figures, larger dynamic range and greater resistance to burn-out than crystal-diode converters. Experimental uhf and microwave tunnel diode converters, stable with input vswr's exceeding 10:1 having 0-db conversion losses and 2.5 to 3-db noise figures are described.

While these noise figures were measured under idealized laboratory conditions with a second stage noise figure of 1.7 db, it should be feasible to attain about 6-db system noise figure in a stable fashion. It should also be possible to use another tunnel diode as local oscillator, although the oscillator drive power of several milliwatts entails the use of a high-current tunnel diode of about 100 ma I_p.

NEGATIVE IMPEDANCE — One design approach,[11] uses a bias operating point just below the peak current, and has a small oscillator-swing driving past the peak current into the negative conductance region. The resulting high-gain converter is sensitive to variations in input impedance and has a limited dynamic range owing to the small amplitude of oscillations. Operating in the negative conductance region, with negative values of g_e gives high gain and good noise performance. Unfortunately, this condition is realized only at the sacrifice of stability and dynamic range; minimum noise figure is obtained at the minimum I_0/g_e operating point.

In a 1,200 Mc converter design[12]

PASSIVE BACKDIODE MIXER

A reverse-connected tunnel diode is used primarily for the negative-conductance portion of its forward characteristic. In the reversed direction, it exhibits a large conductance much closer to the origin than any other diode. If used in this reversed direction primarily, the tunnel diode is called a "backdiode".

In mixer applications, the device is usually subjected to zero d-c bias and driven by an oscillator equally about its origin. The first such device, fully characterized in both forward and reversed direction is the 1N4090 and it will be called a tunnel mixer' in this article.

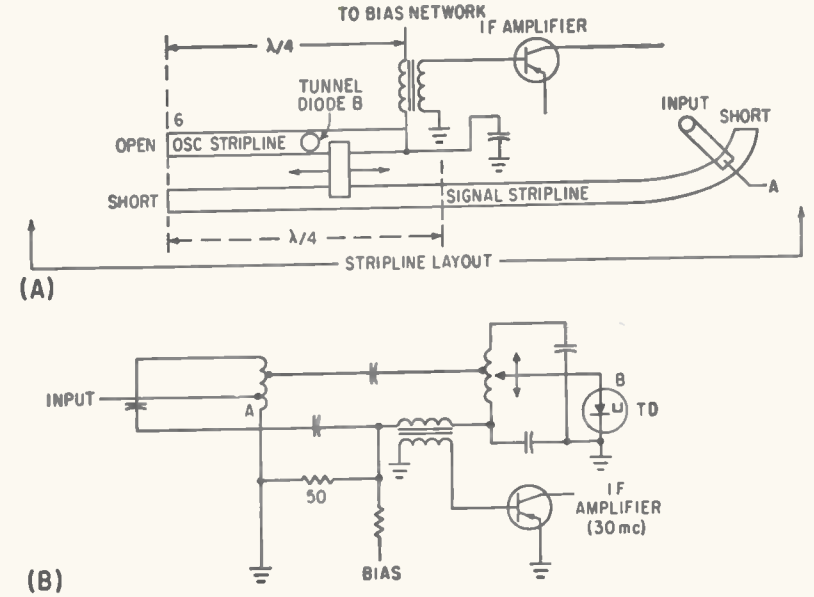
Backdiodes in general are low-current devices (below 1.0 ma) while tunnel diodes have peak currents from 250 μa into the ampere region. Only between 0.25 and 1.0 ma do the two devices overlap. Owing to their lower peak currents, backdiodes have much smaller junction areas and are more fragile than tunnel diodes. The lower-current-concentration material is generally used to make backdiodes mechanically strong

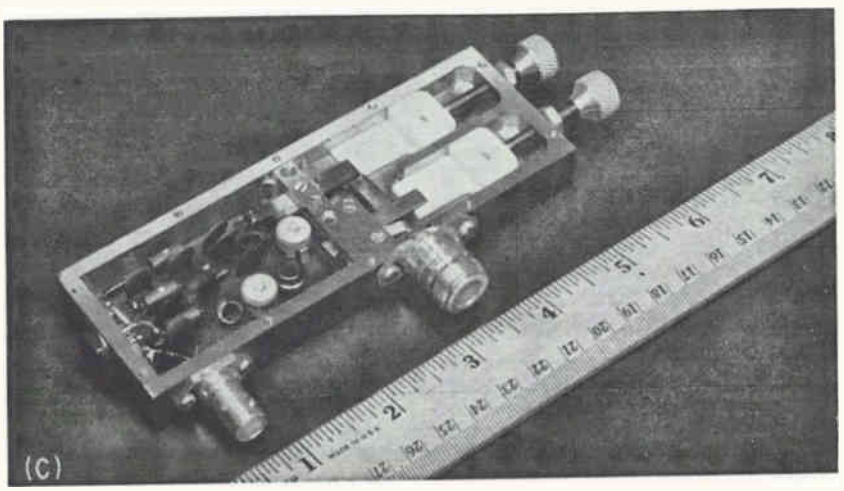
the local oscillator was set at 1,170 Mc and produced a 30-Mc i-f. The tunnel diode, a 1-ma unit, was an early version of the 1N3218A.

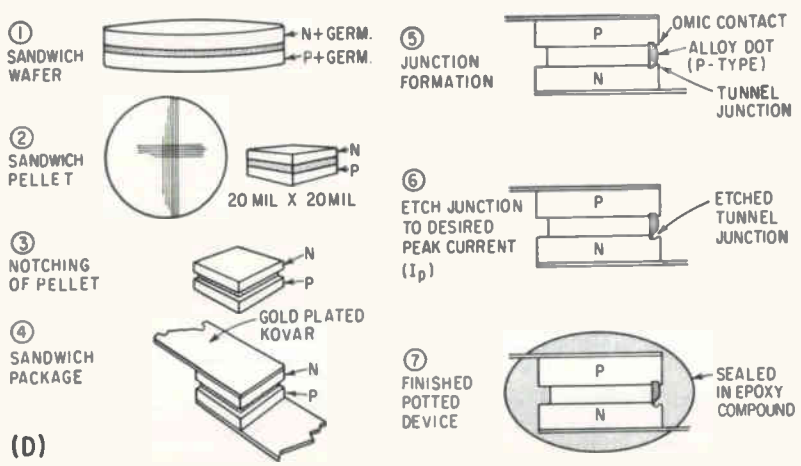
Several noise figure calculations were made for various points of operation about the point of maximum positive slope of the conductance curve in the negative resistance region. Best noise figures were obtained when V_o was between 100 and 200 mv corresponding to the position of minimum IR_d product or minimum I/G_d ratio. With 50 mv peak local-oscillator drive, moderate values of G_i can be obtained with large negative values of G_o. The best calculated value for the noise figure was about 4.7 db. The relative merits of a tunnel diode converter versus by a standard converter require investigation. There is no generality that may be applied: the question must be resolved for each separate application, since each application will have a different set of rules governing stability, gain bandwidth, overall noise figure, and so forth. The noise figure of the converter is in general higher than that of the amplifier. If the gain of the converter is high the system noise figure may approach, or surpass, that of the system using the negative conductance amplifier, since in the process of converting from signal to i-f there is no lossy diode mixer.

USING BACKDIODES — A September 1961 article[18] describes the low-noise properties of backdiodes (see editorial box) used as driven mixers. The article discusses a 13.5 Gc doppler radar mixer (i-f ≈ 1 Kc) and a conventional 13.5 Gc — 30 Mc i-f system, and compares the performance of backdiodes to the best available point-contact mixer diodes in these applications.

In doppler radar systems the i-f frequencies are in the audio range. Here the $1/f$ noise of the mixer is an important consideration. Measurements have shown that backdiodes have much better $1/f$ characteristics than conventional point-contact mixers. This is primarily due to the fact that backdiodes are made with doping levels one to two order of magnitude higher than conventional mixer diodes. A variety of experiments have indi-







TUNNEL DIODE *L-band autodyne converter (A) and its equivalent circuit (B), converter for 3-Gc operation (C), backdiode uses sandwich structure to combine physical support with low inductance and capacitance (D)—Fig. 3*

cated that the surface plays an important part in connection with $1/f$ noise. Since for nearly-degenerate materials the relative change in surface potential is less pronounced than in the nearly intrinsic case, the backdiode's $1/f$ contribution should be smaller than that of the conventional mixer diode. Also, since the resistivity of the semiconductor is reduced, the thermal noise contribution from the spreading resistance may be smaller.

The 1/f noise decreases when the rectified current through the device decreases. Investigations prove that the conversion loss of backdiodes can be kept small at very low levels of local oscillator power, a phenomenon not true for conventional mixers.

In another paper on this subject[14] a 100-Mc balanced mixer converting to 5-Kc obtained a double-channel noise figure of less than 7-db. This is a 30-db improvement over what would be expected from present-day mixers of the point contact variety.

Measurements were also performed from 500 to 2,000-Mc and at 8.9-Gc (with 35-Mc i-f). Noise figures obtained ranged from 5-db at 500-Mc to 14-db at 8.9-Gc.

UHF-TV—In uhf television tuners it is usual to use a vacuum tube oscillator and a diode mixer to perform the frequency conversion. Comparing the performance of backdiodes 1N4090 with conventional mixers (IN82A) at normal l-0 levels without bias or circuit change has shown the 1N4090 to perform at par with the best 1N-82A's. The 1N4090 is a germanium "Tunnel mixer" (backdiode) with a typical capacitance of 1 pf. Somewhat better input and load matching of the circuit to the lower impedance backdiodes might even make the latter look better than their best point-contact counterparts. Other characteristics of the 1N4090 are typical R_s of 4.5 ohms, L_s of only 0.2-nh, and minimum reverse voltage of 500-mv.

OTHER TD APPLICATIONS—Low level detectors provide an interesting c-w application for the backdiode. In a crystal video receiver, the incoming r-f signal is detected right at the antenna and the resulting video amplified by a high-gain video amplifier.

Although such a system is not very sensitive, there are applications where lower sensitivity is acceptable. Examples of such uses lie in beacon radar receivers, and instrumentation square-law detectors. Current sensitivity (β) of the backdiode is better than that for the conventional MA408B detector diode at both 6 and 13.5-Gc.[13] The backdiode also has a wider square-law response as Table III shows. As a result the backdiode is usually more lightly doped than the tunnel diode. To combine low current and low capacitance in one backdiode unit, special packaging, designed for rugged mechanical support is needed. The sandwich structure, Fig. 3D fulfills this need. It consists of a glass layer sandwiched between two germanium wafers. The alloy dot is fused to the two germanium wafers and simultaneously adheres to the glass spacer, thereby providing mechanical strength for the tunnel junction Due to the small overall package dimensions, the parasitic housing capacitance and inductance are only around 0.1 pf and 0.1 nh respectively.

For lower frequency application the sandwich package is furnished with gold-plated ribbon leads; at microwave frequencies, two metal plates provide a pill format to which pressure contact can be made. One suggested mounting method is to mount the pill on the tip of a gold-plated screw, as can be seen in Fig. 1, Part I. The resulting assembly is easy to handle, always properly polarized, can be screwed directly into a type N connector, or can be inserted into cavities and coaxial mounts.

Tunnel and backdiode low level detectors have apppeared on the market[18] with their advertised features claiming the following advantages.

- Better input match for 50 ohm systems—tunnel diodes or backdiodes have low ($\approx$10 ohm) dynamic input resistance, compared to 4,000 to 20,000 ohms for a typical crystal diode.
- Tangential sensitivity — minus 58 to −60-dbm from 50-Mc to 2-Gc with 0.2-Mc video bandpass. Other models are available.

CONCLUSION — There are, of course, many more cw applications for tunnel and backdiodes. Some have already been explored, others will be in the future. Some of the applications that have been examined include frequency multipliers[16] (harmonic oscillators), super-regenerative detectors,[15] parametric motors,[17] pressure transducers[18, 19, 20, 21] radiation detectors,[22] and frequency dividers (Part I).

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Emitter Voltage	V_{EBO}	V	− 0.5	− 0.5	− 0.5
Collector Current	I_C	mA	−10	−10	−10
Emitter Current	I_E	mA	10	10	10
Junction Temperature	T_j	°C	85	85	85
Collector Dissipation	P_C	mW	80	80	80
Ambient Temperature	T_A	°C	60	60	60

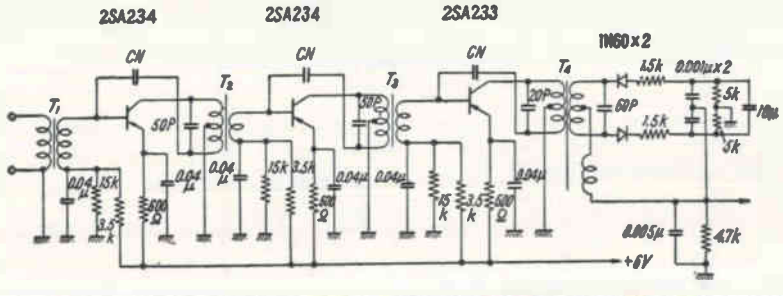
Characteristics (Ta=25°C)

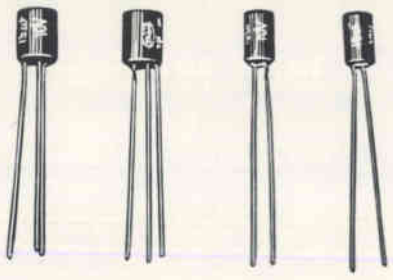
Items	Symbol	Conditions for measurement	Unit	2SA233	2SA234	2SA235
Max. Collector Cut-off-Current	I_{CBO}	$V_C=-20V$ $I_E=0$	μA	−30	−30	−30
Max. Emitter Cut-off-Current	I_{EBO}	$V_E=-0.5V$ $I_C=0$	μA	−50	−50	−50
Current Amplification Factor	h_{fe}	$V_C=-6V$ $I_E=1mA$		50	60	80
Alpha Cut-off Frequency	$f\alpha_b$	$V_C=-6V$ $I_E=1mA$	Mc	90	110	125

Typical Operation (Ta=25°C)

Items	Conditions for Measurement	Unit	2SA233	2SA234	2SA235
Power Gain at FM Radio Frequency	$V_C=-6V$ $I_E=1mA$ $f_S=100Mc/s$ $R_g=75\Omega$ $R_L=2k\Omega$	db	—	—	12
Mixer Gain at FM Radio Frequency	$V_C=-6V$ $I_E=1mA$ $f_S=100Mc/s$ $f_{osc}=110.7Mc$ $R_g=3k\Omega$ $R_L=15k\Omega$	db	—	—	13

10.7 Mc Intermediate Frequency Amplifier Circuit





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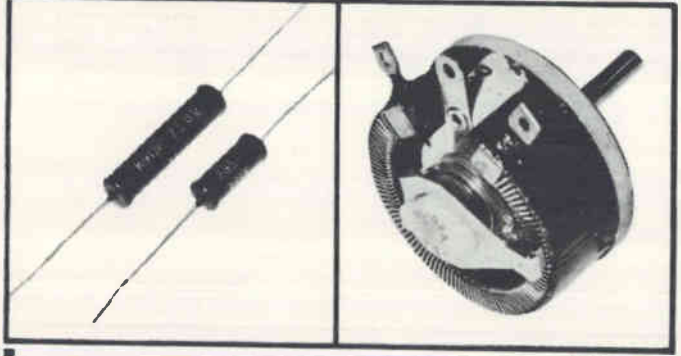

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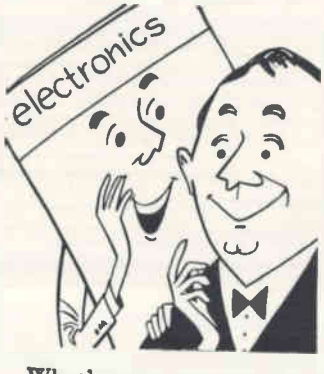

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Type	Package	V_{CBO} max.	V_{EBO} max	I_C max	Power Diss. P_C	Junction Temp. T_j	Current Gain hfe @ f=270 c/s V_{CE}=-6V I_E=1 mW min	max	Cutoff Freq. f_{ab}
2SA29	TO-44	-18V	-0.5V	-5mA	55mW	75°C	20	60	40MC
2SA72	TO-44	-18V	-0.5V	-5mA	55mW	75°C	40	350	40MC

2SA29 Ge. PNP drift transistor for IF stage amplifier with 46 dB power gain at 455 KC.

2SA72 Ge. PNP drift transistor for RF stage amplifier and converter with 40 dB power gain at 1 MC.

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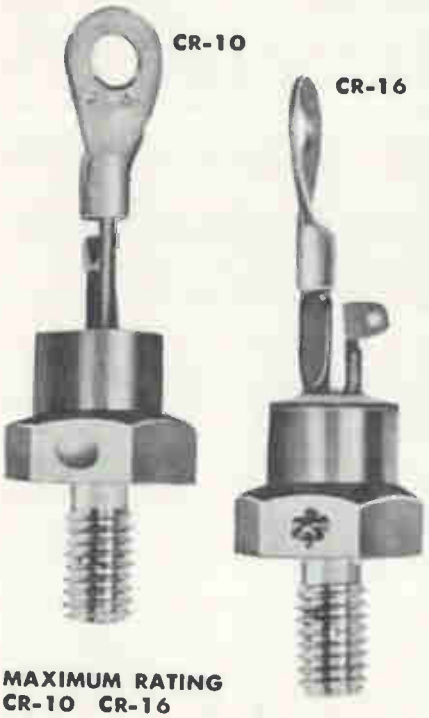
Origin

Silicon **C**ontrolled **R**ectifier

CR-10

CR-16



MAXIMUM RATING
CR-10 CR-16

TYPE Specification	CR-16A CR-10A	CR-16H CR-10H	Units
Peak Voltage (Reverse biased)	25 ~ 400		V
Peak Blocking Forward Voltage	25 ~ 400		V
A.C. Input Voltage	17.5 ~ 280		VRMS
Average Forward Current	(CR-10) 10	(CR-16) 16(Ta=+20°C)	A
Surge Current	(CR-10) 100	(CR-16) 130	A
Peak Gate Power	5		W
Average Gate Power	0.5		W
Peak Gate Current	2		A
Peak Gate Voltage (Forward)	10		V
Peak Gate Voltage (Reverse)	5		V
Junction Temperature	100		°C
Storage Temperature	−40~ +125		°C

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MODEL MI-100

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A novel construction principle helped to make this accomplishment possible. The form is more simplified by setting all the terminals at one position. Because the entire mechanism is given full protection against irregular revolution and above all, electrical noise is entirely eliminated, you may call this the most perfect micromotor yet devised. Please write for complete information on Mitsumi Micromotor, and we will send you specifications and data.

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:MIN. 12PF
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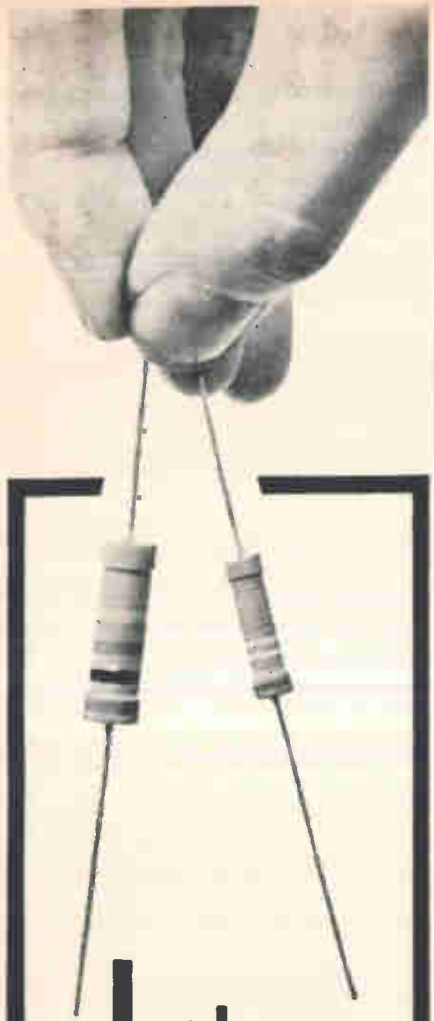

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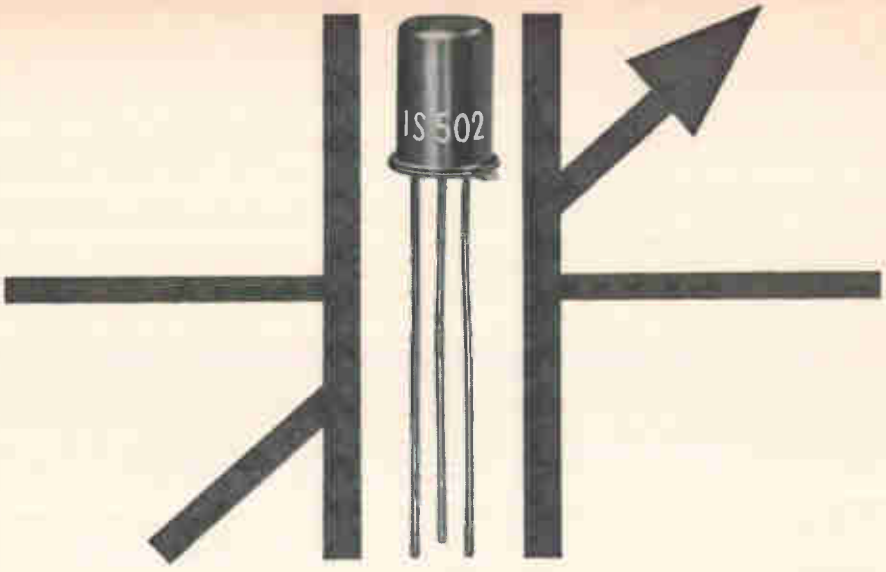

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Fujitsu Varipico is a new diode designed to serve especially as a variable capacitor. Having a "hyper-abrupt" junction, a wide range of capacitance variation is made possible by simply varying a small negative bias voltage. The relationship of capacitance to bias voltage is: $C \propto \frac{1}{V^n}$. Since n can be set anywhere between 1 and 5, the capacitance range is very large. This makes the Varipico extremely useful in many applications such as frequency modulators, sweep generators, signal generators, frequency meters, phase shifters, converters and multipliers, and parametric amplifiers. The Varipico, hermetically sealed in a metal case, measures only 5.7 mm in diameter and 8mm in length, exclusive of leads. For full technical data and application information write to our representative shown below.

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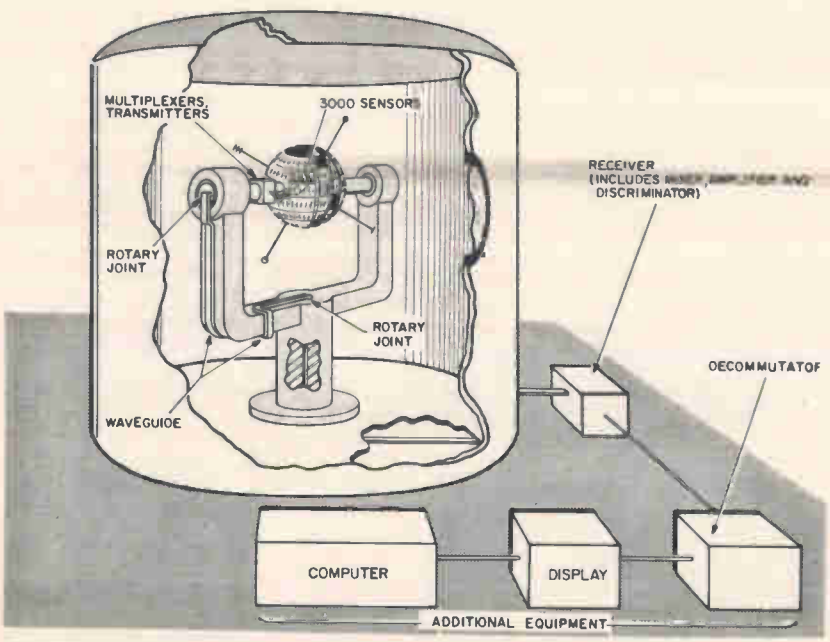
Waveguide Telemeters Space-Chamber Data

Space telemetry system handles 3,000 channels on X-band microwave link

EXPERIMENTAL *waveguide system for telemetering 3,000 channels from space vehicle in space-environment test chamber is demonstrated by feasibility model, above. Diagonal unit at right is model of waveguide network*



SPACE CHAMBER *connection uses waveguide and rotary joint, to achieve 3,000 test connections without cables. With antenna instead of waveguide, system could be used in space*

ACCURATE DATA transmission system that can sample and transmit 3,000 separate input signals with a transmission error of less than 2 percent has been developed by Electro-Optical Systems, Inc. in Pasadena, California.

Demonstration model has been delivered to Air Force's Arnold Engineering Development Center under $133,000 contract for investigation of space-chamber data transmission problems. A fully operational model, based on this scheme, would answer an Air Force requirement for multi-sensor monitoring from a rotating test vehicle in a space chamber environment.

Using PAM/FM (Pulse amplitude modulation/frequency modulation), the system would be the first telemetry unit to operate with 3,000 separate sensors and transmit in space and radiation environments.

MICROWAVE LINK — To avoid cables and still afford signal connection to the test structure, system uses microwave relay, with two waveguide lines attached to moving test unit by rotary waveguide joints. To prevent outgassing and avoid space-environment effects, the joints are made free of dielectric materials, and rotate on metal bearings using a dry-film lubricant.

Reception from the waveguides is provided by a microwave superheterodyne receiver, with an i-f amplifier and discriminator operating at nominal center frequency of 60 Mc, with a 10-Mc bandwidth. The resultant linearity of 0.5 percent is an order-of-magnitude im-

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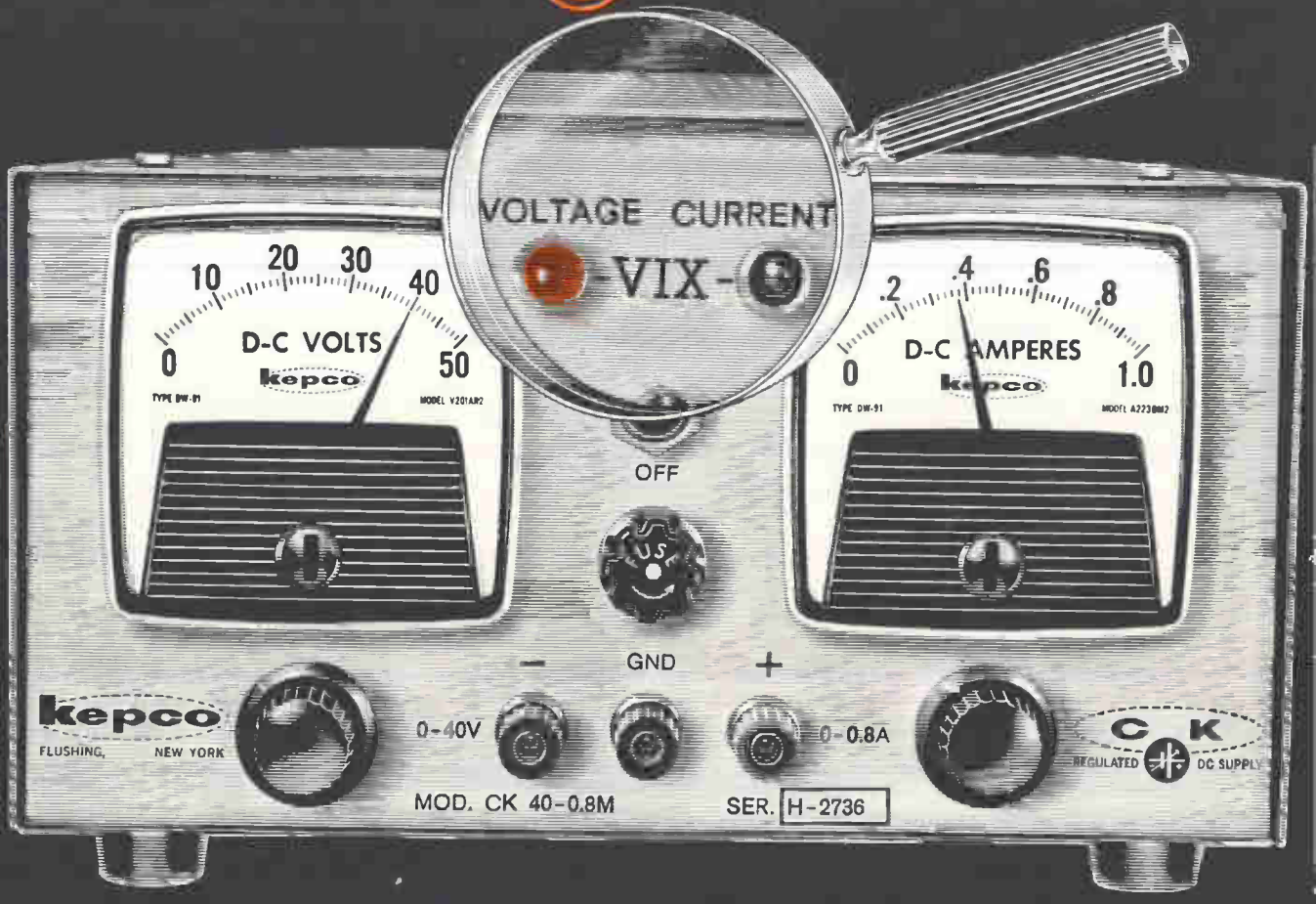

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Kepco voltage/current regulated power supplies in the CK series now come equipped with voltage/current mode indicators called "VIX".* Time saving and added utility are provided by these indicators which show at a glance whether the power supply is in its voltage regulating mode or its current regulating mode. This indication is especially useful in the Kepco CK Models since they have extremely sharp cross-over characteristics.

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0-40	0-0.8	CK 40-0.8M	255.00
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provement over commonly used wide-bandwidth discriminators.

Outputs from the 3,000 sensors attached to the test vehicle will be fed into solid-state multiplexers; 2,400 channels have an 0.5-cps bandwidth, 540 channels at 50 cps bandwidth, 30 channels at 1 Kc and 30 channels at 2 kc. In addition, one or two standard television channels at 4.5 Mc bandwidth and a command channel at 10 Kc can be provided.

Signals are then f modulated in an X-banc for waveguide transmis system can be applied to and environmental test requiring numerous and sensor measurements; said the unit would also in space vehicle flight tenna is substituted for guide network.

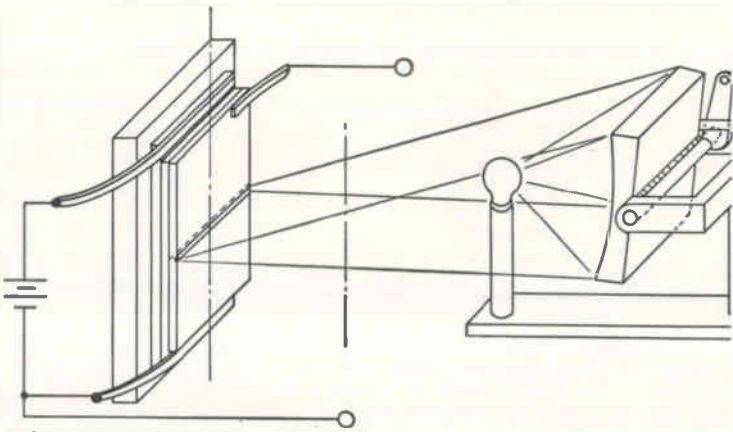
Light Beam Controls Potentiomet

By R. COLMAN
Consultant, New York, N. Y.

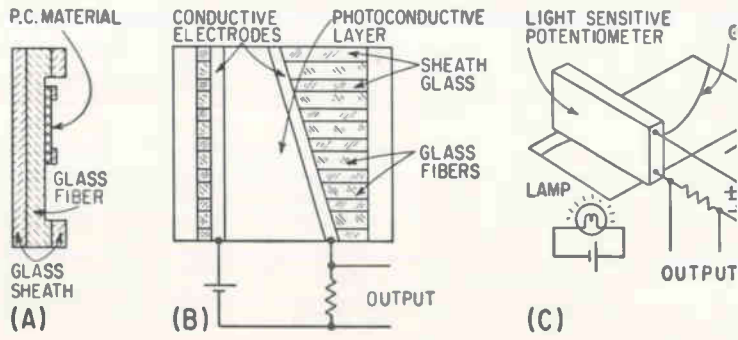
USE OF PHOTOCONDUCTIVE semiconductors in electro-optical potentiometers affords increased reliability, absence of wiping action torque, infinite resolution, absence of contact noise and virtually infinite resistive-element life.

In Fig. 1, a beam from a light source strikes a photo layer at a point determin angular shaft position[1]. creased conductivity of conductive semiconductor illuminated area complet resistance path between trodes. Light-to-dark co ratios of CdS or Cd from 10^6 to 10^9:1.

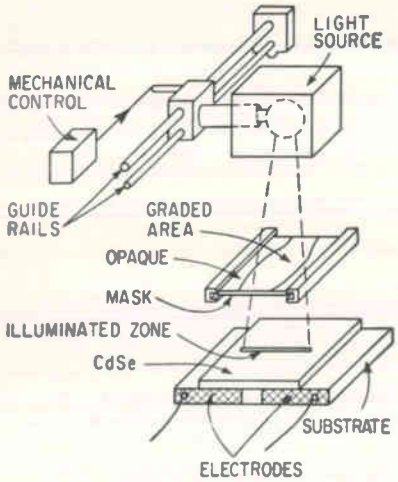
Selective illumination photoconductive surface



ROTATING SHAFT *at right focuses beam onto narrow strip conductor, thus effects variation of resistance—Fig. 1*



LIGHT SENSITIVE *potentiometer can vary resistance according function photographed or drawn on transparent film—Fig. 2*



MOVING LIGHT *focused to a fine line, projected through transparency of desired function, activates photosensitive resistor below—Fig. 3*

achieved either by using a positioned optic fiber array (Fig. 2) or a focused moving cylindrical reflector (Fig. 1). In Fig. 2, light enters the input face of a flat fiber optic array, on one longitudinal face of which is deposited a coupled layer of photoconductive material such as Se, CdS, or AgSe. Since the photoconductive layer can be formed with predetermined longitudinal dimensions, the layer under control of light represents a number of selectively activated variable resistors[3].

When operating as a line-follower data conversion system (Fig. 2C), an opaque film contains information in the form of a transparent graph. Light passing through the transparent graph enters one or more fibers in the fiber optic light guide, establishing a voltage between the output terminals corresponding to the value of the graph at that point.

The flexibility of functional control is shown by a potentiometer specially tailored to produce a required output function, Fig. 3. A light source is moved along guide rails, and control is accomplished by varying the intensity, or form, of the illuminated zone that acts as a potentiometer brush. By changing the image intensity along the photo-conductive layer, the conductivity of the semiconductor is varied. With a suitably graded mask or filter in the beam path, the intensity can be any desired function of the longitudinal position of

the image. To change the form of the function it is only necessary to replace the mask.

REFERENCES

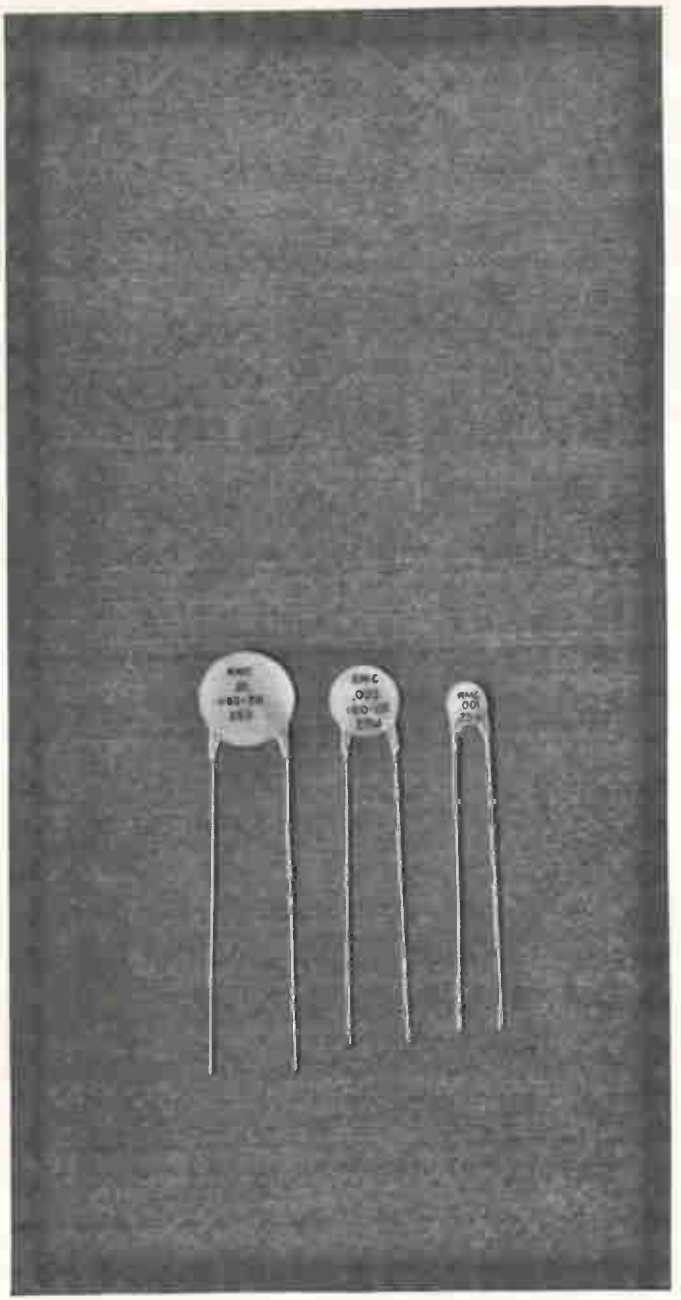
(1) U. S. Patent 3,087,069 A. J. Moncrieff-Yeates, Radiation Controlled Variable Resistance (To Giannini Controls Corp.)
(2) U. S. Patent 3,085,159 J. T. McNaney, Light Radiation Sensitive Variable Resistance Device.

New Velocimeter Claims Increased Stability

SOUND SIGNALS *emitted by two transducers at base of cylindrical section are bounced off reflecting plate, indicated with pencil tip, and their return time measured*

HIGH-PRECISION velocimeter with "complete temperature-pressure stability" for underwater use has been developed by ACF Industries, Inc. The accuracy of the unit, named the TR4, is unaffected for all practical purposes by pressure or temperature of water at the operating depth, claims ACF. The TR4 uses new metals having different rates of linear expansion and a redesigned sound path.

Velocimeters are used in submarine detection and in oceanographic research to provide continuous indication of the velocity of sound in water. The first TR4's, successors to an earlier version in use by Polaris submarines, will be used by Navy's Oceanographic Office in the Antisubmarine Warfare Environmental Prediction System program.



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CIRCLE 79 ON READER SERVICE CARD

NEW PRINCIPLE *of single reversal focused traveling wave tube is explained by General Electric's Karl B. Niclas*

TWT Uses New Focusing Concept

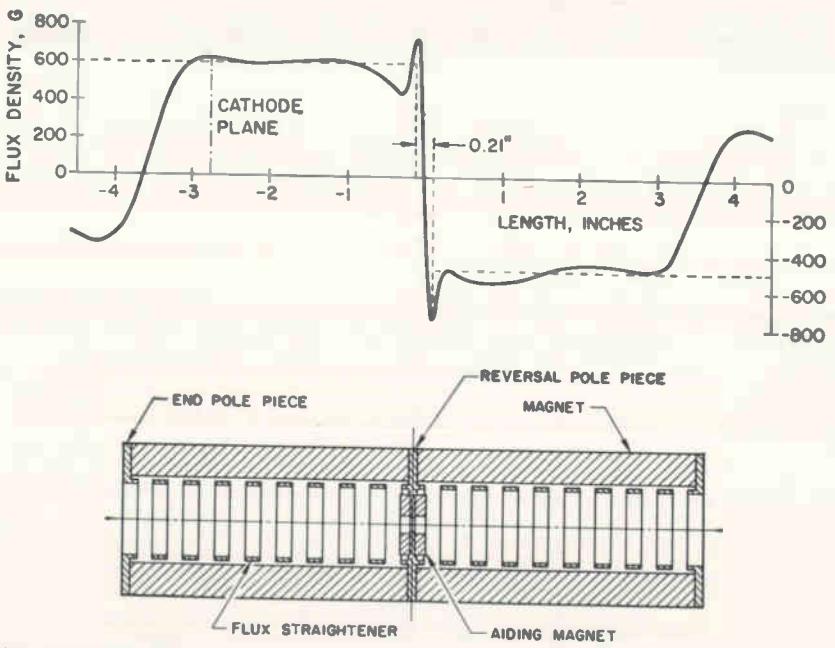
Improved performance now claimed for traveling wave tubes

COMMERCIAL availability of a new family of single reversal focused traveling-wave tubes may have a significant impact on the microwave industry.

The new tubes have been designed to meet the increasing critical need for rugged, lighter weight and more compact traveling-wave tubes with low noise figures, a General Electric spokesman said. No other twt is presently able to meet this combination of requirements, he claimed.

Featuring a new method of beam focusing, the new tubes are expected to be especially suitable for military equipment where close spacing of very low noise twt's is necessary. Applications include advanced radar, countermeasures and telemetry systems in satellites, aircraft, missiles and naval vessels. Initially, GE's Power Tube Department is introducing five X-band single reversal focused tubes. The company will shortly introduce additional X-band and C-band versions. The single reversal focusing principle is expected to apply also to millimeter tubes covering the frequency range of 12 to 40 Gc.

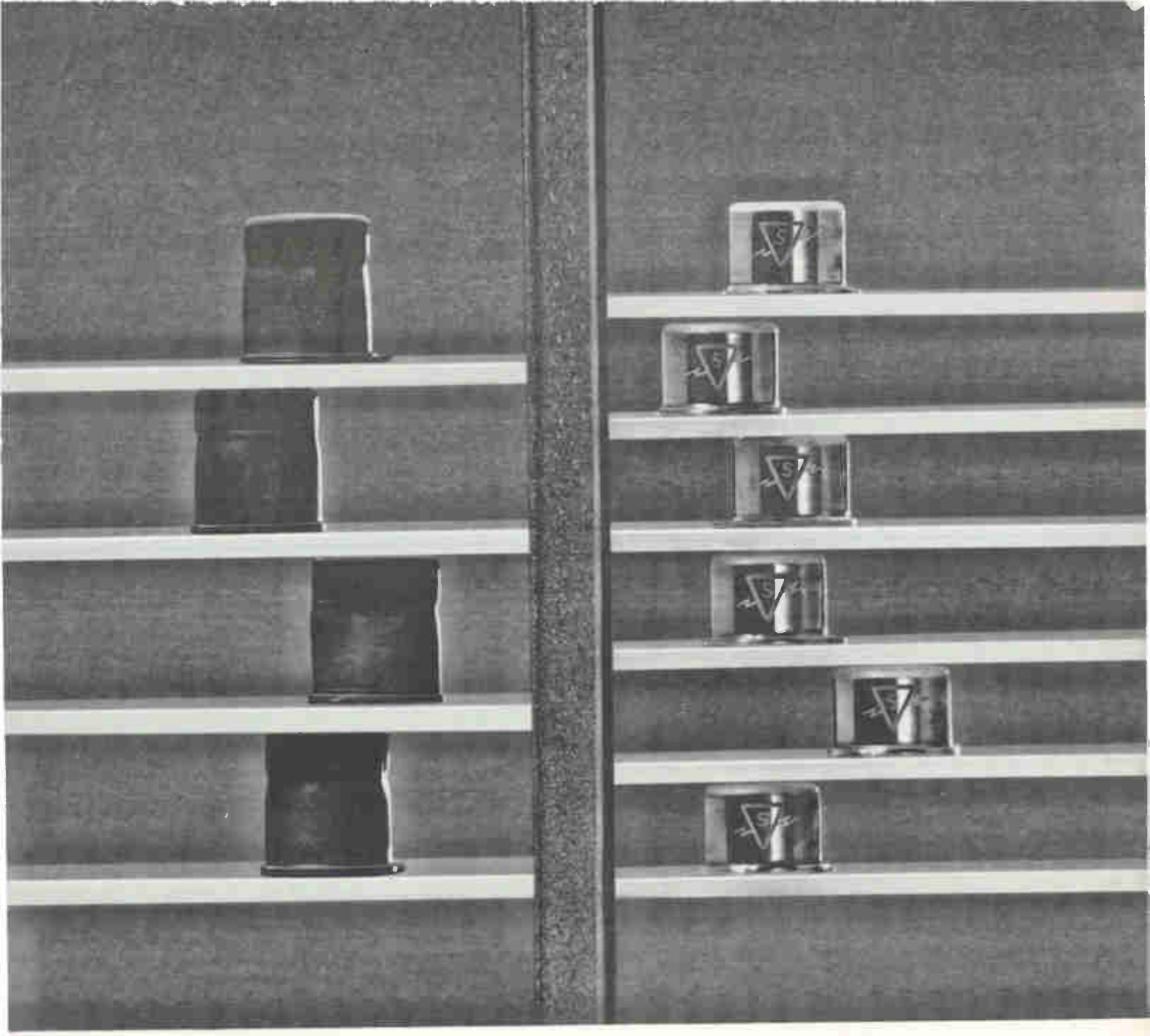
The new tubes were developed by Karl B. Niclas of GE's Traveling Wave Tube Products Section.



MAGNETIC *field, plotted along the beam axis for a single reversal field twt (top). Bottom diagram shows schematic of a single reversal field pm circuit—Fig. 1*

FOCUS—The new twt's use a new focusing concept. Instead of a single uniform magnetic field along the axis of the tube, the field is reversed at the center of the tube, Fig. 1. Instead of one permanent magnet, there are two main magnets and two ring shaped aiding magnets which control the focus of the electron beam. See Fig. 2 for comparison.

Although one uniform field is fine for low-noise characteristics, the flux pattern associated with one long straight magnet creates an external magnetic field which requires bulky shielding or adequate spacing between the tube and other magnetic materials or



Now you can stack 6 germanium 20-watt transistors where only 4 fit before

Why? We reduced the 2N1038 package from the big, old-fashioned top hat (.358" minimum height) to the smaller, standard TO-5 package. This means that higher-than-ever stacking densities will be possible in the next generation of computers and other equipment, using new Sylvania PNP transistors.

What makes this package-shrinking possible? Sylvania has developed a new construction which is far superior for heat dissipation. A copper heat sink, shaped like a rivet and mounted securely to the stem, carries heat out through its broad bottom surface. This new approach effectively lowers typical thermal resistance ratings—which can be further improved by using our small, streamlined accessory heat dissipators.

These transistors, of course, can be handled by automatic insertion equipment you may have for putting standard TO-5 transistors into circuit boards. But there is one important difference from familiar TO-5's. The leads are thicker—a full .025", which can carry the rated 3.5 ampere current without any noticeable power drop.

Offering a new degree of miniaturization, the new 2N1038 series is typical of the way Sylvania looks to future as well as present needs of customers. Semiconductor Division, Sylvania Electric Products Inc., Woburn, Mass.

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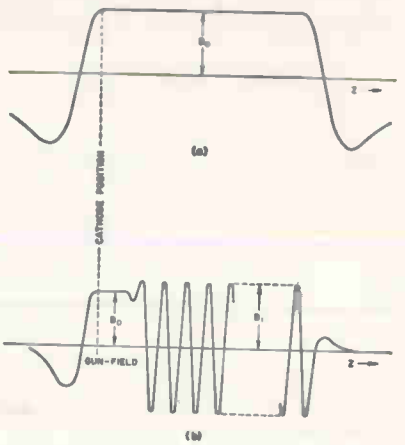
NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

sources, Niclas explained. Equally important, using two magnets reduces the volume of magnetic material in ratio of 4 to 1.

Twenty fields, or magnets, have been used in the periodic-permanent-magnet type of twt. But until the new twt was developed, technological requirements were such that a single uniform field was best for certain twt applications where extremely low noise figures were very important. General Electric has a complete line of low-noise periodic-permanent-magnet focused tubes which do use a number of magnets. These reverse the magnetic field many times, and can be placed in any system without shielding or the need for air spacing. These tubes are very light weight, but their noise figures are somewhat higher than the permanent-magnet-focused twt's.



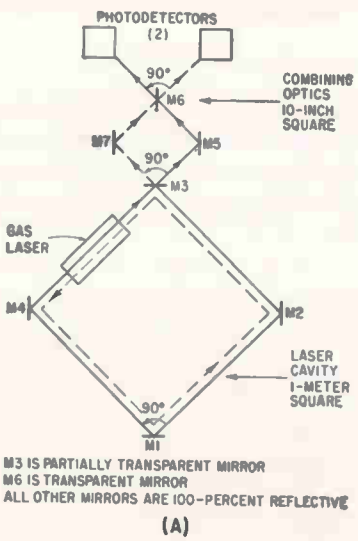
PLOT *of magnetic field along a beam axis for a permanent magnet focused twt (top) and for a periodic permanent magnet focused twt —Fig. 2*

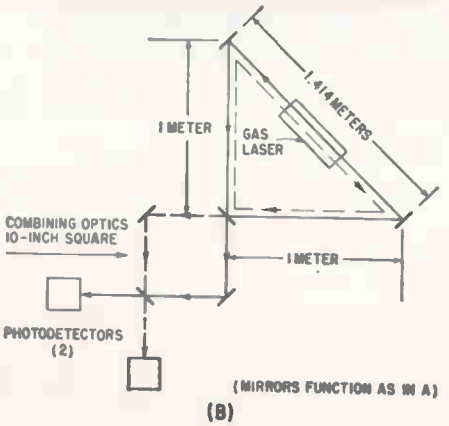
LOW-NOISE—The new single reversal tube was introduced because it retains the low noise figures of straight permanent-magnet tubes, yet is much lighter and does away with the need for shielding.

Basically, the new tubes constitute an extension of the GE product line. In many cases they will replace the straight-field pm tubes. However, ppm tubes will be required for applications where low noise is not as critical and

Laser Gyro's New Configurations

MIRRORS *bounce counter-rotating laser beams around square (A) or triangle (B) to sense and measure direction. Photo and diagram show construction of Sperry Rand's developmental laser gyroscope (ELECTRONICS, p 8, June 21). Beam paths are shown off-center to illustrate direction of travel*





twt's that weigh less than 3 pounds are required, GE says.

The new tubes reportedly have a low-noise advantage of from 2 to 5 db over ppm's, and weigh about half as much as pm tubes with comparable performance characteristics.

Reliability of the new tubes is said to be comparable with existing tubes. Environmental test facilities are used to expose tubes to test situations corresponding to shock of 50 g's, vibrations from 5 to 2,000 cps; temperatures from −65 to 75 C; and altitudes of 100,000 feet.

At this point, costs will be comparable to the existing line of pm and ppm tubes. Ultimately, the new tubes will be cheaper, company says.

Designers are constantly seeking lighter and more compact components for advanced radar and space systems. At the same time, new applications require better performance characteristics for smaller units.

A single reversal twt with low-noise characteristics was developed in England, but it weighed 30 pounds. Although other manufacturers have done experimental work on such tubes, GE claims that their new line is the first single reversal low-noise type to be offered to U.S. system designers.

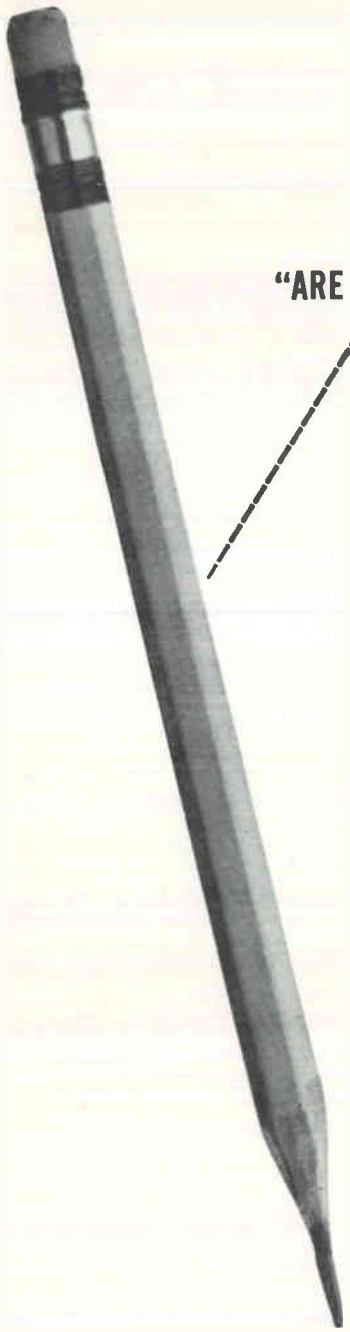
Laminate Tailored For Space Needs

A NEW phenolic resin, developed by Union Carbide Plastics, is said to meet the increasing needs for high temperature-resistant laminating resins used in the electronics industry.

Company says laminates using the new resin, Bakelite phenolic BLSB-3536, are certified to exceed by a large margin the performance requirements of MIL-R-9299A, Type II, Class 2.

Flatwise tests on the new laminates show flexural strength of 70,000 psi, and modulus of elasticity of 3.47 psi x 10^6 after 100 hours at 500 F.

Suggested uses include circuit board applications, molded components, insulation, and structural parts.



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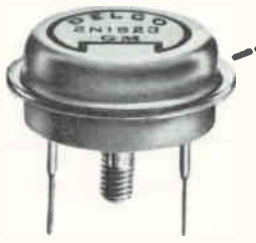
Type	V_{CEO} @ I_C Volts @ Amps	V_{CBO} @ I_{CBO} Volts @ ma	h_{FE} @ I_C Amps	$V_{CE(sat)}$ @ I_C Volts @ Amp	Thermal Resistance
2N1518	40 1.0	50 4	15/60 15	0.7 25	0.8° C/watt
2N1519	60 1.0	80 4	15/60 15	0.7 25	0.8° C/watt
2N1520	40 1.0	50 4	17/68 15	0.6 35	0.8° C/watt
2N1521	60 1.0	80 4	17/68 15	0.6 35	0.8° C/watt
2N1522	40 1.0	50 4	25/100 15	0.5 50	0.8° C/watt
2N1523	60 1.0	80 4	25/100 15	0.5 50	0.8° C/watt



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CIRCLE 85 ON READER SERVICE CARD 85

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Your minimum shipment via Tigers costs about half of what most other airfreight carriers charge. Most carriers figure a minimum shipment at 50 lbs. Tigers' minimum is 25 lbs. multiplied by the established commodity rate, or $4.00 for the shipment . . . whichever is greater.

How can Flying Tigers do it? Simple. They're the Airfreight Specialists. Big shipment or minimum shipment, always specify Flying Tigers—world's largest all-cargo airline.

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FLYING TIGER LINE AIR-FREIGHT SPECIALISTS

Five things you should know about our four TYO capacitors

1

Where to use them—in printed or point-to-point applications in coupling, decoupling, filtering, timing, switching, and computer circuits. TYO's meet all performance requirements of MIL-C-11272B.

2

Sizes—four case sizes cover *pf* ranges between 1-560, 561-1000, 1001-2700, and 2701-10,000 at 300 VDCW from −55 to +125°C.

3

What's inside—capacitive element is glass and aluminum foil, fused into a monolithic element which holds D.F. to less than 0.001 and capacitance change in life to less than 0.5% or 0.5 *pf*. This is the same type element that has made CORNING capacitors the standard for reliability and stability for years.

4

What's outside—special case and potting compound give stand-off insulation, eliminate inter-component, wire, and chassis short circuits. Standard 1.25″ gold plated Dumet leads are welded to capacitive element to make your welding or soldering safer, easier. Leads are spaced on .1″ grids symmetrically with case for fast mounting.

5

Where to get them—your CORNING distributor stocks TYO's in all sizes and values. He's ready to give you fast service for small quantities. For large quantities, contact us directly.

If you have questions, ask him for TYO data sheets, or write us: Corning Glass Works, 3901 Electronics Dr., Raleigh, N. C.

CORNING
ELECTRONICS
A DIVISION OF CORNING GLASS WORKS

←CIRCLE 86 ON READER SERVICE CARD

CIRCLE 87 ON READER SERVICE CARD 87

7½ TEST YEARS

CUT TO 18 MONTHS FOR

60 MILLION DATA TEST HOURS!

BETTER MEASURING FROM EI

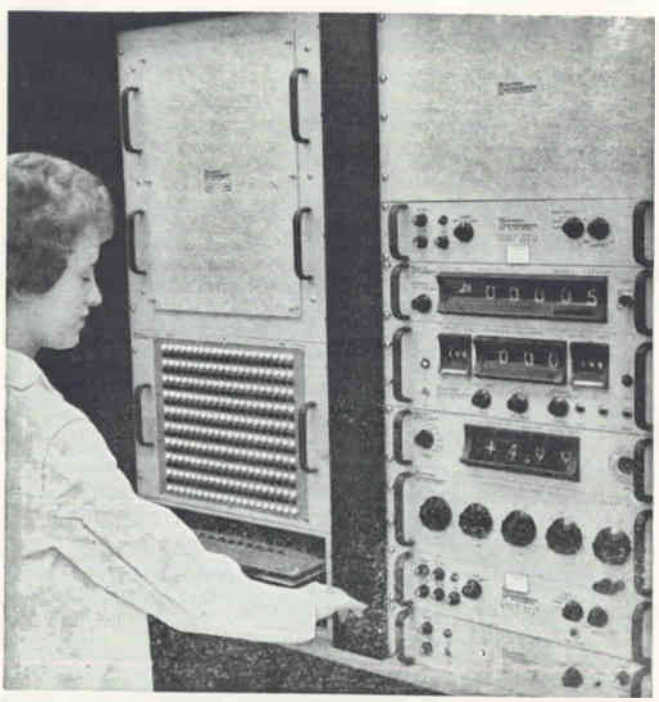
In determinations of acceleration factors for metal and carbon film resistors for the high reliability MINUTEMAN Program, Electra Manufacturing Company uses an Automatic Resistor Data Logging System designed and built by Electro Instruments.

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.

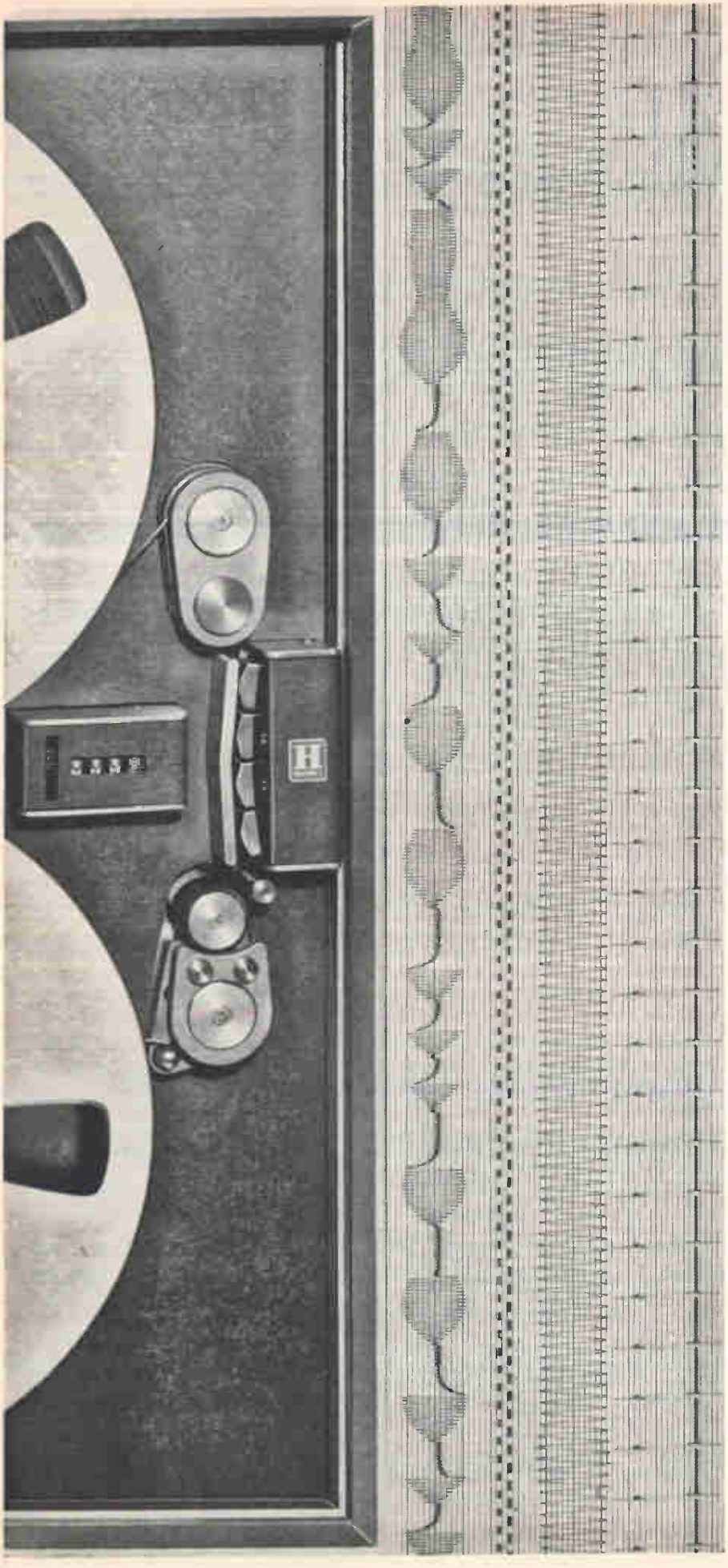
Whether your interest lies in spacecraft, electronic components or industrial processes, we can demonstrate to you the advantages of EI digital instruments in measuring DC volts, AC volts, DC ratios, resistance, capacitance, inductance and impedance. Let EI *all solid state* Digital Multimeters or Complete 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



NOW and/or LATER

To get the most out of analog data, you should be able to see it now or see it later, use it now or use it later.

The ideal combination of recording instruments for making the most of your analog data is a Honeywell tape recorder, such as the compact Honeywell 8100 portable instrumentation recorder/reproducer, used with the Honeywell Visicorder Oscillograph.

For immediate readout, the Visicorder gives you an instantaneous record of 1 to 36 channels of data from DC to 5000 cycles per second. A variety of paper speeds from .1 to 160 inches per second gives you the trace resolution you need. Five models of the Visicorder are available.

At the same time, you can record up to eight channels (plus voice and compensation) of data up to 10,000 cycles on the 8100 portable. Later on, you can play selected portions of your data into the Visicorder. Four tape speeds (1⅞, 3¾, 15, and 30 ips) give you record and playback versatility for whatever frequency you're recording.

In the Honeywell 8100, several head and tape configurations are available (including IRIG). All models have a built-in calibration panel, automatic switching of center frequencies, and a new, improved tape drive that cuts flutter to a minimum and eliminates tape breakage. A built-in monitor scope and voice channel are optional. In addition, Honeywell manufactures complete laboratory tape systems with capacities of up to 60 channels on 2-inch tape.

For complete information about the Honeywell 8100, the Visicorder Oscillograph, and other recording equipment, contact your nearest Honeywell office, or write: Honeywell, Denver Division, Denver 10, Colo. Or call us direct at 303:794-4311. In Canada, contact Honeywell Controls, Ltd., Toronto 17, Ontario.

DATA HANDLING SYSTEMS

Honeywell

POSITIONING FIXTURE *is loaded with relays during welding of other relays. Inset shows multi-exposure photo of beam-impingement traverse on relay. Beam travel is controlled by specially-designed programmer unit in center*

Electron Beam Welding Solves Relay Sealing Problems

Beam travel programmed by cam contour device

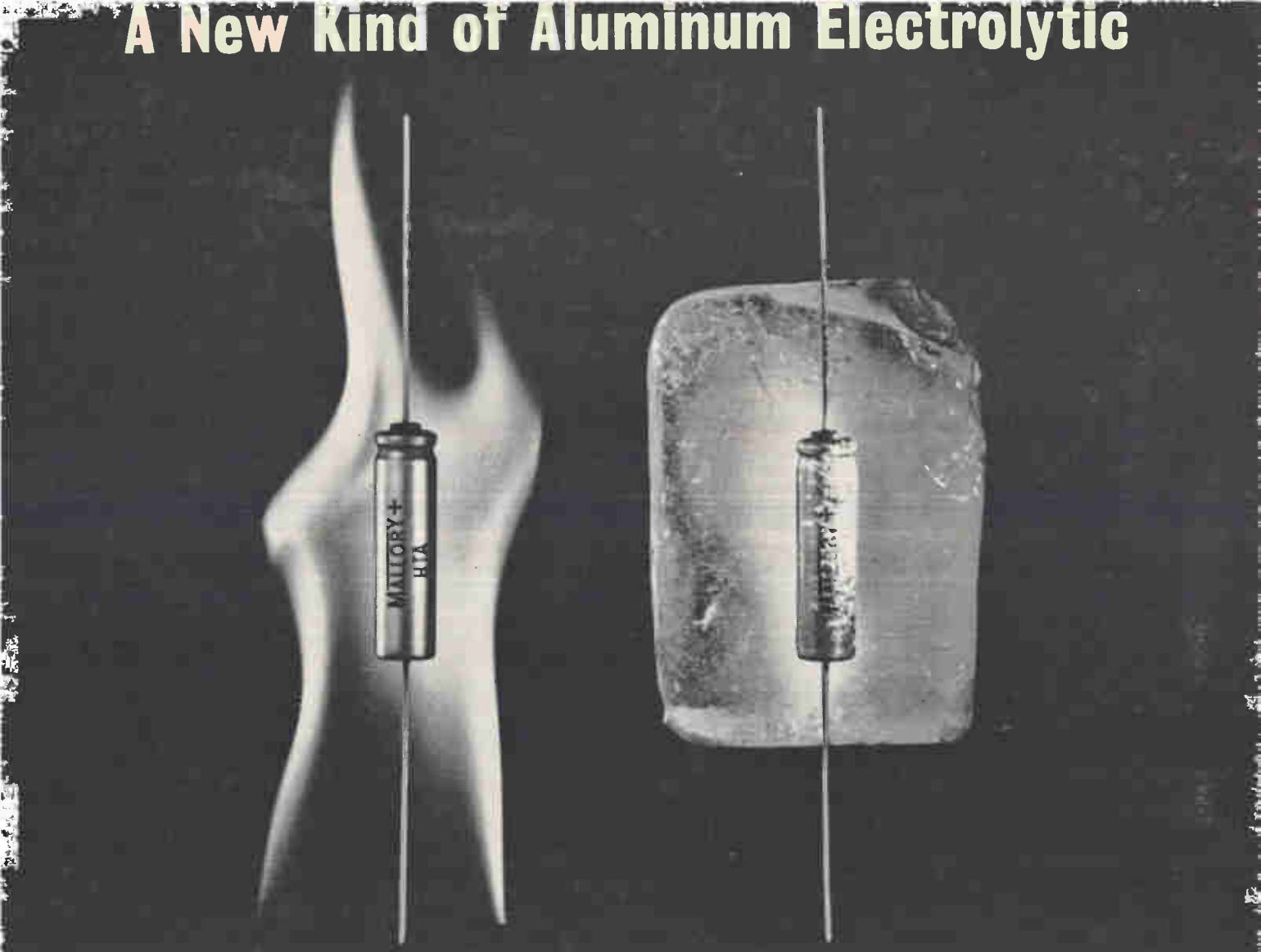
By WERNER C. THEILER
Filtors, Inc.
East Northport, N. Y.

SEARCH for a highly reliable technique for the hermetic sealing of miniature relays gave birth to a uniquely programmed electron beam welding process. This machine tool possesses high-production capabilities: it now seals a rectangular relay measuring 0.400 by 0.800 inch in about 6 seconds. Present operating conditions of pump-down and loading prevent full capitalization of this capability. With a little design modification, however, the process is expected to yield as many as 250 welded assemblies per hour. Contributing to this output is a magnetic method of deflecting the beam in x-y coordinates using an especially-designed cam contour programming device.

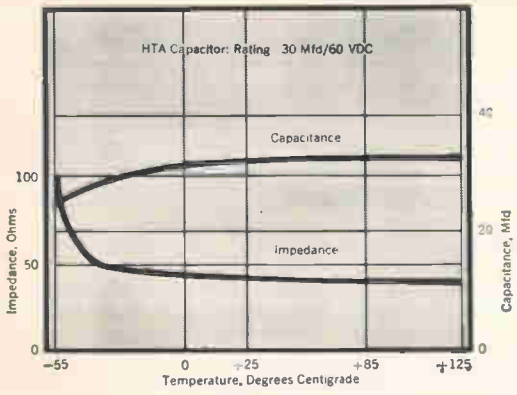
Perusal of available welding information had not supplied a solution to the problem of getting high-reliability seals on a mass-production schedule. We were sure that electron beam welding was the answer, but the complex nature of subminiature relay design with its susceptibility to heat damage, demanded extensive research and development work to develop a system that accurately and automatically controls and restricts travel of the electron beam. This may be a major step in making what is now primarily a novel laboratory tool a high-production welding machine also having great research facility: reliance placed on operator skill has previously been a drawback to mass-production operation. Several fastening as well as sealing problems in relay manufacturing are expected to be solved using the process.

ADVANTAGES — One of the qualities of the electron beam suiting it for high production welding of subminiature relays is that the high energy densities at the impingement point reduces the need for heat sinking: fusion occurs with great concentration and at such a rapid pace that harmful thermal distortion has no time to develop. Heat-affected area is said to be about 1/25 that of the tungsten-and-inert gas welding process because of energy densities as high as 3.8 Kw per sq. in. for a weld

A New Kind of Aluminum Electrolytic



Temperature Spread . . . 180°C



Typical stability of capacitance at low and high temperatures.

From −55°C to +125°C, Mallory HTA aluminum electrolytics retain capacitance stability, to a degree never before possible in an aluminum unit.

Here's a new kind of aluminum electrolytic capacitor with performance characteristics approaching those of tantalum. Type HTA gives you long life and dependability at +125°C without voltage derating . . . yet they hold capacitance at −55°C with negligible drop.

Take a close look at the HTA's temperature performance: you may find this unusual capacitor can fit spots in industrial and commercial equipment where you figured nothing but tantalum would do. Available in ratings of 8 to 300 mfd, 60 to 3 volts. Standard diameter is $\frac{3}{8}$ inch. Case length is $1\frac{3}{16}$ to $1\frac{5}{8}$ inches. Tubular aluminum case, with axial leads. Supplied with Mylar* sleeve if desired.

Call or write for technical data. Mallory Capacitor Company, Indianapolis 6, Indiana . . . a division of P. R. Mallory & Co. Inc.

*Du Pont trademark

P. R. MALLORY & CO. Inc.
MALLORY

CIRCLE 91 ON READER SERVICE CARD

diameter of 0.010 inch. (The Hamilton Standard electron beam machine, which was modified to perform process, is adjusted to a fine beam focus prior to welding using a target surface of pure tungsten coinciding with a plane described by weld lines.)

BEAM TRAVEL—Basically, two approaches could have been used to perform contour welding of relays:

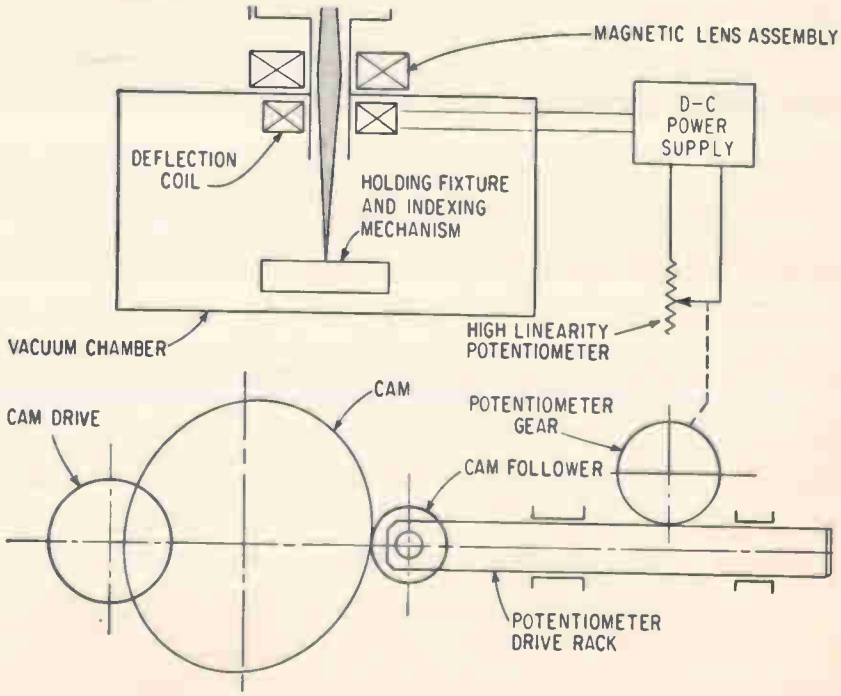
- Conventional technique of guiding the work below the beam by mechanically tracing a template
- Magnetically deflecting the beam so that it follows preset path determined by programmed x-y coordinates while the work remains stationary.

The latter concept was adopted since it offered distinct advantages with respect to operational flexibility. A minimum of alterations were required to adapt the programming system to the Hamilton Standard electron beam welding machine. Two basic weld patterns have been stored in the programming system. Selection between the two is switch-controlled. Additional controls permit return to standard operator-controlled welding.

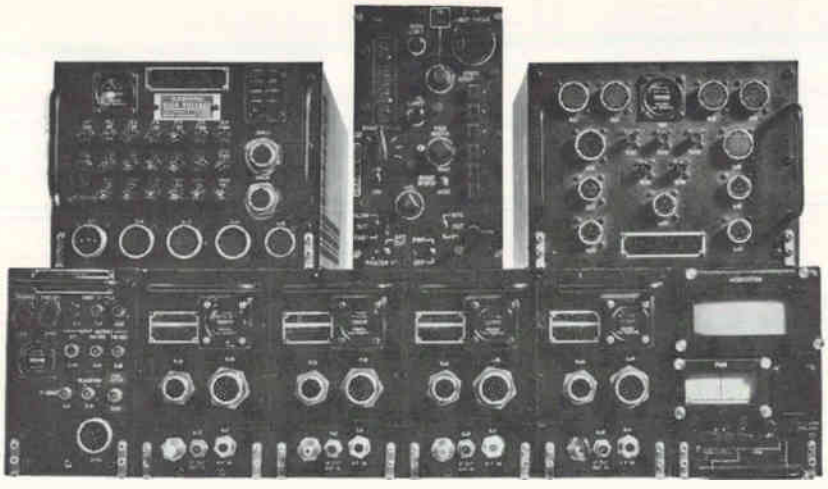
On initiation of the automatic weld cycle, the beam follows the preset pattern by being deflected from its normal vertical orientation to a variable angular orientation so that beam impinges on designated and successive x and y coordinates in the welding plane. High stability d-c signals applied to welder's magnetic deflection lenses supply the exact signal value for each point of the weld line. Power sources supplying signals are controlled by high-linearity potentiometers. They, in turn, are actuated by precision cams driven by a variable gear motor to regulate welding speed from 5 to 60 inches per minute.

Since beam deflection is an angular function, it follows that the maximum distance the beam can be diverted from its vertical path depends on height of welding surface. With the long focal length lens system in the Hamilton Standard machine, the standard focusing range can be sufficiently extended to assure that each point of the pattern will be reached with pin-point accuracy. Generally, a shallow deflection angle is desired for programmed electron-beam welding to achieve maximum pattern repeatability. A sharply angled beam is of particular help where access to weld joint is obscured.

BEAM CONFIGURATION—The beam itself which can be varied in



PROGRAMMER UNIT *is based on cam-drive system that actuates high-linearity potentiometer controlling d-c power supply signals to deflection coils of electron beam welder*



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until now.

What's behind Loral's success in meeting—or exceeding—MIL-SPECS in the creation of "black boxes," both systems and subsystems, for the military for over 15 years?

The quality built into components such as this IF amplifier.

This unit, one of a series of IF amplifiers operating at center frequencies from 30 to 160 megacycles, was developed for a Loral system that meets MIL-E-5400. It is now ready for YOU through our General Products Division.

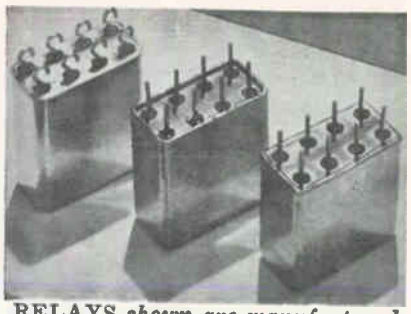
Such amplifiers are available as virtually "off-the-shelf" items and are representative of Loral's R & D capacity to create electronic components that are the best possible buy in the smallest, most reliable package—Value Engineered throughout.

We may have, right now, the electronic component that will help YOU do an important defense job while saving YOU the unnecessary time and cost of undertaking your own R & D. For further information on our complete line of amplifiers and other precision microwave products, write: General Products Division, LORAL ELECTRONICS CORPORATION, 825 Bronx River Avenue, The Bronx 72. New York.

MIL SPEC	MIL-E-5400	BANDPASS RIPPLE	0	GAIN CONTROL	Yes	INPUT IMPEDANCE	50 ohms
PART NUMBER	IF-301	WEIGHT	11.5 oz.	AGC	Yes	OUTPUT IMPEDANCE	50 ohms IF 91 ohms video
CENTER FREQUENCY (MCS)	100	TRANSISTOR COMPLEMENT	2N1195	POWER REQUIREMENTS	25v 110 ma		
BANDWIDTH AT 3db (MCS)	20	NOISE FIGURE db	7 db	DIMENSIONS	11 x 1¼ x 1	VOLTAGE GAIN	50 db RF 66 db video

LORAL

Imprint of Integrity



RELAYS *shown are manufactured by electron-beam welding, tungsten-inert gas welding and soldering (left to right)*

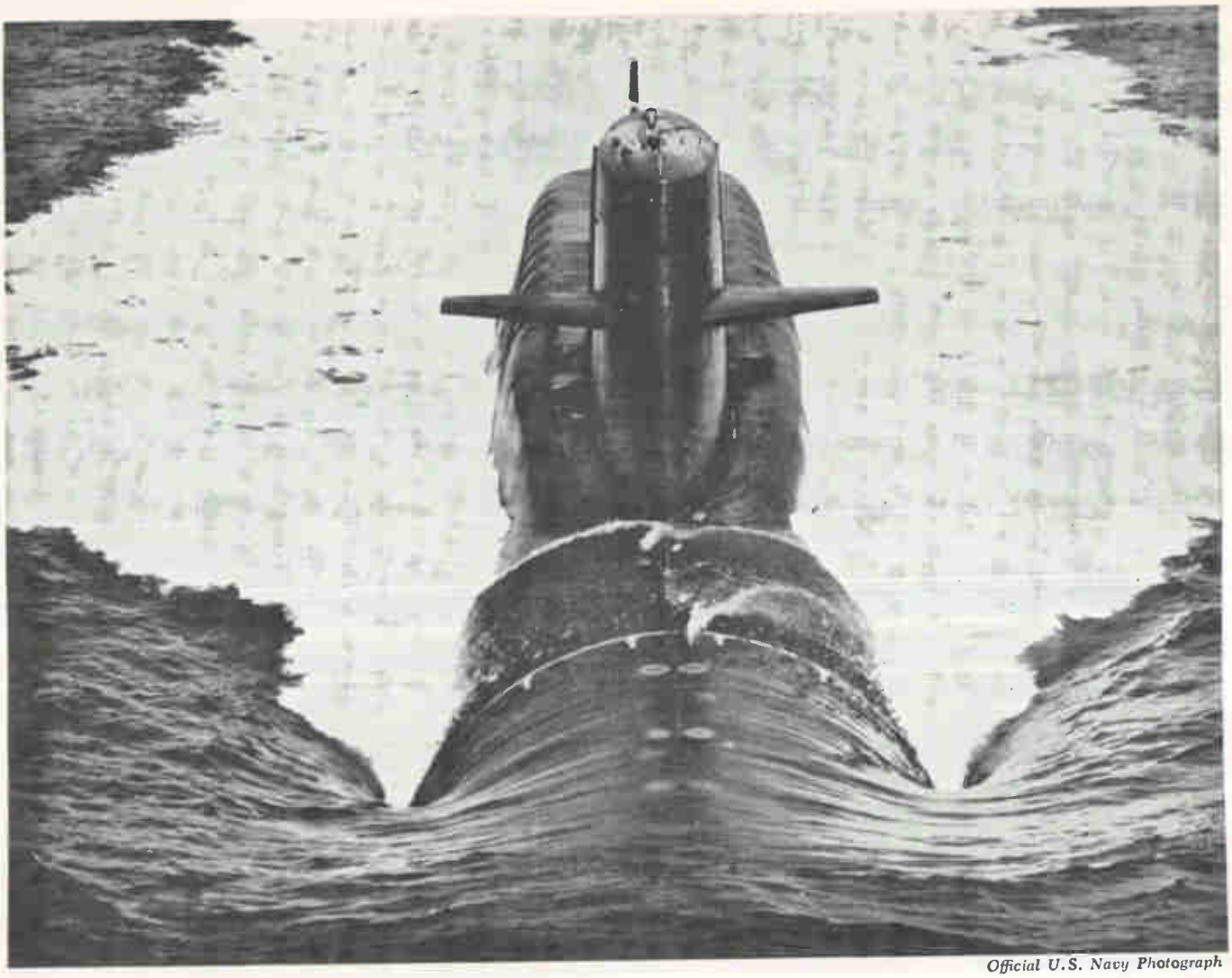
size and power by basic machine, can also be changed with the programmed deflection feature from a spot to an open circle and other shapes such as a sine wave. Circle generation—resulting in a welding motion analogous to that of a planet revolving on its own axis while circling the sun—has produced very successful welds.

Each miniature relay is placed in a specially designed holding fixture with relation to weld pattern described by beam. Fixture does this with two precisely machined locating surfaces and an indexing pin. Rotating each relay in turn to a proper position under beam, the fixture inclues a time mechanism adjusted to beam travel time. At completion of weld, fixture is automatically actuated by this mechanism to place following relay in position. Necessary time for such indexing and welding is adjustable to suit various settings and weld lengths, averaging about 6 seconds. Upon completion of each run, the operator reloads the vacuum chamber with another fixture that has received relays during previous production welding operation. He then immediately starts pump-down cycle. The following idle period is used to inspect welded relays.

Sensing devices check the presence and correct position for each relay before initiating electron beam.

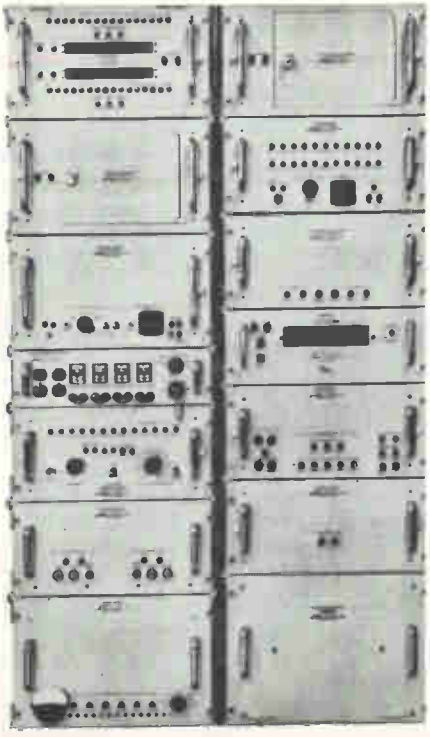
Drill Puts 3,000 Holes In Stamp-Sized Mask

SPECIAL drilling equipment has been developed by Hewlett-Packard to achieve accuracies unavailable in



Official U.S. Navy Photograph

CUBIC digital voltmeters check out Polaris weapons system



Cubic Corporation is proud to have had the opportunity to develop three distinct types of specialized digital voltmeters for use in the Polaris program. The instruments were developed by Cubic and supplied for three specialized applications for check-out functions in the Polaris Fleet Ballistic Missile Weapons System—a key element in the defense of the free world.

One of the major uses of Cubic digital voltmeters in the Polaris program is in the digital data acquisition system built by Interstate Electronics Corporation, Anaheim, California. This system is used in the submarines to acquire data regarding the weapon system performance. It is part of the calibration equipment whose purpose is to insure satisfactory operation of the Polaris missiles. The Cubic instrument is indicated by arrow at left.

The Cubic militarized digital voltmeter features all solid-state plug-in circuitry and lifetime reed relays used for bridge switching. Operating components are compact, rugged and lightweight. A special snap-out replacement readout is available to insure minimum downtime, should maintenance be required. Absolute accuracy of .01% of reading, ±1 digit is provided. Sensitivity is 1 mv. MIL-STD's 16B, 167, 202B are met. For additional information, write to Department B-159.

CUBIC CORPORATION
SAN DIEGO 23, CALIFORNIA
INDUSTRIAL DIVISION

LEADER IN INDUSTRIAL, GEODETIC AND AEROSPACE ELECTRONICS

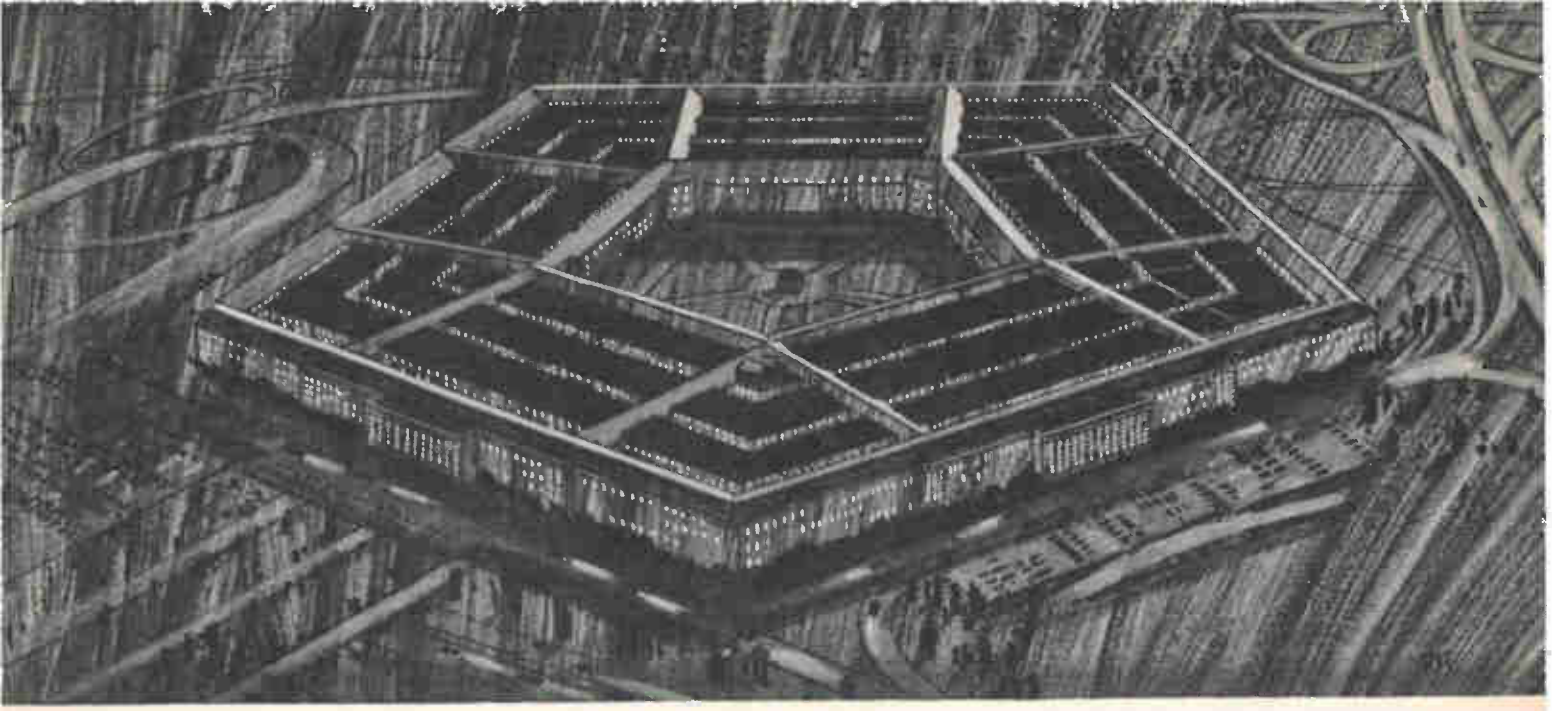
outside shops. Holes obtained are 0.0016-in in diameter to within a tolerance of 50-millionths of an inch and are round to within 5-millionths of an inch. They are being spaced 0.02-inch apart on small postage stamp sized brass photo masks used in semiconductor manufacture—a total of 3025 holes cover mask area. Equipment uses an air-bearing drill and Pratt & Whitney Tape-O-Matic numerical control system. Production time for making a mask reportedly has been cut from 3 weeks to 5½ hours using this equipment. Main feature of equipment is use of air pressure at 90 pounds per sq. in. directed at machine's spindle and drilling platform from all sides, thus acting as springs to stabilize these elements.

Compound Protects Cable Core

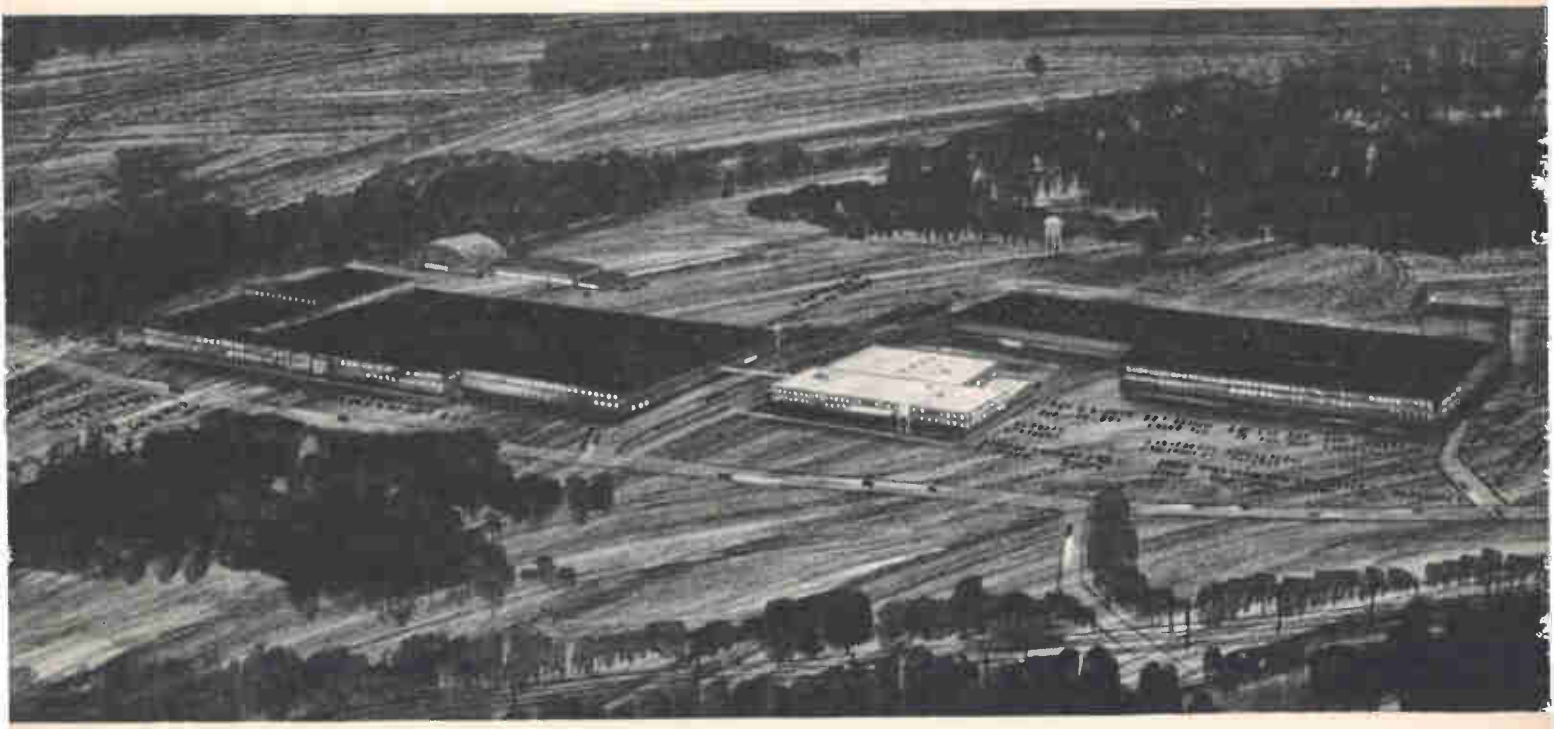
THREE ENGINEERS at Anaconda Wire and Cable Company of Hastings-on Hudson, N. Y. have patented a technique and apparatus that applies filler compound to cores of cable during manufacturing process. Cables, which can include as many as 7 or 8 conductors, are thus made moisture and vapor tight. Inventors are Kenneth R. Bullock, Samson Sortland and George Ansell.

Making It Easy For Assembler

INSTRUCTIONAL *work station for electronic assemblers is built in three sections: parts on left, instructions in center, tools at right. Two sections are at an "effective-vision" angle of 45 degrees. Developed by Otis Elevator's Defense & Industrial Division, the prototype shown was built by Banner Metals Corp.*



Defense Center



Defense Center

In organization and basic purpose, the Westinghouse Baltimore Defense Center effectively parallels the agencies it serves. It represents a unique concentration of defense and space contract capabilities including Systems Management.

These capabilities embrace all environments, from undersea to deep space. They include every activity, from research and development to production. But the greatest strength is the wealth of scientific talent and technical skill in the Westinghouse organization.

For specific information on how the broad capabilities of the Westinghouse Baltimore Defense Center can meet your requirements, phone or write to: Westinghouse Electric Corporation, P.O. Box 868, Three Gateway Center, Pittsburgh 30, Pennsylvania. You can be sure . . . If it's Westinghouse. J-02349

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One reason is because we put a premium on seeing to it that our engineers work under the best of conditions. And it goes a lot deeper than our modern buildings, our fully-equipped R&D labs, our new manufacturing facilities and the high level of professionalism you'll find among our engineers. For instance. You don't work in a bull pen, you are in an office. Your support people are close at hand. We even see to it that you don't have to fight for a space in the parking lot. ☐ If your career is microwave — any phase — and if you are an E.E. or M.E. with a B.S. or advanced degree and 3 to 10 years' experience, we'd like to talk with you. The listings at right tell you what fields are open and where to write.

Current openings for qualified microwave engineers exist in the fields of:

Microwave Systems Design

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TAPE COPY STATION FOR ATLANTIC MISSILE RANGE

Six 1.5-mc Mincom CM-100 Recorder/Reproducers form the backbone of an extremely complex tape copy station recently delivered to the Atlantic Missile Range, through Defense Electronics, Inc., Rockville, Maryland. Set up at AMR last March, the station makes possible for the first time as many as five first-generation copies of prime data tapes in one operation. In addition to the six CM-100's, it also includes two 600-kc Mincom G-100's, two degaussers, and an advanced monitor alarm system policing forty-two 1.5-mc channels. The station is the result of Mincom's long experience with frequency responses of better than 1 mc—an outstanding reliability record since 1955.

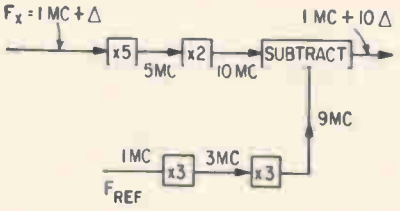
Mincom Division 3M COMPANY

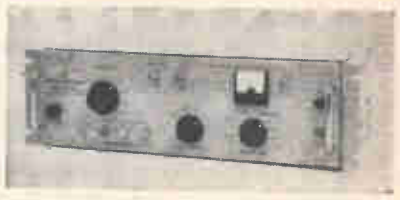
2049 South Barrington Avenue, Los Angeles 25
425 13th Street N. W., Washington 4, D. C.

CIRCLE 99 ON READER SERVICE CARD 99

Comparing Frequencies To 1 Part In 10^{12}

Comparator uses cascaded error magnifying circuits for highest resolution





SOLID-STATE one-piece device performs frequency comparisons that formerly required a number of separate test instruments. The unit permits rapid evaluation of frequency difference between reference and unknown signals at 1, 2.5 and 5 Mc. Frequency difference is processed at an effective 10, 100 or 1,000 times referred to 1 Mc. Five front-panel outputs are provided for recording and display instruments in the model 102 comparator. Unit resolution is better than one part in 10^{12} for 1-second observation time. Observation times as short as 0.0003 sec are possible with corresponding precision.

The comparator obtains its precision by successively multiplying the incoming "unknown" signal (plus its error) by factors of ten, and then subtracting nine-times the reference signal from the result as illustrated in the block diagram.

According to Parzen Research, Inc., 48 Urban Avenue, Westbury, L.I., N.Y., who manufacture the comparator, its applications include measurements of long and short-term signal source stability, alignments of frequency sources for maximum accuracy and stability, evaluation of phase and frequency characteristics of four-terminal networks, and minimum noise adjustment of four-terminal networks.

CIRCLE 301, READER SERVICE CARD

Sensitive Scope Uses Two Beams

DOUBLE-BEAM oscilloscope has a basic sensitivity of 100 microvolts/cm, variable to 50 volts/cm, with continuously variable sweep range from 1 microsecond to 12 seconds/cm. Additional facility is provision for one-shot time base with a "ready" light to facilitate transient photography. Push button beam-finders are particularly useful for detecting traces at higher sensitivities.

Differential input feature eliminates common-mode signals in the ratio 40,000:1 at 0.1 volt/cm, falling to a 1,000:1-ratio at 0.2 mv/cm at 50 Kc. Oscilloscope amplifier passbands are d-c to 50 Kc on the 100-microvolt/cm range, increasing to 1 Mc on the 0.2-volt/cm range. Horizontal deflection is calibrated in steps of 0.1, 0.2, 0.5, 1, and 2-volts/cm and is accurate to 5 percent. Controls include separate focusing for each beam, plus a balance control to equalize the intensities of the two traces. Tektronix Inc, P.O. Box 500, Beavertron, Oregon, manufacture the Type 502A oscilloscope. The illustration shows it being used to tune an electronic organ. (302)

Polycarbonate Capacitor Gives High Stability

CAPABLE of maintaining stability within 1 percent over −55 to 125 C, Series K polycarbonate film capacitors can be supplied with tolerances of ±1 percent and capacitances be-

JFD PRECISION TRIMMER PISTON CAPACITORS ENABLE MOTOROLA'S FREQUENCY STANDARD TO ACHIEVE $1x10^{-11}$ SETABILITY

$1x10^{-11}$
SETABILITY

$5x10^{-11}$
AGING PER DAY

$5x10^{-11}$
SHORT TERM STABILITY, 1 SECOND COUNTS

LESS THAN $2x10^{-10}$
20° C ± 20° C

MODEL VCJ673 0.7 pf-12.0 pf ACTUAL SIZE

MODEL MC623 1.0-28.0 pf ACTUAL SIZE

The Motorola 1011 Silicon Solid State Frequency Standard provides precision tuning, navigational and communications systems measurements for military and industrial standards laboratories. With less than $5x10^{-11}$ crystal aging per day, the Motorola 1011 closely approaches atomic standard ultra-stability.

Because of its exceptional stability, the fine frequency adjust control is setable to 1 part in 10^{-11}. To help achieve this value, the JFD VCJ673 trimmer, a special modification of the JFD Super MAX-C was selected. The sealed interior construction of the JFD VCJ673 locks out all atmospheric effects. C of the unit is 0.7 to 12.0 pf. It offers a capacitance variation of 0.6 pf per full turn. Such variation is, in effect, again demultiplied by the diameter of the geared tuning mechanism for extreme tuning sensitivity. Stability is ± 50 PPM/°C. Its fine vernier adjustment is absolutely linear and repeatable to within ± 1%.

The coarse frequency adjustment uses a JFD MC623 MAX-C Trimmer Sealcap Capacitor for a C of 1.0 to 28.0 pf., in a very compact unit. JFD MAX-C Trimmer Capacitors meet or exceed all applicable performance or environmental requirements of Mil-C-14409A. The unit's rapid tuning characteristics speed setting to the required coarse tuning position.

Thousands of JFD trimmers are serving in demanding applications such as these. Why don't you put JFD trimmer experience to work in your present or projected products?

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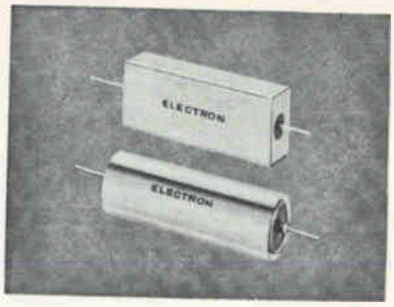
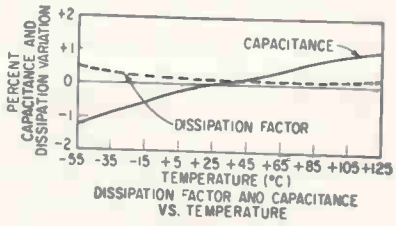
See What's New at JFD WESCON BOOTH No. 3212, 3213

CIRCLE 101 ON READER SERVICE CARD 101





DISSIPATION FACTOR AND CAPACITANCE VS. TEMPERATURE

tween 0.001 and 1.5 microfarads. These capacitors are credited with the characteristics and performance of polystrene dielectrics and have temperature ratings approaching those of Teflon.

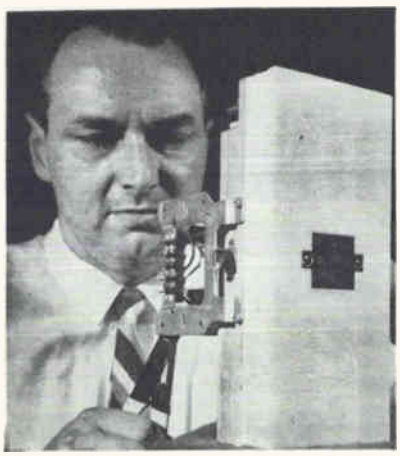
Series K capacitors are intended for use in computers, discriminators, integrators, differentiators, and other circuits where, according to the manufacturer, Electron Products Division, Marshall Industries, 1960 Walker Avenue, Monrovia, California, their high stability, wide temperature range and excellent retrace characteristics provide improved circuit operation.

CIRCLE 303, READER SERVICE CARD

Walnut Sized Amplifier Delivers Five Watts

TRANSISTOR amplifier is assembled in cordwood fashion using standard and miniaturized components. It comes epoxy potted to withstand arduous shock and environmental stresses. Amplifier is designed to drive 400-cycle servo motors and has built-in 90-degree phase shift. Output is linear to 1.5 volts rms and

remains effective to 6 volts rms maximum. Input impedance is around 50 kilohms with a gain of about 10; various models are available with gains ranging up to 1,000 for an input resistance of 4,000 ohms. Typical operating temperature covers −55C to 125C; input supply is 28 volts nominal with 11 watts consumption at maximum output. The amplifier is manufactured by Kearfott Division, General Precision, Inc., Little Falls, N. J. (304)



Cascade Unit with Matched Power Supply

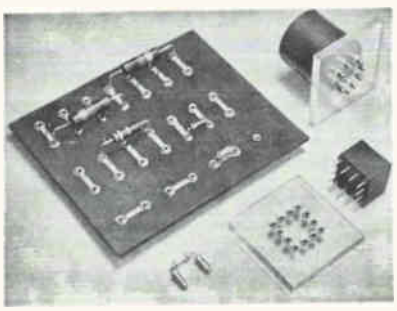
THERMOELECTRIC cascade unit with matched power supply—a complete two-stage heat pump that heats or cools to provide a constant temperature throughout a wide range of conditions—is now available. The W832G03 provides a −50 C cold side temperature while cooling a 400-mw load. It is designed to operate with 24 amperes of d-c device current. The rating is based on an ambient temperature of 24 C. The cascade unit is ideal for use in apparatus for freezing-point measurements, dew-point meters, freezing traps, photomultiplier-tube coolers and many other low-temperature applications. Westinghouse Semiconductor Division, Youngwood, Pa. (305)

Netic Containers Protect Tapes

TWO new round, sturdy, long life, simplified design, spun construction Netic containers, 3½ and 20 in. diameter, fully protect magnetic tapes, components and other magnetically affected devices from unexpected exposure to damaging magnetic fields during transportation or storage. Any in-between size or shape can be fabricated. The Netic S3-5 alloy's shielding effectiveness is not diminished by dropping, rough handling or proximity to magnetic fields as Netic is shock insensitive, non-retentive and does not require periodic annealing. Magnetic Shield Division Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill. (306)

Instrument Panel Kit Saves Time and Expense

COMPLETELY self-contained panel production kit produces up to four color permanent aluminum panels in twenty minutes. No graphic skills are required; no dark room or other special equipment necessary. No dangerous chemicals are involved in the process. Complete operation can be performed on a table. Electro-Kits are priced from $19.95. Halmar Electronics, Inc., 1544 W. Mound St., Columbus 23, Ohio. (307)



P-C Board Jacks Are Reusable

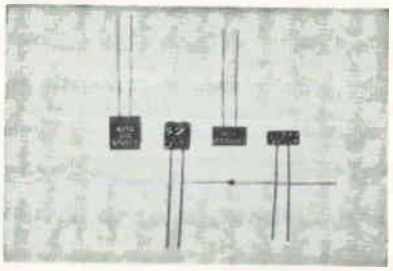
REUSABLE printed circuit board jack prevents damage to components during "burn-in" testing and eliminates the costly replacement of printed board test fixtures. The jack consists of two parts, a drawn cup which is hand, dip or wave soldered

in the board, and a spring receptacle in the cup which holds the component lead in place. Use of the reusable jack in the test board allows for mounting of various components by hand insertion without soldering of the component lead. One jack size accepts a wide variety of components with leads from 0.018 to 0.040. Only one hole size is necessary in the board to mount the jack. AMP Inc., Harrisburg, Pa.

CIRCLE 308, READER SERVICE CARD

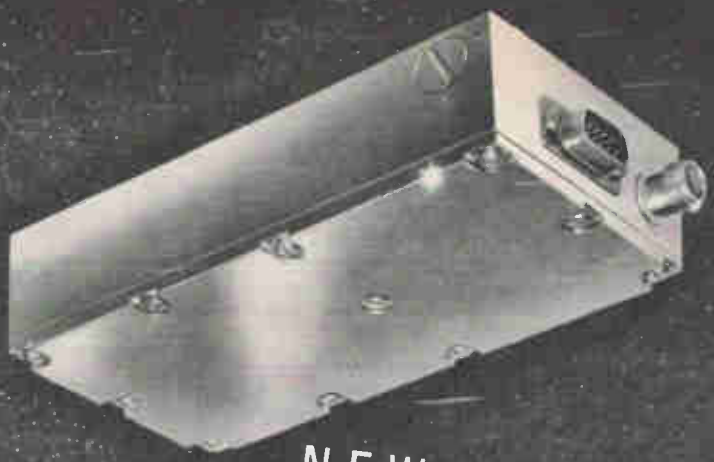
Broadband TWT for UHF Microwave Use

HIGH POWER, broadband traveling wave tube for uhf microwave applications is available. The MA-2001C is an electromagnetically focused, forced air cooled twt designed for electronic countermeasure applications and for new phased-array radars. High power and gain performance are obtained over an octave bandwidth. Frequency range is 400 to 1,000 Mc with a nominal power output of 300 w c-w. Nominal efficiency is 25 percent. Tube weighs 31 lb. Microwave Associates, Inc., South Ave., Burlington, Mass. (309)



Ceramic Capacitors Save Space

RESIN-ENCAPSULATED microminiaturized ceramic capacitors from 10 $\mu\mu$f to 120,000 $\mu\mu$f with 0.025 diameter radial leads are offered. Values to 10,000 $\mu\mu$f also available with gold flash lumet 0.016 diameter axial leads. Working volt-



NEW LEACH TWO-WATT FM TELEMETRY TRANSMITTER HAS WIDEST FREQUENCY MODULATION RESPONSE IN OR OUT OF THIS WORLD!

(5 cps to 125 kcps within 1.5 db)

And hear this! It performs to specs through 20 G's vibration and temperatures to +85°C. It's completely transistorized down to the final power amplifier. It's tiny – 1.3″ x 2.9″ x 5.75″.

And this. The new Leach 2-watt Telemetry Transmitter has a low power consumption (655 milliamps maximum at 28 vdc) and because it's FM, it provides

This Leach Telemetry Transmitter has already passed stringent customer tests. Compare it to your requirements. A call or letter to Leach is the best way to begin.

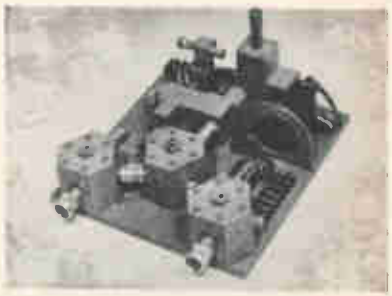
LEACH CORPORATION

CONTROLS DIVISION: 717 N. Coney Ave.
AZUSA, CALIFORNIA • Phone: 334-8211

LEACH INTERNATIONAL S.A.

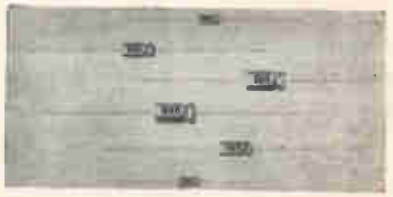
age 200 d-c; temperature 150 C. A units are built to conform to MII C-11015 C. U. S. Capacitor Corp 8917 Melrose Ave., Los Angele Calif.

CIRCLE 310, READER SERVICE CAR



Parametric Amplifier Has Low Noise Figure

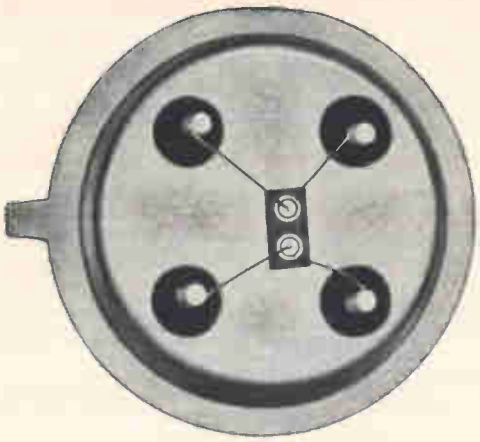
A LOW-NOISE S-band solid-stat parametric amplifier for applica tions as a preamplifier in radar telemetering and satellite-trackin receivers is announced. Basic speci fications: gain, 20 db; bandwidth 50 Mc; noise figure, 2.0 db max including a 10 db second stage frequency tuning range, 2,900 t 3,100 Mc. Micromega Corp., 413 Del Ray Ave., Venice, Calif. (311

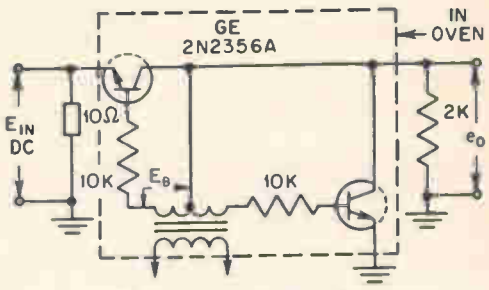


Tantalum Wet Slugs Meet MIL-C-3965/4

TANTALUM wet slug electrolytic ca pacitors conform to MIL-C-3965/4 The CL64 and 65 subminiature ca pacitors are polar units suited fo low voltage transistor application such as filtering, coupling and by pass in both military and industria electronic equipment. They offe high capacitance-to-volume and ca pacitance-to-weight ratios, yet ar said to be substantially lower i cost than other types of tantalun capacitors. Voltage range is fron 6 through 100 v d-c. Capacitanc extends from 4.7 to 560 μf, wit ±20 percent tolerance. IEI Div. Standard Pressed Steel Co. Bo 9036, Nashville, Tenn. (312)

Silicon Choppers

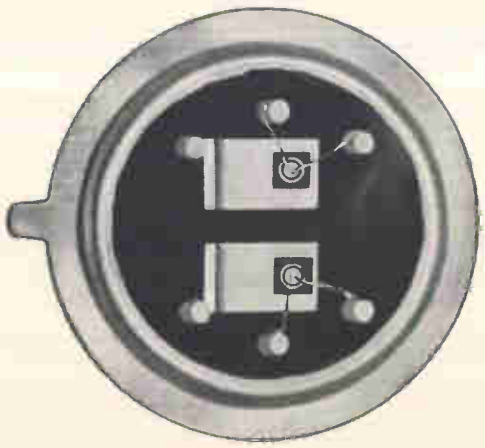


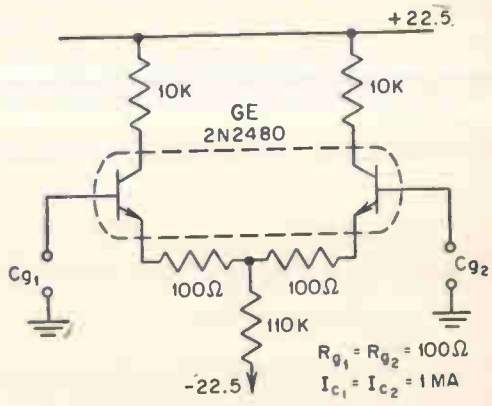


E_B = 12 V_{P-P}, 400 ~ SINE WAVE

Typical Low-Level Chopper
performance is 0.6 μv/°C from −55°C to +155°C

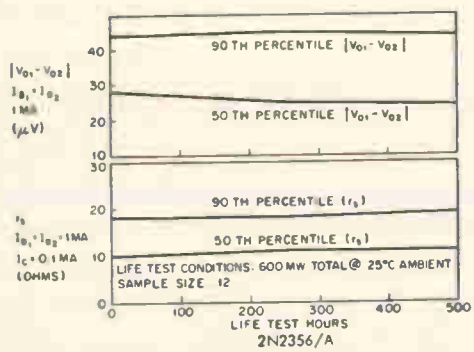
Silicon Differential Amplifiers

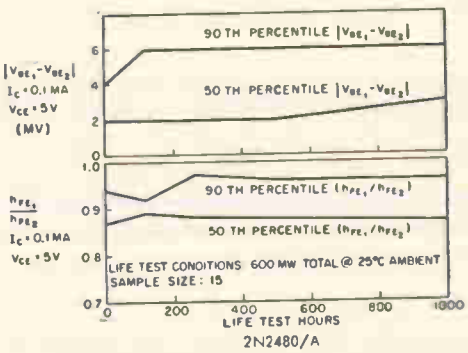




Typical Low Drift Differential Amplifier
drift performance better than 10 μv/°C

feature matched characteristics... extreme stability with life





SILICON NPN CHOPPERS

Five-Terminal TO-5 Package Containing Two Planar Epitaxial Passivated Transistors

Type	Maximum Vo $I_{B1}=I_{B2}=1$ ma $I_{E1}=I_{E2}=0$ μ volts	Minimum V_{EEO} $I_{E1E2}=1$ ma $I_{B1}=I_{B2}=0$ volts	Maximum r_s $I_{B1}=I_{B2}=1$ ma $I_{E1E2}=0.1$ ma ohms	Maximum I_{CEO} or I_{CEO2} V_{CB1} or $V_{CB2}=25V$ na
2N2356	50 @ 25°C	20	40	10
2N2356A	50 @ −55°C to +125°C	20	40	10

SILICON NPN DIFFERENTIAL AMPLIFIERS

Six-Terminal TO-5 Package Containing Two Isolated NPN Planar Transistors

Type	Minimum V_{CEO} $I_C=20$ ma volts	h_{FE} $I_C=1$ ma $V_{CE}=5V$	h_{FE}/h_{FE2} $I_C=0.1$ or 1.0 ma $V_{CE}=5V$	Maximum $\lvert V_{BE1}-V_{BE2}\rvert$ $I_C=0.1$ or 1.0 ma $V_{CE}=5V$ m volts
2N2480	40	30 min	0.8-1.0	10
2N2480A	40	50-200	0.8-1.0	5
12A8	30	30 min	0.6-1.0	15

For complete details, call your local G-E Semiconductor District Sales Manager, or write Section 16F145, Semiconductor Products Department, General Electric Company, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: International General Electric, 159 Madison Avenue, New York, New York.

AVAILABLE THROUGH YOUR G-E SEMICONDUCTOR DISTRIBUTOR

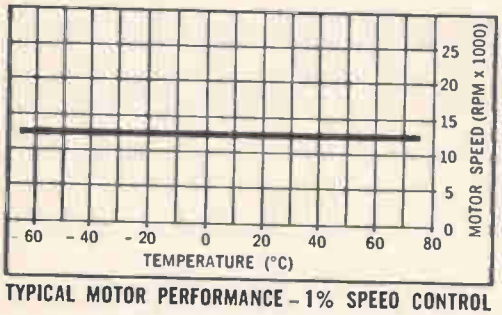
GENERAL ELECTRIC

HOLD D.C. MOTOR SPEED TO 1%...AND BETTER

Globe set out to design a speed control precise enough to control d.c. motor speed exactly while line voltage and ambient temperature varied widely, and under high vibration, in a reasonably priced miniature package.

We have accomplished just that.

The Globe **1% Speed Control** is conservatively named. What it does is to hold the speed of a motor within 1% of the speed you select **while** the ambient temperature is varied over the MIL-E-5272 range from —55° C to 75° C **and while** the input voltage is varied from 22 to 32 v.d.c., **and while** the load is varied from zero to rated value.



TYPICAL MOTOR PERFORMANCE – 1% SPEED CONTROL

■ The control is a solid state device in an 8 cubic inch package. Components are encapsulated to protect against vibration, shock, moisture and dust. Because there are no brushes, motor life can be as high as 10,000 hours at low speeds. The motor is any of several Globe frame size a.c. motors, wound for your application. You may specify any speed between 3,600 and 24,000 rpm (such as 12,027) and know that the motor speed will always be within 1%. But, if you can limit the environmental extremes, or regulate the voltage, control accuracy is improved well within the 1% range. At room temperature we have routinely held accuracies of 0.5% or better. Keep in mind, there are no moving parts to this control, and hence reduced shock and vibration vulnerability.

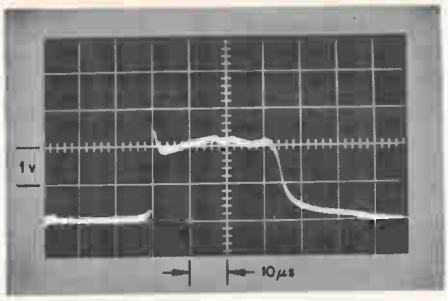
■ Where can you use it? Anywhere that you need accurate speed control. Various kinds of recorders are obvious applications. So are precise timers, samplers, and feed devices. By coupling a Globe gear reducer to the motor, you can specify and obtain literally any shaft speed from 1 revolution per day to 24,000 rpm.

■ Because the Globe 1% Speed Control is designed to be practical, you can specify reverse voltage polarity protection and transient protection in the same size envelope. Only minimum radio noise filtering is needed to meet specs. As a bonus you get all of the benefits of d.c. brushless motors—long life, no brush dust, no brush replacement, no arcing, no mechanical governor or contacts.

■ For the ultimate d.c. speed control, accurate within a few parts per million, we can also furnish a highly sophisticated crystal controlled error correcting feedback device, although the price is several times the modest price of the 1% Speed Control. Request Bulletin S-1.

Globe Industries, Inc., 1784 Stanley Avenue, Dayton 4, Ohio.

GLOBE



Super-orbital entry of a space vehicle—one returning to earth from a planet, rather than from an earth-orbiting mission—would result in searing *radiative* heating in addition to the more familiar *convective* type. As a spacecraft nose enters atmosphere, it pushes the thin air aside. A boundary layer is formed next to the skin. Ahead of that is a compressed mass of air; fronting that, a shock wave. The air behind the shock wave becomes incandescent, ionizes, and radiates to the heat shield. Within the boundary layer, friction heats the nose cone by convection.

Lockheed scientists believe that at higher than escape speed a blunt-nosed vehicle may be unable to sustain the radiative heating. Consequently, a return to the previously discarded sharp nose is indicated. Fluid mechanicists are calculating the heat load, determining how rapidly the nose will ablate and how to keep it sharp. Current shock tube tests are providing some clues.

Another research project in Lockheed's Fluid Mechanics Laboratories relates to the flow of buoyant fluids. A typical study program is the determination of how liquid hydrogen, stored in a tank in space, stratifies. This, in turn, determines the level of pressurization required in order to extract all of the fluid. Scientists made a mathematical model of what they think occurs inside the tank. With this as a guide, an actual tank was constructed to obtain measurements and photographs of the flow to verify their theories.

LOOK AT LOCKHEED... AS A CAREER

Consider Lockheed's leadership in space technology. Evaluate its accomplishments—such as the Polaris missile, the Agena vehicle's superb record of space missions. Examine its outstanding advantages—location, advancement policies, creative climate, opportunity for recognition.

Then write for a brochure that gives you a more complete Look at Lockheed. Address: Research & Development Staff, Dept. M-46B, P.O. Box 504, Sunnyvale, California. Lockheed is an equal opportunity employer.

SCIENTISTS & ENGINEERS: In addition to positions relating to fluid mechanics, other important openings exist for specialists in: Inertial guidance • Orbit thermodynamics • Electromagnetics • Mission & trajectory analysis • Gas dynamics • Chemical and nuclear propulsion • Systems engineering

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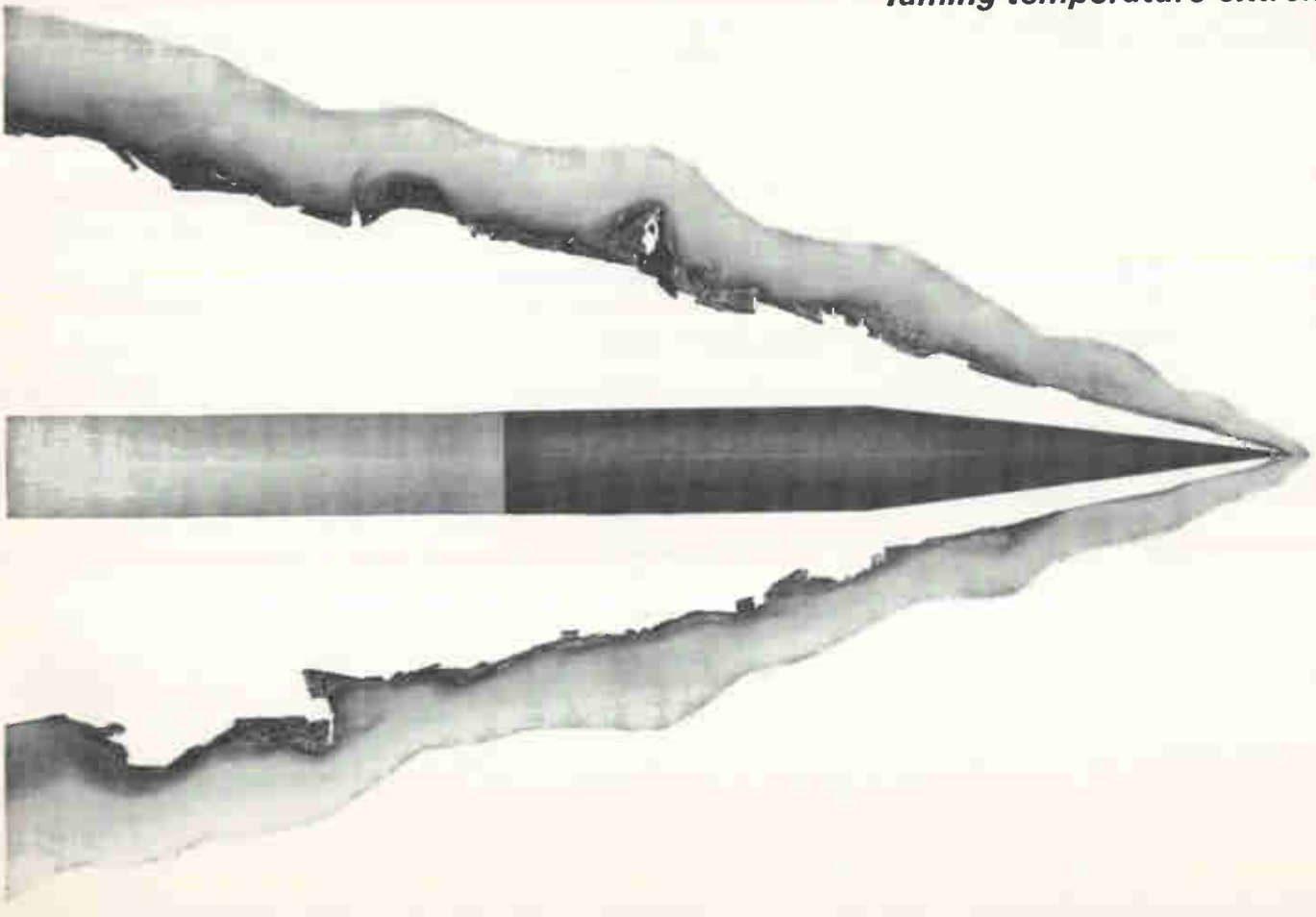
LOOK AT LOCKHEED IN FLUID MECHANICS:

Taming temperature extremes



Literature of the Week

PRECISION GLASS PARTS Hanibal Glass, Inc., 3025 Kilson Drive, Santa Ana, Calif., has available a 4-page catalog describing the broad range of precision glass parts it produces for the electronics industry.
CIRCLE 313, READER SERVICE CARD

LABORATORY POWER SUPPLIES Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J., has available a catalog supplement covering its Magitran line of magnetic-transistor lab power supplies. (314)

TEFLON The Modern Industrial Plastics Division of the Duriron Co., 3337 N. Dixie Drive, Dayton 14, O., offers a brochure featuring applications for Teflon and other fluorocarbon products. (315)

RPM CONTROL & MEASUREMENT Airpax Electronics Inc., Fort Lauderdale, Fla. Catalog S1-1 describes the installation and operation of a comprehensive line of electronic tachometers developed for industrial and military use. (316)

MICA CAPACITORS Sangamo Electric Co., Springfield, Ill., has published bulletin 2321 describing a complete line of fixed terminal, molded mica capacitors. (317)

OSCILLOGRAPH RECORDING SYSTEMS Brush Instruments Division of Clevite Corp., 37th and Perkins, Cleveland 14, O. Brochure 1100 describes oscillograph recording systems for military, industrial, and scientific applications. (318)

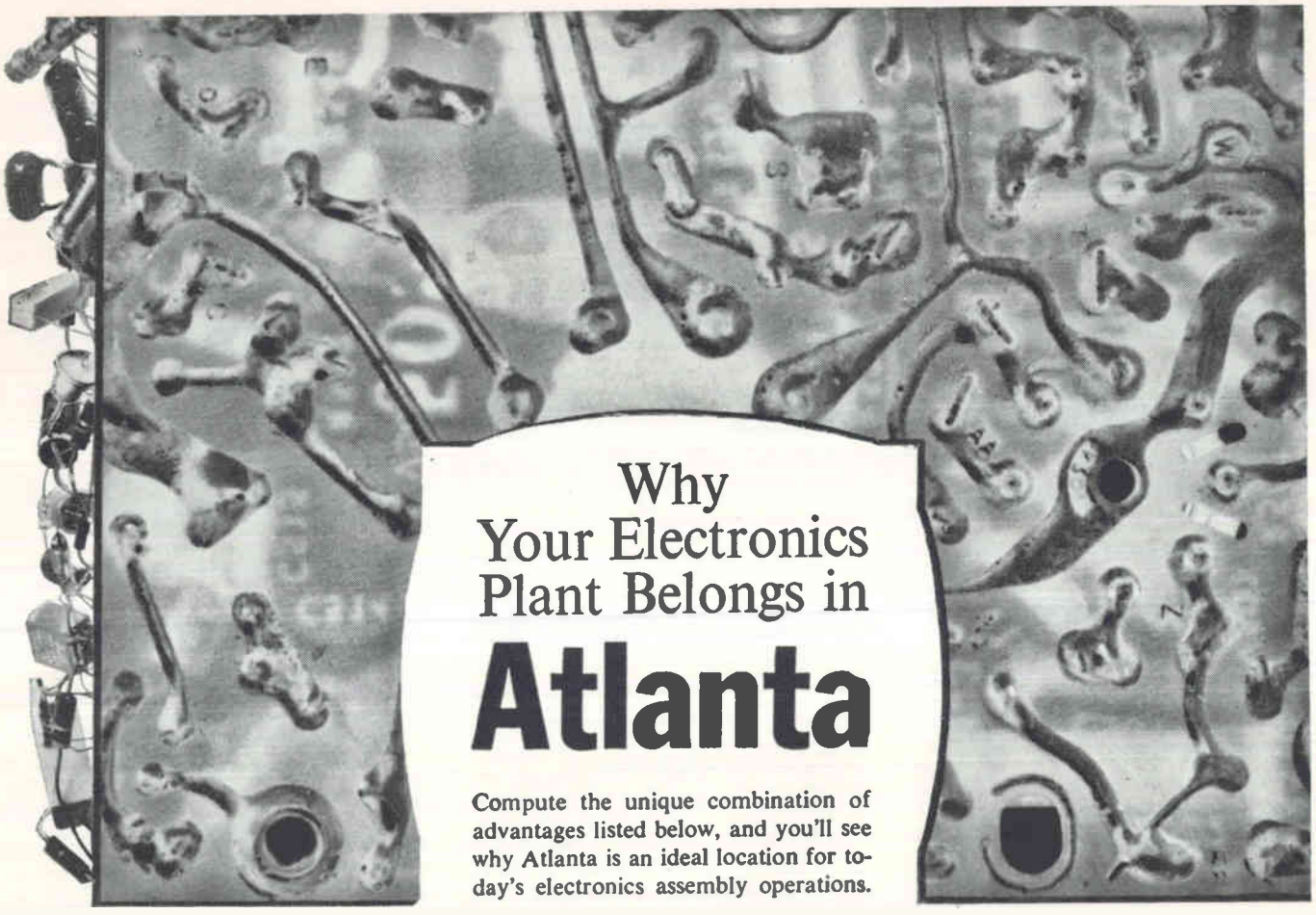
ELECTROLYTIC CAPACITORS Standard Pressed Steel Co., Box 596, Jenkintown, Pa. A 12-page brochure contains application data, construction and performance characteristics on a line of solid tantalum dry slug electrolytic capacitors. (319)

FLAME RETARDANT EPOXY Union Carbide Plastics Co., 270 Park Ave., New York 17, N. Y. Product data folder describes the new Bakelite epoxy resin ERSA-2450 flame retardant laminates. (320)

BOBBINS Thermotech Industries, Inc., 1202 South Fifth St., Hopkins, Minn., offers a two-color 25½ in. by 22 in. chart suitable for wall mounting showing a complete listing of its line of molded coil winding bobbins. (321)

TRANSFORMER DESIGNS Aladdin Electronics, 703 Murfreesboro Road, Nashville, Tenn. Engineering bulletin No. 125 lists standard units in two new series of transformer designs. (322)

DI-HEPTAL SOCKET Connector Corp., 6025 No. Keystone Ave., Chicago 46, Ill. Data sheet 24A covers the



Why Your Electronics Plant Belongs in Atlanta

Compute the unique combination of advantages listed below, and you'll see why Atlanta is an ideal location for today's electronics assembly operations.

High productivity. For every dollar of wages paid, an Atlanta manufacturer of electronic measuring instruments can expect $3.76 in value added by manufacture. In Chicago he would gain only $2.90; in New York-New Jersey, $2.64 (U. S. Census figures). Atlanta's large labor pool also permits a high degree of selective hiring.

Trained engineers and technicians. In 1962 Atlanta's 19 colleges and universities granted over 1,000 Bachelor of Science degrees — more than 200 in electrical engineering and physics. Nearly 300 technicians graduate here yearly.

Proximity to aerospace and atomic energy installations. Atlanta is at the center of some 21 military, NASA, AEC, and airframe manufacturing installations, including Oak Ridge, Redstone Arsenal, Cape Canaveral.

Transportation. Close liaison between manufacturer and customer and rapid freight service are guaranteed by Atlanta's transportation facilities. Seven airlines offer nonstop service from Atlanta to more than 50 cities; 75 truck lines provide scheduled service to every major market in the nation; 7 railroads operate into and out of the city over 13 main lines.

Independent research capabilities. Georgia Tech's Engineering Experiment Station, Emory University, the University of Georgia, plus a number of private companies, offer a wide range of research capabilities on a contractual basis to business and industry.

Ask for an analysis of your company's probable success in Atlanta as prepared by Georgia Tech's 43-man Industrial Development Division. Check coupon; mail with your company letterhead. All inquiries confidential.

Please send me the following reports and other information as checked below.

1. ☐ Calculators and Computers—A Manufacturing Opportunity in Atlanta
2. ☐ Electronic Testing and Measuring Instruments—A Manufacturing Opportunity in Atlanta
3. ☐ Electronics—A Manufacturing Opportunity in Georgia
4. ☐ I would like information on the following aspect(s) of Atlanta's economic and general make-up (list)_____
5. ☐ I want to know my company's prospects for success in Atlanta as analyzed by Georgia Tech's Industrial Development Division. We would be interested primarily in a new ☐ plant ☐ warehouse ☐ sales office ☐ other _____

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Product_____

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CONFIDENTIAL

CIRCLE 111 ON READER SERVICE CARD 111

type 545 miniature crt socket which mates with JEDEC B12-244 diheptal base. (323)

ACTIVE FILTER NETWORKS Guillemin Networks, Inc., 381 Eliot St., Newton 64, Mass. Data sheet describes active filter networks with Q of 200 for l-f applications. (324)

HYDROGEN THYRATRON Calvert Electronics Inc., 220 E. 23rd St., New York 10, N. Y., has an *Application Report* on the English Electric hydrogen thyratron assembly for 75 mw pulse output. (325)

THIN-FILM FLIP-FLOP Halex, Inc., 139 Maryland St., El Segundo, Calif. Specification sheet on model 1010FF microminiature thin-film flip-flop provides complete specifications with diagrams. (326)

TRAVELING WAVE TUBES Sperry Electronic Tube Division, Gainesville, Fla., offers an informative technical paper entitled "Some Factors Affecting Size and Weight of Traveling Wave Tubes." (327)

SERVO MOTORS Kearfott Division, General Precision Aerospace, Little Falls, N. J. Technical data sheet covers the CZO 9634 001 size 40 high power servo motors. (328)

REGULATED SUPPLIES Alpha Scientific Laboratories, Inc., P.O. Box 333, Berkeley 1, Calif. Data sheet covers regulated power supplies for magnets and general purposes. (329)

MAGNETIC CIRCUIT BREAKERS Metals & Controls Inc., a corporate division of Texas Instruments Inc., Attleboro, Mass. Catalog data sheet describes the Klixon 4MC series trip-free magnetic circuit breakers. (330)

OSCILLOSCOPES Tektronix, Inc., Box 500, Beaverton, Ore., has published an 8-page brochure describing 14 types of oscilloscopes designed for rack and console service. Request on business letterhead.

IRON CORE COMPONENTS United Transformer Corp., 150 Varick St., New York 13, N. Y., announces release of its two new 1963-1964 catalogs of iron core components. (331)

MICROWAVES LP Associates, 11924 W. Washington Blvd., Los Angeles 66, Calif. Brochure describes the company's design, development and manufacturing capability in microwave electronics. (332)

REFLEX KLYSTRONS Raytheon Co., Waltham 54, Mass. Four-page, two-color brochure describes six new millimeter reflex klystrons. (333)

VARIABLE RESISTOR CTS of Berne, Inc., Berne, Ind. Data sheet 1400 covers the 1 1/16 in. diameter series 320 RV4 3-w variable resistor. (334)

TELSTAR Bell Telephone Laboratories Inc., 463 West St., New York 14, N. Y. A color reprint of the Bell Laboratories Record contains 10 semitechnical articles about the engineering that went into the Telestar project. (335)

IRC Plans Advanced R&D Center

INTERNATIONAL RESISTANCE Company will start construction on a 72,200-square-foot advanced Research and Development Center in Worcester Township (near Norristown), Pa., in March, 1964. The building, to be situated on an 85-acre tract, will cost approximately $2½ million, when completed.

Walter W. Slocum, president of the Philadelphia-based firm, said the laboratories will be equipped with the most modern scientific instruments for basic research and development in thin films, solid state physics and microcircuitry.

The Center will be completely air-conditioned with special filtering to provide an over-all, dust-free, clean-room environment. To facilitate this environment, laboratories will be windowless, connected by passageways to the main corridors at the front and rear glass walls of the building. All utilities will be supplied through fixed mechanical cores located in the walls forming the passageways. Special ultra-clean white rooms will also be provided.

Aeronutronic Made Division of Philco

AERONUTRONIC division of Ford Motor Co., Dearborn, Mich., has been transferred to Philco Corp., a wholly-owned subsidiary of Ford.

Aeronutronic, which is located in Newport Beach, Calif., and employs 2,500 becomes a division of Philco Corp. John B. Lawson (picture), Aeronutronic general manager, continues in that position and has been elected a vice president of Philco

Corning Announces Four Appointments

KARL R. WUENSCH has been named manufacturing manager of the Electronic Products division of Corning Glass Works, Raleigh, N. C. He had been plant manager of the division's capacitor plant there.

William F. Neuman, who had been manager of the Corning plant at Greencastle, Pa., was appointed to succeed Wuensch.

In other divisional apointments, Norman M. Edelson was named manager product and process development for microcircuits, and Edward A. Pagola was named production superintendent of the division's Ceramic plant in Corning, N. Y. Edelson has been plant manufacturing engineer at Raleigh, and Pagola has been a department foreman at Corning's Greenville, O., plant.

General Electric Elects Corbin

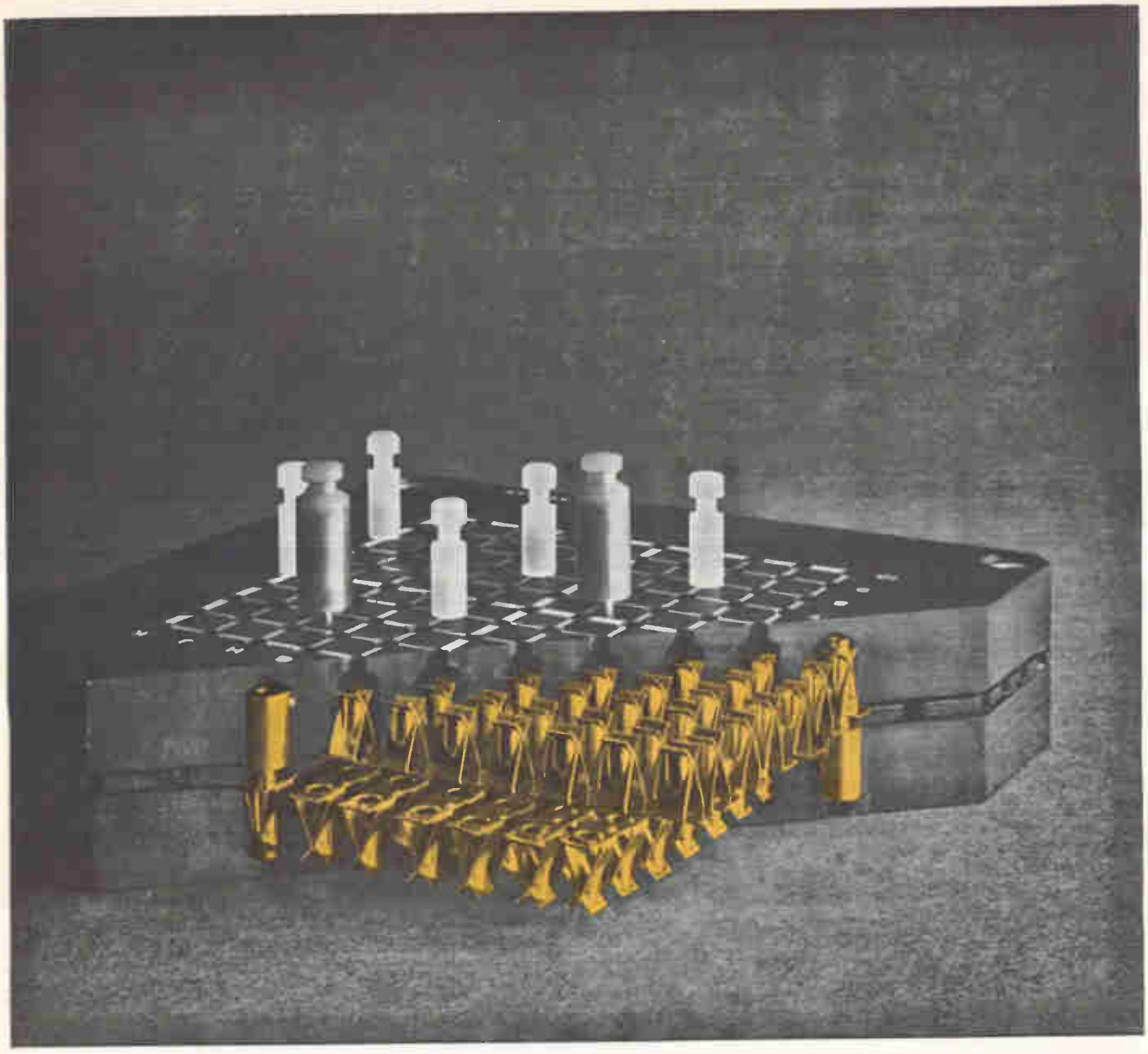
S. WELLFORD CORBIN has been elected a vice president of the General Electric Company, Schenectady, N. Y.

As general manager of GE's Industrial Sales Operation, Corbin heads an organization employing some 8,200 persons and selling hundreds of thousands of products.

Nieminen Takes New Hickok Post

ELECTION of Robert A. Nieminen as executive vice president of the Hickok Electrical Instrument Co., Cleveland, O., is announced.

Nieminen, who has served as vice president of manufacturing since 1960, assumes the additional responsibilities of long-range cor-



Pin down reliability

Here's a **matrix pinboard** that pins down the most important element of all . . . reliability! We've made sure of this by building in quality "extras" to match the requirements of your most complex and costly equipments.

The pinboard assembly is made with rigid, solid phenolic blocks . . . precision made and fitted. The spring busses are precision formed . . . held in place by a phenolic "honey-comb" provided with a special funnel design at the X-Y co-ordinates—**all** to prevent misconnections and malfunctions. Pins are guided into exact position for positive connection and reliable performance.

As for the pins themselves . . . shorting, diode and other component carrying types—none bend or buckle regardless of repeated insertions and extractions. And there's never a chance of insulating-film buildup because we use a special hard gold alloy over nickel plating for both pin **and** springs.

Sound like quality? Good performance? Lasting reliability? Our pinboards give all these and more and here are more reasons why:

- permanent backboard connections made with crimp-type taper pins
- all standard sizes and configurations; special sizes on request
- pinboard panels with interchangeable templates which can be pre-programmed and stored.
- .095 diameter pins
- .250″ x .250″ grid design

Complete information is available on both standard and special size matrix pinboards.

AMP
INCORPORATED
Harrisburg, Pennsylvania

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

CIRCLE 115 ON READER SERVICE CARD 115

porate planning.

Hickok manufactures electronic test and control equipment.

Pearce-Simpson Names Seiden

PEARCE-SIMPSON, INC., Miami, Fla., has announced the appointment of Stanford Seiden to the post of plant manager, electronics division.

Seiden, a 17-year veteran of the electronics industry, is former vice president, manufacturing, Crosby Electronics.

Power Designs Hires Hersh

JOSEPH B. HERSH has been named plant manager of the Power Designs, Inc., Westbury, N. Y., facility. He was formerly vice president-manufacturing of the Radio Receptor division of General Instruments Corp.

Power Designs manufactures precision low and high voltage electronic power supplies.

Schaevitz Engineering Appoints Mahler

RICHARD A. MAHLER, former president of Harvey-Wells Corp., has been appointed vice president of

sales at Schaevitz Engineering, Pennsauken, N. J.

Mahler will be in charge of all sales programs at Schaevitz Engineering and its subsidiaries, including Measurement Control Devices, Philadephia, Pa.; Burrite Electronics Corp., Burbank, Calif.; Southern Electronic Engineering Co., Warner Robins, Ga.; and Triconix, Inc., Waltham, Mass.

Woodward Takes New Philco Post

CHESTER P. WOODWARD has been named manager-technical staff of

RCA REALIGNS DIVISIONS

On July 1, Radio Corporation of America will put into effect a reorganization of its Electron Tube and Semiconductor and Materials divisions. They'll merge into a new organization with five major operating units, headed up by Douglas Y. Smith, vice president, Electronic Components and Devices.

His new staff, providing services to all five units, includes: G. C. Brewster, manager, operations planning and support; Alan M. Glover, division vice president, technical programs; Joseph E. Kelley, division vice president, general sales.

Operating units and their executives are:

- Commercial Receiving Tube and Semiconductor: William H. Painter, division vice-president and general manager. This unit will be responsible for sale of tv picture tubes as well
- Industrial Tube and Semiconductor: C. E. Burnett, division vice president and general manager
- Television Picture Tube: John B. Farese, division vice president and general manager, engineering manufacture and marketing of color and black-and-white picture tubes
- Special Electronic Components: Lloyd R. Day, general manager; development of new and advanced components and devices
- Distributor Products: Harold F. Bersche, division vice president; sale of all RCA electronic components and devices to authorized distributors.

TI Building 435,000-Sq-Ft Plant

ARCHITECTURAL *sketch of new multipurpose building of 435,000 sq ft now under construction in Dallas where Texas Instruments will produce future Shrike air-to-surface tactical missiles. Initial occupancy is scheduled to begin in October and be complete in December*

the Advanced Technology Laboratories of Philco Corporation's Communications and Electronics division, Blue Bell, Pa.

Formerly manager-technical staff of the division's radar laboratory, Woodward will be responsible for the coordination of plans and programs within the Advanced Technology Laboratories.

PEOPLE IN BRIEF

Harry Altman promoted to director of the Range Systems laboratory of ITT Federal Laboratories. **I. J. Steinhoff,** formerly with G.M. Labs., appointed g-m of the Electro-Mechanical div. of Indiana General Corp. **Norton F. Hight** advances to executive engineer in the Systems Engineering dept. of the Government Products div. at Adler Electronics, Inc. **Sanford Brown,** Cleveland engineering consultant, has joined Assembly Products, Inc., as director of quality control. **William C. Hauser,** previously with Aerojet-General Corp., named chief engineer of R. O. Roberts Co., Inc., **Lawrence F. Punte** moves up at Fairchild Semiconductor to head the Process Engineering dept. Computer Instruments Corp. ups **Jack Confredo** to production control mgr. for all operations. Clary Corp. raises **C. A. Christoff** to v-p engineering. **Paul D. Leeke** elevated to research projects mgr. by Mincom div., 3M Co. **William P. Bartley,** with GE since 1949, named mgr. of advance engineering at the Communication Products dept. **James M. Wright** leaves North American Aviation Co. to join Edcliff Instruments as operations mgr. **Vincent F. Procopio,** from General Instrument Corp. to Platronics, Inc. as mgr. of the Hermetic Seals div. **Dana K. Nance,** ex-General Motors Corp., appointed chief engineer of SpaceK Corp. **Donald L. Pyke** leaves Systems Development Corp. to rejoin Thompson Ramo Wooldridge Inc. as asst. to the v-p, R&D. **John Greksouk** (Commander, U.S.N., Ret.) named mgr. of quality assurance at The Technical Material Corp. West Nyack transmitter plant.

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 #
AEROSPACE PLACEMENT CORP. Philadelphia, Penna.	121	1
AMERICAN MACHINE & FOUNDRY CO. Alexandria Div. Alexandria, Va.	120	2
ATOMIC PERSONNEL INC. Philadelphia, Penna.	121	3
BELL AEROSYSTEMS CO., Div. of Bell Aerospace Corporation A Textron Company Buffalo, N. Y.	121	4
COLLINS RADIO COMPANY Dallas, Texas	98	5
GENERAL DYNAMICS/ELECTRONICS A Div. of General Dynamics Corp. Rochester, New York	81*	6
LOCKHEED MISSILES & SPACE CO. Div. of Lockheed Aircraft Corp. Sunnyvale, California	109	7
PAN AMERICAN WORLD AIRWAYS INC. Guided Missiles Range Div. Patrick AFB, Fla.	110**	8
UNION CARBIDE NUCLEAR COMPANY A Div. of Union Carbide Corporation Oak Ridge, Tennessee	79*	9

* These advertisements appeared in the June 14th issue.

** This advertisement appeared in the June 21st 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)

62863

- ☐ Aerospace
- ☐ Antennas
- ☐ ASW
- ☐ Circuits
- ☐ Communications
- ☐ Components
- ☐ Computers
- ☐ ECM
- ☐ Electron Tubes
- ☐ Engineering Writing
- ☐ Fire Control
- ☐ Human Factors
- ☐ Infrared
- ☐ Instrumentation
- ☐ Medicine
- ☐ Microwave
- ☐ Navigation
- ☐ Operations Research
- ☐ Optics
- ☐ Packaging
- ☐ Radar
- ☐ Radio—TV
- ☐ Simulators
- ☐ Solid State
- ☐ Telemetry
- ☐ Transformers
- ☐ Other .....
- ☐ .....
- ☐ .....
- ☐ .....

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

TO THE ENGINEER INTERESTED IN *PROFESSIONAL ADVANCEMENT*

We are addressing this to the Electronics Engineer who has been in research and development for some years and is now seriously assessing his long range goals and interests. We are particularly interested in the engineer who has a solid background in electronic circuitry and who is presently restricted in his opportunities for professional recognition.

If this strikes a responsive chord, we have a position which may be of more than casual interest to you. We are seeking a man well grounded in electronics, particularly in solid state circuit design, to work in a senior capacity as a member of our professional staff. He must be able to provide technical leadership in his area of research and to work closely with the program sponsor.

Like most positions of responsibility, there are demanding aspects of the job; some travel, proposal writing, pressure on occasion. However, the position offers immeasurable prospects for personal development, an excellent salary and the opportunity to contribute directly to the growth of the company, and furtherance of the national research effort in space.

If you would like to explore this opportunity in detail, please call or write the Director of Personnel, King 8-7221

AMERICAN MACHINE & FOUNDRY CO.

Alexandria Division

1025 North Royal St., Alexandria, Virginia

AN EQUAL OPPORTUNITY EMPLOYER

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

DISPLAYED	——*RATES*——	*UNDISPLAYED*
The advertising is $27.25 per inch for all advertising other than on a contract basis. AN ADVERTISING INCH is measured 7/8" vert. on a column, 3 cols.—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.		$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line. BOX NUMBERS count as one line additional. DISCOUNT of 10% if full payment is made in advance for four consecutive insertions.

Send NEW ADS or Inquiries to Classified Adv. Div. of Electronics, P. O. Box 12, N. Y. 36, N. Y.

WANTED:

AN/TRC-24 RADIO SET COMPONENTS

AM-912/TRC
AM-913/TRC
AM-915/TRC
PP-685/TRC
R-417/TRC
T-302/TRC

W-2402, Electronics
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

CIRCLE 954 ON READER SERVICE CARD

U. S. MICROWAVE

AMERICA'S LEADING DISTRIBUTOR OF ELECTRONIC TUBES

Klystrons, Transmitting, Magnetrons, Amplitrons, Rectifiers, Thyrotrons, BWO, TWT, Exotic Types, XFA, MBK, COAX Mag, Image converters, Orthicon, Photomultiplier, Transistor, Zener, Cathode-Ray, Storage.

Distributors of Specialized Electronic Equipment—Nuclear, Geophysical

EXPORT INQUIRIES INVITED—ALL LANGUAGES

U. S. MICROWAVE

P. O. Box "G"

Collingswood, New Jersey

Call Collect, Area Code 609 - WO 6-2929

CIRCLE 950 ON READER SERVICE CARD

OVER 2,000,000

RELAYS

IN STOCK!

Send for Catalog 55

Universal RELAY CORP.

42 WHITE ST., N.Y. 13, N.Y. • Walker 5-6900

CIRCLE 952 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/APS-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 955 ON READER SERVICE CARD

FOR SALE

Standard 3-channel open-wire Carrier Terminals and Repeaters.

Standard v-f carrier-telegraph terminals.

Standard v-f ringers, v-f repeaters, repeating coils, condensers, filters, retard coils, polar relays.

Complete list on request

FS-2435, Electronics
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

CIRCLE 953 ON READER SERVICE CARD

LOOKING FOR

USED/SURPLUS ELECTRONIC EQUIPMENT/COMPONENTS?

For an up-to-date listing of such equipment see Searchlight Section of June 14th issue.

EMPLOYMENT OPPORTUNITIES

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.

— 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—count as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

INDEX TO ADVERTISERS

- AMP Incorporated 115
Air Express 21
Ampex Corporation 48
Atlanta Chamber of Commerce... 111

Baltimore Gas & Electric Co..... 16
Bendix Corporation, The
Bendix Pacific Division 31
- Black & Webster, Inc..... 34
- Bliley Electric Co..... 116
- Bulova Electronics Div..... 28

Cambridge Thermionic Corp..... 36
Connon Electric Co..... 14
Carborundum Company, The 17
Cleco Division of Reed Roller
Bit Co. 117
Collins Radio Co..... 98
Cominco Products, Inc..... 116
- Corning Electronics Div. of
Corning Glass Works..... 87
Cubic Corp. 95

Daytona Beach Industrial Area.. 118
- Defense Electronics, Inc..... 40
Delco Radio 85

- Eastman Kodak Co..... 37
- Edgerton, Germeshausen &
Grier, Inc. 35
Electro Instruments Inc..... 88
Electro Nuclear Laboratories..... 49
Electronic Industries
Association of Japan..... 67
Electronic Memories Inc..... 33

Fluke Mfg. Co., Inc., John..... 20
Flying Tiger Line..... 86
Fujitsu Ltd. 73

General Electric
Industrial Tube 15
Semiconductor Products Dept.. 107
Silicone Products Dept..... 92
- General Findings Inc..... 112
Globe Ind., Inc. 108

Hamilton Standard Div. of
United Aircraft Corp. 43
- Hart Manufacturing Co..... 112
- Hewlett-Packard Company
inside front cover, 10, 11
- Hitachi, Ltd. 69
Honeywell Denver Division..... 89
Hyperion Ind., Inc.....102, 103

- J F D Electronics Corp..... 101
- Japan Piezo Electric Co., Ltd..... 67

- Keithley Instruments, Inc..... 104
- Kepco, Inc. 75
- Kester Solder Co..... 29
Kintel A Division of
Cohu Electronics Inc.....3d cover
- Kyoritsu Electrical Instruments
Works, Ltd. 68

- Leach Corporation 105
- Leach and Garner Co..... 112
- Lepel High Frequency
Laboratories, Inc. 113
- Litton Industries Electron Tube Div. 46
Lockheed Missiles & Space Co..... 109
Loral Electronics Corp..... 93

Mallory and Co., Inc., P. R..... 91
Melpar Inc. 39
- Microswitch Division of Honeywell 83
Minnesota Mining & Mfg. Co.
Mincon Division 99
Mitsumi Electric Co., Ltd..... 72
Motorola Military Electronics
Div. 24, 25
Murata Mfg. Co., Ltd..... 68

NRC Equipment Co..... 84
- NAVCOR 27
- Nichicon Capacitor Ltd..... 70
North American Philips Co., Inc.
Electrix Div. 76
- North Atlantic Industries, Inc..... 77

Origin Electric Co., Ltd..... 72

Paktron Div. of Illinois Tool Works 78
Pennsalt Chemicals Corp..... 13
- Potter Instrument Co., Inc..... 19

- Radio Corporation of America. 4th cover
Radio Materials Co..... 79
Reeves Instrument Corp. Sub. of
Dynamics Corp. of America... 45
Ribet-Desjardins 106
Rome Cable Div. of Alcoa..... 30

Sangamo Electric Co.....41, 42
Sankaisha Co., Ltd..... 72
Sanken Electric Co., Ltd..... 68
- Servo Corporation of America.... 38
- Shimada Physical & Chemical Ind.,
Co., Ltd. 72
Siliconix Inc. 23
Sprague Electric Co.....4, 9
Standard Telephones & Cables, Ltd. 44
Sylvania Electric Products, Inc.
Electron Tube Div..... 81
Synthane Corp. 113

TDK Electronics Co., Ltd..... 70
Tektronix, Inc. 50
Thiokol Chemical Corp..... 47
- Tokyo Shibaura Electric Co., Ltd.. 71
- Torwico Electronics Inc..... 6
- Toyo Electronics Ind., Corp..... 73
Toyo Musen Co., Ltd..... 68
- Tung-Sol Electric, Inc..... 5

United Control Corp..... 96
- United Shoe Machinery Corp.... 104
- Utica Drop Forge & Herbrand Tool
Division, Kelsey-Hayes Co. 110

- Varo Inc. 46
Vitro Laboratories..... 94
- Westinghouse Electric Corp..... 97

Yagishita Electric Co..... 70
Yokogawa Electric Works, Inc.... 82

■

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

PROFESSIONAL SERVICES 121
EMPLOYMENT OPPORTUNITIES 120-121
EQUIPMENT
(Used or Surplus New)
For Sale 120
WANTED 120

CLASSIFIED INDEX

Aerospace Placement Corp..... 121
American Machinery & Foundry
Co., Alexandria Div..... 120
Atomic Personnel Inc..... 121
Bell Aerosystems Co., Div. of
Bell Aerospace Corp. A. Tex-
tron Corp. 121
- Radio Research Instrument Co.... 120
- Universal Relay Corp..... 120
U. S. Microwave 120

■

• See advertisement in the July 25, 1962 issue of Electronics Buyers' Guide for complete line of products or services.

This Index and our Reader Service Numbers are published as a service. Every precaution is taken to make them accurate, but electronics assumes no responsibilities for errors or omissions.

electronics

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Associated Business Publications

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DAVID CUNNIFF
Promotion Manager

■

Electronics Buyers' Guide
R. S. QUINT
General Manager

■

RICHARD J. TOMLINSON
Business Manager
THEODORE R. GEIPEL
Production Manager

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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):
Kenneth George
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)

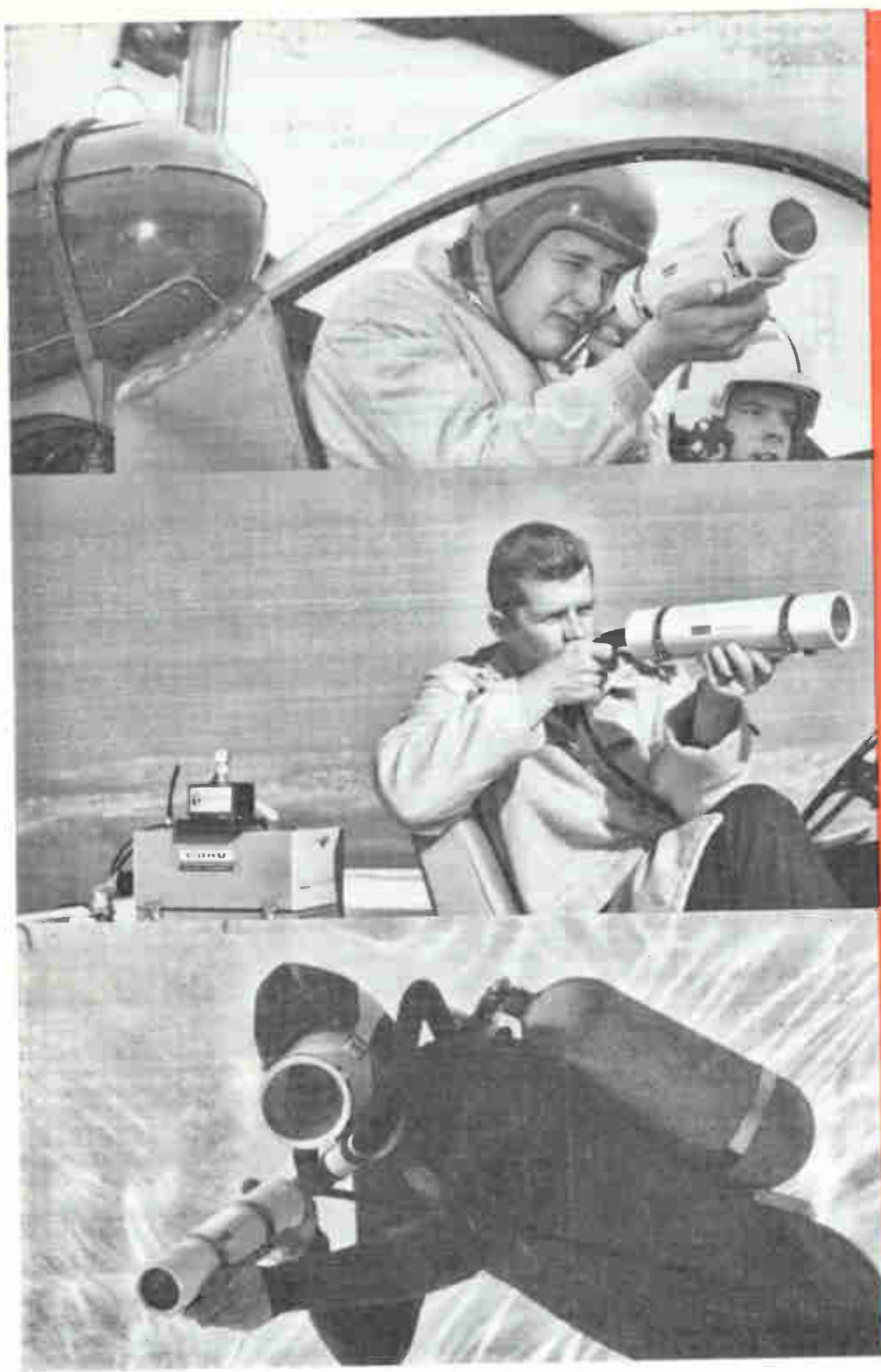
SAN FRANCISCO (11):
Richard C. Alcorn
255 California Street, Douglas 2-4600
(area code 415)

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



NEW
KIN TEL TV CAMERAS
LET YOU

send direct, visual reports from just about anywhere!

And under just about any kind of condition. In deep space. In explosive environments. In temperatures ranging from –17°C to +70°C. In water. In pipelines, deep wells, boilers (its 3-inch diameter barrel permits operation in restricted areas).

In addition, KIN TEL'S new 2000 series cameras are available with a built-in 4-1 zoom lens; provide the clearest pictures available anywhere–up to 700 lines of horizontal resolution; and–thanks to all solid state circuits–are as trouble-free as you can buy.

Send us your RFQ. The 2000 series cameras are the newest addition to one of the industry's largest lines of television equipment. With KIN TEL'S three basic TV systems and 207 separate in-stock components, KIN TEL can help you custom build a completely checked-out TV system to fit your exact needs. And do it faster and less expensively than you thought possible. Contact us or the KIN TEL representative near you.

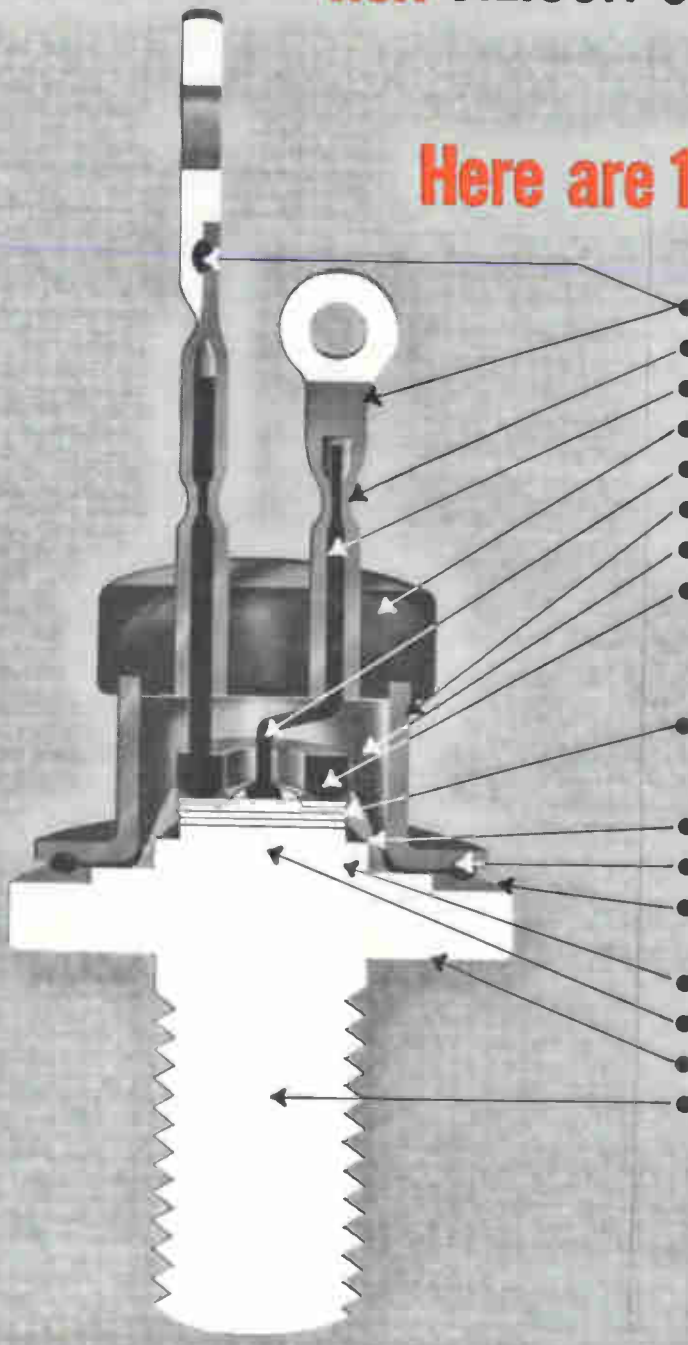
5725 Kearny Villa Road,
San Diego 12, California
Phone 277-6700
(Area Code 714)

COHU
ELECTRONICS, INC
KIN TEL DIVISION

CIRCLE 901 ON READER SERVICE CARD

NOW SWITCH WITH RCA SILICON CONTROLLED RECTIFIERS

Here are 16 solid reasons why



- Welded construction
- Intimate ohmic contact
- Rugged leads
- Dense glass
- Concentric gate lead
- Kovar seal
- Ultra-dry inert atmosphere
- Massive copper lead for uniform current-density. Annular ring for internal heat sinking
- N (Cathode) / P (Gate) / N (Base) / P (Anode) — All diffused structure; Symmetrical gate-cathode design
- Multi-coat encapsulation
- Welded seal
- Steel weld ring—brazed and integrally cold-headed with stud
- Stress-isolating pedestal
- Direct solder construction
- Flat surface for thermal contact
- Sturdy zirconium alloy stud

Check the outstanding construction and operating features of RCA's two new families of silicon controlled rectifiers...RCA 2N681 to 2N689 and RCA 2N1842A to 2N1850A...all-diffused, SCR's for power control and electrical switching applications in industrial apparatus and military equipment.

FORWARD CURRENT	BLOCKING VOLTAGE								
25 Amp (RMS) 16 Amp (Avg) @ 65°C	25	50	100	150	200	250	300	400	500
	2N681	2N682	2N683	2N684	2N685	2N686	2N687	2N688	2N689
16 Amp (RMS) 10 Amp (Avg) @ 80°C	2N1842A	2N1843A	2N1844A	2N1845A	2N1846A	2N1847A	2N1848A	2N1849A	2N1850A

These RCA Silicon Controlled Rectifiers are designed for use in your circuits at their full ratings—full current at peak reverse and peak forward blocking voltage. And RCA brings you all these big operating advantages: • Application tested for 100% safety margin on surge current • Very low thermal resistance • Forward voltage drop measured at high current (100 Amps for 2N681 family) • Installation torque capability = 50 inch-lbs • Tight control of firing characteristics • Long term operating stability • 100% aging at maximum ratings and 100% dynamic testing.

Call your RCA Representative today for complete details on these rugged new RCA SCR's . . . or write RCA Semiconductor and Materials Division, Commercial Engineering, Section IN-7-4, Somerville, N. J.

Write today for your free copy of this new RCA Application Note. SMA-16 . . "Circuit Factor Charts For Use In Applications With RCA Silicon Controlled Rectifiers"

AVAILABLE THROUGH YOUR RCA DISTRIBUTOR

The Most Trusted Name in Electronics

CIRCLE 902 ON READER SERVICE CARD