

July 18, 1960

# missiles and rockets

THE MISSILE / SPACE WEEKLY

JUL 21 1960  
HOUSTON PUBLIC LIBRARY  
Houston, Texas



*GE's Thermionic Converters*

**FOURTH ANNUAL ENGINEERING PROGRESS ISSUE**  
**And World Missile/Space Encyclopedia**  
Including New Directory of Rocket Engines

This Issue \$1.50

AN AMERICAN AVIATION PUBLICATION



## SEALING UNLIMITED AT -420°F

through continual in-plant development  
testing of fluid regulators and controls

When you're dealing with temperatures ranging from near-absolute zero to several hundred degrees above zero... with fluids that have so minute a molecular structure as hydrogen and helium... with the critical space-weight factors of missiles... these are conditions that demand continual in-plant testing by the manufacturer. It's fundamental to reliable fluid system sealing, control and regulation.

That's why Hadley is so uniquely suited to development programs such as the new hydrogen engine, as well as other space vehicle and ground support systems.

As designers and fabricators of fluid control systems on many of the operational missile programs, Hadley has combined expert engineering with its own comprehensive functional and environmental test facilities to check out every stage of development.

You'll save time, money and insure critically reliable fluid control by checking Hadley first. Write for Information Brochure MR-1094-2.

b.h. **H**adley, inc.

1427 SOUTH GAREY AVENUE, POMONA, CALIFORNIA  
■ NATIONAL 9-5075 ■ TWX Pomona 7552

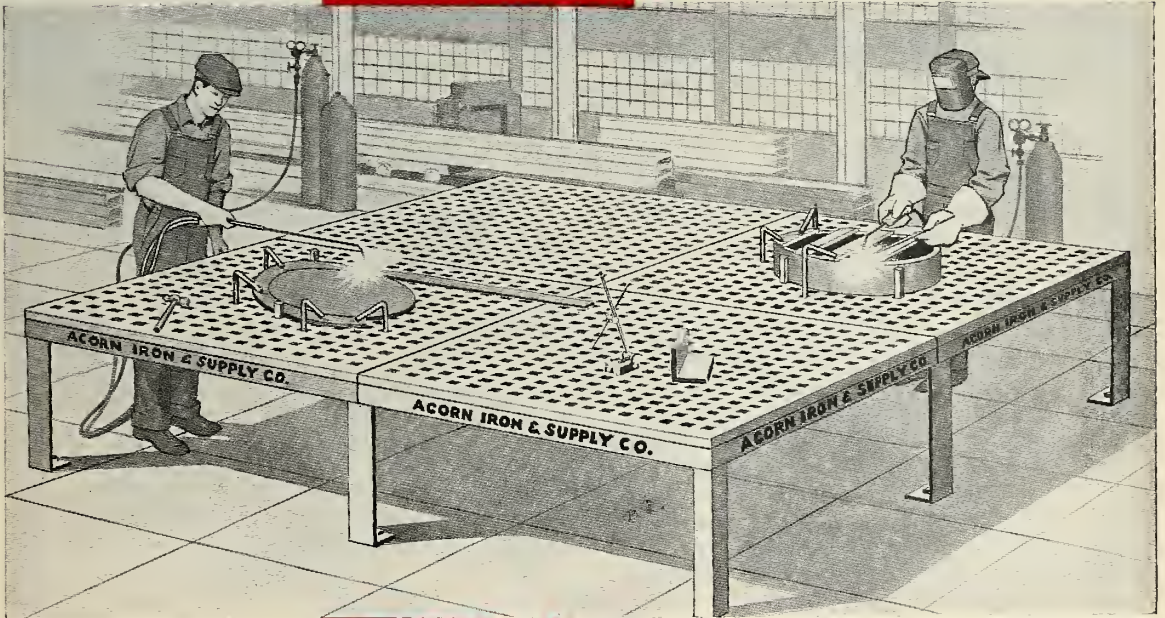
Openings exist for qualified engineers.

for research, design,  
and development . . .  
in electronics,  
aircraft, missiles,  
metal fabrication,  
maintenance and  
plant engineering

**LAYOUT**  
and **SET-UP BLOCKS**  
or **WELDING PLATENS**

- Bending Blocks
- Surface Plates
- Bed Plates
- Floor Plates

**TOOLS and ACCESSORIES**



**SERVING INDUSTRY  
EVERYWHERE**

Used singly or in multiple groupings, ACORN Welding Platens or Bending Blocks are standard equipment in many shipyards, railroads, pipe and steel fabricators, welding shops, research laboratories, and wherever metal is formed, shaped or welded.

**MODELS**

2650	2'6" x 5'0"
4040	4'0" x 4'0"
5050	5'0" x 5'0"
5060	5'0" x 6'0"
5080	5'0" x 8'0"
3610	3'6" x 10'0"

Write today  
for  
illustrated  
literature  
with full  
particulars

Each Block or Platen has 1 3/4" square holes, spaced approximately 3 1/2" center to center. These holes are used for clamping, dogging or spacing. The Blocks can be easily joined together to make a table in various multiples. The working surfaces and side edges are machined to within .005" degree of flatness. Blocks are semi-steel castings, with a tensile strength of 30,000 to 32,000 lbs. per square inch. Arm Clamps, Hold-Down Dogs, Drift Pins, Hold-Down Bolts, Angle Blocks, etc., also available.

**ACORN**

**IRON and SUPPLY CO.**

Delaware Ave. and Poplar St.  
Philadelphia 23, Pa.  
WAlnut 2-7070

**OUR 56th YEAR . . . . .**



## LIQUIDOMETER instrumentation capability

... offers the dependability of long experience in both electronic and electromechanical instrument control systems, plus the versatility of original design.

If you are concerned with space vehicles, aircraft, ground support units, or test facilities—you are invited to investigate Liquidometer.

A new booklet outlining our capabilities is available on request.

**THE LIQUIDOMETER CORP.**

DEPT. V LONG ISLAND CITY 1, NEW YORK

Since 1920



of proven quality



Circle No. 3 on Subscriber Service Card.

**CLARKE NEWLON**  
Executive Editor

**WILLIAM E. HOWARD**  
Acting Managing Editor

Donald E. Perry ..... Industry  
James Baar ..... Defense & Legislative  
William Beller ..... Engineering  
Hal Gettings ..... Electronics/GSE  
Charles D. LaFond ..... Electronics  
Jay Holmes ..... NASA  
John F. Judge ..... Advanced Materials  
Paul Means ..... Special Projects & Legislative  
Reed Bundy ..... News Editor  
David Newman ..... Copy Editor  
James J. Haggerty ..... Contributor, Industry Affairs  
Dr. I. M. Levitt ..... Contributor, Astrophysics  
Michael Lorenzo ..... Contributor, Propulsion  
Dr. Albert Parry ..... Contributor, Soviet Affairs  
Dr. Hubertus Strughold ..... Contributor, Space Medicine  
G. V. E. Thompson ..... Contributor, British Astronautics  
Gwen Cammack, Heather David, .....

Editorial Assistants  
William Martin ..... Art Director  
Bacil Guiley ..... Assistant Art Director

**BUREAUS**  
**LOS ANGELES** ..... 8929 Wilshire Boulevard  
William J. Goughlin, Bureau Chief  
Frank G. McGuire ..... Propulsion  
Richard van Osten .....

**NEW YORK** ..... 20 East 46th Street

**PARIS** ..... 11 Rue Condorcet  
Jean-Marie Riche .....

**GENEVA** ..... 10 Rue Grenus  
Anthony Vandyk .....

**ENGLAND** ..... 25 Dunsford Rise, Coulsdon, Surrey  
Michael Donne .....

**EDITORIAL ADVISORY BOARD**

Dr. Peter Castruccio ..... Dr. Arthur Kantrowitz  
Conrad H. Hoepfner ..... Dr. Eugen Saenger  
Richard F. Gompertz ..... Robert P. Haviland  
Alexander Satin ..... Vice Adm. Harry Sanders (ret.)

•  
**Edward D. Muhlfield**  
Publisher

Walton E. Brown ..... Advertising Sales Manager  
Paul B. Kinney ..... Eastern Advertising Manager  
James W. Claar ..... Western Advertising Manager  
Richard Gibson ..... Director of Marketing  
Patricia Behling ..... Promotion Assistant  
Eugene White ..... Circulation Manager  
John F. Walen ..... Production Manager  
Elsie Gray ..... Advertising Service Manager  
Barbara Barnett ..... Production Assistant

Published each Monday with the exception of the last Monday in December by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C.

Wayne W. Parrish  
President

Leonard A. Eisner  
Exec. Vice President and General Manager

Fred S. Hunter  
Vice Pres. and Editorial Director

Printed at the Telegraph Press, Harrisburg, Pa. Second Class postage paid at Washington, D.C., and at additional mailing offices. Copyright 1960, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Postal Union Nations—1 year, \$5.00; 2 years, \$8.00; 3 years, \$10.00. Foreign—1 year, \$10.00; 2 years, \$18.00; 3 years, \$26.00. Single Copy rate—\$5.00. Subscriptions are solicited only from persons with identifiable commercial or professional interests in the missile/space industry. Subscription orders and changes of address should be referred to Circulation Fulfillment Mgr., M/R, 1001 Vermont Ave., N.W., Washington 5, D.C. Please allow 4 weeks for change to become effective and enclose recent address label if possible.



## THE COVER

GE engineer checks a group of production type thermionic converters. Developed for use in auxiliary power systems for space vehicles, each unit has one-watt output.

## July 18 HEADLINES

U. S. Fears Castro May Get Russian Missiles .....	51
Kiwi-A-Prime Test Brings Flyable Model Nearer ....	52
Navy Buys Norwegian Anti-submarine Missiles ....	56
NASA Seeks Second Liquid Hydrogen Plant in West ..	57
Teams Bid for NASA Orbiting Observatory Award ...	57
STL Among Four Firms Studying NASA Moon Payload	58
New Sound Technique for Voice from Space .....	97

## 1960 ENGINEERING PROGRESS REPORT

Propulsion: Highlight is Hydrogen-LOX Trend .....	71
Circuitry: Reliability Now Main Integration Goal .....	72
Guidance: Big Gains in Gyros, Microelectronics .....	74
Telemetry: PCM Moves into Missile/Space R&D .....	75
Instrumentation: Range Accuracy—New Challenge ..	76
GSE: Air Force Does Something About Reliability ....	77
Materials: Foundation Research Speeds Navy Ideas ..	78
Space Medicine: Augmented Field Ready to Expand ..	79

## M/R'S FOURTH ANNUAL WORLD

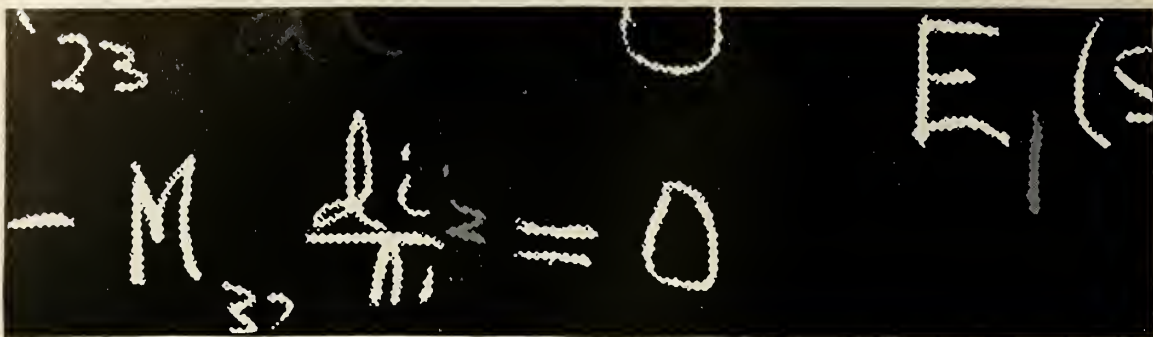
MISSILE/SPACE ENCYCLOPEDIA .....	107
Including for the first time a directory of rocket engines	

## DEPARTMENTS

When and Where ...	10	Technical Countdown	68
Mergers & Expansions	18	Products & Processes	157
Letters .....	24	Names in the News	165
The Countdown .....	37	Contracts .....	166
Editorial .....	170		

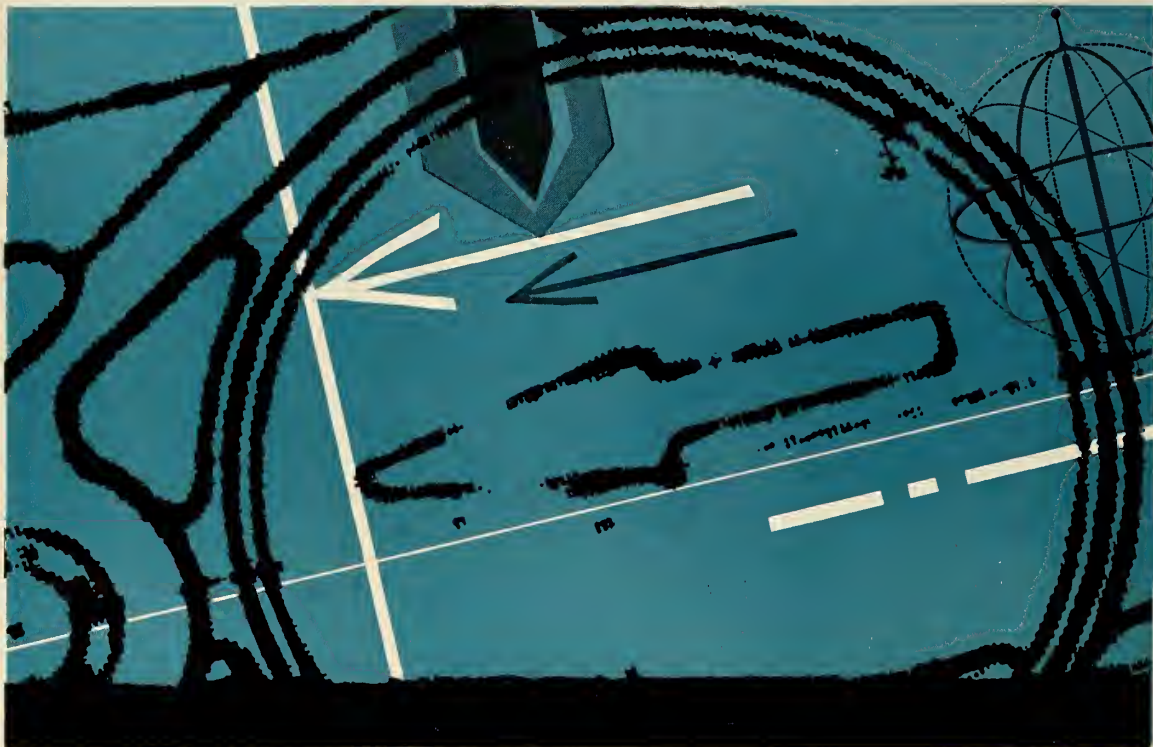
39,420 copies this issue






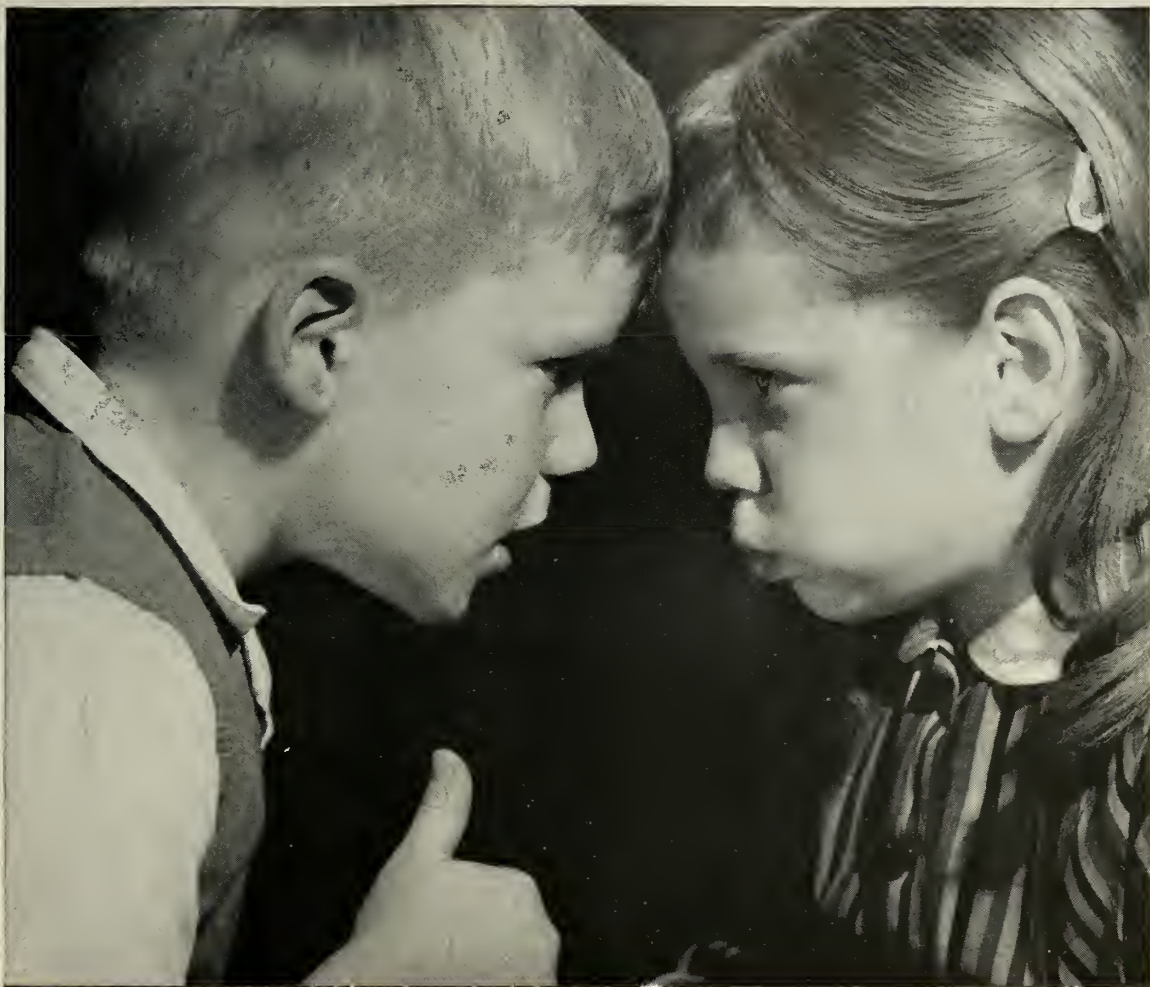
General Motors pledges

## AC QUESTMANSHIP



**AC Seeks and Solves the Significant**—AC Design and Development is moving far ahead in new technology—the result of GM's commitment to make ever larger contributions to the defense establishment. AC plans to resolve problems even more advanced than AChiever inertial guidance for Titan / This is AC QUESTMANSHIP. It's a scientific quest for the development of significant new components and systems . . . to advance AC's many projects in guidance, navigation, control and detection / Dr. James H. Bell, AC's Director of Navigation and Guidance, sees this as a "creative challenge". His group takes new concepts and designs them into producible hardware having performance, reliability and long life. He strongly supports the fact that an AC future offers scientists and engineers "a great opportunity to progress with a successful and aggressive organization" / If you have a B.S., M.S., or Ph.D. in the electronics, scientific, electrical or mechanical fields, plus related experience, you may qualify for our specially selected staff. If you are a "Seeker and Solver", write the Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, 7929 So. Howell Ave., Milwaukee, Wisconsin.

**GUIDANCE / NAVIGATION / CONTROL / DETECTION / AC SPARK PLUG**  The Electronics Division of General Motors



## “I am so going to the moon

For further information about challenging positions in the fields of advanced systems design, solid state and plasma physics, computer system design techniques and space dynamics, including navigation, guidance and simulation—and for descriptive Melpar brochure—write to Professional Employment Supervisor, 3644 Arlington Blvd., Falls Church, Virginia, in historic Fairfax County, 10 miles from Washington, D. C.

... and you can't go, 'cause you're a girl!" Today, children are growing faster. Their interests cover a wider range—from roller skates to rockets. With a most effective systems management and continuous program evaluation—Melpar, too, has grown. Today, Melpar's respected position of leadership is reflected in equipments designed, developed, and produced by Melpar to form an integral part of many advanced weapons systems. Such equipments will comprise a part of the *first manned-satellite* launched into orbital flight. In such advanced areas there is unlimited opportunity for the personal and professional growth of creative engineers. If you are ready to share in the challenge this represents, *there is an important place for you at Melpar.*

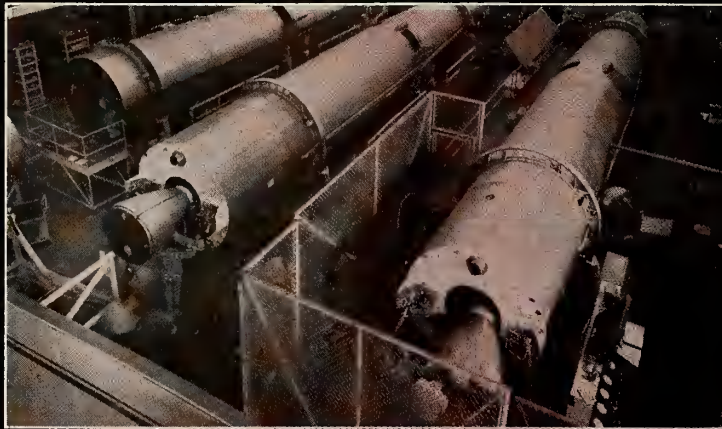
An Arsenal of Technology

**MELPAR**  **INC**

A Subsidiary of Westinghouse Air Brake Company

**MELPAR PRODUCTS:** reconnaissance systems • antennas • telemetering • radar systems • potting resins • flight simulators • direction finders • aids to navigation • fire control systems • ordnance electronics • microwave components • countermeasures systems • communications equipment • electronic training devices • analog and digital computers • automatic testers for systems • transistorization of equipment • acoustics, audio & ultrasonic systems • multicomponent assembly units (automation) • printed circuitry • encapsulation techniques • data handling equipment (including magnetic recorders)

**OPERATIONAL** under two flags...



## **THOR DETERS AGGRESSION**

Now rolling from assembly lines in the U.S.A. and being deployed by our ally, Great Britain, is the aggressor-detering, nuclear-armed THOR missile. Exceptional reliability has been achieved in this IRBM missile through simplicity of design and dependability of components.

Vickers pumps were selected for the vital hydraulic system on the THOR because of their proven reliability record, based upon millions of flight hours in military and commercial aircraft. Vickers-built components or complete auxiliary power systems are aboard nearly every missile built in America.

For the future, Vickers is working side by side with contractors, such as Douglas on new and revolutionary APU concepts for missiles and spacecraft of the next generation.

Your nearby Application Engineer can "fill you in" on the latest and most promising of these Vickers developments. Write for Bulletin A-5233A



*Vickers Main System Hydraulic Pump being installed on THOR*

AERO HYDRAULICS DIVISION

**VICKERS INCORPORATED**

TORRANCE, CALIFORNIA · DETROIT 32, MICHIGAN

division of

**SPERRY RAND CORPORATION**

8486





# A nalytical Engineers:

*Want to see the whole picture?*

Some engineers are content to stay in their own technological backyards. But many others prefer to work in an inter-disciplinary environment, where everything they do is concerned with the total system.

If you are interested in seeing and understanding the whole picture, rather than just a small segment of it, we think you'll be interested in System Development Corporation. Our work is concerned with the design and development of extremely large systems in which high-speed digital computers aid men in decision-making. The relative capabilities and roles of men, machines, and associated system components pose intriguing problems for creative minds.

At the present time we have key openings for engineers with proved analytical ability in the areas of communications, computers and associated equipment, simulation, information theory, weapons system analysis. Please send your inquiry to Mr. E. A. Shaw, SDC, 2414 Colorado Avenue, Santa Monica, California.

.....  
"A Mathematical Model of an Air Defense Operation and a Method of Evaluation," a paper by SDC's staff, is available upon request. Please address inquiries to Mr. E. A. Shaw at SDC.  
.....



**SYSTEM DEVELOPMENT CORPORATION**

*Santa Monica, California • Lodi, New Jersey*

# A WEDGE of PROGRESS

## BELOCK INSTRUMENT CORPORATION

presents its new subsidiary

## ASTRO-SPACE LABORATORIES, INC.

### THE WEDGE of PROGRESS

pierces the vast unknowns of space. Its leading edge is research and development of guidance and control...requiring a calibre of scientific capability rooted in step-by-step accomplishment since the earliest days of rocketry. Under the guidance of Dr. Frederick K. Mueller and his team of space scientists, Astro-Space Laboratories will engage in research, development and production of systems for space vehicles. Directly supporting these efforts will be Belock's extensive facilities at College Point, N. Y. C. Write for descriptive brochure.

**ASTRO-SPACE  
LABORATORIES, Inc.**  
HUNTSVILLE, ALABAMA

a subsidiary of BELOCK INSTRUMENT CORPORATION

## when and where

### JULY

- American Rocket Society, Propellants Combustion and Liquid Rockets Conference, Ohio State University, Columbus, July 18-19.
- Third International Conference on Medical Electronics, sponsored by Institution of Electrical Engineers, Olympia, London, July 21-27.
- Pennsylvania State University R&D Management, Development Seminar, University Park, July 24-29.
- Thermochemistry of Rocket Propulsion, a short course, University of Calif., Los Angeles, July 25-Aug. 5.
- Denver Research Institute, Seventh Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

### AUGUST

- 4th Global Communications Symposium, co-sponsored by IRE, Prof., Group on Communications Systems, and U.S. Signal Corps (100th Anniversary), Statler-Hilton Hotel, Washington, D.C., Aug. 1-3.
- Massachusetts Institute of Technology, Special Summer Program on Modulation Theory and Systems, Cambridge, Aug. 1-12.
- International Symposium on Rarefied Gas Dynamics, University of Calif., Berkeley, Aug. 3-6.
- University of Connecticut, Institute for Practical Research on Operations, Storrs, Aug. 7-13.
- University of Connecticut, Third Annual Institute on Missile Technology, Storrs, Aug. 7-19.
- American Astronautical Society, Western National Meeting, Olympic Hotel, Seattle, Aug. 8-11.
- American Institute of Electrical Engineers, 1960 Pacific General Meeting, El Cortez Hotel, San Diego, Calif., Aug. 8-12.
- ASME-AICHE Heat Transfer Conference and Exhibit, Statler Hilton, Buffalo, N.Y., Aug. 15-17.
- XIth International Astronautical Congress, International Astronautical Federation, Stockholm, Aug. 15-20.
- Cryogenic Engineering Conference, University of Colorado and NBS, Boulder, Colo., Aug. 23-25.
- Western Electronics Show and Convention, Los Angeles Memorial Sports Arena, Los Angeles, Aug. 23-26.
- International Union of Pure and Applied Physics, International Conference on High Energy Nuclear Physics, University of Rochester, Rochester, Aug. 25-Sept. 3.
- The German Rocket Society, Annual Meeting, Hanover, Germany, Aug. 26-28.
- University of Connecticut, Eleventh Annual Basic Statistical Quality Control, Storrs, Institute, Aug. 28-Sept. 9.
- The Combustion Institute, 8th Interna-

(Continued on page 14)

missiles and rockets, July 18, 1960



THOR  
 MACE  
 TITAN  
 HAWK  
 ATLAS  
 SNARK  
 NIKE B  
 BOMARC  
 NIKE ZEUS  
 SPARROW I  
 SPARROW II  
 SPARROW III  
 NIKE HERCULES  
 SIDEWINDER  
 REGULUS II  
 VANGUARD  
 PERSHING  
 BULL PUP  
 POLARIS  
 CORVUS  
 FALCON

## **N/D's Unique "White Rooms"** *Improve Miniature Ball Bearing Reliability!*

In these rooms infinitesimal air-borne contaminants are scientifically whisked from the air . . . away from super-precision miniature ball bearing parts. New Departure's White Rooms date back nearly twenty years. And today, they're a major factor in N/D's growing recognition as a leader in M/I ball bearing reliability.

At N/D, miniature ball bearings are completely assembled in properly humidified, temperature controlled atmospheres. Advanced air filter systems completely change the air in these spotless rooms every few minutes. In addition, pressurized access

air locks and individual counter-top pressurized chambers are used by N/D's skilled technicians during final assembly and statistical inspections.

These methods and equipment are only a few of the reasons why more and more major missile contractors, today, rely on New Departure Miniature and Instrument ball bearings.

If you are working on a new miniature ball bearing application where reliability is critical, include an N/D Sales Engineer in your design discussions. Call or write Department L.S., New Departure Division, General Motors Corporation, Bristol, Connecticut.

  
**NEW DEPARTMENT**  
 MINIATURE & INSTRUMENT BALL BEARINGS  
*proved reliability you can build around*

Get this  
**NEW**  
 Stratoflex  
 Catalog



**... BEFORE YOU SPECIFY HOSE AND FITTINGS  
 FOR AIRCRAFT AND MISSILES!**

- Contains helpful information on Stratoflex low, medium and high pressure hose, hose fittings and hose assemblies for aircraft and missile fluid lines.
- Complete accessory data including Stratoflex "Firesleeved", "Protective Covered" and "Internally Supported" Assemblies.
- Engineering data including hose installation instructions, tube forming and joining methods, twist angle information and minimum bend radii chart.

SF13-0

MAIL COUPON BELOW FOR YOUR FREE COPY!




P.O. Box 10398 • Fort Worth, Texas  
 Branch Plants: Hawthorne, Cal., Fort Wayne, Toronto  
 In Canada: Stratoflex of Canada, Inc.

SALES OFFICES:  
 Atlanta, Chicago  
 Cleveland, Dayton  
 Detroit, Fort Wayne  
 Fort Worth, Hawthorne  
 Houston, Kansas City  
 Milwaukee, New York  
 Philadelphia  
 Pittsburgh, San Diego,  
 San Francisco, Seattle  
 Toronto, Tulsa

Stratoflex, Inc.  
 P. O. Box 10398, Fort Worth 14, Texas  
 Please send me your new 54-page Aircraft  
 & Missile Catalog:

Name \_\_\_\_\_  
 Title \_\_\_\_\_  
 Firm \_\_\_\_\_  
 Address \_\_\_\_\_  
 City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_



# He juggled the hottest potatoes in the Seawolf

...the fuel elements for its nuclear power plant.

Periodically, spent elements must be removed and replaced with fresh ones. The problem—utterly original and fiendishly difficult—was to do the job safely, quickly, and, above all, surely.

This AMF engineer designed the refueling system that did the job. One of his major problems was the fuel elements' liquid sodium environment. Sodium burns fiercely when brought in contact with either air or water. Yet, it had to be exposed during element transfer. Solution: an inert helium blanket to isolate the sodium.

Though awesomely intricate, the refueling machinery had to be designed to work in cramped quarters. The high radioactivity of the environment made the handling problem still more difficult.

That's why, though remotely controlled, all apparatus is *manually* operated. It removes the element and transfers it to a disposal container with complete safety, accuracy, and a degree of reliability that approaches the supernatural.

## Single Command Concept

The solution of this first-time-in-history problem is one more example of AMF's resourcefulness.

AMF people are organized in a *single operational unit* offering a wide range of engineering and production capability. Its purpose: to accept assignments at any stage from concept through development, production, and service training... and to complete them faster... in

- Ground Support Equipment
- Weapon Systems
- Undersea Warfare
- Radar
- Automatic Handling & Processing
- Range Instrumentation
- Space Environment Equipment
- Nuclear Research & Development

GOVERNMENT PRODUCTS GROUP,  
AMF Building, 261 Madison Avenue,  
New York 16, N. Y.



# Double Duty in Space

THE NEW Nems-Clarke 1906 AM/FM/CW Receiver has been reduced in height from 8 $\frac{3}{8}$ " to 3 $\frac{1}{2}$ " with no sacrifice of performance. With a tuning range of 30-260mc it gives more information while using less space. The 1906 Receiver has wide application in surveillance, countermeasures, direction finding and similar specialized military functions.

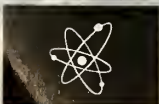


**1906 RECEIVER**

Tuning Range ..... 30-260mc (two bands: 30-60mc, 60-260mc switched)  
 Noise Figure ..... 6db maximum  
 Input Impedance ..... 50 ohms unbalanced to Type N connector on rear apron  
 IF Rejection ..... 65db minimum  
 Image Rejection ..... 60db minimum  
 IF ..... 21.4mc  
 IF Bandwidths: 300kc, 20kc (switchable from front panel)  
 Power Input, 115/230v AC, 50/60 cycles, 100w approx.  
 Size ..... 19" wide, 3 $\frac{1}{2}$ " high, 15" maximum depth

**NEMS·CLARKE CO.**

A DIVISION  
OF VITRO  
CORPORATION  
OF AMERICA



919 JESUP-BLAIR DRIVE  
SILVER SPRING  
MARYLAND

PRECISION ELECTRONICS SINCE 1909

## . . . when and where

(Continued from page 10)

tional Symposium on Combustion, Cal-Tech, Pasadena, Aug. 29-Sept. 2.

10th International Congress of Applied Mechanics, Congress Bldg., Stresa, Italy, Aug. 31-Sept. 7.

### SEPTEMBER

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

SOCIETY of British Aircraft Constructors Show and Flying Display, Farnborough, England, Sept. 6-11.

Electronics Industries Association, Second Conference on Value Engineering, Disneyland Hotel, Anaheim, Sept. 7-8.

Joint Automatic Control Conference, Mass. Institute of Technology, Cambridge, Sept. 7-9.

American Chemical Society, 138 National Meeting, New York, N.Y., Sept. 11-16.

Second International Congress in the Aeronautical Sciences, sponsored by the International Council of the Aeronautical Sciences, Zurich, Switzerland, Sept. 12-16.

IIIrd International Congress on Surface Activity, Cologne, Germany, Sept. 12-17.

Electronic Industries Association, Fall Conference, Sheraton-French Lick Hotel, French Lick, Ind., Sept. 13-16.

Engineering Management Conference, sponsored by American Institute of Electrical Engineers, and American Society of Mechanical Engineers, Morrison Hotel, Chicago, Sept. 14-16.

American Forces Chemical Association, 15th Annual Meeting, Sheraton Park Hotel, Washington, D.C., Sept. 15-16.

Institute of Radio Engineers, National Symposium on Space Electronics & Telemetry, Shoreham Hotel, Washington, D.C., Sept. 19-22.

ASME-AIEE Power Conference, Bellevue-Stratford Hotel, Philadelphia, Sept. 21-23.

Industrial Electronics Symposium, sponsored by Institute of Radio Engineers and American Institute of Electrical Engineers, Manger Hotel, Cleveland, Sept. 21-22.

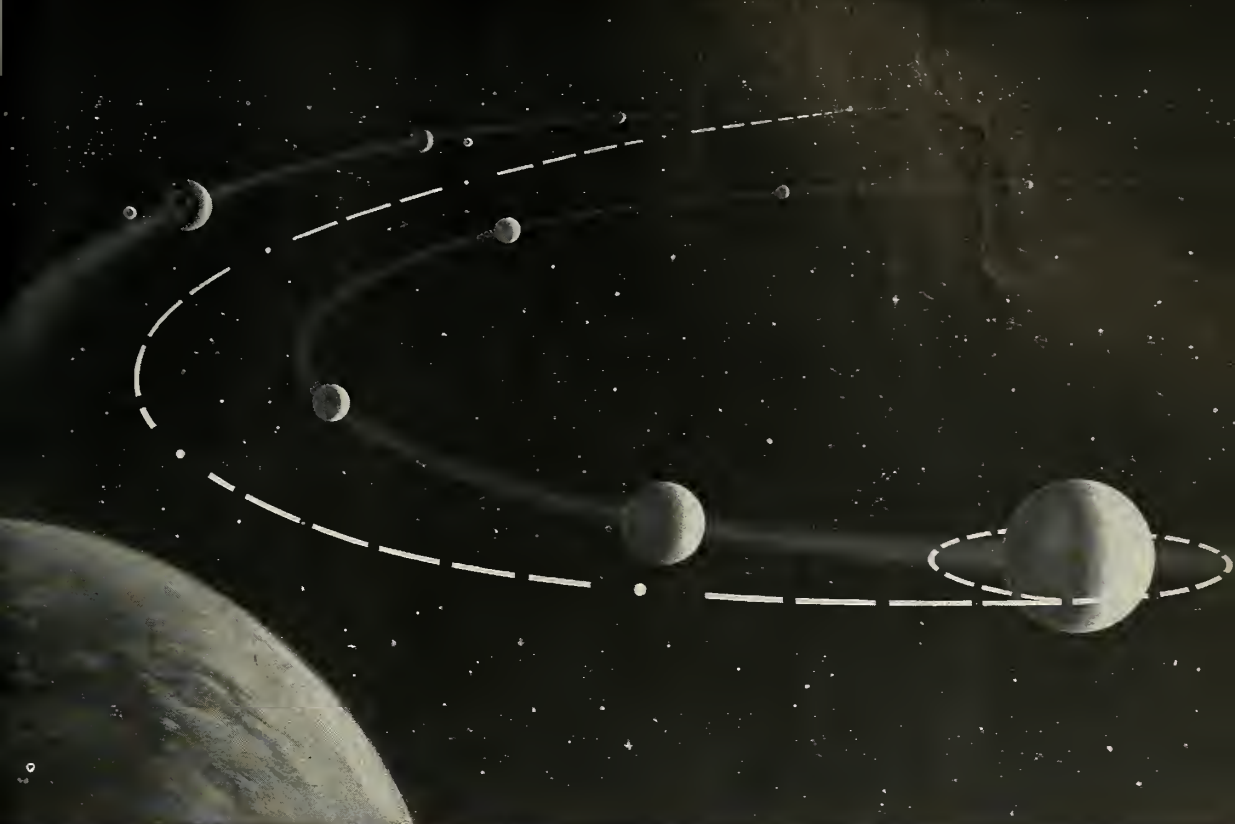
Air Force Association, National Convention and Aerospace Panorama, San Francisco, Sept. 21-25.

American Ceramic Society, Electronics Division, Hotel Schroeder, Milwaukee, Sept. 22-23.

American Institute of Chemical Engineers, Mayo Hotel, Tulsa, Okla, Sept. 25-28.

missiles and rockets, July 18, 1960

A possible Earth to Venus Trajectory (dotted line) for 107-day flight programmed for burnout conditions over Cape Canaveral on 16 January 1961 at 15.65 hours (ephemeris time). Illustration shows positions of Earth, Venus, vehicle at eighteen-day intervals.



**MISSILE AND SPACE  
VEHICLE**  
DEPARTMENT

*...center for missile and space technology research  
and development at General Electric*

# Progress in defining space trajectories

Astrodynamicists at General Electric's Missile and Space Vehicle Department are currently mapping space . . . determining trajectories for flights from the Earth to other bodies of our solar system.

Under these funded studies, MSVD has recently completed a program of error analysis of trajectories to the Moon involving the four-body gravitational system, as well as a study of flight paths to Venus.

From consideration of the total gravitational field, specific space missions are computed when date of departure, trip time and launch site are specified. The exact launch burnout conditions are determined for the time of day which maximizes the additional boost caused by the Earth's rotation. Employing new techniques, MSVD scientists have made these determinations with as few as three corrective computer runs. These methods also can be applied to flights to other planets of our solar system.

In addition, the Department is developing methods to determine orbital parameters of earth satellites using only Doppler information. This MSVD experience in tracking techniques and computer programs permitted analysis of the Russian Lunik III trajectory.

For more information about MSVD's progress in all phases of space technology, write for the new Department Bulletin, Section 160-92, General Electric Co., Missile and Space Vehicle Department, Philadelphia 1, Penna.

**GENERAL ELECTRIC**

**MISSILE AND SPACE VEHICLE DEPARTMENT**

*A Department of the Defense Electronics Division*

Scientists and Engineers interested in career opportunities in Space Technology, contact Mr. T. H. Sebring, Dept. 160, MSVD



**MOST  
ADVANCED  
OPERATIONAL  
ELECTRONIC  
WARFARE  
SYSTEM  
FOR OUR  
ARMED  
FORCES**



"Big Stick" of the Strategic Air Command, Boeing B-52 Missile Bomber fleet is being equipped with Hallicrafters Electronic Countermeasures, most potent means yet devised to confuse and disrupt hostile radar and missile guidance.

For more than a quarter-century, Hallicrafters has worked in close partnership with our armed forces on fast solutions to critical military electronics problems. Example: new airborne Electronic Countermeasures equipments of very advanced design, now being produced to protect our military aircraft. This kind of teamwork continues to pay off for America—in more effective, more reliable, more economical electronic warfare systems.

**hallicrafters  company**

Facilities, and Quick Reaction Capability in Airborne, Ground, Naval and Missile electronic systems for countermeasures . . . reconnaissance . . . maintenance and technical support . . . communications.

**U R G E N T   P R O B L E M S   R E L I A B L Y   S O L V E D**

Circle No. 13 on Subscriber Service Card.



The Baltimore Steel Company

# PIONEERS & LEADERS

*in the design and production of  
containers for rockets and missiles*



Forty-three-foot-long aluminum containers created by The Baltimore Steel Company for the periscopes for the Polaris missile submarine, the Skate, the Nautilus and other atomic submarines. The Baltimore Steel Company is the only company producing this type of container. Designed, built and tested under contract with the U.S. Navy Bureau of Ships.



In the important race through space, where national survival is increasingly dependent on the precision and accuracy of this nation's missiles and rockets, it is vitally necessary that these missiles be packed, stored and delivered in the proper containers. These containers must be able to withstand vigorous transportation stresses under all sorts of atmospheric conditions, without in the slightest degree affecting the missile and disturbing its highly sensitive instrumentation and electronic equipment.

The Baltimore Steel Company is very proud of its role as a pioneer and leader in designing, creating and producing containers for the Military Services and industrial concerns, exactly tailored to the individual requirements of each program. The Baltimore Steel Company has been a major factor in the successful development of containers for all types of aircraft engines, missiles, torpedos, and various ordnance items.

From assisting in the creation of the original design, and through every step to the delivery of the finished product, The Baltimore Steel Company is well equipped, through experience and know-how, and with the capacity and capability to handle all container requirements promptly, efficiently, economically.

Containers for components of these other missiles have been designed and produced by The Baltimore Steel Co.

- HAWK      ● TERRIER      ● POLARIS
- MACE      ● CORPORAL      ● TALOS
- MATADOR      ● ASTOR      ● GREBE-JATO



For immediate assistance write or call:

*Container Division*

## The Baltimore Steel Company

1400 Eastern Avenue, Baltimore 31, Md. • 501 North Point Road, Baltimore 6, Md.



There is no substitute for experience and know-how. The Baltimore Steel Company has built tens of thousands of containers for reciprocating engines, turbo-props, jets, torpedos, transmissions for tanks, and other ordnance material . . . where absolute accuracy, precision and dependability are required. The Baltimore Steel Company is successfully meeting new challenges and problems brought to it regularly by American industry and the Military Services.



Container for Inertial Guidance Platform for the Redstone Missile. This complex container, custom built by The Baltimore Steel Company, is insulated and thermostatically controlled, to prevent exposure to low temperature.



**missile  
tracker  
for  
china lake**

Kollmorgen Missile Tracking Binoculars are an integral part of an acquisition and photography system which records tactical air-to-air missile performance at China Lake Naval Ordnance Testing Station. These binoculars, adapted from a basic Kollmorgen design, are high magnification, wide-field instruments with unusual light-gathering power. An operator is able to spot a missile-launching aircraft and track the missile from the time it is fired until it finds its target—all at extreme ranges. Among other Kollmorgen contributions to the missiles field are the bunker periscopes at Cape Canaveral.

By combining optics, mechanics and frequently electronics, Kollmorgen designs many different types of instruments and systems for industrial and defense viewing and inspection applications. A new illustrated brochure describes our design and manufacturing facilities and primary fields of interest. For your copy, write Dept. 107.



**KOLLMORGEN**

optical corporation  
NORTHAMPTON, MASSACHUSETTS

**mergers & expansions**

**BELL INTERCONTINENTAL CORP.** which before the sale of its defense subsidiaries to Textron, Inc. was known as Bell Aircraft Corp., has elected James F. Connaughton president and chief executive officer. Admiral Robert B. Carney, (USN Ret.), former Chief of Naval Operations, has been named a director and chairman of the board. Herbert Brownell, former U.S. Attorney General now with Lord, Day and Lord, has been retained as special counsel.

**COLLINS RADIO CO.** recently broke ground for a 30,000-sq.-foot communications and data processing center in northeast Cedar Rapids, Iowa. The center will be used by all of Collins' divisions throughout the United States and Canada.

**DORSETT ELECTRONICS LABS** of Norman, Okla., has merged with Carter and Galantin, Inc. of Chicago, a firm which provides marketing programs for industry, including the manufacture of training and sales devices and films. Carter and Galantin will become a Dorsett division, but continue to operate its facilities in Chicago, New York and Atlanta under its own name. Dorsett produces airborne telemetering systems and audiovisual devices.

**ARNOUX CORP.** of Los Angeles has acquired Telemetrics, Inc., producers of simulators and signal converters. Robert L. Burr will be general manager of Telemetrics.

**CONSOLIDATED ELECTRODYNAMICS CORP.**, Bell & Howell subsidiary, has established a Technical Supplies Dept. to market recording paper for oscillography, photographic chemicals for oscillogram processing, and magnetic tape for instrumentation. The department will make headquarters in Pasadena.

**EMPIRE STATE LABS** has been purchased by Helmuth W. Waldorf, former President and owner of the Waldorf Instrument Co., now a F. C. Huyck Corp. division. Waldorf assumes the position of president of the laboratories, which have been incorporated under the name Empire Flight Components, Inc.

**RAMO-WOOLDRIDGE DIV.** of TRW has opened a Northeastern District Office in Lexington, Mass. . . . J. M. Loge has been incorporated under the name Loge Electronics, Inc.

**BARDEN CORP.** has purchased a 50% stock interest in E.M.O. Instrumentation Ltd., British manufacturer of precision ball bearings . . . H. K. Porter Co. has acquired Acieries & Ateliers de Construction de Marpent, (Continued on page 26)

**THE PROBLEM:**  
Development of a new,  
highly reliable rocket  
propulsion system

**IN FINDING  
A SOLUTION:**

**2 HEADS  
ARE BETTER THAN 1**

**BUT ARE...**

**4 BETTER THAN 2?**

**8 BETTER THAN 4?**

**16 BETTER THAN 8?**

**32 BETTER THAN 16?**

**64 BETTER THAN 32?**

**128 BETTER THAN 64?**

At United Technology Corporation, the old adage—"two heads are better than one"—is viewed with respect.

But it also is recognized that at some point, too many can cause excessive administrative detail, confusion, and red tape which increases the difficulty of finding the solution to the original technical problem.

The emphasis—corporate philosophy—at United Technology Corporation, therefore, is on quality—capacity of mind, talent and experience, rather than on sheer numbers of people. This approach permits the maximum percentage of scientific and engineering man-hours to be devoted to the analyses and experimentation required to obtain the best answers to the technical problems at hand.



**UNITED  
TECHNOLOGY  
CORPORATION**

A subsidiary of United Aircraft Corporation  
P. O. Box 358 • Sunnyvale, Calif.

Circle No. 16 on Subscriber Service Card.

# MARMAN

## Leads in Joint and Coupling Engineering

Pictured at the left are a few of the many V-Band Couplings and Joints designed and produced by Marman for every aircraft and missile application. Marman V-Band Couplings are ideal for connecting all sizes of tubing, piping and ducting used in fluid transfer and structural applications. The lightweight Marman J13 V-Band Joint provides efficient sealing for pneumatic and hot air or gas lines. The J11 V-Band Joint may be used for fluid systems. Marman high-performance CONOSEAL Joints provide a leakproof seal where zero leakage is required over a wide temperature range.

Call an Marman's 20 years of experience when you have a joint or coupling problem. Highly skilled and experienced engineers are ready to be of assistance to you. Also send for the new Marman Catalog No. 800 showing hundreds of joints available from stock.

CONOSEAL is an Aeroquip Trademark

  
**MARMAN DIVISION**

11214 Exposition Blvd., Los Angeles 64, California

Joints, V-Band Couplings and Flanges, Fuel and Hot Air Couplings, Band Clamps, Instrument Clamps, Bellows, Ducting, and Universal Joints.



W. M. Willis, Chief Engineer of Marman Division, displays some of the many couplings and joints developed by Marman engineers.

**A WIDE PERFORMANCE RANGE IS POSSIBLE THROUGH DIFFERENT FLANGE AND GASKET DESIGNS AS ILLUSTRATED**



Standard V Band Couplings and flanges for high-strength structural connection of components and tubing, choice of solid or formed flanges.



J13 Joints provide a lightweight connection for standard and thin wall tubing where low leakage rate is permissible.



J11 Joints for fuel connections where zero leakage is not required, as well as lube, air and gas lines for temperatures up to 1000° F., pressures to 4000 psig.

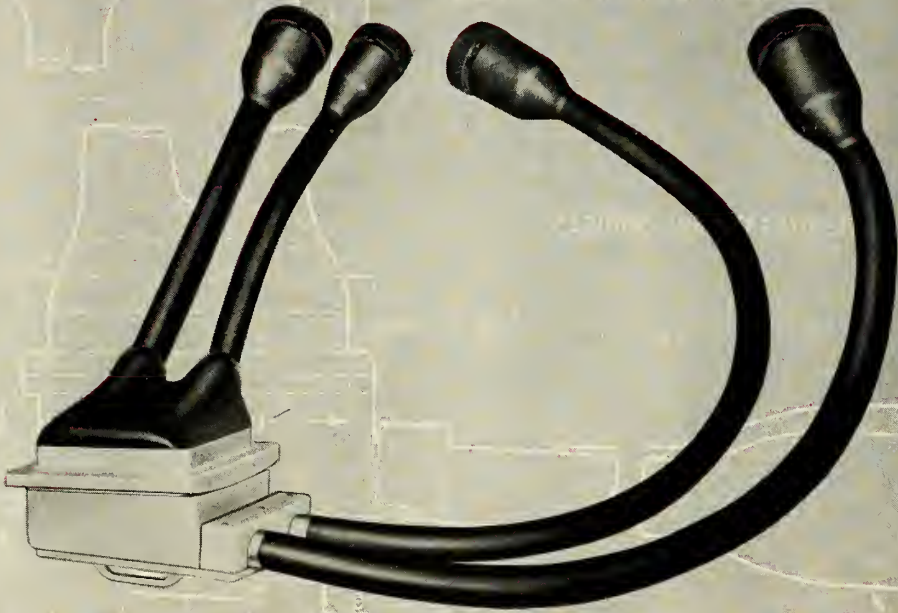


CONOSEAL Joints provide zero-leakage connection of tubing and piping over temperature range of -425° F. to +2000° F., pressures to 20,000 psig.

for an extension in Reliability

engineered...

# CANNON PLUG/HARNESS SYSTEMS



## SINGLE RESPONSIBILITY FOR PERFORMANCE OF PLUG/HARNESS SYSTEMS...RELIABILITY GUARANTEED!

■ **CANNON PLUG/HARNESS SYSTEMS** are designed and manufactured under rigid, quality-controlled conditions in a separate, highly specialized facility completely equipped to handle all phases of design, development and manufacture. As a single source supplier for both plugs and harness assemblies, Cannon can assume complete responsibility for the reliability of the "Cannon Plug/Harness System" as a whole.

■ **COMPLETE TESTING FACILITIES:** Extensive testing equipment is also available to duplicate environmental conditions. These include vibration tests, temperature cycling tests, and heat flux tests duplicating heat re-entry conditions. Each system is 100% tested for continuity and for high potential and insulation resistance, shorts or grounds as well as humidity, VSWR, contact retention, etc. Certified test reports are available.

■ **SPECIAL DESIGN SERVICES:** Because Cannon is a single source supplier of the plugs and completes the termination, it is possible to select and recommend cables and termination techniques designed to custom-match the proper plug for the assembly. The complete assembly can thus be manufactured and tested under conditions prohibited to single-source suppliers.

■ **FASTER DELIVERY — NO COST PYRAMIDING:** A special, separate facility devoted to umbilical and harnessing production offers the most up-to-date production techniques to provide the industry's fastest delivery — plus no pyramiding of costs. Customers draw on Cannon's capabilities as the world's largest exclusive manufacturer of electrical plugs.

■ **FIELD TECHNICAL ASSISTANCE:** Experienced specialized sales engineers are available to discuss and assist customers in the technical aspects of plug-harness system requirements prior to manufacture and after installation in the field.

**CANNON PLUG/HARNESS SYSTEMS ARE MANUFACTURED IN OUR PHOENIX, ARIZONA FACILITY**

For further information  
write for Catalog HC-1 to:

**CANNON  
ELECTRIC  
COMPANY**  
3208 HUMBOLDT STREET  
LOS ANGELES 31, CALIF.



# CANNON PLUGS

Bouncing a voice through 2000 miles of space . . .

## Another Philco achievement in global communications

As part of a major study of space communications techniques, Philco is prime contractor for an Air Force project to relay high frequency radio communications around the curvature of the earth, through space. Known as the Passive Satellite Relay Link, it will reflect voice and teletype signals from a 100 ft. aluminum-skinned plastic balloon. Under NASA's Project Echo, the balloon is to be launched into a 1,000 mile earth orbit for use as a passive communications reflector.

The parametric amplifiers, receiving antennas, and tracking and receiving systems are Philco designed, built and installed. The entire program is managed by Philco, under the supervision of the Communications Directorate, Rome Air Development Center.

This is one more step in man's utilization of outer space . . . and another important Philco achievement in global communications. For capacity, facilities and experience in advanced electronic systems, look to the leader . . . look to Philco.

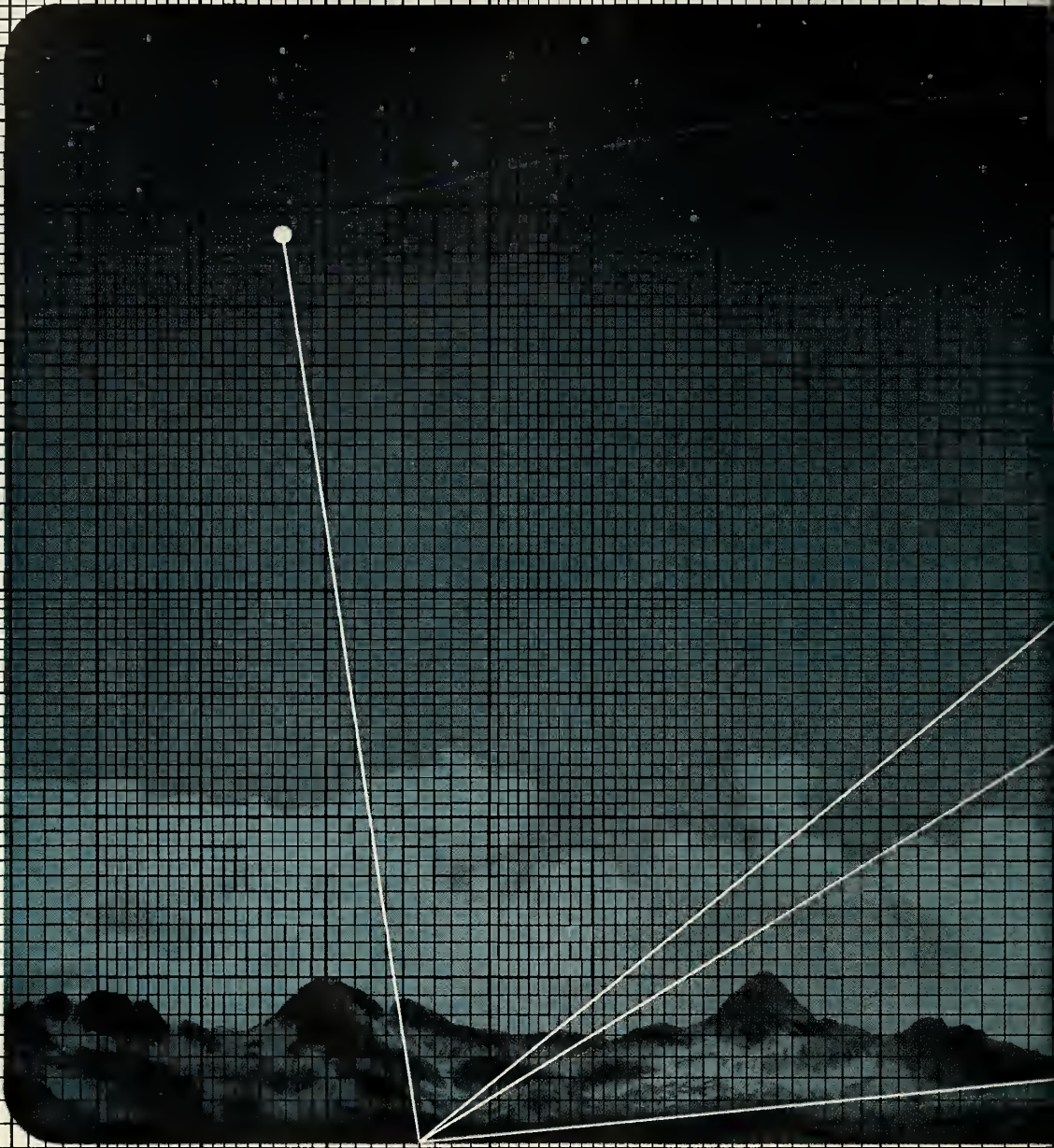
Government & Industrial Group, Philadelphia 44, Pennsylvania

# PHILCO®




*Famous for Quality the World Over*

Communications and Weapons Division • Computer Division • Sierra Electronic Division  
Western Development Laboratories



**PRECISE  
MEASUREMENT  
IN SPACE...with New Westinghouse Radar Technique**



 An entirely new Westinghouse radar technique now under development at the Electronics Division will sharply increase the accuracy of radar detection, identification and tracking of objects in space.

Utilizing a single radar, the Westinghouse technique opens the door to many important new applications. Among them are accurate measurement of objects in space, satellite re-

connaisance, air-to-ground surveillance and mapping and ground-to-air tracking and identification.

We would be pleased to discuss these new developments with qualified persons on a classified, need-to-know basis. Contact: Marketing Manager, Electronics Division, Westinghouse Electric Corporation, Baltimore, Maryland.

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

Circle No. 20 on Subscriber Service Card.

## The Law's Injustice

To the Editor:

Your article on "The Renegotiation Mess" in the July 4 issue of M/R is most interesting and certainly provides a considerable amount of enlightening information.

But there is one facet of Renegotiation which was not mentioned. This is the portion of the law which pertains to manufacturers' representatives.

There are many points about this section of the law which are most unfair to the bona fide manufacturers' representative, the corrections for which are long overdue.

Over the years the minimum reporting amount for manufacturers has been increased, until this amount is four times that contained in the original law. The amount for manufacturers' representatives' reporting has not been changed at all.

Probably the most unfair portion is that (the fees of) manufacturers' representatives alone have been singled out from all of the consultants, professional people, and other independent contractors, and are separately renegotiated, rather

than being renegotiated through the manufacturer.

Other provisions of this law make it possible for a manufacturers' representative's fees to be renegotiated even though none of the companies he represents is covered.

When any changes in the Renegotiation Act are considered by Congress, as they supposedly will be by this House committee, the matter of its application to manufacturers' representatives should be given fair and impartial consideration.

Kenneth E. Hughes  
Union City, N.J.

## First Drone Directory

To the Editor:

I would be very grateful if you would please send me a reprint of the Directory of U.S. Aerial Targets and Combat Surveillance Drones which appeared in the June 27 M/R. To my knowledge this is the first time anyone has compiled such a directory. Congratulations on a remarkable job.

Leonard Matula  
Chicago

## Misleading Title

To the Editor:

I would like to comment on my article in the April 18 M/R which you entitled "How to Propose a Research Program." As submitted, the title was, "A Philosophy for Propellant Research" . . .

While the article does tie in with research proposals, it was concerned primarily with the establishment of criteria for determining the validity of a research approach. Obviously, it did not provide an adequate treatment of the subject, "How to Propose a Research Program," since this was not its intent.

Charles N. Bernstein  
Group Scientist, Propellants  
and Polymers  
Rocketdyne Division, North  
American Aviation, Inc.  
Canoga Park, Calif.

## Bad Siting at Tucson?

To the Editor:

Enclosed are some further press stories and other items bearing on our local protest against Air Force siting policies (M/R, June 13, page 17). The sites of

# WHITTAKER CONTROLS PLANNED RELIABILITY

*is important in the  
Discoverer Satellite Program*



WHITTAKER RELIEF VALVES . . . control individual propellant tank pressures, differential tank pressures and provides tank dump feature.

Planned Reliability is important to the success of the Discoverer Satellite Program. When the Thor-Agena launch vehicle thunders off the pad toward orbit position for the second stage, valves and fluid control systems must function with predetermined accuracy to assure successful positioning and stabilization of the satellite.

The wide acceptance of Whittaker Controls Products for the most difficult and exacting applications is the result of design integrity and precise adherence to sound engineering and manufacturing principles.

Advanced design concepts, environmental testing and quality-controlled production . . . assure you of Planned Reliability in every valve and fluid control system that bears the famous Whittaker name!

*Advanced concepts now being planned at Whittaker Controls present unusual and challenging opportunities for qualified engineers. Why not inquire now?*



the first nine of Tucson's 18 *Titans* were publicly announced on June 8. They insure 100% certainty that lethal fallout from enemy attack will hit Tucson should war come. All escape routes out of the city will be destroyed because the policy is to build these sites right beside good highways and Tucson has only five highways leading through the surrounding mountains. Tucson will become the *worst-sited* of all the *Atlas* and *Titan* bases in the country if something is not done to forestall use of the announced site locations.

We are appealing for Congressional investigation of the entire policy with respect to fixed-base ICBM's . . . We hope that you may take note of this step in our protest by reporting it in M/R. We were very pleased to see the earlier note you ran on this issue.

J. E. McDonald, Chairman  
Committee Against Ringing  
Tucson With Titans  
Tucson, Ariz.

## FDR to Blame?

To the Editor:

It certainly would be a pity if this otherwise excellent technical publication should degenerate into a political digest.

Your discussion (M/R, June 6) of the so-called public relations "Fiasco", and especially the thinly veiled attack upon the Vice President of the United States, is unnecessary and ill-advised.

If this editorial is politically inspired it can be deflated easily: Our country is in this predicament thanks to F.D.R. and H.S.T. and their give-away policies in Yalta and Potsdam.

Who, in his right mind, could trust a donkey-riding crusader, waving a defeatist banner and galloping toward ultimate disaster?

A. J. Jankunas  
Engineer  
Cicero, Ill.

## Cheap Fuel Suggestion

To the Editor:

In a recent Soviet Affairs section, Dr. Parry quotes a Russian scientist as having said that ". . . Pacific Ocean hurricanes roar incessantly, with winds reaching 30 to 35 miles per second."

Could it be that we have missed out on something? With a wind velocity of this magnitude, 126,000 miles per hour, we may no longer need to provide a powerplant for our space shots. We can simply place a missile into the wind, guide it correctly, and the Pacific hurricane will carry it off into space. What a weight saving!

Charles O. Heller  
Santa Monica, Calif.

*It was a typographical error which we are still trying to figure out.—Ed.*

**OTAL**  
**APABILITIES**

For Fluid Control Systems  
with Planned Reliability

**WC**  
**WHITTAKER CONTROLS:** Designs and produces fluid control systems, subsystems and components for military and commercial aircraft and missiles.

**NI**  
**NARMCO INDUSTRIES:** Specializing in research and manufacturing in the field of lightweight, high-strength structural components and materials for a variety of Military and Industrial applications.

**WG**  
**WHITTAKER GYRO:** Leading designer and manufacturer of precision gyroscopes, accelerometers, guidance and control systems.

**MA**  
**MONROVIA AVIATION:** Producers of precision aircraft structural assemblies and portable air conditioning units for ground support.

**TSI**  
**TELECOMPUTING SERVICES, INC.:** Specialists in data processing and data systems engineering.

**ES**  
**ELECTRONIC SYSTEMS:** Specialists in systems management, and in the design and manufacture of complex electronic and nucleonic equipment for Government and Industry.

**DI**  
**DATA INSTRUMENTS:** Leading designer and producer of data reduction systems, industrial control and ground support equipment.

**CB**  
**COOK BATTERIES:** Designers and manufacturers of automatically and manually activated silver zinc batteries for missile applications.

**EC**  
**ELECTRONIC COMPONENTS:** Designers and producers of micro-miniature relays, sub-miniature ceramic capacitors, magnetic amplifiers, transformers and delay lines.

**PE**  
**PHOENIX ENGINEERING:** Manufacturer and assembler of precision machined missile, aircraft and electronic parts.



**WHITTAKER REGULATOR . . .**  
Controls pressure on propellant tanks for expulsion of fuel and oxidizer to engines.



**WHITTAKER PRESSURE REGULATOR . . .**  
programmed for future missile use. is gold plated for balance of solar radiation. . . regulates gas pressure to nozzle valves in vernier control system.

• Write for your copy of the Whittaker Controls engineering, testing and production Capabilities Brochure.

## WHITTAKER CONTROLS

Division of

915 North Citrus Avenue  
Los Angeles 38, California  
Phone: HOLLYWOOD 4-0181



### WHITTAKER CONTROLS

"Time-Proven Reliability in Fuel, Pneumatic and Hydraulic Fluid Controls and Systems!"

#### FIELD ENGINEERING OFFICES:

**ATLANTA:** 3272 Peachtree Road, N. E., Atlanta, Georgia • Phone: CEdar 3-5291  
**DAYTON:** Talbott Bldg., Suite 313, 131 North Ludlow Street, Dayton 2, Ohio • Phone: BAIdwin 2-5595  
**NEW YORK:** 600 Old Country Road, Suite 327, Garden City, L. I., New York • Phone: Pioneer 1-4440  
**SEATTLE:** 3308 White Bldg., Seattle 1, Washington • Phone: MAIn 3-6150  
**WICHITA:** 6427 East Kellogg Street, Wichita 1, Kansas • Phone: MUrray 2-0332

## TELECOMPUTING CORPORATION

Los Angeles, California

Telecomputing Corporation is a unique combination of carefully integrated organizations. It is staffed with scientific talent of rare ability, designed for the purpose of managing entire Space Technology and Weapon System Projects. Telecomputing is developing advanced concepts in industrial and military control systems.

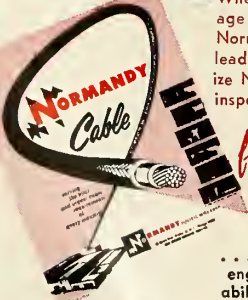
Circle No. 21 on Subscriber Service Card.

For deliveries that keep pace  
with your urgent needs in outer space . . .

# SHIELDED CABLES from **NORMANDY**



When your need for heavy duty, high voltage cable is urgent, you can depend on Normandy deliveries! Many of America's leading missile and spacecraft projects utilize Normandy's huge inventories of source-inspected stock . . . so should you!



**free!** THIS NEW CATALOG MAY  
SPELL THE DIFFERENCE BETWEEN  
DELAY AND ON SCHEDULE!

WRITE M. R. MATES

. . . for your free copy showing the latest  
engineering data and the on-the-spot avail-  
ability of the cable you require in a hurry!

IMPERVIOUS SHEATHED SHIELDED CABLES • SILICONE HI-TEMP HEAT, FLAME AND OIL RESISTANT CONTROL CABLES • TWISTED PAIR SHIELDED TTTS & TT RSA • LATEST IN COAXIALS DBSP-MCOS-HOF-MMOP-DSS-MHFF-TTHFWA-SHFS • FURNISHED WITH INSPECTION FORMS



**NORMANDY ELECTRIC WIRE CORP.**

125 Second St., Brooklyn 31, N. Y. Phone: TR 5-9863 Cable: Normwire, New York

Circle No. 22 on Subscriber Service Card.

## . . . mergers & expansions

(Continued from page 18)

French producer of steel, railway cars and industrial products . . . Bendix Corp. has purchased a controlling interest in Diseradores y Constructores, S.A., one of Mexico's leading tool-and-die firms.

**ATLANTIC RESEARCH CORP.** has begun work on a \$1.5 million addition to its facilities at Alexandria, Va. The 120,000-sq.-ft. building will be connected to the original plant by an overhead walkway.

**GIANNINI SCIENTIFIC** has purchased Wiley Electronics Co. of Phoenix, Ariz., formerly a subsidiary of Savage Industries. Giannini, which already numbers Plasmadyne, Plasmakote and Flight Research among its subsidiary corporations, is negotiating for further mergers with as yet unnamed companies.

**PYROFUZE CORP.** has been organized by the Sigmund Cohn Corp., of Mount Vernon, N. Y. The firm will manufacture specially processed Pyroforic Products, a bi-metallic product that disintegrates with explosive violence at 600°C without support of oxygen.

## financial news

**Aerojet General Corp.**—Consolidated sales reached \$200.5 million for the six months ended May 31, an increase of 29% over the same period last year. Earnings were up 16% from \$3.8 million to \$4.5 million.

**Digitronics Corp.**—Sales for the fiscal year ended March 31 totaled \$822,000, a 50% increase over the \$553,000 reported for FY 1959. Net income for 1960 amounted to \$35,652, compared to \$23,618 for the previous year.

**Sanders Associates, Inc.**—New business in excess of \$30 million raises Sanders' backlog to \$50 million. President Royden Sanders said the firm expects total sales for the year ending July 31 to reach \$17 million; he forecasts a 50% rise next year.

**Infrared Industries**—Record sales reached \$1.8 million, an increase of 50% over FY 1959, and net earnings increased 28% to \$122,207.

**Wilson Bros.**—Sales for the first five months of this year jumped 72% to \$14.9 million, compared to \$8.6 million for the same period last year. The firm expects sales of about \$38 million for 1960.

missiles and rockets, July 18, 1960



# DEPENDABILITY

another outstanding attribute of

# DIMAZINE<sup>®</sup>

unsym-Dimethylhydrazine, UDMH

## THE STORABLE FUEL

The sure dependability of DIMAZINE has been convincingly demonstrated in many ways and under a wide variety of ground and flight conditions.

DIMAZINE provides fast, dependable hypergolic starts followed by smooth, stable combustion and easier shutdowns. Dependable instant readiness is assured for years by its outstanding stability during storage in sealed missile tankage. You can also depend on DIMAZINE'S

high chemical purity and uniformity, high thermal stability, low freezing point, low shock sensitivity, minimum susceptibility to contamination and high compatibility with almost all metals and appropriate sealing materials.

These manifold advantages combine to make DIMAZINE *the outstanding storable fuel*. We will be pleased to work with you in evaluating DIMAZINE and to supply detailed data on its properties and handling.

*Putting Ideas to Work*

FOOD MACHINERY AND CHEMICAL CORPORATION

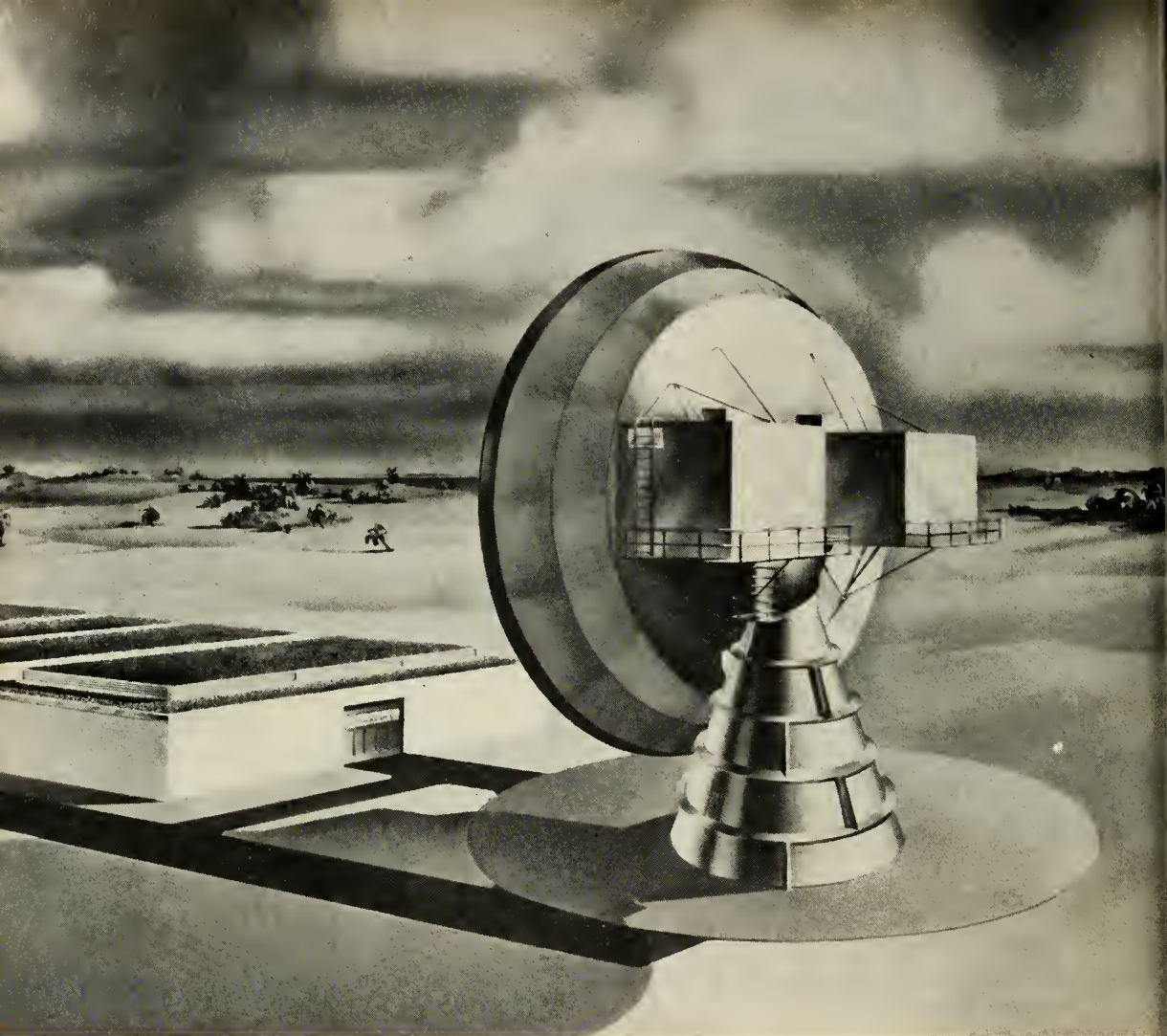
**Chlor-Alkali Division**

General Sales Offices:

161 E. 42nd STREET, NEW YORK 17

Circle No. 23 on Subscriber Service Card.





Five-story high antenna for Pincushion radar will be part of a new Advanced Research Projects Agency installation to be set up in mid-Pacific.

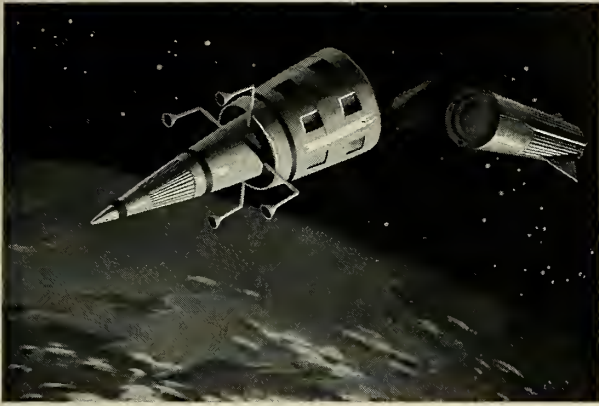
**A unique radar designed to track and identify the warhead of ICBMs thousands of miles away is now being developed by Raytheon.**

Designated "Pincushion", because of its microwave beam pattern formation, the 80-ton Raytheon radar will be part of Project Defender, ARPA's program to develop advanced anti-ICBM concepts.

RAYTHEON COMPANY, WALTHAM, MASS.



EXCELLENCE IN ELECTRONICS

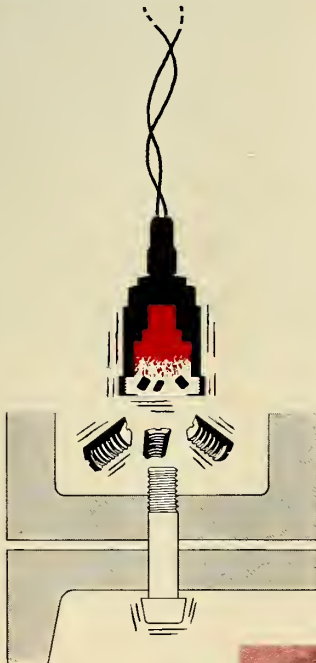


#### TYPICAL APPLICATIONS

- SEPARATION OF MULTI-STAGE VEHICLES AND NOSE CONES.
- RELEASE FROM LAUNCHING PADS.
- RELEASE OF BOOST ROCKETS AND LAUNCHING SLEDS.
- RELEASE OF TANKS AND JETTISONABLE ITEMS.

## FOR SEPARATION SYSTEMS THE NEW

# SEPARATION NUT



Write for brochure . . . describes how the Nut works, high speed photos, design goals, typical applications and summary of the test program.

PATENT APPLIED FOR.

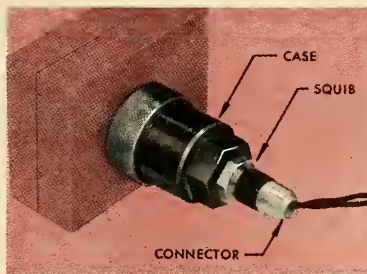
A unique, safer and more efficient method for separation systems is offered by the Separation Nut.

The Separation Nut is unique because its controlled separation is a highly reliable mechanical function activated by a very small explosive charge.

By using the Nut's small explosive charge rather than the "brute force" explosive techniques so commonly used to fail high strength material in explosive bolts, the Separation Nut can substantially reduce a potentially hazardous condition to installation crews and to the vehicle itself.

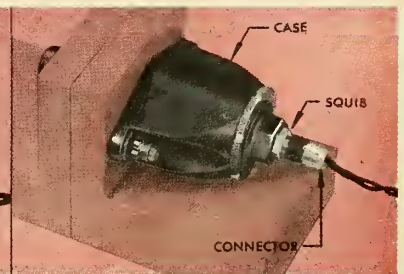
More compact joints can be designed since Separation Nuts are used in combination with standard diameter, high strength bolts used at full allowables.

Separation Nuts reflect another new fastening concept developed in Hi-Shear's specialized engineering and laboratory test facilities for the specific needs of space vehicles and high performance aircraft.



#### NON-CAPTIVE NUT

Basic configuration . . . accommodates bolt thread sizes including 1/4-28 thru 3/4-16.



#### CAPTIVE NUT

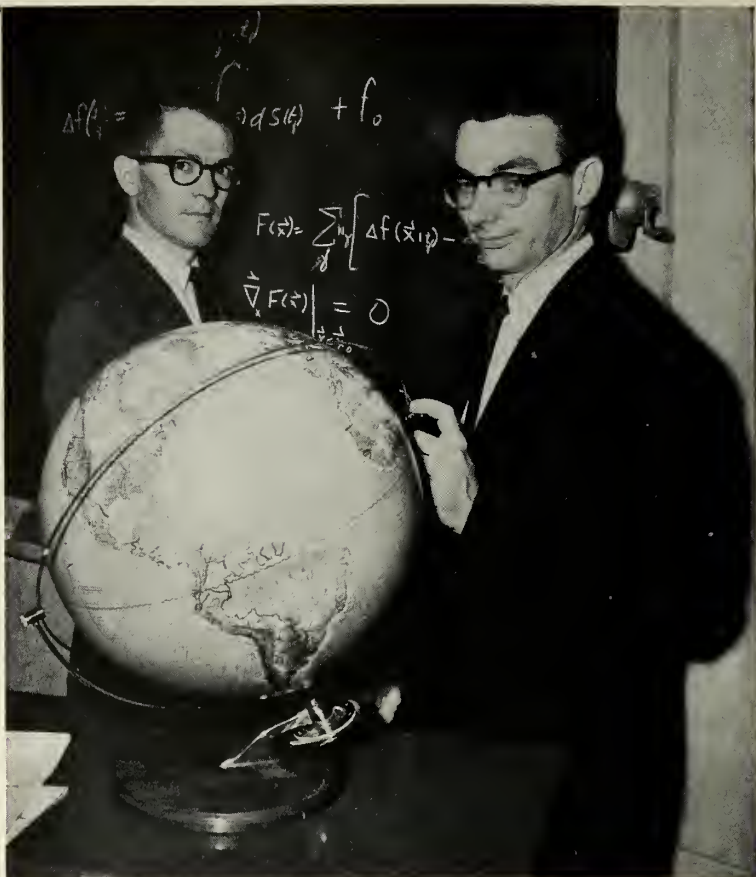
Because only a low explosive charge is used, all fragments can be easily contained by Nut's case. A similar case can arrest a bolt after detonation.

**hi-shear** CORPORATION

2600 WEST 247TH STREET, TORRANCE, CALIFORNIA, U.S.A.

Circle No. 24 on Subscriber Service Card.

# Scientific Freedom at APL



APL scientists Drs. G. Weiffenbach and W. H. Guier, originators of the fundamental concept that led to Project Transit, the navigational satellite program sponsored by the U. S. Navy.

Project Transit—the first of its satellites already is orbiting the earth—was sparked by the side-interests of physicists at the Applied Physics Laboratory less than three years ago. The Project, an important contribution to the science of navigation, was kindled because of the Laboratory's policy of encouraging its scientists free rein in exploring tangential thoughts.

Scientists and engineers seeking a favorable atmosphere for creative accomplishment are invited to associate with a resourceful research group at APL. Direct your inquiry to—

*Professional Staff Appointments*

The Johns Hopkins University  
The Applied Physics Laboratory

8603 Georgia Avenue, Silver Spring, Maryland



*Spark for the edge of outer space:*

## **BENDIX IGNITION ON NORTH AMERICAN'S X-15**

The X-15 project is a truly national research effort by the Air Force, Navy, and National Aeronautics and Space Agency. In manned flight, the X-15 will scorch through uncharted skies at speeds of more than 4,000 miles an hour.

This edge-of-space craft will take its pilot closer to

the stars than any human has ever dared to venture. 50,000 pounds of thrust will be provided by the most powerful single-chamber rocket engine ever built for manned flight. The ignition system was specially designed and produced for this installation by Bendix® . . . foremost name in ignition.

**Scintilla Division**  
SIDNEY, NEW YORK



Canadian Affiliate: Avionics Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. Export Sales and Service: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

Circle No. 25 on Subscriber Service Card.



From an original painting for CECO by R. T. Handville

**Contributing to the superb performance . . .** of each Ryan Q-2C Firebee is a Continental J-69 turbojet equipped with single-package *engine control and fuel pump* engineered and precision-produced by Chandler Evans.

Products, too, are "known by the company they keep", and CECO is proud to be airborne with an array of important missiles as well as with many of the latest and finest military and commercial aircraft.

**CHANDLER EVANS CORPORATION • WEST HARTFORD 1, CONNECTICUT**

*Interesting, informative literature on many CECO products is yours for the asking. Please address your request to Department 30.*







IN  
AN  
INSTANT...

because this oxidizer's stored aboard

**Nitrogen Tetroxide** provides immediate, hypergolic ignition with amine fuels. Even after 9 years of storage, nitrogen tetroxide is ready for instant use. Combustion efficiencies closely approach the theoretical 99%.

**$N_2O_4$** —Requires no refrigeration—can be stored indefinitely in missiles at launching sites.—Can be used with most fuels—including those containing carbon.—Eliminates rough starts—fast reaction prevents accumulation

of propellants in thrust chambers.—Allows throttleable control of motors.

We'll gladly supply technical literature, including: a 59-page Product Bulletin, and a brochure entitled "Large Scale Handling of Nitrogen Tetroxide."

For specifications and local offices, see our insert in Chemical Materials Catalog, pages 475-482 and in Chemical Week Buyers Guide, pages 37-44.

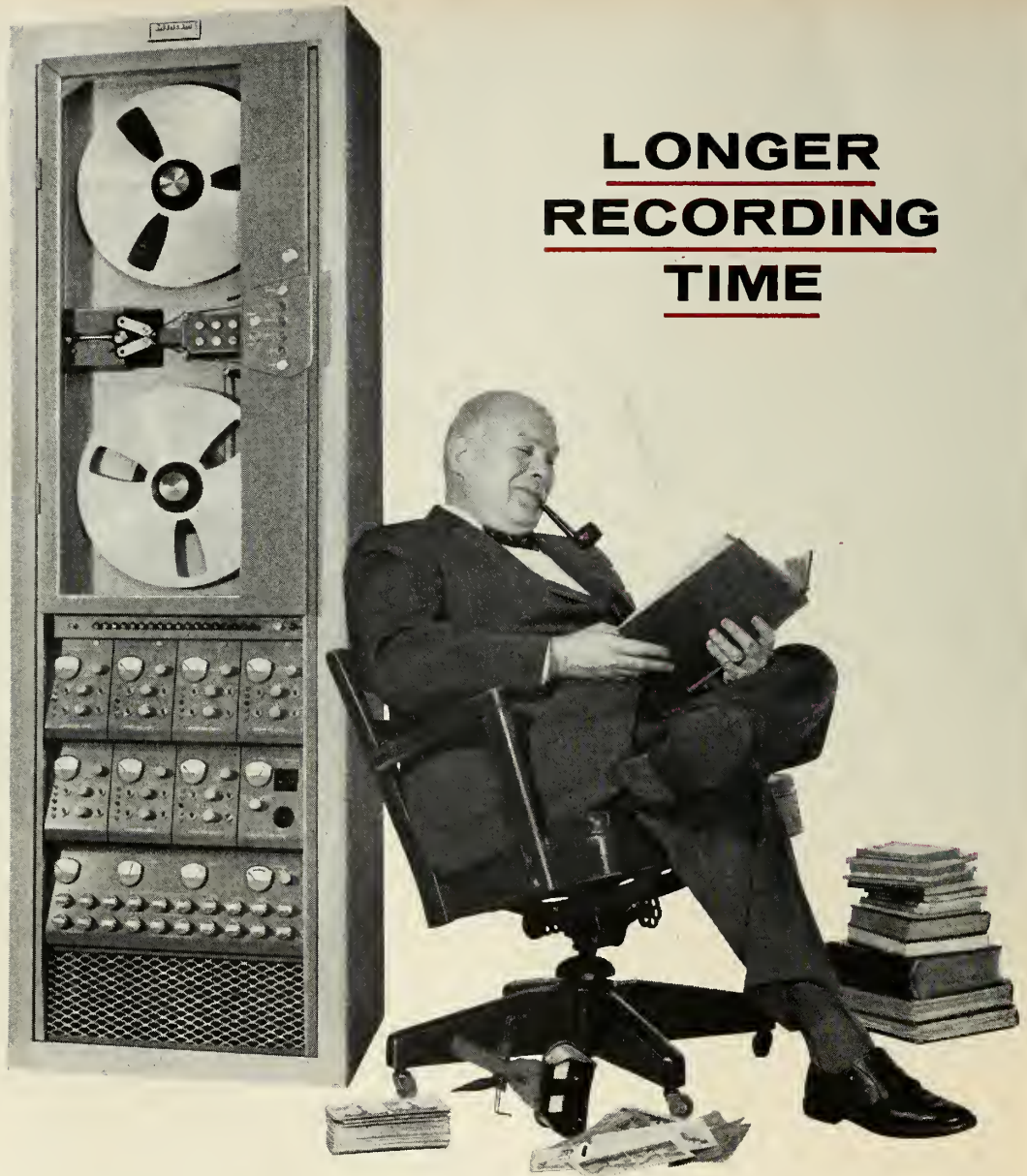
BASIC TO  
AMERICA'S  
PROGRESS



**NITROGEN DIVISION**

Dept. NT14-40-1, 40 Rector Street, New York 6, N.Y.

# LONGER RECORDING TIME



Longer recording time because of higher tape packing density at all six speeds — from 3 hours and 12 minutes at 62.5 kc—7½ ips, to 12 minutes recording 1 mc—120 ips. That's only one advantage of the new **Mincom Model CM-100 Magnetic Tape Instrumentation Recorder/Reproducer**. Read on: CM-100, an analog system, does the work of two systems by storing both analog and pulse data simultaneously and with equal facility. Also: One-rack compactness, no belt changes, all-dynamic braking, seven 1 mc tracks on ½-inch tape, built-in calibration, IRIG compatibility, only twelve moving parts with four easy adjustments. Interested? Write today for brochure.

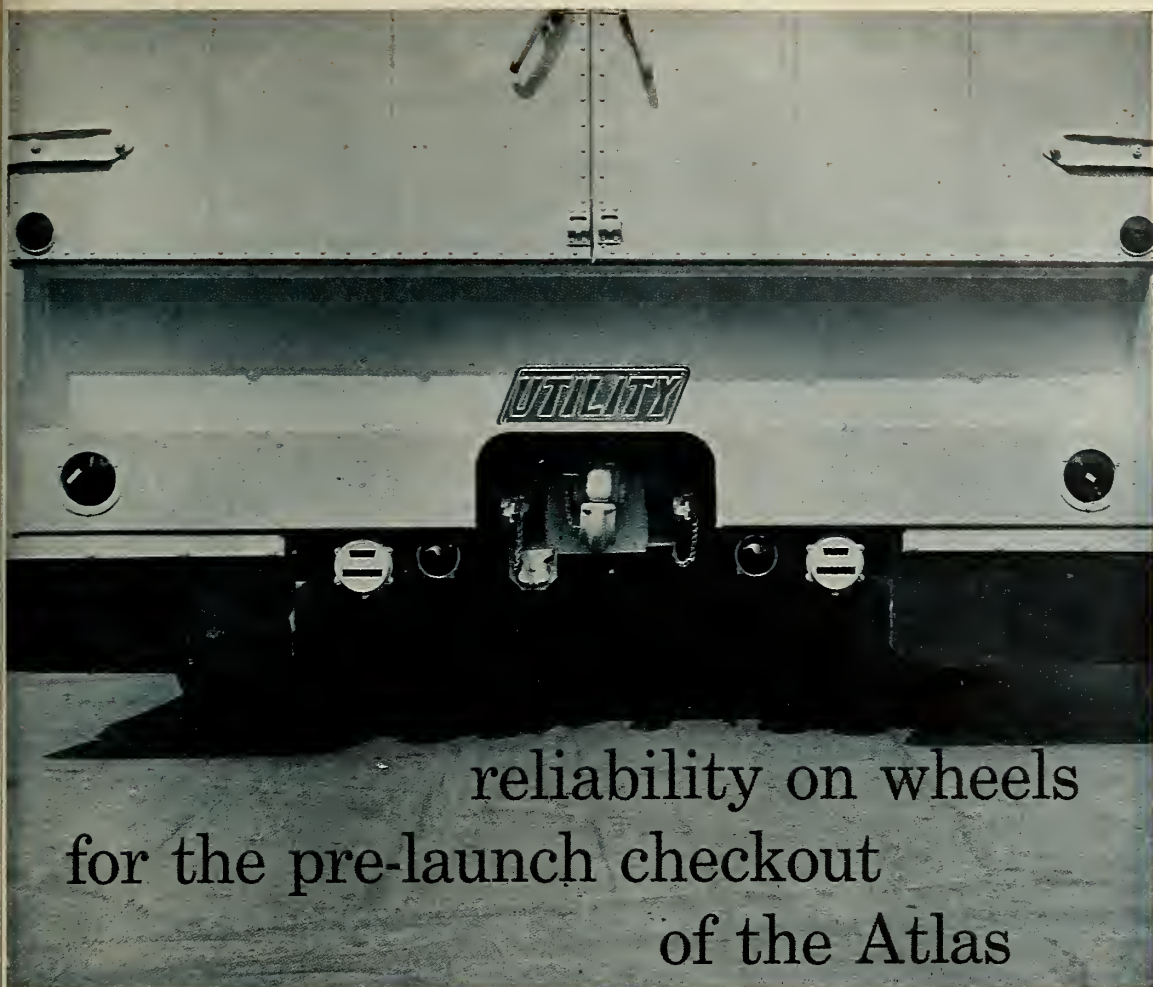
62.5 KC—7½ IPS—192 MIN • 100 KC—12 IPS—120 MIN • 125 KC—15 IPS—96 MIN • 250 KC—30 IPS—48 MIN • 500 KC—60 IPS—24 MIN  
1 MC—120 IPS—12 MIN



... WHERE RESEARCH IS THE KEY TO TOMORROW

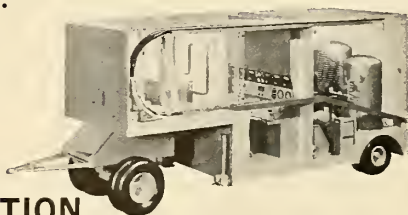
**MINCOM** DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

2049 SOUTH BARRINGTON AVENUE, LOS ANGELES 25, CALIFORNIA • 425 13th STREET N.W., WASHINGTON 4, D. C.



reliability on wheels  
for the pre-launch checkout  
of the Atlas

CV-A Part No. 27-08239-1 is another way of saying accurate, reliable ground support equipment – mounted on a trailer for mobility. Designed for Convair-Astronautics, this CSC system is used in the pre-launch checkout program for the Atlas missile. Packaged in a standard-size, highway semi-trailer, the pneumatic, dynamic system provides all necessary manual and automatic controls and an air-conditioned control room for operating personnel. Repeatability and reliability were the most important design criteria for the system, which is fully described in CSC Bulletin 3025-X2.



**CONSOLIDATED SYSTEMS**  
1500 So. Shamrock Ave., Monrovia, California



**CORPORATION**  
*a subsidiary of*  
**CEC/Bell & Howell**

Another USAF missile  
develops from a program  
which is in itself a...



Titan, America's two-stage intercontinental ballistic missile, is making giant strides — attaining new goals in U.S. missile technology. It has repeatedly demonstrated its ability to accomplish stage separation and altitude start of the sustainer engine. Equally outstanding successes in guidance and nose cone ejection-recovery are making Titan a significant contribution to our national space potential; a highly sophisticated missile system powerful enough to deliver a warhead accurately at more than 5,500-mile range.

As Titan continues to develop toward a state of operational capability, it provides another demonstration of the remarkable successes of the U.S. Air Force's ballistic missile program. This program, conceived only six years ago, has produced progress beyond expectation in an undertaking never before equalled in complexity.

Space Technology Laboratories is responsible for over-all systems engineering and technical direction for Titan, as it has been for Thor, Atlas, Minuteman and related space programs. Principal associate contractors for Titan include: The Martin Company for airframe and system integration, Avco Manufacturing Corporation for nose cone, Bell Telephone Laboratories and Remington-Rand for guidance, Aerojet-General Corporation for propulsion.

**SPACE TECHNOLOGY LABORATORIES, INC.**



P. O. Box 95004, Los Angeles 45, California

Los Angeles • Santa Maria • Edwards Rocket Base • Cheyenne • Cape Canaveral • Manchester, England • Singapore • Hawaii

## WASHINGTON

### A Ship Becalmed

Strong winds blowing out of the Democratic convention for greater defense spending are leaving the Eisenhower Administration unmoved. COUNTDOWN is told the Administration has all but decided to stand firm on its earlier refusal to use the extra half-billion dollars Congress tacked on the defense budget for missiles and space. There are reports, however, that some extra dollars may be released for the missile-packing B-70 bomber. How much, no one will say.

### Undersea Revolution

Navy planners are eyeing the Reynolds Metal Co. Aluminaut—an experimental submarine designed to go down 15,000 ft. Now entering the construction phase, the Aluminaut could revolutionize undersea warfare. Made of high-strength aluminum alloy six inches thick, the sub will be roughly 33 ft. long, have an inside diameter of 7 ft. and be capable of carrying a 3-man crew 100 miles. Endurance of its silver-zinc storage batteries will be two days. Designed for oceanographic exploration, the sub would be able to outdive all known submarines by several thousand feet.

### Almost Operational

The most potent air-to-air missile to be developed in years—the nuclear-tipped *GAR-11*—is now scheduled to be in Air Force squadrons by the end of this year. Made by Hughes Aircraft, *GAR-11* is the big brother of the *Falcon* missile family.

### On the Pad

October 1 is the latest date to be set for the launching by NASA of an *Atlas-Able* with a \$5 million moon-orbit payload. . . . Next shot in the *Mercury* program—possibly by the end of July—will be a test of the McDonnell production capsule atop an *Atlas*.

### Courier Shot Slips

Launch of the Army Signal Corps' *Courier* delayed-repeater communications satellite—originally set for July 15—is expected to slip about a month. The reason: congestion at the pad.

## INDUSTRY

### AF Project 3059 to Aerojet

Aerojet-General has won the hot competition for the Air Force's Project 3059—the development of a million-pound-thrust solid-propellant booster. Grand Central Rocket Co. has won a smaller, supporting contract to pursue a related approach on the giant, segmented motor. The Aerojet contract for FY '61 is for about \$4 million. Size of the GCR award has yet to be established—but it will be for considerably less.

### On Mahogany Row

Joining Northrop Corp. this week as a senior v.p. in charge of the company's research and advanced technology is Richard E. Horner, 42, associate administrator of NASA. Horner, who had held the NASA post 15 months, made his departure plans known some time ago (M/R, April 11). . . . W. R. Studhalter is Rocketdyne's new program manager on the J-2 200,000-lb.-thrust liquid hydrogen engine for *Saturn*.

### Tops in '59

General Dynamics Corp. topped the nation's defense contractors in 1959 with contract awards totalling \$1.5 billion. Boeing—the 1958 leader—was second with \$1.2 billion. General Electric dropped from third to fifth place (\$915 million), while Lockheed (\$932 million) and North American (\$925 million) each advanced one position—to third and fourth places respectively.

## INTERNATIONAL

### Polaris for NATO

The United States is now pushing hard a plan to arm NATO with 300 *Polaris* missiles. Britain and West Germany are expected to go along. However, Scandinavian countries are cool to the idea and France wants control over the nuclear warheads as the price for accepting them on French soil.

### Bouillabaisse of Missile Deals

- Aerojet-General and SNECMA (France) have entered into an agreement calling for development work on an IRBM.

- French and German anti-tank missile competitors—Nord and Boelkow—have worked out a joint agreement on a new type of missile. Details are secret.

- SEPR (France) has just revealed details of its agreement with Rocketdyne (COUNTDOWN July 11, July 4) as involving the sale of small liquid-fueled rockets in the U.S. and in Europe, Turkey and Iran. SEPR is also tying up on joint development of new solid fuels with Bombrini Parodi-Delfine (Italy).

### New French Missile

Sud Aviation *SE 4400* surface-to-air missile has been dropped by the military and in its place a new, secret version is being developed which will be both faster and have a longer range. The *SE 4400* may be incorporated into some French space experiments.

### Jolly Comment from Abroad

A recent issue of *Flight* magazine, a British publication, displays a picture of an upended *Seaslug* missile being sprayed with water. The caption reads: "Environmental test, British style. Were this an American missile, the test concerned—which is to prove *Seaslug's* impermeability to driving rain—would be in a specially built million-dollar test facility with a name like TWERPS (Test Water Environmental Rain Proofing System). We British just hoist the thing up with a crane borrowed from the plant department, call out the works' fire brigade, and let them have a jolly good squirt."

# EXCELCO



RV-A-10 • SERGEANT  
AIR FORCE — RE-ENTRY X-17  
POLARIS — RE-ENTRY X-36  
JUPITER JR. • JUPITER SR.  
POLARIS O • POLARIS A  
POLARIS AIX • POLARIS A2-MOD 1-2-3  
NIKE HERCULES • NIKE ZEUS  
MINUTEMAN • PERSHING  
N.A.S.A. PROGRAMS • SCOUT  
LITTLE JOE

•  
*and many other  
classified projects*



Builders of more large, thin wall, high strength solid propellant rocket engine cases and nozzles for development purposes than any other company in America.

A small experienced organization geared to handle your development and prototype requirements for static and flight tests in the shortest possible time.

*Call or write:*

**EXCELCO DEVELOPMENTS**

**MILL STREET • SILVER CREEK, NEW YORK**

Circle No. 30 on Subscriber Service Card.

# CHECKUP on your Control Valves... CHECKOFF these Annin Advantages



\**Providing the optimum in design and performance features*

**MINIMUM PARTS** and simplicity of construction in Pneumatic Position Unit.

**THREE POINT** guiding and self lubricating seals in pneumatic piston actuators.

**ADJUSTABLE TOP LOADING** of piston permitting optimum control performance over maximum range of conditions on pneumatic positioning actuator.

**BODY ORIENTATION** as specified on any three-way valve at no extra charge.

**CORNER VALVE BODY** construction 1/2" through 2" in all body ratings converted on job site.

**WIDE SELECTIVE** range of reduced port (Pee Wee construction) trim available with CV ranges 2.5, 1.5, 1.0, 0.60, 0.25, 0.10, .063, .040, .025, .016, .010, at no extra charge.

**REDUCED PORTS** stepped down three or more sizes interchangeable in all models.

**MINIMUM CV** available of .000001.

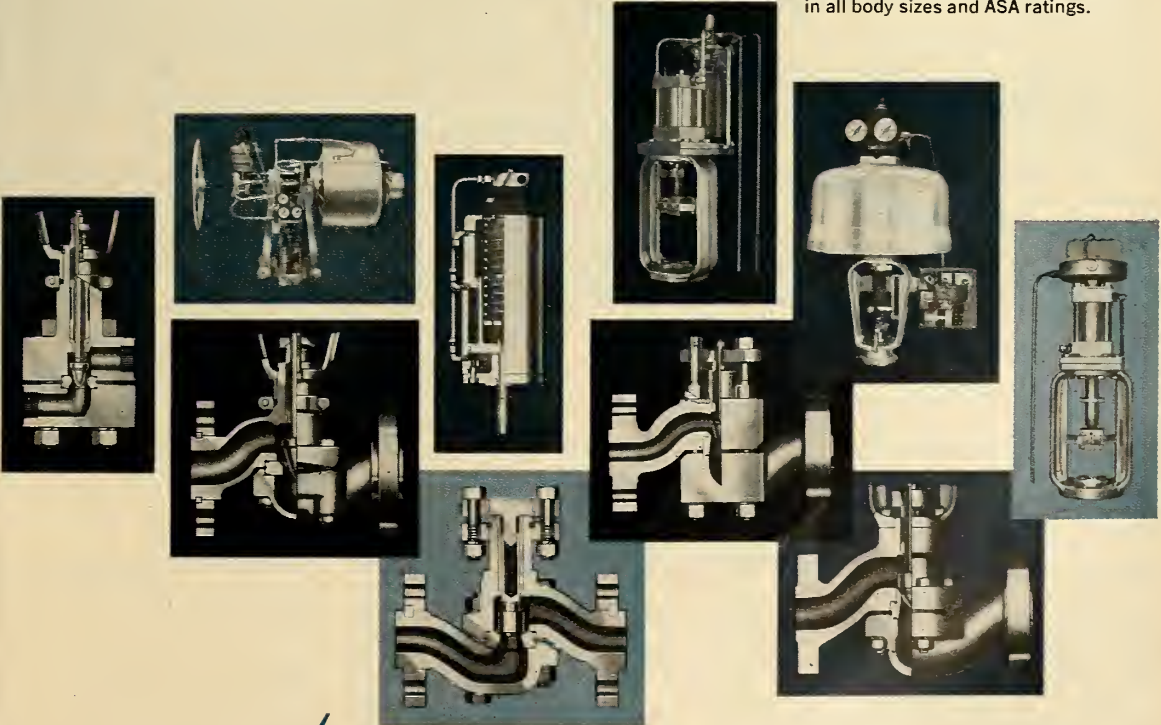
**NO EXTRA CHARGE** for reduced ports in any model 1 inch and under.

**SOFT SEAT** construction for guaranteed bubble tight shut off available in all models at minimum cost.

**WIDE CHOICE** of special body gasketing for all applications within temperature-pressure limitations of any valve.

**TEFLON CHEVRON** packing standard on all valves. Other types on request.

**SPLIT BODY CHECK VALVE** available in all body sizes and ASA ratings.




*Annin*

**VALVES**

**THE ANNIN COMPANY**

1040 South Vail Avenue  
Montebello, California



**PUT  
YOUR  
WIRE  
&  
CABLE  
PROBLEMS  
IN  
OUR  
HANDS  
!**

*To help conquer extremes . . . from known to*





Electronic Cable, Military-Specification Wire and Cable, Special Defense Products, Instrumentation Cable, High-Frequency Cable, Shipboard Cable, Communication Wire and Cable, Control Cable, Power Cable, Cable Accessories

*the unknown*, from intense heat and cold, to mechanical abuse, to attack from radiation and corrosive or unusual atmospheres, to extremes of voltage, current and frequency . . . there's proven capability at Anaconda with industry's broadest line of wire and cable. There's reliability—assured by strict quality control. There are the modern facilities of nine plants strategically located across the nation. In addition, experienced engineering talent is immediately available to help you solve new and unusual wire and cable problems. Whether you need development samples or huge production runs of wire and cable—ranging from fine magnet wire to missile breakaway cable, ask the Man from Anaconda. Or call or write: The Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

60266

**ANACONDA**<sup>®</sup>  
WIRE & CABLE

# EVERY BALLISTIC MISSILE NOSE CONE

**RECOVERED IN THE FREE WORLD  
was brought back by a  
RE-ENTRY RECOVERY SYSTEM  
Conceived, Designed,  
Developed, Manufactured,  
and Tested by**



**SUCCESSFUL RECOVERY OF THE JUPITER C, JUPITER, ATLAS, AND THOR-ABLE BALLISTIC MISSILE NOSE CONES WAS ACCOMPLISHED BY COOK ELECTRIC COMPANY RE-ENTRY RECOVERY PACKAGES.**

**CURRENT PROJECTS INCLUDE THE MINUTEMAN AND TITAN DATA CASSETTES AND RECOVERY OF THE SATURN BOOSTER.**

Scientists and engineers with experience in the following fields are invited to explore the wide range of openings now available:

#### **COOK RESEARCH LABORATORIES**

- Aerospace Vehicle Landing Systems
- Instrumented Test Vehicles
- ECM, ECCM Studies and Equipment
- Target Simulators, Flight Simulators
- ASW Systems and Subsystems
- Control Systems, Computer Input-Output Systems, Signal Processing, and Analysis Systems
- Weapon Systems and Subsystems

#### **INLAND TESTING LABORATORIES**

- Instrument Calibration and Repair
- Electronic Manufacturing
- Field Services
- Reliability Testing and Engineering
- Qualification and Environmental Testing and Engineering
- Nuclear Irradiation Analyses and Studies
- Wind Tunnel Studies

#### **CINEFONICS**

- Film Reports and Documentation

COOK TECHNOLOGICAL CENTER



6401 OAKTON STREET  
MORTON GROVE, ILLINOIS

Stability

Availability

Shipability

Storability

Desirability

Dependability

Flexibility

Compatibility

## Investigate

the many advantages of  
**Chlorine Trifluoride (ClF<sub>3</sub>)**  
as a rocket fuel oxidizer!

### Desirability

—Chlorine Trifluoride is one of the most powerful rocket fuel oxidizers known. Its performance compares favorably with other oxidizers far more difficult to handle.

### Properties

—CTF has many characteristics desirable in a storable propellant, with a wide liquid temperature range. It has a low freezing point (−105°F) and a moderate boiling point (53°F). Vapor pressure is 80 psia at 140°F.

### Storability

—Unlike most liquid propellants, Chlorine Trifluoride requires no refrigeration. It is handled and stored safely and conveniently in standard steel cylinders. No special storing precautions necessary.

### Availability

—CTF has been produced commercially by General Chemical for almost 10 years. Readily available in ton and 150-lb. steel cylinders and in smaller sizes.

### Stability

—CTF has very high shock resistance; is shipped nationally via common carriers. It is thermally stable up to 450°F.

### Dependability

—CTF gives predictable performance. In addition, CTF is hypergolic with hydrogen fuels over a wide range of pressures and temperatures.

### Flexibility

—CTF can be used under all geographic and climatic conditions. No need for fixed supply points.

### Compatibility

—CTF can be used satisfactorily with properly passivated steels, nickel alloys, copper and other common metals.

### Density

—CTF's high density (1.825 gm/cc at 68°F or approximately 15.3 lbs./gallon) leads to outstanding density impulse values with a variety of rocket fuels.

Write today for a free copy of our technical bulletin, "Chlorine Trifluoride." Company letterhead, please.



# CTF

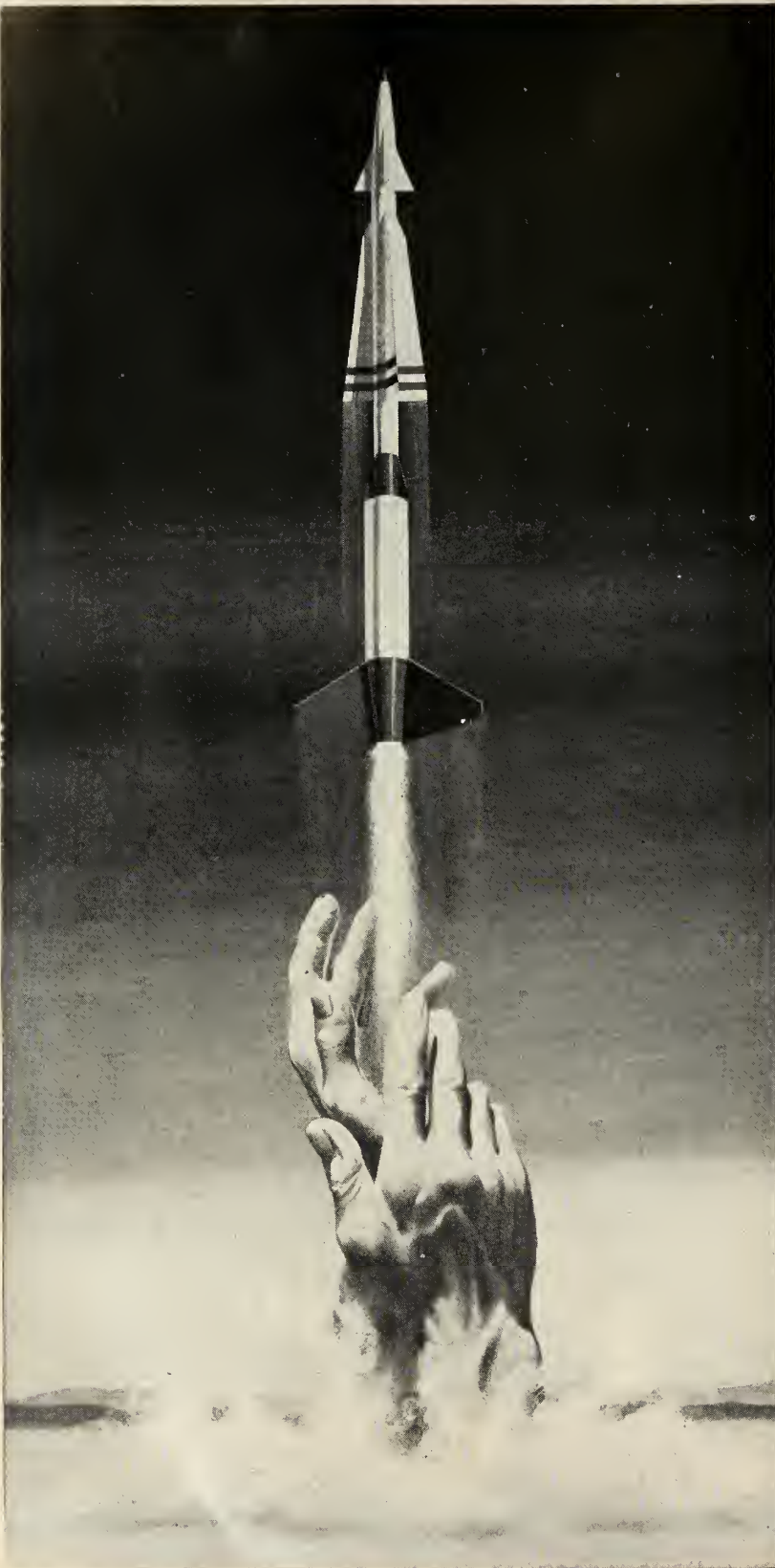
**ideal storable oxidizer**

*First in Fluorine Chemistry*

Allied  
Chemical

**GENERAL CHEMICAL DIVISION**

40 Rector Street, New York 6, N. Y.



## rockets and missiles

Componentry capabilities of the Kelsey-Hayes Company as a supplier of precision propulsion assemblies, structural parts and exotic high temperature materials for first and second generation rockets and missiles include—  
Swivel nozzles, hydraulic control systems and auxiliary power supply systems for thrust vector control; weldments, rocket and combustion chambers for liquid and solid propellant propulsion systems; inner cones, exhaust cones, rotating wheel assemblies; vacuum induction melted alloys to withstand corrosive and extremely high temperature atmospheres; advanced design, research and development in gas dynamics, internal ballistics, transient heat and thermal stress analysis.  
Kelsey-Hayes Company,  
General Offices: Detroit 32, Michigan

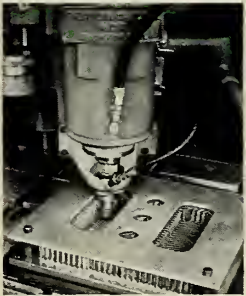
## **KELSEY- HAYES** COMPANY

Automotive, Aviation and Agricultural Parts  
Hand Tools for Industry and Home

18 PLANTS. Detroit and Jackson, Michigan;  
Los Angeles; Philadelphia and McKeesport,  
Pennsylvania; Springfield, Ohio; New Hartford  
and Utica, New York; Davenport, Iowa;  
Windsor, Ontario, Canada.



# NOW Anocut Electrolytic Machining for CAVITY-SINKING as well as ROTATING-WHEEL applications



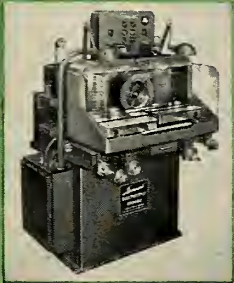
MACHINING POCKETS IN FRAGILE STAINLESS STEEL HONEY-COMB FREE OF LAYOVER AND BURR. PHOTO COURTESY EKSTROM, CARLSON & CO.

## Rotating-Wheel Anocut

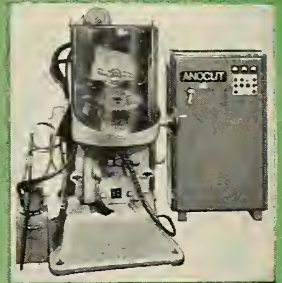
is used for metals which are (1) hard, (2) tough, (3) heat sensitive or (4) easily burred wherever an open surface is to be machined to high accuracy and high finish. It will produce surfaces which are flat or curved (inside or outside) or continuous forms, as in form grinding. Wherever a rotating wheel can be applied this method offers tremendous savings in time and abrasive cost.



MOUNTING STATOR RING FOR ELECTROLYTIC MACHINING OF VANE TIPS TO ACHIEVE PRECISE CONCENTRICITY AND SIZE. OPERATION IS FAST AND ELIMINATES DEBURRING, SAVING LABOR COSTS AND REDUCING SCRAP.



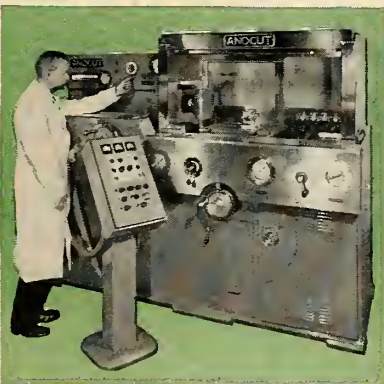
MODEL EG-12 ELECTROLYTIC OSCILLATING GRINDER WITH TWO AIR-OPERATED TILTING TABLES. DESIGNED FOR PRODUCTION WORK ON FLAT SURFACES OF JET ENGINE AND ROCKET ENGINE COMPONENTS AND OTHER TOUGH OR HARDENED STEEL PARTS, DOVE-TAIL OR CIRCULAR FORM TOOLS, ETC. PHOTO COURTESY HAMMOND MACHINERY BUILDERS, INC.



AUTOMATIC ELECTROLYTIC FACE MILL GRINDER. VARIABLE SPEED MOVABLE RAM CAN BE ADJUSTED TO SHARPEN COMPLETE CUTTER IN ONE REVOLUTION OF TABLE, REMOVING .005" TO .020" FROM EACH TOOTH. FORTY-FOUR TOOTH CUTTER, 16" DIAMETER, SHARPENED IN 22 MINUTES, REMOVING .012" FROM EACH TOOTH, GRINDING CARBIDE AND STEEL SIMULTANEOUSLY. PHOTO COURTESY OLIVER INSTRUMENT CO.

## NEW MACHINE - SAME PRINCIPLE

**Plunge-Electrode Anocut** sinks a shaped electrode into hard or tough metals by the same electrochemical principle as rotating-wheel Anocut. Unlike electro-discharge spark machines it has high removal capacity, no electrode wear, and is therefore intended for repetitive production jobs.



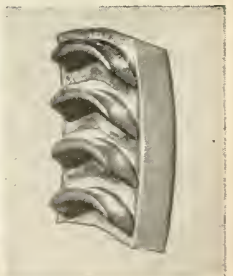
MODEL HCS-59 ELECTROLYTIC CAVITY-SINKER. APPLIES SAME BASIC ELECTROLYTIC PRINCIPLE TO THE SINKING OF IRREGULAR HOLES AND SHAPES FOLLOWING THE CONTOUR OF THE ELECTRODE MADE FOR THE PURPOSE, THE ELECTRODE IS SIMPLY PLUNGED LINEARLY INTO THE WORK MATERIAL.



HEXAGONAL HOLE 1" DEEP, 1/4" ACROSS FLATS, IN UDIMET 700. NOTE STRAIGHTNESS AND SHARPNESS OF WALLS WHERE ELECTRODE BROKE THROUGH. CONICAL TIP IN BOTTOM OF BLIND HOLE CAN BE ELIMINATED. INTERIOR-COATED ELECTRODE USED FOR ROUND HOLES IN BACKGROUND.



SEVEN INCH LONG, .078" DIAMETER HOLE ELECTROLYTICALLY "DRILLED" IN UDIMET 700. ROD HAS BEEN SURFACE GROUND TO EXAMINE STRAIGHTNESS OF HOLE. NO WEAR ON ELECTRODE.



ELECTROLYTIC TREPANNING. DESIRED FORM EXTENDS INTO INTERIOR OF SHAPED ELECTRODE. NOTE HIGH FINISH ON BLADE FORM.

# ANOCUT

ENGINEERING COMPANY

631 WEST WASHINGTON BLVD. • CHICAGO 6, ILL. • PHONE STATE 2-5480

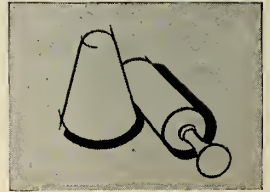
T. M. Reg.

# Garlock's unique position

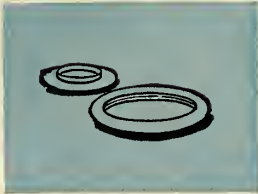
## in the missiles industry . . .

may be of infinite value to you. *Acceptance:* Right now Garlock is supplying rocket motor components for various phases of development and production of seven different missiles. *Flexibility:* Garlock has the people, the equipment, and the experience to swing into prototype production on short notice, and to follow this with full-scale production as needed. *Diversified Abilities:* Garlock is thoroughly familiar with the design and manufacture of components from a wide range of basic materials—metals, rubber, phenolics, fluorocarbons and other plastics. *Completely Integrated Staff:* Garlock's product design, tool design, pilot manufacturing and production staffs are completely integrated for efficient handling of a project from start to finish. Garlock engineers will work to your design—or with you in developing designs. Write or call Military Products, Garlock Inc., Palmyra, New York.

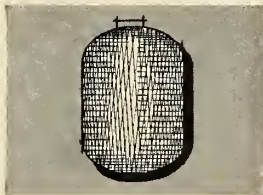
**GARLOCK**



**MISSILE PARTS FROM INERT MATERIALS** include newly developed asbestos-phenolic compound for nozzles . . . nose cones of fluorocarbon plastics.



**GARLOCK METAL FITTINGS FOR ROCKET MOTOR CASES** such as blast tube and thrust terminator support rings are machined to extremely close tolerances. Made from special materials offering minimum weight, maximum strength and rigidity.



**FILAMENT WOUND ROCKET MOTOR CASES** made by exclusive Garlock method results in structure much lighter and stronger than steel.



**INSULATION FOR SOLID FUEL ROCKET MOTORS** made by Garlock is rubber-like compound which encounters gas velocities of Mach 3, temperatures to 5500° F, prolonged ambient temperatures of 300° F.

Garlock components are presently used in the development and production of:

Vanguard • Super Vanguard • Minuteman  
Nike Hercules • Super Tartar • Terrier • Polaris



## ENGINEERING TEAMWORK IN SPACE EXPLORATION

Engineers and scientists interested in a wide range of activities will appreciate the advanced nature of research and development projects under way at JPL. These projects include research, basic and applied, in Electronics, Solid State Physics, Propulsion, Aerodynamics, Structures and Materials and the design, development and analysis of space probes and satellites. Individually responsible engineers and scientists work together as a thoroughly integrated

team in accomplishing the complete objective.

Programs involve guidance, telemetering, data recording and reduction, instrumentation, structures, propulsion, materials, solid state physics, components, heat transfer problems and systems analysis and are constantly influenced by continuing JPL space exploration research providing individuals with challenging assignments in almost every phase of engineering and

science. Staff progress in diverse fields of activity is constantly being made.

Pioneering in basic research, applied research and development engineering in space exploration proves to be a stimulating attraction for engineers and scientists with innate curiosity and intense interest in the future of space exploration.

More men of this type are needed — if you believe you are qualified for the JPL team, send in your resume today.



### CALIFORNIA INSTITUTE OF TECHNOLOGY JET PROPULSION LABORATORY

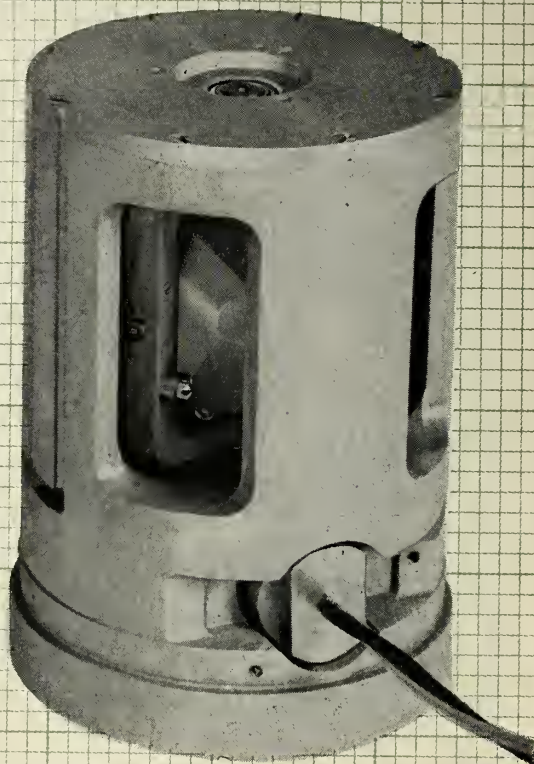
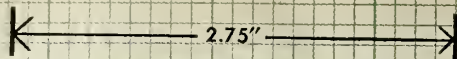
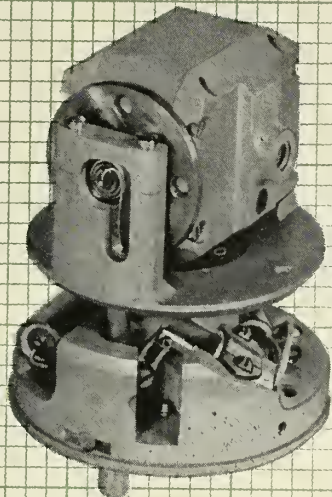
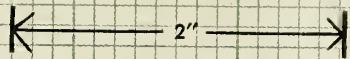
A Research Facility operated for the National Aeronautics and Space Administration  
PASADENA, CALIFORNIA

*Employment opportunities for Engineers and Scientists interested in basic and applied research in these fields:*

COMMUNICATIONS • MICROWAVE • SERVOMECHANISMS • COMPUTERS • LIQUID AND SOLID PROPULSION  
• STRUCTURES • CHEMISTRY • INSTRUMENTATION • MATHEMATICS • AND SOLID STATE PHYSICS •

*Send professional resume, with full qualifications and experience, for our immediate consideration*

Circle No. 38 on Subscriber Service Card.



# New! 2° of Freedom Gyros

## MINIATURE ELECTRIC GYRO—Type PHU

- Extremely rugged, small, lightweight, accurate
- Size: 2" x 2.5" overall dim.
- Weight: 250 grams
- Scorsby Drift: 1° per min. max.
- Outer gimbal readout

*For applications where size and weight savings are critical, without sacrifice of accuracy and reliability.*

## PYROTECHNIC GYRO—Type PHM

- Rugged, inexpensive, expendable
- Size: 2.75" x 4" overall dim.
- Weight: 800 grams
- Drift: 1° per min., first 3 minutes
- Runup and uncage time: less than 50 ms.
- Outer gimbal readout: potentiometer, microsyn or commutator

*Gyro wheel cartridge energized. All gases generated may be contained within the outer housing (hermetic seal if desired). Low cost, high production potential. Extremely rugged, can withstand 100 G shock.*

*Write today for detailed info.*



# Greenleaf MANUFACTURING

DIVISION OF MANDREL INDUSTRIES, INC.  
7814 MAPLEWOOD INDUSTRIAL COURT, ST. LOUIS 17, MISSOURI



# WORKING PARTNERS

## ROCKETDYNE AND SOUNDCRAFT INSTRUMENTATION TAPES



At North American Aviation's Rocketdyne division, the recording of rocket engine performance on static stands, calls for the use of only the most reliable of instrumentation tapes, like Soundcraft. Why? Because Soundcraft Instrumentation Tapes combine exact physical and electrical properties so necessary to assure absolute reliability of performance—as a direct result of being manufactured in the world's most modern tape plant under the most advanced quality control system.

In short, experience has proven that Soundcraft Instrumentation Tapes *work best* in recording of critical rocket testing operations. Why not let precision-made, error-free Soundcraft Instrumentation Tapes go to work for you? Complete literature on request.

### REEVES **SOUNDCRAFT** CORP.

Great Pasture Rd., Danbury, Conn. • Chicago: 28 E. Jackson Blvd. ☐  
Los Angeles: 342 N. LaBrea • Toronto: 700 Weston Rd. ☐

Circle No. 40 on Subscriber Service Card.



## TIROS GROUND STATIONS...

### Nerve Centers For A Satellite

Over 25,000 informative cloud-cover pictures have been received from TIROS I since it was launched on April 1. In two months the satellite had completed 1000 orbits and travelled 27,500,000 statute miles. This means not only that TIROS itself has performed as planned, but that the complex problems of command and control, as well as signal reception and processing, have been successfully surmounted. Like the satellite, the special ground station equipments were designed and built by RCA Astro-Electronics Division under the auspices of NASA and technical direction of the U.S. Army Signal Corps.

Major components at each of the four ground stations include:

- Five TV receivers and four beacon receivers used in diversity reception to minimize signal fading
- A programmer which pre-programs different combinations of operating modes, and a 200 watt command transmitter
- A TV monitor to display the picture signal for the automatic recording camera. The camera is equipped to make either positive or negative films
- An indexer and sun angle computer which generate an index number and sun angle indication for each picture, used for geographical orientation
- An attitude recorder which picks up the earth-horizon signal for spin axis position computation

- Two standard 4-channel tape recorders to back up the monitor
- Two paper recorders to monitor forty telemetered satellite parameters
- An antenna programmer which directs the antenna to follow the orbit of the satellite when it is in range of the ground stations

All program functions are timed by a master clock which is synched to standard time signals from WWV. In addition to normal picture direct transmission and record functions, the programmer can also command spin-up. After two months the spin rate had decreased to 9.4 rpm's due to the effect of the earth's magnetic field. On command from the ground, two solid propellant spin-up rockets on the satellite were fired, increasing the spin to 12.8 rpm's.

AED's own ground station was used to process photos from the magnetic tapes for the first one hundred orbits.

The integrated design and development of these TIROS ground stations is an indication of AED's capability in *total satellite systems*. This capability will become increasingly critical as more and more complex satellites and space probes are launched to advance man's understanding and control of his universe. To discover how you can draw on this broad R & D experience, contact the Marketing Manager, RCA Astro-Electronics Division, Princeton, N. J.



The Most Trusted Name in Electronics  
RADIO CORPORATION OF AMERICA

# Will Castro Get Red Missiles?

by James Baar

The ominous possibility that Russia will provide Cuba with missiles is haunting U.S. strategists this week.

Only a month ago such an idea was generally considered far-fetched. Following the events of the last few days, it has to be taken into consideration in all U.S. planning for the Western Hemisphere.

Cuban Boss Fidel Castro and his red henchman, Ernesto Guevara, are swiftly moving Cuba into the Soviet economic orbit as the last fiscal ties with the United States are snapped.

A Soviet decision to "sell" Castro missiles and provide a military mission to help establish Cuban missile bases would be only another step in implementing a Russian move into the Western Hemisphere.

Unless thwarted by stiff—possibly armed—U.S. action, the Cold War gains for Russia would be enormous:

- Castro would have placed in his hands weapons with which he could cause great difficulties for the United States.

- Cuba could intimidate all of Central America and resume the Castro regime's previously ill-fated attempts to spread the Castro Revolution and expand Cuban territorial holdings.

- Russia would have a new bargaining counter with which to demand withdrawal of U.S. overseas bases.

- The Communist Bloc would have a powerful base from which to increase its activities throughout Latin America.

The Russians are known to have large stockpiles of tactical and intermediate-range ballistic missiles from which they could draw "sales" to Castro. These missiles could be deployed in Cuba at fixed bases or on mobile platforms.

IRBM's launched from Cuba could hit much of the United States. New York, Washington, Chicago and Denver would be within range. Shorter-range tactical Soviet missiles such as the *Komet 2* could hit much of the Deep South—including the *Polaris*-loading depot at Charleston, S.C., and Cape Canaveral.

But even more important to Soviet and Cuban strategy is that such missiles could hit any city or military target throughout Mexico and the small



**CUBAN-BASED IRBM's (made in Russia) could be launched 1500 nautical miles to strike targets throughout Central America and much of the United States.**

nations of Central America.

They could strike anywhere in the islands of the West Indies and across the Caribbean into Venezuela, Ecuador and northern Brazil.

The Panama Canal could be held hostage.

Castro, armed with Soviet missiles and a growing army, would become the greatest military power in Latin America.

Soviet Premier Nikita Khrushchev would face relatively small losses in exchange for such attractive gains.

The principal loss would be the alarming of Latin American nations. This could result in possible united armed action against Cuba and the stiffening of resistance to local Communist groups.

However, Khrushchev apparently does not consider this a serious risk or he would not have openly defied the Monroe Doctrine with his threat earlier this month to come to Cuba's aid with ICBM's.

Nor would a Latin American war embroiling the United States necessarily not be to Khrushchev's taste. He

and Latin America's Communists might well feel that whatever Cuba's fate, the odds are in favor of their emerging in control of many key Latin American posts.

All in all the arming of Castro with missiles must appear very attractive to the Kremlin in the last days of the Eisenhower Administration.

## Boeing Gets \$247 Million For More Minuteman R&D

The Air Force and Boeing Airplane Co. this last week announced the signing of a \$247-million R&D contract for the huge *Minuteman* ICBM program.

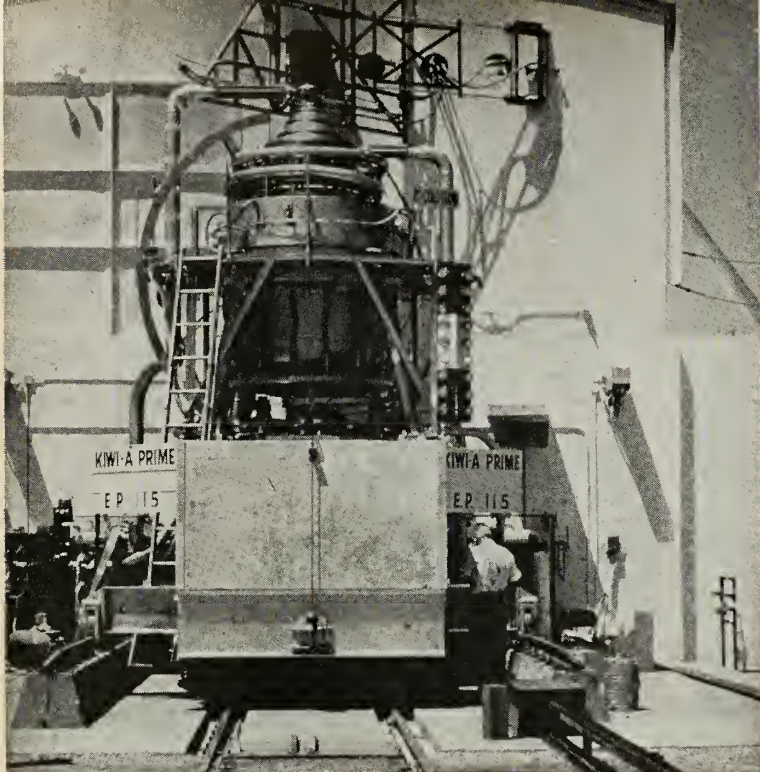
The contract, running through Dec. 31, 1961, replaces a letter contract that authorized Boeing to begin work on the *Minutemen* that will be deployed in fixed bases. A contract covering *Minutemen* that will be deployed aboard trains is expected to be negotiated during the next few months.

The three-stage *Minuteman* is scheduled to be operational in mid-1962.

Theories proven . . .

## Kiwi-A-Prime

by Richard van Osten



ABOVE: Kiwi-A-Prime reactor shown on rails in exclusive M/R photo. Its fuel element is believed to represent a major improvement over earlier Kiwi-A.

BELOW: Close-up of Kiwi-A-Prime reactor cold flow unit shows ducting of system used for handling liquids, instrumentation wiring and structural member arrangement.



The U.S. took one more step along the path to a nuclear-powered rocket with the first full power run of Project Rover's Kiwi-A Prime reactor at the Atomic Energy Commission's Nevada test site.

Although total power time was approximately 15 minute and full power was maintained for only about five minutes, personnel from Los Alamos Scientific Laboratory expressed extreme pleasure with the July 8 results.

Exact details of the test operation are still pretty much under wraps. But Dr. Keith Boyer, project director for NTS, told M/R the power obtained was "similar" to that achieved with the successful run of Kiwi-A last year.

Output of the solid-fuel (uranium-235) heat-exchanger, direct, open-cycle reactor was not the test's primary object, however. What LASL scientists were trying to achieve was a validation of their design theories. This, they claim, was accomplished.

Kiwi-A Prime is the nearest approach so far to a system and component design that could be flown—not that the reactor is anywhere near a flyable configuration, it is simply "a lot closer," according to test personnel. It is being developed jointly by the AEC and the National Aeronautics and Space Administration.

Security regulations do not permit full disclosure of differences between Kiwi-A and Kiwi-A-Prime. It is known, however, that one major area of improvement is the fuel element—a long-standing problem with all reactor types.

• **Test delayed**—The test went well despite a several hour delay when a methane supply line valve malfunctioned. The methane is used to light off the cloud of hot hydrogen which rises from the reactor nozzle so that it burns rather than accumulate undetected and possibly explode. Operations could have been conducted with-

missiles and rockets, July 18, 1960

# Run Brings Flight Closer

Testers highly pleased with success of first full-power trial of advanced reaction; Rover director sees program on right track

out the methane flare, but B-57 sampling aircraft took a rather dim view of flying through an unburned cloud of hydrogen. The reactor had to be shut down for the repair, then brought up to power again.

During the full power run, sparks shot out of the reactor exhaust on several occasions. Dr. Alvin Graves, director of LASL's Test Division, said he had no idea what the reason was, but teardown, scheduled to begin the following day, would probably show some slight internal damage.

Another short delay was encountered early in the test when the reactor's scram system (for fast shutdown) was set too close to the operating point.

Next step will be detailed examination of Kiwi-A-Prime following disassembly. Later this year, Kiwi A3, presently still at LASL, will be brought to the site for tests.

• **Kiwi B series**—Kiwi A3 is "almost identical" to Kiwi-A-Prime, LASL says, but the test program is different. The reactor will be run up to power several times, then run to failure.

When Kiwi A3 experiments are completed, the existing test cell (A) at NTS will be modified for additional hydrogen storage in preparation for next year's test program on the Kiwi B series.

In addition to the modified test cell A, a new unit, test cell C, will be constructed for Kiwi B experiments. Some of this construction is complete—extension of the railroad to carry the reactors, a vehicle road and a water line have been installed. First phase of the test cell proper will be built by Okland Construction Co., Salt Lake City, Utah, under a \$1.1 million contract.

Work will consist of a heavy reinforced concrete test cell building, a similarly constructed propellant fill sta-

tion building, furnishing and erecting two prefabricated metal buildings, constructing a cooling tower and an outdoor power substation, installing utility systems, and installing government-furnished equipment. The new test cell is expected to be operational by the summer of 1961.

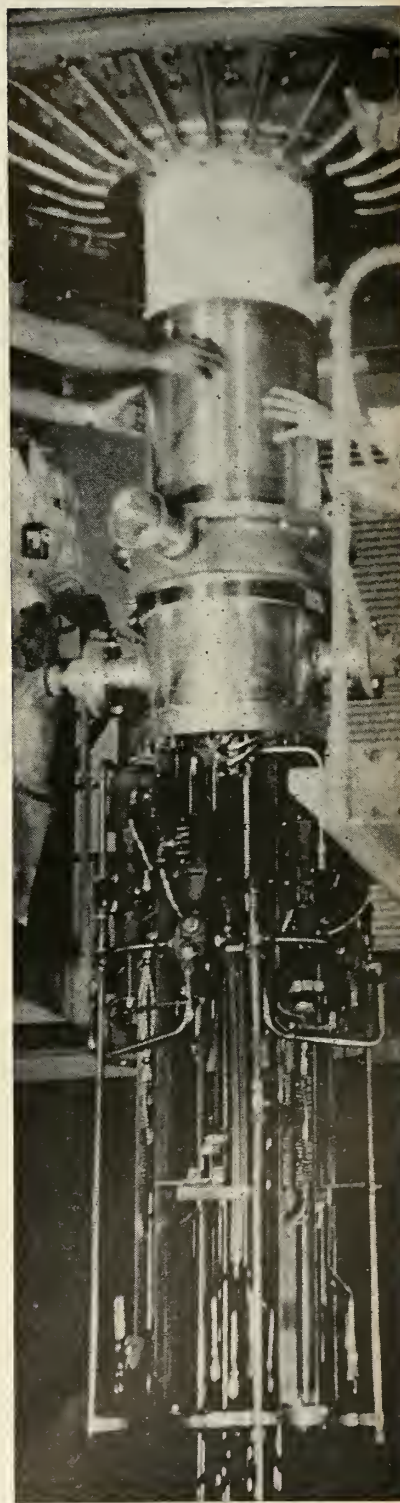
The power run of Kiwi-A-Prime marked still another innovation. This was the first time LASL personnel had tried out a new instrumentation system, which incorporated multiplexed and commutated data pick-off signals which are fed to Ampex recorders. The tapes will subsequently be fed into an IBM 704 computer for reduction.

• **Look for surprises**—The previous system (M/R, July 4, 1960) worked well, but much information was not reduced because of the complexities. With the new system, Dr. Boyer said it is easier to reduce all data rather than select portions to be reduced as before.

Asked his opinion as to the feasibility of the *Rover* project, Dr. Boyer said he was personally convinced they were on the right track—particularly after the successful test of Kiwi-A and now, Kiwi-A-Prime.

"But," he cautioned, "we still have not mastered the problem, and we may be due for some surprises."

The Kiwi-A-Prime test was observed by U.S. Senators Albert Gore (D-Tenn.), Henry Jackson (D-Wash.), and Wallace Bennett (R-Utah), all members of the Joint Committee on Atomic Energy. Other congressional observers were Representatives Craig Hosmer (R-Calif.) and William Bates (R-Mass.). Observers included also representatives from the AEC, NASA, National Academy of Sciences, the Military Liaison Committee, Joint Committee of Atomic Energy, and Dr. York's office.



INTERNAL assembly is installed in hot reactor at Nevada Test Site. ACF assembled hardware. Photos by Frank McGuire.

many applications likely . . .

# 'Laser' Broadens the Radio Spectrum

by Hal Gettings

A new era in electronics opened up this week with the long-sought development of the laser—an optical maser and key to optical-frequency communications.

The "laser"—Light Amplification by Stimulated Emission of Radiation—extends the radio spectrum from 50 gigacycles (kmc) up to 500,000 gigacycles, which includes infrared and approaches visible light.

An extension of such magnitude vastly increases the number of available communications channels.

This first laser was developed at Hughes Aircraft Company's research laboratories in a company-funded project under the direction of Dr. Theodore H. Maiman, a senior staff physicist.

In addition to radar and communications, a host of other applications are seen for the new device.

The laser is the first true light amplifier. It provides a new scientific tool for investigating properties of matter and performing basic experiments of physics. It can be used as a source of highly concentrated light for industrial, chemical, and medical purposes.

• **Coherence**—The most significant factor of the new development is that the laser is able to generate a "coherent" beam—heretofore possible only in the conventional radio frequencies. "Coherence" signifies the definiteness of the frequency of radiation—the smaller the band, the more coherent the source. Usual light sources—such as a carbon arc or incandescent lamp—generate energy over a relatively wide

band of the electro-magnetic spectrum. Consequently, they cannot be focused to a very narrow beam, and dissipate rapidly with distance.

As an example, the best available searchlight aimed at the moon would spread over 25,000 miles—even if it could reach that far.

In contrast, the laser radiates an almost perfectly parallel beam, less than one-hundredth of a degree of arc wide. Aimed at the moon, such a beam would illuminate an area less than ten miles wide. A beam directed at the earth from a satellite at 1000 miles altitude would be concentrated into an area about 200 feet wide. Using it as a "light-radar" could make it possible to take detailed pictures with a super-clarity never before obtained.

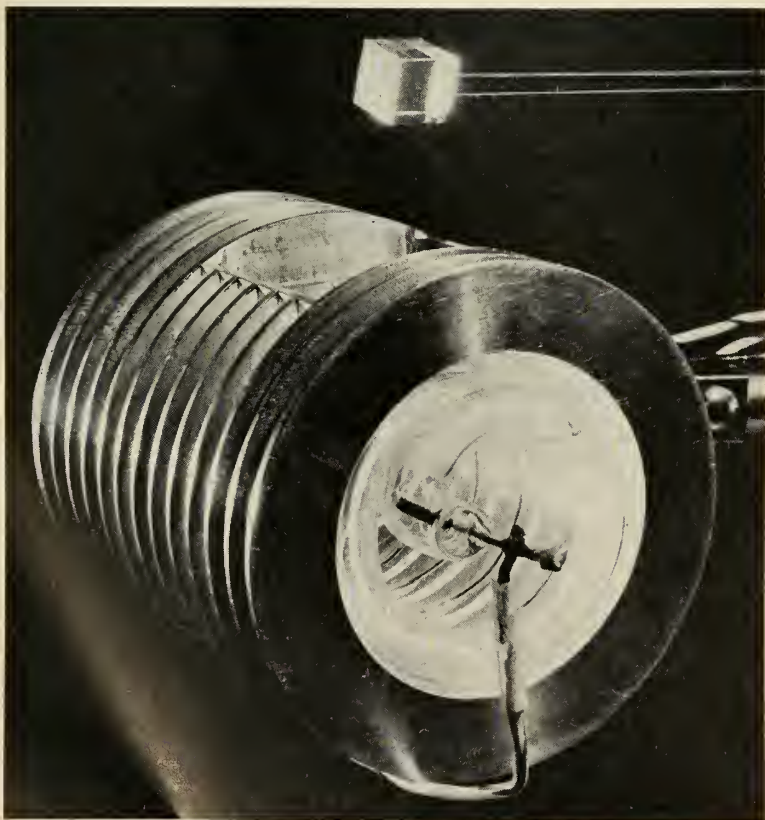
The heart of the laser is a half-inch cube of synthetic ruby crystal. Irradiated by a light source—such as a powerful flash tube lamp—the tightly packed atoms of the ruby are excited to a higher energy state and energy is reradiated in a narrow band of frequencies. The excited atoms are coupled to an atomic resonator and stimulated to emit the radiation together. This is in contrast to ordinary light sources where the atoms radiate individually at random and produce "incoherent" light energy.

• **Glorious color**—Due to its coherence, the laser is a source of very high "effective" temperature, while it itself remains physically cool. By comparison, an ordinary arc lamp would have to be at an impossible temperature of several billion degrees to generate as bright a signal as the laser.

Coherence, too, has an important effect on color. Since the color of light is a manifestation of its frequency band, its purity is determined by the width of the emitted spectrum. Consequently, the laser should be able to generate the purest colors ever known.

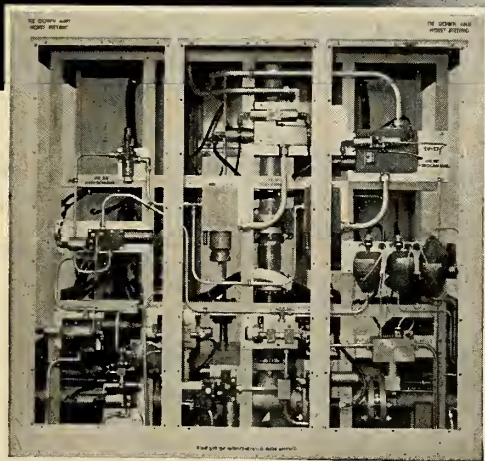
The Hughes effort in this field is one of several programs being conducted in many industrial and educational scientific laboratories. Some are privately and some publicly supported; others are under defense contracts.

Competition in even such an exotic area as this is not unknown. It is fairly certain that parallel or similar significant advances will make their appearance in the near future. The Hughes development is but the first.



CUBE OF SYNTHETIC ruby crystal is heart of laser. High-intensity light from flash tube lamp (glass helix in center) excites ruby's atoms which reradiate sharp beam of coherent light.

# WILL IT WORK UP HERE?



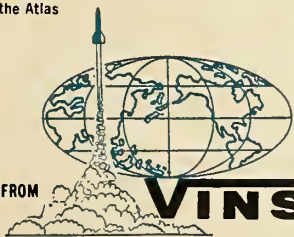
Vinson valves are used in the dynamic checkout unit built by Consolidated Systems Corporation for use in the Atlas missile program.

Behavior of helium and nitrogen valves can be predicted if you simulate conditions and pre-test on the ground. Pressure regulators, relief valves, and flow controls must be better than the systems they are checking. It takes knowledge gleaned from experience to design ground support units that guarantee expected behavior of a missile *up here*.

*Vinson designed valves and regulators for both the dynamic and static checkout systems for the Atlas. Whether your control problem is simple or complex, consult Vinson engineers.*

Differential relief, solenoid and priority valves.  
Flow and pressure regulators.  
Reservoirs and accumulators.

EXPECT MORE FROM



**VINSON** SYSTEMS



8044 Woodley Avenue, Van Nuys, California  
TRiangle 3-3510 • State 6-7210

# Navy Buys High-Accuracy Norwegian ASW Missiles

The Navy is planning to equip two destroyer escorts with Norwegian ASW *Terne* missiles.

The *Terne* is a surface-to-under-water missile that carries a depth-charge warhead. It is manufactured by Kongsberg Vapenfabrikk.

The Navy announced this last week the award of an approximately \$1.5 million contract to Arma for the integration of *Ternes* into present shipboard missile systems—presumably *Alfa*—and the modification of existing fire control equipment.

The newest model of the *Terne*—the Mark 7—weighs 264 lbs. The depth charge alone weighs 105 lbs. The *Terne* is 77.5 in. long. It has a 7.9-in. diameter.

*Alfa*, which has been operational aboard U.S. ships since 1952, weighs 500 lbs. It is 102 in. long and has a 12.7-in. diameter.

*Alfa's* effective range is about 900 yards. *Terne's* range is believed to be longer. *Terne's* accuracy has been described as "better than a quarter of 1%."

*Terne* is launched from Norwegian ships with a 2.5-ton deck launcher that carries six missiles, fired singly or in salvos.



Exclusive M/R photo of *Terne*.

## Von Braun Completes Top Staff Appointments

Dr. Wernher von Braun, director of the Marshall Space Flight Center at Huntsville, Ala., last week completed selection of his top staff assistants.

The Marshall Center, which was set up July 1 from von Braun's group in the Army Ballistic Missile Agency, now has a staff of 4900 and eventually will total 5500.

Von Braun made these appointments: Saturn Systems Office, Dr. O. H. Lange; Agena-B and Centaur Systems Office, Dr. Hans Heuter; Weapons Systems Office, Werhen Tiller; Future Projects Office, H. H. Koelle; Technical Program Coordination Office, Dr. George Constan; Office of Technical Services, David Newby; Office of Management Services, V. C. Sorensen; Office of Financial Management, Claude Stockton; Office of Purchasing and Contracting, Wilbur Davis; Management Analysis Office, C. W. Huth.

There are two deputy directors. Dr. Eberhard F. M. Rees, von Braun's deputy for many years with ABMA, will head the operating departments as deputy director for research and development. Delmar M. Morris, government administrator formerly with the Atomic Energy Commission and TVA, is deputy director for administration.

# The Navy's Polaris: *from nowhere to anywhere*





## NASA Seeks New Western Source of Liquid Hydrogen

The National Aeronautics and Space Administration needs a second supply of liquid hydrogen in the California-Nevada area, it told industry last week.

At a preliminary bidders' conference July 12, representatives of about 15 companies were told that in about a year there will be requirements for additional supply varying from 35,000 to 60,000 lbs. daily for a period of five years. The only major source on the West Coast at present is a Linde Co. plant at Torrance, Calif., which went on stream June 27.

Under a NASA-Linde contract, NASA has first call on up to 275,000 lbs. a month produced at the new Linde plant. Linde has said the plant can produce six tons a day if required.

The NASA group, headed by William P. Kelly, Jr., head of the Procurement Assistance Branch in the Procurement and Supply Division, told the industry representatives that requests for bids would be issued in the near future.

The NASA spokesmen said it was believed that the plant could be built in a year. Several industry spokesmen disagreed, saying the construction would take more time.

It was indicated that the contract to be awarded would provide that the winning company build the plant with its own funds and NASA would be committed to buy from the second plant after first meeting its needs from the Linde plant.

The present NASA contract with Linde calls for the purchase of liquid hydrogen on the following basis: First 100,000 lbs. in any month at 66¢/lb., next 50,000 lbs. at 57¢/lb., next 50,000 lbs. at 55¢/lb., and last 75,000 lbs. at 32¢/lb.

## Firms Compete for Contract On Orbiting Observatory

Four companies and seven teams of companies are bidding for a contract to design and develop a 3500-lb. orbiting astronomical observatory (OAO) for the National Aeronautics and Space Administration.

The observatory, largest payload attempted by NASA to date, would carry telescopes and other instruments and point them at parts of the sky with the accuracy and steadiness of a ground telescope.

The OAO would be boosted into orbit by an *Atlas-Agena B* vehicle. Harry J. Goett, director of NASA's Goddard Space Flight Center, told the House Appropriations Subcommittee in

March that OAO would go into operation in about 2½ years. This would indicate a flight by late 1962.

The Goddard Center, which will move later this year from Washington to Greenbelt, Md., will have charge of developing the satellite. NASA did not say how much money would be involved in the contract. However, it was understood it would be worth upwards of \$10 million to the winner.

Astronomical observation from above the atmosphere is greatly improved because it avoids the distortion of visible light and the blockage of radiation in many wavelengths caused by the atmosphere. Rudimentary observations by rocket have already changed many of the ideas previously held about the nature of the galaxy.

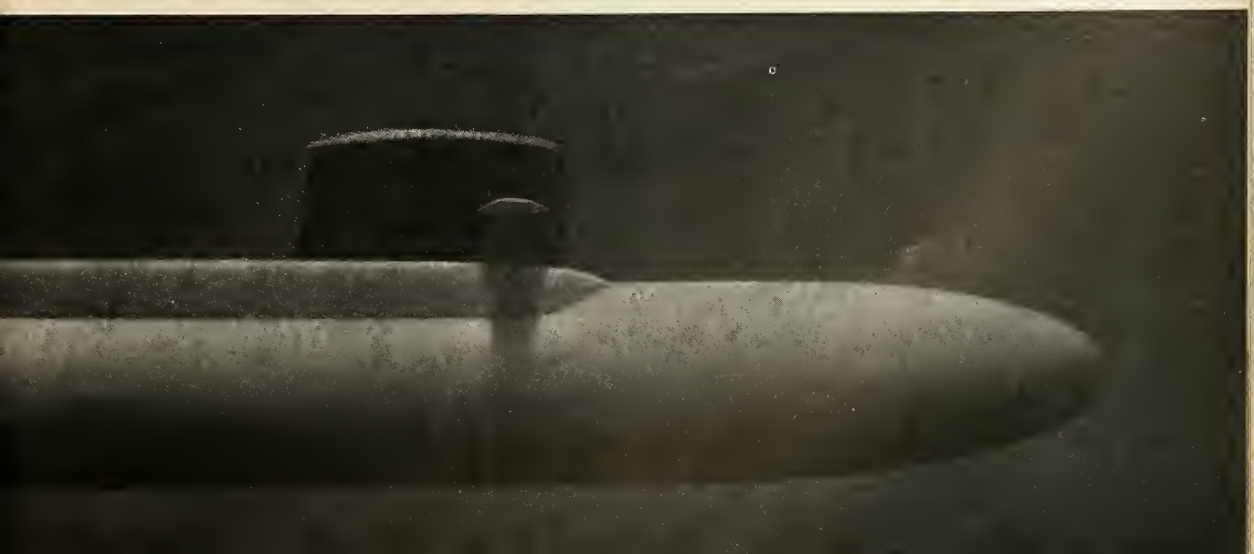
NASA asked for bids on May 5. Bids were received July 5. Individual companies bidding were Lockheed Missiles and Space Division, Aeronutronics Division of Ford Motor Co., Hughes Aircraft and the General Electric Missiles and Space Division. These were the team bids:

Bendix and Republic Aviation Systems Division, The Martin Co. and General Precision Instruments Inc., Westinghouse Electric and Grumman Aircraft, McDonnell Aircraft and Philco, Aerojet-General and Motorola, the three-way combination of Radio Corp.

Erupting from the ocean that blankets most of the earth, the Navy's Polaris missile will have the range to reach any strategic target. It will be launched from mobile bases that are safe from surprise attack—nuclear-powered submarines that cruise fast and deep for weeks on end, each carrying 16 Polaris missiles. This is the Navy's Fleet Ballistic Missile system. It becomes operational this year. Lockheed is prime contractor and system manager for the Polaris missile.

**LOCKHEED**

MISSILES & SPACE DIVISION



# 3

# VITAL SPACE AGE ANSWERS ... THROUGH ULTRASONICS

## 1. HOW MUCH?

Acoustica Ultrasonic Sensors provide near-instantaneous, completely safe response to liquid-level changes as small as  $\frac{1}{32}$ " with complete reliability...in practically any liquid...with extreme reliability...infinitesimal power drain...at temperatures from  $-423^{\circ}\text{F}$  to  $+500^{\circ}\text{F}$ .

## 2. HOW FAST?

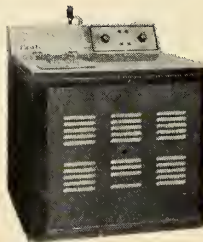
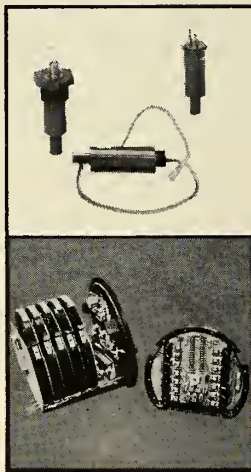
Acoustica Propellant Utilization Systems... proven both in ICBM flight and in the ground-support environment... report and automatically control the rate of propellant loading and the rate and ratio at which liquids are fed to missile engines in flight. They help insure successful adherence to flight plans.

## 3. HOW CLEAN?

Acoustica Ultrasonic Cleaning Systems assure the absolute cleanliness needed by electronic and mechanical components for in-flight and in-space reliability. With Acoustica's special *Multipower* techniques, parts are literally *blasted* free of even invisible dirt particles for maximum protection against malfunction.

*How Acoustica is equipped and staffed and what it produces to help solve some of the Space Age's basic problems is described in our latest brochures. Write today for our*

*"PORTRAIT OF CAPABILITIES"*



# acoustica

ACOUSTICA ASSOCIATES, INC.  
10400 Aviation Blvd., Los Angeles 45, Calif.

of America, North American Aviation and Perkin-Elmer Corp., and the four-way combination of Douglas Aircraft, Itek Corp., International Business Machines and Vidya of the Massachusetts Institute of Technology.

## Soviets Finish Latest Series of Pacific Shots

Russia completed testing a new long-range rocket by firing it 8070 miles into the Pacific testing range and impacting the dummy last stage "right at the target point."

The July 7 firing was the second and last in a phase of testing which began only two days before. Tass said the first rocket travelled 8078 miles, although the Pentagon estimated the distance as 7700 miles. U.S. Navy planes reported sighting both flights although they could not determine whether the payloads impacted in the target area.

The Soviets expressed complete satisfaction at the results of the two tests. Tass reported that "these launches yielded all data necessary to complete the development of a carrier rocket designed for further conquest of outer space."

## STL Among Four Companies Doing Moon Payload Study

Space Technology Laboratories last week won its first contract with the National Aeronautics and Space Administration.

NASA chose STL and three other companies to make five-month competing studies of design and size of a package weighing about 2500 lbs. that would make a soft landing on the moon. The others are McDonnell Aircraft, North American's Missile Division and Hughes Aircraft.

STL has been free to contract for competitive government business since July 1, when Aerospace Corp., a non-profit organization, was formed to provide the Air Force with systems engineering and technical direction of missile systems, and took over such work from STL.

NASA announced on July 10 that its Jet Propulsion Laboratory will negotiate contracts with the four companies calling for studies to be completed in December. The individual contracts will be in the neighborhood of \$100,000. However, the winner of the competition will be in line for NASA business totaling \$50-\$100 million over the next several years.

STL has designed payloads for NASA in the past. But the work was done in its capacity as an agency of the Air Force. A division of Thompson-

*(Continued on page 62)*

missiles and rockets, July 18, 1960



**Bendix-Pacific**

**MORE PERFORMANCE  
PER POUND!**

**AIRBORNE MILITARY RADAR**

Advanced terrain clearance, terrain weather surveillance, and fire control systems.

**ANTI-SUBMARINE WARFARE**

Major producer of ASW systems and sonar equipment, including outstanding transducer developments.

**ELECTRO-MECHANICAL**

Geneva-loc actuators, timing and sequencing devices, and high-response clutch actuators.

**HYDRAULICS**

Servo control systems, actuators, valves and accumulators for hydraulic and pneumatic high performance airborne and ground support equipment.

**INSTRUMENTATION**

Airborne and ground telemetering systems and components and digital data handling and control for industrial and military applications.

**MISSILE GUIDANCE**

Pioneer and one of major sources for active, semi-active and passive homing guidance systems.

**SYSTEMS RESEARCH**

Advanced development, systems analysis and operations research.

**TEST EQUIPMENT**

Design, development and production of tactical and manufacturing support equipment for weapons systems.



DIVISION OF BENDIX AVIATION CORPORATION

NORTH HOLLYWOOD, CALIFORNIA

NEW YORK CITY • DAYTON • WASHINGTON, D. C. • DALLAS • SEATTLE

**THE  
WESTINGHOUSE  
SALES  
ENGINEER  
IS A  
SHORTCUT TO**



**EXPERT  
ENGINEERING  
ASSISTANCE**



Don't wade through a complicated maze to get expert engineering assistance from space age specialists.

Contact your Westinghouse sales engineer.

Designing R&D test equipment? Ground handling and support equipment? Ground power supplies? Anything from a complete facility electrical system to application of a single transistor? We can help.

The Westinghouse sales engineer sets up the shortcut. He focuses the immediate attention of our Aviation Facilities Group on your specific aerospace problem. This group works with product design engineers in over 65 different Westinghouse facilities. Their close coordination saves you time and money.

Bypass the complicated maze. Call the Westinghouse sales engineer. Or write: Aviation Facilities Section, Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. *You can be sure if it's Westinghouse.*

J-92800

### MEET SOME OF THE AIRCRAFT/MISSILE/SPACE SPECIALISTS BACKING UP THE WESTINGHOUSE SALES ENGINEER:



A. M. Bruning, Engineer-In-Charge,  
Advanced Development Group  
Age: 33  
B.E., Johns Hopkins, 1949  
M.S., Mathematics, University of  
Pittsburgh, 1956  
Specialties: Arc Heated Aero-  
dynamic and Thermodynamic  
Test Facilities, MHD Research  
Facilities  
Years with Westinghouse: 8



W. J. Walker, Engineer-In-Charge,  
Aviation Facilities Group  
Age: 42  
B.S.M.E., University of Southern  
California, 1949  
Specialties: Wind Tunnels, Sonic  
Fatigue Test Facilities,  
Hardened Base Equipment,  
Launchers  
Years with Westinghouse: 11



R. A. Feranchak  
Age: 29  
B.S.E.E., Youngstown College, 1952  
Specialties: Arc Heated Aero-  
dynamic and Thermodynamic  
Test Facilities, Explosive  
Forming, Rotating Equipment  
Test Stands  
Years with Westinghouse: 7



R. F. Leepa  
Age: 29  
B.S.E.E., Lafayette College, 1953  
Specialties: Military Power Plants,  
Radar Antenna Drives  
Years with Westinghouse: 6



P. J. Hawkshaw  
Age: 36  
B.S.E.E., Catholic University, 1950  
Specialties: Continuous-Flow and  
Hot Shot Wind Tunnels,  
Explosive Forming  
Years with Westinghouse: 9



J. McDonald  
Age: 43  
A.B., Chemistry, Engineering,  
Physics, University of California,  
1938  
Specialties: Arc Chamber and  
MHD Generator Development  
Years with Westinghouse: 13



H. C. Lee  
Age: 40  
B.S.E.E., Chiao Tung University  
(Shanghai), 1942  
M.S., Engineering, Cornell  
University, 1949  
Ph.D., Cornell University, 1951  
Specialties: Arc Chamber and  
MHD Generator Development  
Years with Westinghouse: 2



H. A. Zollinger  
Age: 30  
B.S.E.E., Michigan College of  
Mining and Technology, 1951  
M.S.E.E., University of Pittsburgh,  
1958  
Specialties: Drive Systems for  
Loaders, Elevators, Erectors  
and Launchers  
Years with Westinghouse: 9

# Westinghouse

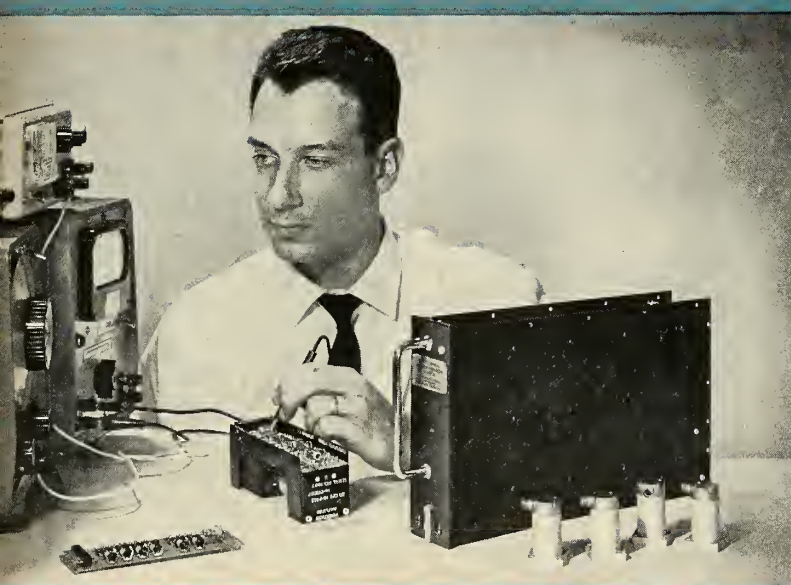


# VIBRATION

...to stop it, find it!

That's the first step. Then you've got to monitor or measure it before you can move in for fast control.

Consolidated takes you all the way in finding and measuring vibration...with an airborne system for turbojet and turboprop engines...and meters and filters for analysis of turbine engines in test cells and on run-up stands...with ground equipment that detects and measures vibration in such static industrial devices as pipelines and air-conditioning systems.



Engineer checks out airborne vibration amplifier at Consolidated Systems Corp.

## Where's your vibration problem?

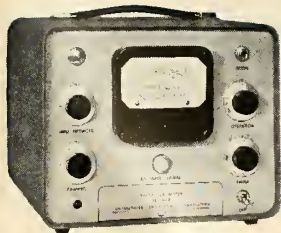
If it's airborne, consider Consolidated Systems Corp.'s vibration-monitoring system. Its transistorized design and printed circuitry assure reliability and compact packaging. The four-channel modular amplifier is easily accessible and the four CEC vibration transducers are operative to 500°F. This system requires only 5 watts.

Write for Bulletin 3011A-X9.

### FOR GROUND APPLICATIONS

CEC's portable Type 1-117 Vibration Meter is equally efficient in the field, in the laboratory and on the production line. Provides direct indications of average vibratory velocity and peak-to-peak displacement on a large, easy-to-read meter.

Write for Bulletin CEC 1538C-X1.



Transducer Division

# CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell • FINER PRODUCTS THROUGH IMAGINATION

(Continued from page 58)

Ramo-Wooldridge Inc., STL will continue to provide systems engineering of ICBM weapon systems until development is completed. Aerospace Corp. took over the supervision for new missiles and advanced detection systems.

The moon payload, a follow-up to Project *Ranger*, has no name as yet. It will be boosted by an *Atlas-Centaur* vehicle. First flight is expected in 1963. *Ranger* will rough-land a seismometer on the moon's surface about 1962. NASA officials want the soft-land payload to hit at not more than 27 ft./sec., compared with *Ranger's* speed of more than 300 ft./sec.

A bidders' conference was held at JPL on May 13. Twenty-seven companies filed bids, which were received on June 6.

## First Submerged Shot Of Polaris Near at Hand

The *Polaris* test program moved toward a dramatic climax this week as the George Washington prepared to launch the first live *Polaris* while submerged off the coast of Florida.

The test follows nearly 70 launchings of *Polaris* test vehicles beginning in 1957. The program's box score: 46 successes; 19 partial successes; four failures.

The *Polaris'* latest string of launching successes ended July 6 when a malfunction in the 15-ton missile's second stage cut short a flight from a land-based pad at Cape Canaveral.

The next day another *Polaris* veered out of control seconds after it was launched at sea from the Observation Island test ship. A range safety officer destroyed it and the broken missile fell into the Atlantic a few hundred yards from the ship.

## GE to Install Trajectory Measuring System at Cape

A \$15½-million contract for a new precision missile trajectory measurement system has been awarded to General Electric Co. by the Air Force.

The new system—called MISTRAM—will be first installed at Cape Canaveral. Additional stations will be added later at down-range island sites and elsewhere on the U.S. East Coast. The basic system is scheduled to be in operation by January, 1962.

According to GE, MISTRAM will be more accurate than any trajectory system presently available for U.S. missile test ranges. Basis for the super-accuracy of the system is a method of using phase-stabilization to correct for baseline deviations caused by changes in temperature and equipment. In addition, the system will be able to pin-

← Circle No. 46 on Subscriber Service Card.

point measuring-station locations on the earth by utilizing orbiting satellites.

A novel feature of MISTRAM is the elimination of precision tracking antennas. Signals received from the missile will be processed by a computer to determine its trajectory from derived position and velocity measurements.

## TRW Will Build Solar Power Units for NASA

A \$4.3-million contract to supply two Sunflower I solar auxiliary power units in two years was agreed upon last week by the National Aeronautics and Space Administration and TAPCO Group, Thompson Ramo Wooldridge Inc.

NASA announced in April its plan to negotiate with TRW for development of the 3000-watt spacecraft APU, designed to operate for a year within nose fairings usable on *Centaur* and *Saturn* launch vehicles. It will weigh about 700 lbs.

The system will consist of a foldable petal-type solar collector that will open to a diameter of about 32 ft. The sun's rays will boil liquid mercury, which will drive a turbogenerator to produce electric power. An energy storage unit will permit continuous operation, even when the craft is in the earth's shadow.

TRW originally estimated the cost of development at \$4.9 million.

## Getting Named Head Of Aerospace Corp.

Dr. Ivan A. Getting will be the first president of Aerospace Corp., successor to Space Technology Labs as manager of the Air Force missile and space programs.

Dr. Getting is former vice president for research and engineering for the Raytheon Co., and during World War II was director of fire control and Army radar for the Radiation Laboratory of Massachusetts Institute of Technology. He has also been Professor of Electrical Engineering at MIT.

The appointment is effective August 1.

## Broad Range of Topics Scheduled at WESCON

Workshop sessions on the wide-ranging aspects of manned-machine systems will be among the primary attractions in the technical program of this year's Western Electronic Show and Convention (WESCON).

Scheduled for Los Angeles, August 23-26, the West's big four-day electronics meeting is jointly sponsored by Institute of Radio Engineers and

Circle No. 47 on Subscriber Service Card. →

# VIBRATION

## ... detect it immediately!

First things first. You can't stop vibration until you've isolated it — and CEC produces a transducer family noted for ferreting out even the slightest hint of vibration.

Wherever unbalance is present — in engines, machinery, motors, generators and countless industrial applications — this line of vibration transducers insures fast detection, helps you get right to the heart of the trouble.

### CEC'S NEW TYPE 4-123A VIBRATION TRANSDUCER

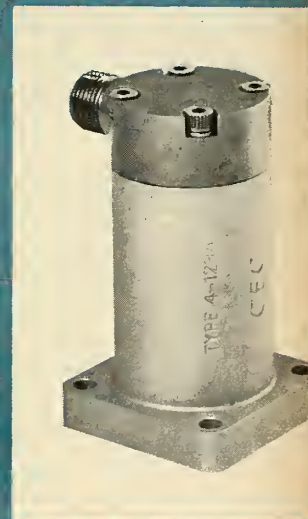
Now widely used by the aircraft and electronics industries, detects vibration instantly in operating jet engines while airborne or during ground tests. This rugged, omnidirectional transducer assures a frequency response of 45 to 2000 cps with constant damping over a temperature range of  $-65^{\circ}\text{F}$ . to  $+500^{\circ}\text{F}$ .  
*Write for Bulletin CEC 1628-X1.*

### HIGH TEMPERATURE TYPE 4-124

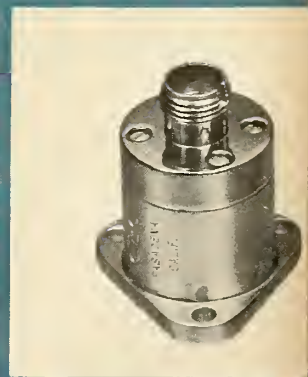
Like Type 4-123A is hermetically sealed against sand and dust, functions perfectly in oily, corrosive and humid atmospheres. When the environment is rugged, Type 4-124 operates at temperature extremes to  $+800^{\circ}\text{F}$ .  
*Write for Bulletin CEC 4124-X1.*

### CEC TYPE 4-118

Is ideal for use where space is limited or when a heavier transducer would invalidate test results. Low sensitivity to transverse accelerations and accurate performance in any mounting plane make the 4-118 desirable for mobile tests. Output may be coupled to a recording oscillograph or the unit may be used with a vibration meter or oscilloscope. *Write for Bulletin CEC 1535D-X1.*



BOTH UNITS SHOWN ACTUAL SIZE



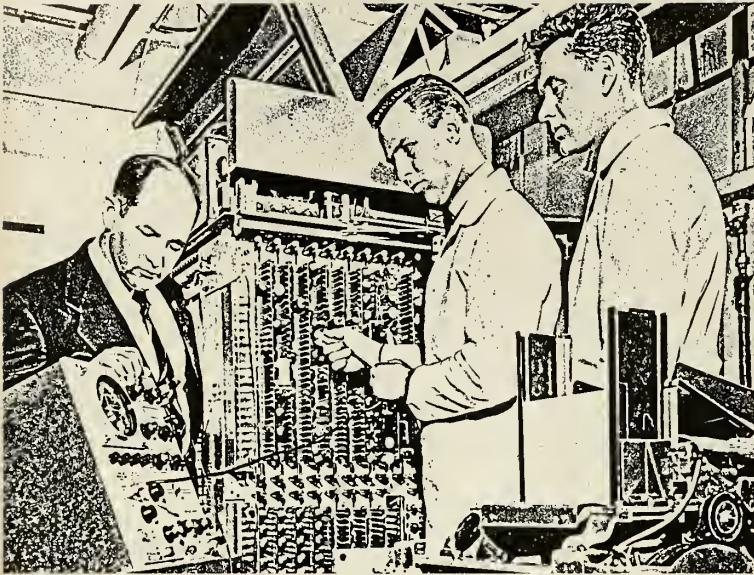
Transducer Division

# CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell • FINER PRODUCTS THROUGH IMAGINATION

AT UNIVAC ...



## An Atmosphere of Achievement

There's a fresh enthusiasm at Remington Rand Univac. The opportunity for personal progress and satisfaction has never been greater. We refer to it as Univac's *Atmosphere of Achievement*—an excellent environment in which engineers and scientists can enjoy unlimited opportunities for professional advancement.

Contributing greatly to this atmosphere are demanding programs involving extraordinary degrees of ultra-reliability. One Univac computer, as example, has logged thousands of hours while maintaining a reliability rating of 99.992 per cent.

Opportunities for participation in creative programs of far-reaching magnitude now exist at Remington Rand Univac. Included among those immediately available are:

### DEVELOPMENT ENGINEERS

To develop advanced techniques in high speed memory circuits, switching circuits, and other phases of data processing. Engineers are also required for work on communications systems, antenna couplers, and servo-mechanisms.

### SYSTEMS ENGINEERS

Engineering, Mathematics, or Physics degree with experience in weapons and missile guidance systems involving digital control, digital conversion, radar and communications information processing, and input-output equipment.

### PHYSICISTS

B.S., M.S., and Ph.D. levels for research and development of systems, high speed circuitry of digital computers, and for physical research including evaporative thin film research and ferro-magnetic domain behavior as applied to computer elements.

### RELIABILITY & QUALITY ASSURANCE ENGRS.

To perform reliability analysis and predictions, develop failure reporting procedures, analyze failures, recommend corrective action, set up and implement quality assurance programs.

### PRODUCTION ENGINEERS

To plan automated processes, methods and tooling for the world's most reliable computers. These openings on production programs require imagination and creativity. Engineering degree preferred, with experience on electronic equipment.

### MECHANICAL ENGINEERS

To design and develop miniature airborne electronic packaging which will meet severe environmental specifications.

### OTHER OPENINGS

Mathematicians and Programmers . . . Field Engineers, (Domestic and Overseas Assignments) . . . Engineer Writers . . . Specifications Engineers.

Send complete resume of education and experience to:

R. K. PATTERSON, Dept. B-7

# Remington Rand Univac

DIVISION OF SPERRY RAND CORPORATION  
2750 West Seventh Street, St. Paul 16, Minnesota

Circle No. 48 on Subscriber Service Card.



Western Electronic Manufacturers Association.

Each day's technical program will include a workshop session. Subjects to be included: Management of Manned Machine Systems (moderator: R. L. Clark, DOD); Analysis of Manned Machine Systems (moderator: Lt. Col. A. Debbons, RADD); Synthesis and Design of Manned Machine Systems (moderator: D. T. McRuer, Systems Technology, Inc.); Operation and Training of Manned Machine Systems (moderator: J. Lyman, UCLA).

The program includes 40 technical sessions on electronics and related areas with more than 200 speakers presenting papers. The preliminary schedule lists sessions on the following subjects:

Systems and maintainability; pulse-handling techniques; communications; management of manned machine systems; semiconductor devices and tubes; communication values of the technical symposium; varactors and tunnel diode applications; instrumentation; circuit theory; semiconductor devices;

Computers; stereo multiplex broadcasting; microwave theory and techniques; analysis of manned machine systems; microwave tubes; computer circuits and devices; magnetic data recording; working with engineers; vehicular communications; component and systems reliability; air traffic control;

Antennas; synthesis and design of manned machine systems; microminiaturization; government and industry engineering proposals; the *Pioneer V* experiments; bioinstrumentation systems; military electronics; information theory and modulation methods; operation and training of manned machine systems; coding methods and telemetry.

An innovation in this year's technical sessions will be a women's program on the subject, "Engineering: The Woman's Role."

## Cole Connector Uses New Alignment Principle

LOS ANGELES—A new principle for self-aligning contacts is used in a connector developed by Cole Electric Co. for ground service equipment of the *Atlas* weapon system.

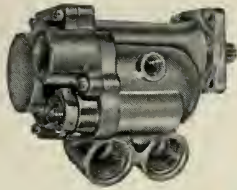
Cole has just received a production contract for the connector from Convair Astronautics.

Basic principle of the self-aligning electrical connector is that of a universal joint employing a two-ball split-sleeve design. The ball end of each contact pin mates with a split-sleeve socket that is loosely retained with another ball to form a receptacle unit.

Garter springs on the split-sleeve provide expansion or contraction of

missiles and rockets, July 18, 1960

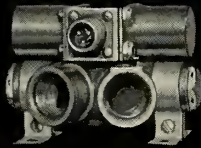




**PUMPS** — positive displacement types — wide range for handling most types of fluids, speeds to 60,000 RPM



**HYDRAULIC MOTORS** — compact — gear type / range to 30 HP / speeds to 60,000 RPM — rotation either direction.



**VALVES** — many types for many uses — hydraulic / pneumatic / manually, solenoid or pressure operated / pressures to 12,000 PSI.



**PUMPS** — positive displacement types — electric motor driven / operate on wide range of fluids / pressures to 4000 PSI.



**PUMPS** — dynamic types — submerged and line mounted — electric motor driven fluid pumps with highest V/L ratio — operate on wide range of liquids.



**PACKAGED COMPONENTS** — integrated — modular hydraulic and electrical auxiliary power supplies / electric, gas or shaft energized / missile, aircraft and ground support applications.

# ADEL RELIABILITY makes the difference

Specialists since 1938... dedicated to serving aviation in design-engineering, research and development, qualification and testing, and production backed by rigid quality control.

**PRODUCTS** HYDRAULIC • PNEUMATIC • FUEL • MECHANICAL  
ELECTRICAL • PACKAGED COMPONENTS • SYSTEMS  
**APPLICATIONS** JET AND TURBO PROP AIRCRAFT  
COMMERCIAL AND PRIVATE AIRCRAFT • DRONES  
MISSILES AND ROCKETS • GROUND SUPPORT EQUIPMENT

*write today for complete specifications*

*Products illustrated are representative of equipment now being designed and manufactured.*

## ADEL PRECISION PRODUCTS

reliability

A DIVISION OF GENERAL METALS CORPORATION  
10777 VANOWEN ST., BURBANK, CALIFORNIA  
DISTRICT OFFICES:  
MINEOLA, L.I. NEW YORK • DAYTON, OHIO • WICHITA, KANSAS



## ENGINEERS SITE ACTIVATION

We're rolling up our sleeves for the next important step of activating bases throughout the United States. Design or liaison engineers with B.S. in M.E. or E.E. and experience in electrical or mechanical systems are required for liaison work at missile launching complexes, or design support work on launch control equipment, propulsion systems, automatic programming and missile checkout equipment operations.

Assignments are at Warren Air Force Base, Cheyenne, Wyoming; Offutt Air Force Base, Omaha, Nebraska; Fairchild Air Force Base, Spokane, Washington; and in San Diego.

Please send complete resume to Mr. R. Merwin, Engineering Personnel Administrator, Dept. 130-90, 5521 Kearny Villa Road, San Diego, Calif.



**CONVAIR/ASTRONAUTICS**  
CONVAIR DIVISION OF  
**GENERAL DYNAMICS**

Circle No. 50 on Subscriber Service Card.

the sleeve to allow easy entrance or withdrawal regardless of the alignment of the pin or connector. Optimum electrical contact is assured.

Cole says the unique two-ball and socket action permits unusual flexibility, allowing the junction to be made quickly and easily even though pins may have become misaligned due to rough treatment, high shock, vibration or extreme temperature changes.

The self-aligning feature also allows angular insertion or extraction without damaging the pins or increasing pressures.

Pressures required to open or close are extremely low. Cole says a 48-contact Cole Connector using #16 pins require an insertion force of 18 lbs. and an extraction force of 15 lbs. compared to 100 lbs. and 125 lbs. for conventional connectors of the same type.

This made it possible to design the Atlas system without the use of complex opening and closing devices. Since the self-aligning contact pins can be inserted at an angle without damage, the Cole connector opens and closes like a book.

Use of this hinged action makes possible a lower weight and cheaper unit than the use of screw-on, screw-jack or power-lever types, the company says, and connection and disconnection also is faster and easier.

The unit has been built for rough use. In tests, the connector was dropped more than 5 ft. to pavement some 2000 times without major damage.

Cole reports that the self-aligning principle makes it possible to design a connector with virtually any number of contacts of various capacities. Contact pins for the connectors are available in 15, 30, 75, 150 and 300 amp. capacities and any combination of pins sizes can be used in a single connector.

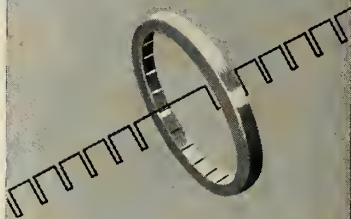
This was done in the connectors for the Atlas system, which originally called for a number of different connector designs to accommodate the many cable configurations.

Cole simplified the problem by designing just one basic connector to serve all types of cables.

### Pentagon Studying Whether Ads Are Allowable Costs

The Department of Defense is currently conducting a detailed analysis of all trade publications to determine whether or not advertising in them is an allowable item of cost under the Armed Services Procurement Act, according to a letter written by Gen. Arno Leuhman, chief of Air Force information, to the publisher of Air Force Magazine.

## Time-Sharing Problem?



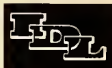
### IDL MAY HAVE A SOLUTION -

Your data handling system, whether RF carrier or wire transmission line, may require time-sharing to increase its capacity and efficiency.

In the past, the advantages of motor driven switches used for multiplexing were outweighed by their disadvantages. They were smaller, lighter and simpler but, because of high contact resistance, bounce and short life, they contaminated data.

Then IDL introduced multi-fingered brushes traveling on the inner periphery of cylindrical sections to minimize resistance and bounce and extend trouble-free life to hundreds of hours. These concepts have been successfully applied to missiles in sampling 900 data points per second for more than 500 hours without signal contamination even in the milli-volt signal level ranges.

For example, Switch No. 500660 is a complete unit within a compact case, available at reasonable cost and capable of sampling up to 180 transducers. It combines 2 poles of 30 data channels with 2 poles of 60 data channels, each operating at 5 rps.



For further information, write for Technical Bulletin No. 500660, or let us propose a solution to your Time-Sharing Problem.

**INSTRUMENT DEVELOPMENT LABORATORIES**  
INCORPORATED  
Subsidiary of Royal McBee Corporation

28 MECHANIC STREET, ATTLEBORO, MASS.

Circle No. 51 on Subscriber Service Card.



## Return from Space

The first astronauts will return from outer space in ballistic capsules with parachute recovery. The re-entry vehicles used by subsequent space travellers, however, will return to earth in controlled glides much as conventional aircraft do.

This problem of "controlled return" is undergoing intensive study at Grumman, with preliminary designs of re-entry vehicles well under way. Collateral projects include space defense weapons, orbiting astronomical observatories, manned lunar vehicles, and upper stages of booster vehicles.

For these and future studies, Grumman is building a team of space engineers and scientists with the following qualifications:

... **Navigation and Guidance.** Minimum of 5 years' experience in guidance and navigation and components for missiles and space vehicles.

... **Celestial Mechanics and Trajectories.** Minimum of 5 years' experience in celestial mechanics, missile and space vehicle trajectory analysis and related areas.

... **Communications.** Minimum of 5 years' experience in theory and design of radar and communication systems with special emphasis on radio guidance, radio and radar tracking and communication systems for missiles and space vehicles.

... **Dynamics.** Minimum of 5 years' experience in dynamic analysis, the theory of rigid and elastic body dynamics and/or the design and instrumentation of attitude control systems for missiles and space vehicles.

Send your resume in strict confidence to Mr. A. Wilder, Manager Engineering Employment, Dept. GR-86 to arrange for a mutually convenient interview.



# GRUMMAN

AIRCRAFT ENGINEERING CORPORATION

Bethpage • Long Island • New York

# Technical Countdown

## ELECTRONICS

### New Techniques for Anti-jamming

An interesting concept applied to the problem of anti-jamming protection for communication satellites is termed "graceful degradation." Aim is to have a system capable of stepped-up performance during ECM attack but to automatically lower operating requirements when the satellite is not subject to jamming.

### Yes, We Have No Communication Satellites

Most of the work in perfecting a practical communications satellite system is still ahead of us, according to F. R. Kappel, president of AT&T. Contrary to some "over-enthusiastic publicity," he says, a limited system is five years away and commercial applications about 10 years in the future, "if all goes well."

### Reliability High for Titan "Athena"

Reliability of the *Titan* guidance computer, Athena, is reported to be rated at 99.92% after over 21,000 hours of continuous operation of four models. Remington Rand Univac has just received AF contracts of over \$26 million for production of the solid-state computers.

### Ozone vs. Weather and People

An ozone analyzer being developed by Armour Research Foundation at Illinois Tech is expected to shed some light on the part ozone plays in determining atmospheric circulation. Another application is as a monitor for manned space vehicles cabins flying through the ozone layer between 40,000 and 150,000 ft. Even low concentrations of ozone (2 ppm) can cause severe lung irritation.

### Down-range Pickle Jar

A "pickle-jar navigation aid" helped a down-range telemetry ship reach its assigned position southeast of Ascension during an *Atlas* shoot some time ago. Devised on the spot by Pan Am technicians, the jar was used as a lighted buoy to determine ocean current drift during a storm that blocked out conventional navigation fixes.

### Negative Ions for Health?

A recent Air Force study demonstrates that positive ions, originating mainly from carbon dioxide, promote various harmful effects, including an increased vulnerability to trauma. Negative ions, originating from oxygen, are said to have beneficial effects. Conclusion: fill space cabins with negative ions.

## ADVANCED MATERIALS

### PH Stainless Process Licensed

Armco Steel granted a license to Republic Steel to produce and sell Armco's 17-7 PH, 17-4 PH, and PH 15-7 MO. Precipitation-hardenable stainless steels are used extensively in supersonic flight environments.

### Mach 27 Wind Tunnel in Operation

Boeing has commenced full-scale operation with a "Hotshot" wind tunnel. Hypervelocities are attained by use of electrical energy impulses equivalent to five million horsepower stored in 2280 capacitors. Temperatures up to 14,000°F and simulated altitudes of 50 miles can be reached in the 56-foot tunnel.

## ASW ENGINEERING

### Batteries vs. Rockets

Solid-fuel rockets for torpedo propulsion will have a hard time pushing batteries out of the picture. Many in the Navy feel that solids have a long way to go technically and that more money in battery research would produce the breakthrough needed to give required high-energy levels.

### System is the Thing

ASW weapons should be designed as a system, according to some manufacturers in the business. They say the Navy should decide on a comprehensive and feasible system and go to work on implementing it with appropriate vehicles and hardware.

### Drone Helicopter for ASW

A Gyrodyne *DSN-1* drone helicopter made its first at-sea landing aboard the USS *Mitscher* July 1. The experimental model is the first remote-controlled helicopter built expressly for use in destroyers. It will be used to carry homing torpedoes to kill enemy submarines.

## PROPULSION

### Agema Engine Passes Restart Tests

The Bell 8081 engine for Lockheed *Agema B* has reportedly passed a series of successful restart tests under simulated vacuum conditions. Tests were conducted at Arnold Engineering Development Center, Tullahoma, Tenn.

### Test Sled Hits Mach 3.5

A 2.5-ton monorail sled was boosted to a record velocity of 2650 mph at Holloman AFB last month. The 48-foot sled, largest ever fired at Holloman, covered 5½ miles in 15 seconds. It was propelled by three Hercules Powder Co. *Nike* boosters.

### Swan Song for X-7

Final flight is scheduled this week for the Lockheed *X-7*, a ramjet-powered test missile that holds the West's air-breathing-vehicle speed record of Mach 4.31. The program at Holloman AFB will end with this flight, the 130th. *X-7*'s have a success record of 75% in testing ramjet engines and gathering data on exotic fuels over the last 13 years.

### Research Needed to Advance Air-breathers

Research in three areas is needed to advance the high-Mach-number air-breathing engine science, speakers told an AGARD meeting in Milan this spring. The areas: high-temperature recombination rates of hydrogen-air and hydrocarbon-air; effect of shock on flow, mixing and combustion; and turbomachinery design.

### How Does a Solid Rocket Burn?

Ignition of solid propellants has been shown to occur entirely in the gas phase, contrary to a widely held technical view. So says the Air Force Office of Scientific Research. Bolstering the agency's notion is a partly developed mathematical theory of composite propellant burning based on experimental studies of ammonium perchlorate combustion.



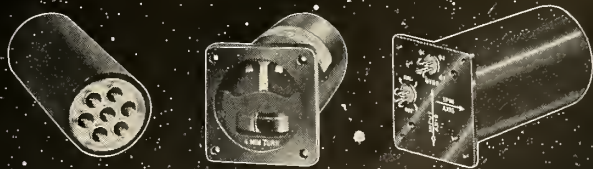
# what is R.C. Allen

It's a name, first of all, that has been synonymous for over 17 years with the production of 90% of the aircraft industry's turn and slip indicators... and for the past decade, with the production of rate gyroscopic instruments.

... it's an experienced prime and subcontractor, skilled in designing, developing, and producing LOW COST precision aircraft and missile instruments and control system components.

... and, it's a standard for dependability in meeting all contractual obligations.

Write... today... for free product and facilities data.



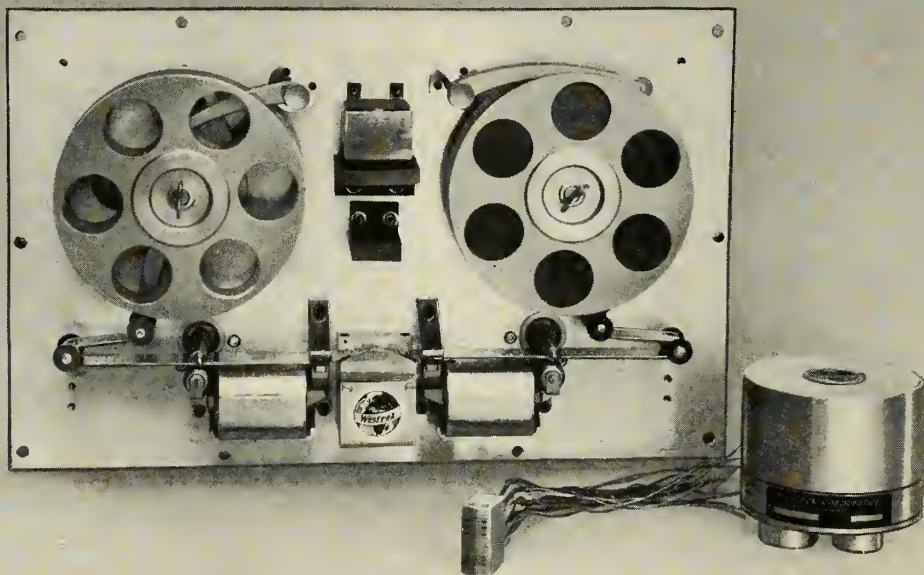
For reliable assistance on your instrumentation and component problems, contact:

## R.C. Allen

**AIRCRAFT INSTRUMENT DIVISION**  
333 COMMERCE AVENUE, S.W. • GRAND RAPIDS, MICHIGAN

# A WESTREX BRIEFING...

To your specifications for recording, storing, and recovering data, Westrex brings more than a quarter of a century of experience. Our major disciplines are (1) electronics, (2) mechanics, as needed in mechanical design for precise tape-pulling mechanisms, and (3) optics. Here, briefed, are descriptions of some of our new products...



**PERFORATED TAPE READERS** A new Westrex perforated tape reader handles 8 levels of information; reads in both directions at continuous speeds up to 1400 characters per second; stops on character at 200 characters per second. Starting time 22 milliseconds, stopping time 1 millisecond. Remote control operation and logic level output to meet your specific needs. Solid state electronics, with miniaturized etched circuit, plug-in modules. End of tape sensing by logic read out.

**MAGNETIC HEADS** These include multiple section instrumentation heads; memory drum heads; and erase-record-reproduce assemblies for applications that range from sound systems to missiles. Catalog items or custom-built units to your requirements. Our experience assures proper utilization of design factors that most economically meet your needs. Consideration of your special requirements, such as high crosstalk rejection, stability under extreme environmental conditions, and precise mechanical

tolerances, are a part of our service to customers. What are your needs?

**MINIATURE AIRBORNE TAPE RECORDERS** Designed to withstand impacts of 1500 G's, a new Westrex miniature recorder can simultaneously record and monitor 14 tracks of information. With 14 tracks to the inch, unique shielding provides a crosstalk ratio of over 40 db at 5000 c.p.s. Precise gap alignment, obtained by optical lapping methods, maintains gap scatter within plus or minus 50 microinches. The positively-driven tape-pulling mechanism, and virtually continuously supported tape, are features which reflect our unique and proprietary knowledge in this field. The entire hermetically-sealed recording unit is contained in a single cylinder 3 inches high and 4 inches in diameter.

For information on this and other Westrex products, address your inquiry to Mr. L. A. Call, Westrex Corporation, Recording Department, 6601 Romaine Street, Hollywood 28, California.



## Westrex Corporation

A DIVISION OF LITTON INDUSTRIES



# Hydrogen-LOX Development Exceeds Forecasts

- **Rapid progress of LOX-liquid hydrogen system is year's most important trend**
- **Engine hardware is area of greatest solids improvement**
- **Nuclear rocket gets firm development objective**
- **Ion engine development programs spur electrical propulsion**

An interview with Elliot Mitchell, assistant director for propulsion, Office of Launch Vehicle Programs, NASA.

The most significant propulsion trend of the last 12 months is the unexpectedly rapid progress of the liquid hydrogen-LOX system.

This is the opinion of Elliot Mitchell, top propulsion specialist of the National Aeronautics and Space Administration. He says that NASA, taking advantage of the trend, has decided to give maximum support to development of a large LOX-hydrogen engine and to exploit the system for upper stages of advanced vehicles such as *Saturn*.

Mitchell, assistant director for propulsion on the staff of Maj. Gen. Don R. Ostrander, NASA director of launch vehicle programs, declared in an interview that Pratt & Whitney Division of United Aircraft has made tremendous progress in its work on a 15,000-lb.-thrust hydrogen engine for the *Centaur* and *Saturn* programs.

"The performance of this engine, including combustion problems, has come along extremely well," Mitchell said. "The handling of hydrogen on a large scale is a lot more reasonable than any of us had optimistically hoped."

The NASA propulsion chief recalled that Rocketdyne Division, North American Aviation, was chosen this spring to develop a LOX-hydrogen engine of 200,000 lbs. thrust, more than 13 times the power of the Pratt & Whitney engine. And the P&W powerplant itself will be updated to about 17,500 lbs.

Mitchell was asked for his assessment of progress in all major propulsion areas in the last year. He ex-

pressed these opinions:

• **Storables**—The combination of nitrogen tetroxide and hydrazine-type fuels has gained momentum, he said. "If we are talking storable liquids, this combination is reasonable and provides a higher impulse."

Mitchell said, however, that not enough is known at present to endorse the use of any storable propellant system for use in space. "We need to understand theoretically and experimentally how high-energy particles affect propellants, the chamber material and their interaction."

Both NASA and the Air Force are making plans for experimental studies simulating radiation and other space environment effects on storable propellants, he added. Industrial contractors have been asked to make proposals.

Mitchell noted also that work is progressing rapidly on the *Saturn* booster and the 1½-million-lb.-thrust F-1 engine. Although no breakthroughs are involved in these LOX-kerosene engines, he said, they are great engineering jobs that are progressing very successfully.

As for *Saturn*, he said the anticipated heat problems have not been severe—"the result of a combination of good fortune and damned good engineering." He added:

"The thoroughness of the Marshall Research Center team's approach under Dr. Werner von Braun is overwhelming. It is a team effort that is a pleasure to watch."

• **Solids**—The spectacular success of the *Polaris* and *Minuteman* systems in the last year has demonstrated that large solid motors can be reduced to reliable practice, Mitchell asserted.

The area of greatest progress has been in engine hardware rather than in the propellant itself, Mitchell reported. Hardware improvements have taken place in development of high-performance cases, production of reliable, useful thrust vectoring, and termination and solution of insulation problems.

Mitchell said he does not expect any tremendous progress in the near future on improving solids except for some entirely new propellant that might come from the research sponsored by the Defense Department's Advanced Research Projects Agency. And in such a case, he asserted, experience shows that such a new fuel could not be brought into operation in less than five years.

Improvements in the near future, he said, will come from marginal increments of 5 or 6 seconds in specific impulse, better mass ratios and other little tricks.

"But as we go into systems significantly better in  $I_{sp}$ , we will find ourselves aggravating many problems that we are handling relatively simply today," he continued. "We may encounter breakthroughs we don't see today, but I feel significant gains in performance will come hard."

Another important development in solids is continuous processing, Mitchell declared. This will be the manufacturing method for any future programs based on large-volume production.

In motor case fabrication, Mitchell predicted a wider application of fiber glass and plastic, which he said has very great growth potential, both in performance and cost.

For large-volume production, steel cases probably will maintain a cost

(Continued on page 84)

# Reliability Replaces Size Reduction As Main Objective of Integration

- *Reliability is biggest advantage*
- *Cuts promised in cost, size and power consumption*
- *Integrated circuits demand integrated processes, teams*
- *Need for materials research grows*
- *New assembly and processing techniques required*

by Dr. H. W. Welch, Jr.\*

There is much speculation over the impact of recent advances in solid-state integrated circuits on the future of electronics.

Without speculation, it should be possible to review recent activity in this field and provide a measure of progress. This, subtracted from what we know we need to accommodate our present electronics capacity, should give us a less speculative idea of what remains to be accomplished.

To measure progress, we should ask, "Where have we been trying to go?"

The implication of the terms first applied to describe the integrated circuit effort—microelectronics and micro-modules—was that reduction in size was the objective.

● **Main objectives**—Recently, however, there has been more emphasis on the reliability—rather than small size—of the equipment manufactured with the new methods. Higher reliability is expected to result from reducing the numbers of interconnections and more closely controlling assembly procedures.

Ultimately, costs should be lowered through reduction in parts inventory, reduction in number of manufacturing processes, and general applicability of mass-production techniques.

Along with size reduction, there may be an increase in speed of action and a decrease in power consumption. These three factors have become important as complexity has increased in

terms both of total number of components and of number of different kinds of components. This is particularly true in data- and information-processing systems, which have increased in complexity faster than have signal processing systems.

Increase in reliability and speed, decrease in cost, size and power consumption have emerged as the real objectives we hope to achieve by new approaches to circuit construction. These, plus one other, are no different than the objectives we have had for years.

The other objective—and probably the most important—is to enable systems to perform under environmental conditions never experienced before. As a by-product of the effort we may expect systems to perform new functions in applications not previously conceived or attempted.

● **New approaches, technologies**—These objectives are being approached through greater application of solid-state phenomena and the development of closer integration of circuits.

In the past, circuits have been integrated topologically—through point-to-point interconnection of a variety of components in a readily discernible network. Now we are looking toward three basically different methods of integration in which the network is increasingly less discernible: integration by the overlapping of thin films of solids having a variety of electrical and magnetic properties; volume junctions in semiconducting, dielectric and magnetic solids; and complete molecular integration such as exists in the coupling between electron spins and the lattice in magnetic solids.

To construct integrated circuits by

these methods it has been necessary for industry to expand its capability to perform the necessary processes.

Previously, to take an extreme view, the equipment manufacturer had only one process to perform in electrical assembly: soldering. Some had developed capability for printed wiring. Other processes were performed in the mechanical packaging and protection from environment.

With the new approaches to integration, four new technologies become essential for a complete processing capability: semiconductor technology (single-crystal growth, diffusion, alloying, etching, thermo-compression bonding, etching, etc.); thin-film technology (evaporation, sputtering, pyrolysis, masking, surface cleaning and preparation, etc.); electronic ceramic technology (mixing, extruding, pressing, firing, annealing, glazing, grinding, etc.); and solid encapsulation technology (chemical preparation of glasses, deposition of inorganic, non-metallic solids, surface preparation, annealing, etc.).

Along with these process technologies, the measurement of basic electrical properties of solids—conductivity, dielectric constant, magnetic permeability and environmental testing—must be accomplished in order to know that a process has been successful. In addition, means for internal examination of solid-state characteristics such as crystal structure, diffusion depth, impurity concentration, grain structure, etc., must be available.

Most important, does the resulting circuit have the electrical characteristics to perform the functions for which it was designed? In other words, could it be designed in the first place

\**Director of Research and Development, Military Electronics Div., Motorola Inc.*



and is it reproducible from written process specifications and drawings? This question must be answered by and to the satisfaction of the systems and equipment engineers with their methods of measurement from the terminals of the resulting circuits.

• **Teamwork required**—Integration of processes leads to the need for integration of people into a team. Chemists, physicists, electronic engineers, electromagnetic engineers, mechanical engineers, metallurgists, ceramicists, and techniques highly skilled in vacuum techniques, evaporation, heat treating, chemical processes, and such, must work in close communication as a team to accomplish the end result.

This is borne out by the observation that any completed circuit is so closely tied together mechanically, thermally, and chemically, as well as electronically, that diagnosis of a malfunction might involve any or all of the mentioned disciplines.

The interconnected components approach has led to specialists in resistors, capacitors, transistors, inductances, insulated wire, etc. The integrated-circuit integrated-process approach requires close integration into a team of people with the same special qualifications.

### Where We Stand

Now that we have established a yardstick against which progress can be measured, let us see how far we have progressed.

Most significantly, for the first time in the history of electronics, a number of teams of scientists and engineers have been established with the common objective of building electronic systems from the basic solid materials rather than components made by specialists. Ten to 15 such teams exist within the broad spectrum of disciplines mentioned above. The average size is from 20 to 30 qualified scientists and engineers.

My estimate would be that between 300 and 500 scientists and engineers have been assigned to this effort and that less than 15% of these are electronic circuit engineers. This concentration of effort is bringing a refreshing new look into the electronic industry.

• **New discoveries**—Integration of processes has brought many of our solid-state scientists closer to the application with the result, surprising to some, that they are discovering problems of basic nature that they did not know existed. Electrical properties of thin films such as conductivity and dielectric constant are better understood, as are chemical and physical properties such as effects of impurities and vapor pressure.

Chemical interactions between masks, substrates, and circuit elements not isolated physically from one another have been discovered and eliminated by changes in processing techniques. Better control of processes of deposition, diffusion, alloying, crystal growth, surface preparation, etc., has been achieved. New methods for performing these processes have been developed. Crystal growth by the dendritic process, through constraining apertures, and by the epitaxial process is better understood. Each of these methods lends itself to the integrated-process approach to circuit construction.

The suppliers of electronic materials are having demands placed upon them for higher purity and better particle size control. Quantities are still not large enough to make the chemical industries really excited, but they are cooperating.

The semiconductor industry—in addition to looking at new approaches to crystal growth—has developed methods for placing more than one transistor or diode in one semiconducting substrate and have added resistance and capacitance within the same substrate to make complete circuit functions.

• **Adding materials**—Much attention has been given to deposition of tin oxide and high-resistivity metals, and the anodization of tantalum for resistance elements. All of these approaches meet the high designability and reproductibility criteria. Anodization of tantalum and deposition of quartz have met the same criteria for the formation of dielectrics. Conducting and magnetic metallic film deposition has reached a high degree of maturity.

Preparation of ceramic, glass, quartz, beryllia, and alumina substrates is now better understood. Problems of smoothness, cleanliness, and shape control still exist. Substrates other than semiconductor suitable for epitaxial growth of semiconducting solids remain to be found.

Solid encapsulation at low temperatures with glass and inorganic solids of more regular crystalline structure has been achieved but not brought to a high degree of maturity. Organic encapsulants suitable for long-life application have not been developed.

• **Searching for shapes**—A generally acceptable solution to the problem of interconnection and packaging of subassemblies of integrated circuitry has not materialized.

It is generally agreed that modules with more than one circuit element per substrate are desirable. The upper limit will be determined by a complex compromise of factors such as yield per process, yield per module, encap-

sulation and packaging, replacement frequency and expense, deterioration due to chemical interaction, tooling costs, quantity to be manufactured, etc. It is unlikely that a single standard module shape will be accepted.

The hybrid approach of combining integrated circuits with more or less standard components is beginning to be generally recognized as necessary for immediate application. This is particularly true where precision resistors, high selectivity, flat response over precisely determined pass bands or impedance transformation are needed.

We have established teams and developed and improved processes. What has actually been accomplished in the development and manufacture of integrated circuits? I prefer not to answer this question but would like to give the reader a check list which may provide a sobering as well as a challenging influence.

The following is a list of functions presently performed in electronic equipment over a frequency range from d-c through microwaves, over a wide range of power levels, and over wide environmental extremes. This list is reasonably complete in that almost any electronic equipment can be built if all functions can be accomplished.

- Frequency generation
- Pulse generation
- Amplification
- Rectification
- Impedance transformation
- Radiation and absorption (antennas)
- Attenuation
- Frequency modulation
- Phase modulation
- Amplitude modulation
- Electromagnetic signal detection
- Electromagnetic signal mixing
- Electrical-to-light conversion (and vice versa)
- Electrical-to-heat conversion (and vice versa)
- Electromechanical conversion (and vice versa)
- Frequency discrimination
- Pulse counting
- Isolation and circulation (unilateral attenuation)
- Amplitude limiting (function generation)
- Bandwidth limiting (filtering)
- Analog addition and multiplication
- Digital addition and multiplication
- Long and short-term signal storage
- Tuning or control of other functions (frequency, bandwidth, attenuation, etc.)
- Frequency multiplication or translation

(Continued on page 86)

# Notable Gains Made in Gyros, Microelectronics

- **Technology is keeping pace**
- **Hardware progress in gyros**
- **Impact of microelectronics**
- **Lagging accelerometer development**
- **IR scanner accuracy needs improvement**

by Charles W. Benfield\*

Development of new and better techniques and equipment for space navigation and guidance has received noteworthy attention during the past year. Seldom have so many attacked a technical problem with so much vigor, enthusiasm, and ingenuity.

The year witnessed some significant hardware progress in gyros—the primary element in precision and reliability in space guidance.

Minneapolis-Honeywell announced start of production on a gyro with a ceramic, self-generating gas spin-bearing. This instrument is 2.75 in. long, 2.182 in. in diameter and weighs half a pound. The company claims a factor of 10 improvement in accuracy and a 30:1 reduction in bearing noise over the gyro's MIG predecessor. The precisely balanced rotor is suspended in its ceramic bearings on a film of gas only 25 micro-inches thick—yet stiffer than the steel ball bearings it replaces.

Jet Propulsion Laboratory is conducting development work of a more exotic nature. A precisely machined sphere, coated with superconductive metal, is supported on a magnetic field at cryogenic temperatures. Thus de-coupled from external torques, the spin axis of the sphere remains fixed in inertial space like the axes of the planets themselves.

Achieving the same result in a different approach, Minneapolis-Honeywell experimentally proved the feasibility of electrically suspending a beryllium sphere in a vacuum. A major program is underway to bring this radi-

cally new gyro into production for a shipboard inertial navigation system for *Polaris* submarines. Its applicability to space guidance systems is also being extensively studied.

This device and the JPL cryogenic gyro both hold promise for orders-of-magnitude improvement in accuracy and stability over conventional gyros.

General Electric announced development of a cryogenically suspended, spherically symmetrical rotor wheel spun up by torque coils located in its cylindrical, axial cavity and suspended on a spherical array of magnetic bearings in a vacuum chamber. An experimental cylindrical rotor was spun up to 20,000 rpm with coast-down time of 16 hours. While similar in principle to the JPL gyro, the GE device will be a different configuration, and may possibly have some unique advantages.

Accelerometer development was lagging a bit; there were many exotic dreams of cryogenically or electrically levitated seismic masses, gaseous inertial masses and "chemical" accelerometers—but little new hardware forthcoming. Still dreamed of is a  $10^{-15}$  g threshold sensor for observing minor forces. JPL is developing a miniature quartz pendulum accelerometer.

• **Some leaps forward**—Microelectronics development is paving the way toward realization of the extremely complicated, super-reliable, electronic brains for automatic guidance of space vehicles.

Progress in this area took a surprising forward leap with a number of feasibility models by Westinghouse, including a button-sized, five-watt audio amplifier and a video amplifier dwarfed by a paper clip. RCA's micromodule program has produced working models

of whole devices based upon stacks of 0.310" square by 10-mil thick ceramic wafers. Such techniques offer equipment component densities of 250,000 parts per cubic foot. Texas Instruments advertised off-the-shelf availability of a match-head-sized multivibrator.

Microelectronics development programs are well under way at General Electric, Bell Labs., Clevite, Sylvania, Pacific Semiconductor, Fairchild Semiconductor Corp., Philco, Transiron, Honeywell, and many others. As usual, much unpublicized basic research at government laboratories is behind such industrial progress. Talk of  $10^{11}$  components per cubic inch is occasionally heard from the more optimistic participants in serious discussions on the subject.

• **Hardware to come**—Determination of "local vertical direction" and altitude above a planet by infrared is under study by many laboratories. Several horizon scanners have reached the hardware stage, and many disk scanners are on the drawing boards. Present accuracies leave much to be desired.

Hardware solutions are required in this problem area, before a space craft can be brought to a safe landing upon a strange world. The problem of measuring vector velocity relative to a planet is receiving much theoretical attention at JPL and elsewhere.

Star trackers now have over ten years of progressive development behind them, and many companies are studying their adaptation to space navigation. Accuracies to one arc-second are expected to be achieved in working hardware.

IBM and American Bosch Arma have announced progress in miniaturization of high-speed digital computers for space navigation. Both companies are expected to make considerable use of microelectronics developments.

Philco's Dr. Goley has proposed using radio interferometry for accurate distance measurement in deep space.

The Navy's *Transit* satellite program gives excellent promise for a payoff from the space efforts by providing a high-accuracy, all-weather navigation scheme for vehicles on or near the earth's surface. This program is progressing very well indeed; eventually the doppler techniques developed may be applicable to near-earth guidance of spacecraft.

High-precision ground-based radar, working with space-borne transponders, is receiving much attention for tracking and for injection guidance, particularly for near-earth and cislunar operations. It is to be expected that the first manned lunar flights will be closely tracked by radar and notified of their position and velocity by radio.

\*Systems development engineer, Minneapolis-Honeywell Regulator Co., Military Products Group

# TCM Moves Into Missile/Space R & D

- **Extended range and measurement capabilities**
- **New techniques for space**
- **Low-level multiplexing**
- **Hybrid-systems investigation**
- **New components and subsystems**

by Conrad H. Hoepfner\*

Telemetry advanced at a faster rate during the past year—and its applications received greater publicity than ever before.

Foremost among the year's accomplishments were extended range, greater numbers and varieties of measurements, and development of more efficient systems.

Transistorization of telemetry receivers is now almost complete, providing greater compactness and reliability.

Pulse code modulation telemetry—already well established in static testing, data reduction and sled tests—has been used for the first time in space vehicles. It is in production for two major missile programs: *Minuteman* and *Titan*. The first PCM ground receiving station for missiles has been installed at the Atlantic Missile Range, following installations for aircraft testing at Edwards AFB, Norair, Douglas and Republic.

PCM telemetry is unique among data handling systems in that it employs "computer language." Data, as it is received, is in a form for direct entry into digital computers for further processing, computations, corrections, plotting and printing. All of the bugs are not yet worked out of these telemetry systems; and advanced PCM system is still under development for Wright-Patterson AFB.

• **Biggest boost**—Probably the most significant adjunct to PCM telemetry systems has been the low-level multiplexer. While this device is not limited in its applications to PCM methods, it is a logical companion to the PCM voltage encoder.

Prior to the development of the low-level multiplexer it was necessary to use an amplifier following each low-level transducer of the thermo-

couple, strain-gage and resistance-bridge types. These made equipments large, power-consuming and difficult to maintain.

There are now 11 low-level multiplexers in data-processing systems in operation in the Thiokol Utah plant. These operate to a resolution of ten microvolts and a full-scale of ten millivolts. They are subject to errors caused by temperature changes and vibration, but are being developed to appear soon in aircraft and missile test programs.

• **The new challenge**—Telemetry has been forced to expand its scope to accommodate the new demands for scientific data. Mainly used heretofore for measuring temperatures, accelerations, positions, motions, and electrical characteristics internal to missiles and aircraft, it is now being employed to explore space.

The measurement of radiation density, ion density, atmospheric composition, visible and ultra-violet light, magnetic fields, particle impacts and the transmission of photographs, have required new transducers and also new data conditioning equipment to "normalize" the measurements for transmission over telemetry links.

There have been new demands on the telemeter for handling greater quantities of data with greater accuracy over longer distances. In many cases this has led to pre-transmission processing and reduction of data.

• **Thinking revolution**—A three-year comprehensive study of telemetry methods and systems sponsored by the Department of Defense has been completed. This study was unusual in the fact that measurements were made to decide upon controversial assumptions for calculations. Many of the results revolutionize thinking along certain lines and have revised previously established standards.

A conclusion of the report was that a combination pulse amplitude modulation and pulse code modulation system would prove most useful for

future military test applications. The PAM portion would be used for low-accuracy data and the PCM high-accuracy data.

Needless to say, such a system is not now in use; its advent would make obsolete many millions of dollars worth of telemetry equipment now installed in test sites throughout the country.

Other noteworthy developments:

• The Teletbit system of variable bit rate, allowing exchange of information speed for transmission distance.

• Wide-band recorders for recording on magnetic tape the greater information rates provided by modern telemeters.

• Use of large receiving antennas even at high frequencies to enhance the telemetry signal. One system at Vandenberg AFB employs omnidirectional direction-finding antennas used in conjunction with extremely narrow band receivers to point the large telemetry antenna in the proper direction—a problem which becomes more serious as the size of the receiving antenna is increased.

• Use of light diffraction and optical filters to simulate electrical filters employed in data separation, interpolation, and extrapolation. An extremely precise filter characteristic is applied to a very large number of data channels by a relatively small and simple device. Methods are being explored to permit its use in actual data systems.

It is also heartening to note the gradual infiltration of government-developed telemetry techniques and equipments into American industry. The dissemination of information about telemetry is much slower, however, than the passage of information through the telemetry system.

Telemetry has moved in to investigate the destructive effects of wind-induced vibration to electrical transmission lines and telephone lines. Applications to mobile equipment, rotating equipment, flaw-detection and sensing portions of industrial process control are just beginning.

One of the leaders in the military telemetry field, for instance, has entered into a royalty agreement which permits a newly formed commercial organization to apply its developments to industrial applications. Equipment developed by this company will be supplied to the electric utility industries and to the medical field.

\*President, Electronics Corp., Chairman, IRE PGSET, and Member of M/R's Editorial Advisory Board.

# Range Accuracy Poses New Challenges

- **New guidelines for progress**
- **Microwave systems**
- **New frequencies, techniques**
- **Improved equipment**

by **W. C. Wootton, Jr.**

*Secretary, Inter-Range Instrumentation Group*

NEW GUIDELINES established during the past year set the stage for future developments in telemetry and range instrumentation. It is evident that although significant progress has been made in the recent past, the most significant is yet to come.

The final report of the Aeronutronic telemetry study, released in early 1960, provided industry with the guidance it had awaited.

And another important direction developed in May, when the 1435-1535 mc radio frequency band was endorsed anew for missile telemetry used by the Inter-Range Instrumentation Group (IRIG) and Aeronautical Flight Testing and Radio Coordinating Counsel.

● **Pulse code modulation**—To meet the need for increased accuracy and more efficient operation, PCM telemetry systems are being developed. Many of these, especially those for Air Force projects, have unique characteristics and do not meet standards recommended by the Aerospace Industries Association or IRIG for PCM telemetry systems. Picatinny Arsenal and several others, however, are developing standard PCM systems for use on the missile test ranges.

Contrasting the PCM developments are several systems being developed to instrument the *Saturn* booster. One of these is a 216-channel PAM-FM-FM system. The other is a frequency deviation system with a high data bandwidth capacity.

Pulse amplitude code modulation (PACM) as opposed to PCM was recommended in the Aeronutronic study report for future missile telemetry operations. In this system the PCM signal is amplitude modulated with additional channels of analog data. Size and weight are slightly greater than that of a PCM system alone, but efficiency is increased without appreciably changing the radio-frequency requirement.

PAM channels are used where requirements exist for medium accuracy (1% error) analog channels. The PCM channels are provided to meet high accuracy requirements or where it is desired to use digital techniques. It is believed that variations of PACM-FM will effectively meet the majority of future missile telemetry requirements.

● **Microwave systems**—The need to move missile telemetry operations out of the VHF telemetry band (216-260 mc) by 1970 has prompted work on systems that would operate in the microwave frequency region. A development model of a 2200 mc transmitter was built recently by General Electronic Laboratories under an Air Force contract. Another airborne unit

designed to operate at 2200 mc was built by Spectralab Instrument Company and turned over to the contracting agency at White Sands Missile Range for evaluation.

While these recent developments have been encouraging, even greater hope is held for the 1435-1535 mc band where airborne package size can be reduced. It is believed that developments in these microwave bands must be continued at the fastest possible rate if a reliable and operational system is to be available by 1970.

Ground station equipment compatible with the new airborne units is also being developed. Examples are the fabrication of a 2200 mc traveling-wave maser capable of being mounted on the rear of a parabolic dish, and Radiation, Inc.'s development of a 2200 mc correlation detection receiver.

● **Receivers, antennas, and transducers**—Several of the national test ranges have sponsored receiver improvement programs and emphasized the development of optimum capability for PCM and time-multiplexed signals. Since much effort has already gone into receiver front end improvement, emphasis is now being placed on the detection process.

A number of automatic tracking antennas have been developed to meet the growing need for this type of antenna in both space and missile testing. These generally have relatively high gain and can be used as acquisition aids to other instrumentation systems, in addition to their use in the telemetry system.

A Users' Symposium on Telemetry Transducers was held for the first time this past year, to review transducer development effort, both in the United States and abroad. It was apparent from this meeting that additional effort was needed to standardize transducer terminology and to establish calibration and testing procedures. To this end the National Bureau of Standards Telemetry Transducer Group has been working to develop test methods for dynamic testing of transducers, while Wright Air Development Division has been working to standardize testing and calibration procedures.

● **Studies and reports**—Many study and evaluation reports on telemetry have been released recently. These include "The Case of FM-AM Versus FM-FM Telemetry" by Dr. L. L. Rauch, for Wright Air Development Division; a number of reports by Naval Ordnance Laboratory at Corona; a number of Naval Air Development Center reports; and an IRIG Recommendation, No. 101-60, "Magnetic Tape Recorder/Reproducer Standards for Telemetry Applications."

# AF Does Something About Reliability

- *Reliability and maintainability biggest challenge*
- *New programs for configuration control, commercial equipment use, calibration standards, understandable maintenance data*

The Air Force in the past year has been doing something about those much bandied-about words in Ground Support Equipment—reliability and maintainability. This is the word from the Aircraft and Missiles Division, Chief of Staff for Materiel.

It's being accomplished through new and strengthened programs in configuration control, buying commercial equipment when it will do the job, setting up calibration standards, and getting technical data for the field maintenance airman in a form which he can understand.

Within the past two months, even a definition of GSE has been adopted to take some of the confusion out of the many terms used in the field.

Since management problems are often best resolved by the application of management techniques rather than by developing new definitions, Air Force has settled on this GSE definition:

"Any or all implements or devices which are required on the ground to make a weapon system, support system, control system, sub-system or equipment operational in its intended environment. This includes all equipment required to install, launch, arrest, guide, control, direct, inspect, test, service, adjust, calibrate, appraise, gauge, measure, repair, overhaul, assemble, disassemble, handle, transport, safeguard, record, store, actuate, maintain or operate the system, sub-system, end item, or component. This definition applies regardless of method of development, funding or procurement."

● **Maintainability through standardization**—With the end goals of using less manpower, fewer tools and the minimum in supplies and logistics, Air Force is striving for optimum standardization of ground support equipment, realizing that in many instances full standardization is not possible.

Such optimum standardization

holds true for the whole gamut of GSE—transport/erector vehicles, materials and fuel handling equipments, launchers, electronic check-out and data processing systems.

With more standardization, Air Force feels better maintainability will be the result. With this working philosophy, many directives and instructions are being pointed toward the design engineer to have him design equipment which can be maintained with minimal effort and cost.

In this effort, Air Force is practicing what is termed configuration control. For example, it doesn't want 100 fork lift trucks of five or more configurations, but rather, 100 of the same configuration.

This, in turn, has led to increased purchasing of commercial equipment when available without designing new varieties. For instance, in recent months the trend has been to get away from using military engines in some vehicles and purchasing commercial types when available.

● **Boiling down data**—In the complex GSE field, Air Force is also taking a long hard look at contractors' preparation of technical data for equipment maintenance.

"Our fault is that we've gone overboard with an excessive amount of data and have lost sight of the man who must use this data to maintain a particular piece of equipment," one officer commented. Biggest problem is to get the data out of the PhD class, and make it simple, readable and understandable.

Previously, Ballistic Missile Division had responsibility for technical data in the missile programs. It has now been moved to Air Materiel Command, which is reviewing all specifications and formulating revisions to make it more usable in the hands of the technician.

● **One system of calibration**—In still another area—calibration support for missile systems—the Air Force has realized there has been a lack of uniform action in the establishment of calibration and repair facilities for base precision measurement equipment, particularly with respect to the support of contractors during the installation and checkout phase.

This has been because separate contractor facilities have been established at some missile bases while, at other locations, Air Force commands had made arrangements for the base calibration facility to be used in support of the contract.

The Air Force accordingly has ruled that the establishment of separate missile base contractor installation and checkout facilities for calibration and repair of precision measurement equipment is not in its best interests and will result in unnecessary expense.

So the Air Force's calibration system, rather than separate industrial systems, will be used exclusively. One reason: the Air Force feels that its operating personnel can get valuable experience and training when they recognize the exact calibration needs of a particular weapon system at an early date.

Further, a single source for standards of known accuracy with respect to the National Bureau of Standards will be available. Since the same source will be used during and after installation and checkout phase, no post inspection-and-checkout phase operational difficulties should arise due to differences in contractor-versus-Air Force calibration systems.

In one ballistic missile program, Air Force discovered that the unusual large amount of R&D GSE left over when phasing into the operational system required some 13,000 calibrations. This has since been reduced by some 40%.

# Foundation Research Speeds Ideas for Navy

- *BuWeaps program stimulates scientists*
- *Eliminates ponderous decision processes*
- *Makes individual responsible—and saves money*

by John F. Judge

The Navy is cultivating Missile Age ideas through a unique, red-tapeless program—Foundation Research.

Initiated about 10 years ago in the old Bureau of Ordnance, the program spread to the Bureau of Aeronautics in 1957. Since the two bureaus merged to form the current Bureau of Weapons, the Foundation has become an \$8-million-a-year idea mill.

Bureau officials couldn't be happier with the results.

The original objective was twofold—to give the individual station money to exploit the promising ideas of its employees, and to create an attractive working atmosphere. Both purposes are being fulfilled.

The effect on the morale of the scientists is reflected in the high retention rates of the various laboratories.

Originally the funding was allocated as a definite fraction of the annual budget of a particular station. Now money is distributed in proportion to the possible contributors of new ideas. The amount is still less than 5% of a station's total budget.

Each station involved in the program administers its own funds.

● **Streamlined routine**—In operation, the program begins with an idea or a suggestion from an individual. The proposal is submitted to a small board composed of the installation commander, the chief scientist, and the laboratory, or project directors.

The proposal is rated for merit; if it is approved, initial funds are allocated for the program and the scientist goes to work. Many such projects are subsequently removed from the Foundation and funded under supporting research. Still others begin and end within the Foundation—supplying needed information and data for pres-

ent or future use in allied fields.

For a long time, no formal reports were required. But they were encouraged—for fiscal ammunition if for nothing else.

The bulk of the projects are basic in nature. Some, which concern weapons systems, are classified, but the majority are published in various forms.

Foundation research led to over 300 such published papers from the Naval Ordnance Laboratory at White Oak alone.

One classic idea resulted in the air-to-air *Sidewinder* missile. Another, now being pursued at the Naval Air Material Center, Philadelphia, has attracted national interest. M. J. Devine's work in solid film lubricants is being closely watched by both government and industry.

Computers are being redesigned or created from scratch. The miniaturization of antennas is another fruitful area.

A striking example of the effectiveness of the Foundation Research idea is the current program at the Naval Air Materials Center. In one year the grants there rose from \$41,000 for three projects to \$310,000 for 15 projects.

The wide range of disciplines involved can best be illustrated by describing some of the areas covered by the researchers.

● **Statics and dynamics of fluids**—to provide a theoretical basis for the solution of hydraulic, hydrodynamic and gasdynamic problems.

● **Hydrogen embrittlement**—knowledge of the mechanisms problems of hydrogen embrittlement and the embrittling characteristics of a deuterium bath.

● **Plastics, elastomers and fibers**—research and development of organic

metal-cordination polymers possessing exceptional thermal stability, gamma radiation resistance and strong mechanical properties.

● **Solid film lubrication**—Determination of the mechanisms by which metal surfaces are lubricated by solid films and to provide a definite working theory. Investigation of lubricity as a function of solid structure, particle size, film hardness and lubricant-bearing reactivity. This is the study that aroused national interest.

● **Radiant heating**—Determine the effects of infrared heat on the structural efficiency of aircraft and missile components and to correlate the laboratory and flight test effects with true aerodynamic heating.

● **Brittle metal effects**—Determination of the role of oxygen in the brittle behavior of metals. The study is aimed at understanding the effect of such behavior in the refractory metals.

● **Energy absorption**—Obtain fundamental information on energy absorption materials for the general purpose of improving the state of the art. There are an increasing number of developments in which, if energy is added to a device, a certain portion of this energy is absorbed or reconvered at the end of the cycle. *Polaris* missile recovery is one such development.

● **Heat**—Developing methods for measuring the heat of interior and exterior surfaces of aircraft and missiles undergoing constant changes in heat conditions and thermal shock. This study is directed toward answering a need for heat measurements under materials such as fiberglass, ceramics and thin specimens of honeycomb construction.

● **Strain gages**—Definition of the areas of future effort in the elevated strain gage field.

● **Polyamide polymers**—effects of exposures to ionizing, ultraviolet and thermal radiation.

Besides NAMC and White Oak, stations included in the program are: Naval Ordnance Testing Station, China Lake, Calif.; NOL, Corona; Naval Weapons, Dahlgren, Va.; NUO, Newport, R.I.; NAL, Johnsville, Pa.; Naval Missile Center, Point Mugu, Calif.; and the David Taylor Aerodynamics Laboratory near Washington, D.C.

Expenditures involved are small in comparison to the net worth of Foundation Research. Dr. Edward S. Lamar, Chief Scientist, Research, Development, Test and Evaluation, BuWeaps, points out that no good ideas ever came from a full stomach. The basic principle is to keep the researchers a little hungry—and emphasize brain-power rather than chrome-plated equipment.

# Augmented Field Ready to Expand

- **USAF, NASA, industry boost the science**
- **Solar flares found hazard to space travel**
- **Instrumenting animals for flight tests**
- **'Bathtub' research on weightlessness**

by Lt. Col. David G. Simons  
and Dr. Hubertus Strughold\*

A firm groundwork has been laid for an expanding aerospace medical activity during the past year. On three fronts—military, civilian and industrial—new organizations have been created or augmented and put into operation.

Organized this past October, the Air Force Aerospace Medical Center, located at Brooks AFB, San Antonio, united under one command USAF's School of Aviation Medicine, Epidemiological Laboratory and the Medical Service School. This integrating move shows the growing importance of aerospace medicine to the Air Force. Further evidence is that Congress has authorized an \$8-million building expansion program at the facility.

In the same vein, it is notable that early this past March the Office of Life Sciences was created by the National Aeronautics and Space Administration. Heading it is Dr. Clark T. Randt.

This office formed the fifth major division of NASA and ranks equally with the offices of space flight programs, launch vehicle programs, advanced research programs, and business administration.

The ambitious program of research in all aspects of space biology and medicine outlined by Dr. Randt for his office is matched by the decision of most major aircraft companies to establish a space medicine research group. Thus the growing base of space medicine research is being widened further by the appearance of such groups in Boeing, Martin, Northrop, North American, Douglas, Lockheed, Convair and Chance Vought.

● **Solar flares a problem**—Satellite, balloon and space probe experiments have clarified the radiation hazards to

\*Col. Simons is chief of the Bio-astronautics Branch, USAF School of Aviation Medicine. Dr. Strughold is Professor of Space Medicine and Advisor for Research at USAF Aerospace Medical Center, and an M/R advisor.

be expected in manned space flight. It is known that the core of the inner Van Allen radiation belt maintains a steady radiation intensity. *Explorer VII* has now clearly demonstrated the variable nature of the outer Van Allen belt. This variation was particularly evident for the ten days following the large magnetic storm of this past March 31.

Early this past spring, many exciting results significant to space medicine came from *Pioneer V*. The vehicle was about five million miles from earth and it was a time of intense solar activity. It was learned, for example, that the well-known cosmic radiation disturbance called a "Forbush decrease" occurs on a solar, or galactic scale. It is clearly unrelated to terrestrial influences.

This finding serves warning that variations in cosmic radiation intensities may occur during space flight, resulting from galactic disturbances encountered by the sun in its path through interstellar space.

Balloon studies conducted over Minnesota together with the *Pioneer V* data confirm the growing suspicion that solar flares represent a major radiation hazard during interplanetary travel. In order to reduce a "typical" flare exposure to an acceptable 10 Rem (roentgen equivalent man) within a four-foot radius living compartment would require a calculated 10,000 pounds of carbon.

From an early report from *Pioneer V* it was discovered that a ring current of about five million amperes circulates at a distance from 7 to 13 earth radii from us. This current represents a radiation hazard of undetermined magnitude. However, the likelihood that the current is composed of low energy particles is encouraging.

The Russian *Lunik II*, which approached the moon last September, reported no radiation belts corresponding to the Van Allen belts surrounding the moon. This is good news to prospective space travelers.

● **Monkeys instrumented**—This past December, NASA's *Little Joe* rocket

flight to test the *Mercury* capsule recovery system under the most adverse dynamic flight conditions included two SAM monkeys. The subjects were painstakingly instrumented through several techniques new to space flight animal experimentation.

An eye-motion detector which sensed the changes in voltage distribution resulting from eye motions recorded the occurrence of nystagmus—the sweeping eye motion produced by motion sickness and other disturbances of equilibrium. These sweeping motions were observed during the period of high accelerations which occurred in all three axes during the emergency escape phase of the test flight. These continued through the short 20-second interval of weightlessness.

The psychomotor task test, which required the animals to pull a lever in response to a flashing light, showed a marked loss in performance during the acceleration and weightlessness phase. The vectorcardiogram, an advanced technique for indicating the electrical vector forces produced by the muscular contractions of the heart, revealed significant changes during the same acceleration and weightlessness phase.

● **Two-man crews okayed**—The initial run of SAM's two-man space-cabin simulator in March confined two Air Force volunteers in a reduced-pressure, oxygen-enriched atmosphere. They were completely isolated for a 14-day period. It was found that the important weight-saving measure of distilling waste water for all non-drinking purposes proved acceptable and practical.

The experiment also showed that the assumed rates of water loss through respiration and sweating under reduced pressure conditions are significantly in error when applied over this period of time.

The usually proposed nutritional energy requirements of approximately 3000 calories per man per day appear to be significantly lower, approximately 2200 to 2500 calories.

The fact that no major psychological disturbances were observed points to the feasibility of two-man crews for space missions of durations on the order of two weeks. Crews of this size are desirable for work scheduled and mutual emotional support considerations.

A major question concerning the  
(Continued on page 92)

# A Crisis in Electronics Standards

*Meeting sponsored by NBS and AIA notes emergency created by lack of standards for higher frequencies and begins search for answers*

Lack of national electronic standards for new higher radio frequencies is causing confusion, excessive delays, and loss of money for both industry and the national defense program.

This was pointed out at the recent 1960 Conference on Standards and Electronic Measurements at National Bureau of Standards Boulder Laboratories by Lloyd B. Wilson, chief of the primary standards lab of Sperry Gyroscope. He said that military needs and the space program are requiring accuracies of measurement unheard of a few years ago and for which calibration instruments do not exist.

The Conference is the first of a series of measurement research conferences between industry and NBS initiated by Aerospace Industries Association to probe each field of measurement in depth to determine which needs are most urgent and how they might best be met.

The AIA-NBS conference was the first to provide a discussion of mutual problems between the men who develop electronic standards and those who use them. Industry personnel rep-

resented firms who had indicated that they particularly needed better standards for measuring microwave power and attenuation. NBS representatives included project leaders and section chiefs who are responsible for developing standards and measuring methods and providing calibration services.

As revealed at the conference, NBS Radio Standards Laboratory has made dramatic progress in developing new standards. Examples: A technique for measuring small attenuations to accuracies exceeding one ten-thousandth of a decibel and a microwave standard of power at X-band frequencies that has been the world's most accurate to date.

It was pointed out, however, that the Laboratory has been swamped by the needs created through the amazing growth of electronics during the past decade.

• **Where standards fall short**—A primary purpose of the meeting was to suggest action which might be taken by NBS, the electronic industry, military, and scientific organizations to help meet the emergency. That an

emergency exists was confirmed by specific situations reported at the conference:

- The million-dollar development of radomes is proceeding more by trial and error than through test and analysis because precise phase and amplitude measurements do not exist in the required frequency range.

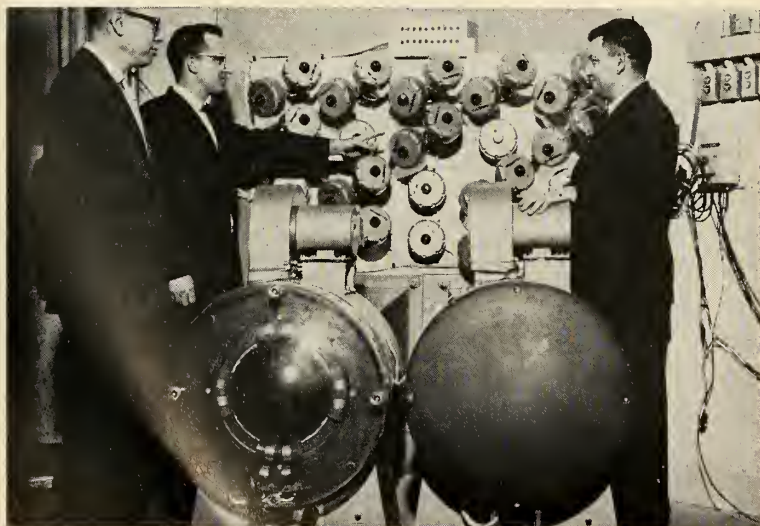
- One firm has to use its precision measurement laboratory facilities to test sections of coaxial cable from the production line since adequate production-line standards are not available.

- Klystron tubes—used to generate high-power signals for radar detection systems—are being over-designed just to be sure that they are powerful enough to do the job. This is necessary because there is no way to precisely measure the peak microwave power generated by these tubes.

- The performance measurement of modern radars requires the testing of many new and complex items of equipment. Quite often the radar is considered to have failed when the fault was within the test instruments.

*(Continued on page 82)*

## Avco Builds Record Noise Generator for Sud



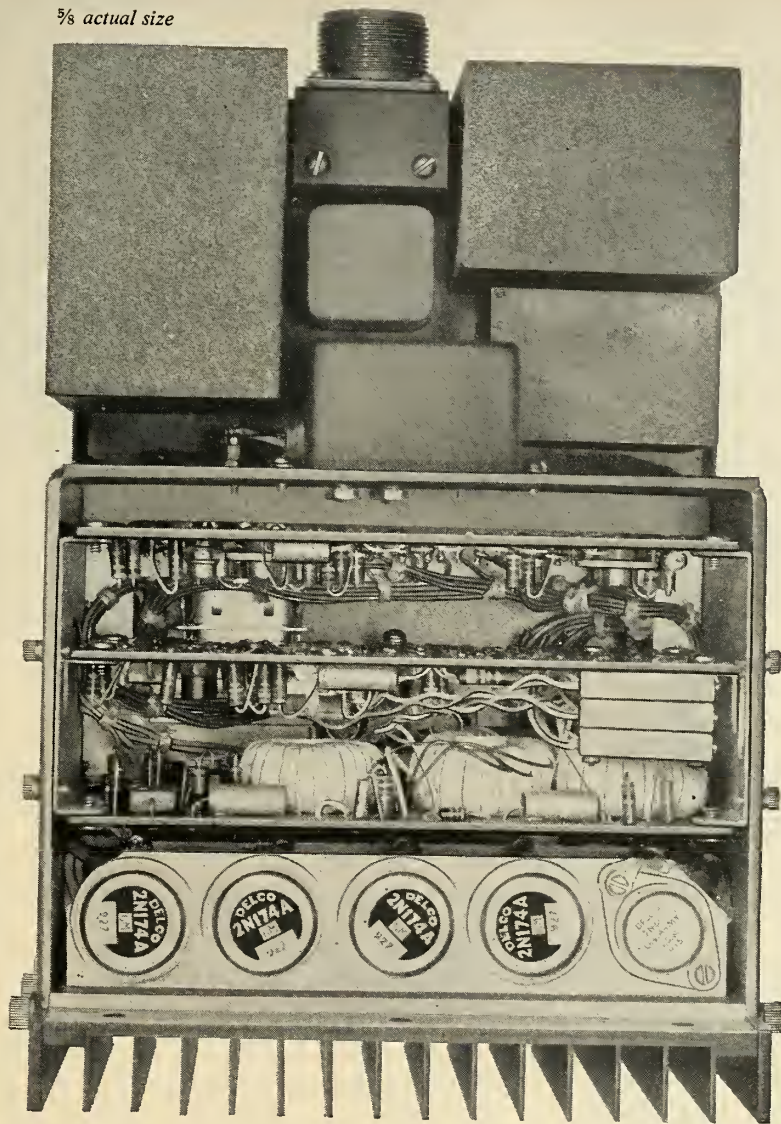
This acoustic noise generator—capable of producing the highest sound pressure level ever achieved in a large-capacity reverberant chamber—has been delivered to Sud Aviation by Avco-RAD, Wilmington, Mass., designer and builder. The French aircraft/missile firm will use the noise facility to test components and systems in its research center in Cannes, France.

The rocket-engine noise simulator pumps 146 decibels into a 200 cubic foot pentagonal reverberant chamber where individual octave band sound pressure levels can be maintained within  $\pm 3$  db with a specimen as large as 20 cubic feet.

The generator covers an audio frequency band from 37 to 9600 cps with 36 noise generators and 21 power amplifiers. Noise levels as high as 170 db can be produced at discrete frequencies.



5/8 actual size



HIGH CAPACITY STATIC INVERTERS WITH NO MOVING PARTS

# FROM DELCO RADIO NEW IDEAS FOR DEFENSE

Delco Radio's high capacity Static Inverters and Converters fill a critical need in missile guidance and control—offering extremely reliable, very highly regulated power of precise frequency. The Static Inverters use direct crystal-frequency control and digital logic circuits to produce accurate, single or polyphase power output. They have no moving parts. There is nothing that can get out of adjustment. Electrical characteristics are: High Capacity—150 to 4,000 volt-amperes. High Efficiency—65 to 90% depending on power and control (precision and regulation) required. Accurate Phase Angle Control—to 0.5 degree. Precise Frequency Control—up to 6 parts per million maximum variation under all load and environmental conditions. Voltage Amplitude Control—to  $\pm 1\%$  no load to full load. Low Distortion—typically 2% total harmonic distortion. Delco Radio has developed and produced power supplies for missiles such as the Air Force's Ballistic Intermediate Range Thor, Intercontinental Titan, and the pilotless aircraft Mace. For further information on military electronics, write to our Sales Department. *Physicists and electronics engineers: Join Delco Radio's search for new and better products through Solid State Physics.*

PIONEERING PRECISION PRODUCTS THROUGH SOLID STATE PHYSICS



Division of General Motors • Kokomo, Indiana

Circle No. 55 on Subscriber Service Card.

# ZIP

and  
it's  
covered!

## Zippertubing®

Instant Covering for All Applications!

Zippertubing, an economical on-the-job method of jacketing, is a flat tape, available in a wide range of materials, that has a patented extruded plastic track electronically welded to both edges. The tape or jacket is wrapped around the object to be covered so that the tracks engage, then "zip" shut. If permanent closure is required, a special sealant is provided that fuses the tracks together.



### GENERAL PURPOSE

Standard without overlap. Generally conforms to MIL-I-631C.



### MILITARY TYPE

with overlap Type 74 meets requirements of MIL-I-7444B. Type 63 meets MIL-I-631-C. QPL certificates of conformance or test reports furnished on request.



### SHIELDED ZIPPERTUBING®

copper. These conductive metals are laminated to vinyl-impregnated Nylon or glass cloth. When zipped around wires, it provides immediate 100% coverage for grounding RF and UHF interference.

### THERMAZIP

Protects cables or pipes from high temperature exposures. Type ALAS utilizes aluminized asbestos cloth. Type ALSR utilizes silicon rubber-impregnated glass cloth.



### ZT PROTECTORS®

NEW! Protective plastic covers with plastic zipper closure for splices and break-outs. Installation time is measured in minutes—not hours! Full range of sizes and colors.



### SPECIAL CONSULTATION

At your request, our Field Engineer will call or you can mail your design concept to us for evaluation and quotation. All requests confidential.

the Zippertubing® co.

752 S. SAN PEDRO STREET  
LOS ANGELES 14, CALIFORNIA  
PHONE MA 4-6664

During WESCON

Visit us at Booth 2320

Pat. and Pat. Applied For

Circle No. 64 on Subscriber Service Card.

(Continued from page 80)

• Measurements of microwave power, for example—made on different days by the same equipment—will disagree by 50%. Yet, as one speaker pointed out, some radar systems are operated close to breakdown and it is necessary to hold a given power level to keep a system operating. Under such conditions, a 5% error in measurement becomes the difference between operating and not operating.

The meeting revealed what is possible now in microwave power and attenuation, and NBS obtained a better idea of what accuracies are most urgently needed. Discussions indicated that in a few cases NBS can provide interim standards—even within current facilities—that will be a great help to many users.

As an example, NBS currently provides calibrations of microwave power measuring instruments between 8200 mc and 12,400 mc. By using different techniques, calibration can be extended to lower frequencies in the near future. This service will provide somewhat lower accuracy but will help meet many of the immediate needs expressed at the conference.

• **Equipment lacking**—On the other hand, however—even though the techniques are known—many standards cannot be extended to new frequency ranges because of lack of personnel and equipment.

For instance, an urgent need exists for the extension of a current microwave attenuation standard to three higher frequency ranges. Yet, to evaluate this technique at even one new frequency range in the millimeter wave region requires \$11,000 worth of new equipment—more than the present total annual equipment funds allotted to the project involved.

Dollars alone are not the answer. NBS representatives were asked to estimate how long it might take—at today's activity level—to develop minimum acceptable standards which do not presently exist for the frequencies (up to 100 gigacycles) and quantities most needed today. Based on many unknowns, the estimates—varying with measurements involved—ranged from five to ten years for most quantities. And an increase of several times the current budget would shorten this delay no more than half, according to NBS. The main time delay would be the hiring of capable personnel and their initial training.

Estimates make no provision for the new needs which will arise and must be met during the next few years.

Participants agreed that it is frequently difficult to discover whether an

expressed need is realistic. Examples were given of "impossible" accuracies specified to "play safe." They further agreed, however, that most of the stated accuracies described at the conference are really and urgently needed.

AIA industry representatives were asked to state not only what was needed but also why this was required—to help estimate the urgency of the needs. NBS described for each field the state-of-the-art in research, development, and calibration. From discussion of the presentations, tentative recommendations evolved for action by the Bureau, industry, the military, and scientific organizations. These will be carefully reviewed by AIA and then officially presented to the groups involved.

## Niobium Oxidation Cause Isolated by NBS Studies

The oxidative behavior of niobium—a potential high-temperature structural candidate—has been studied in detail at the National Bureau of Standards.

The oxidation problem is caused by the continual nucleation and growth of porous niobium pentoxide—which incessantly presents fresh metal surface to oxygen.

Investigators at NBS oxidized niobium specimens under controlled conditions in a sensitive vacuum microbalance. Examinations after different periods of oxidation led to the discovery.

Electron diffraction patterns of the initially formed oxide showed certain features of both niobium oxide and niobium dioxide. Although little or no change occurred in the predominant interference color, indicating that the film thickness remained constant, a continual increase in weight showed that oxygen was still being absorbed by the system.

Pentoxide globules form beneath the initial film and push upwards until the film's tensile limit is reached, rupturing the original oxidation film.

The globules coalesce into a continuous, porous layer which increases in thickness. The metal surface is continually exposed to oxygen because the large volume increase which accompanies the conversion of niobium to its pentoxide hinders the formation of a stable interface between the metal and the pentoxide. The reaction becomes a surface reaction of constant rate and rapid oxidation results.

The study was sponsored by the Air Force Office of Scientific Research.

# 3M Materials Memo

News of materials for the aerospace industry... selected from the 27,000 products of the 3M Company



## ■ Where good contacts count

Good reliable connections are useful in any circles these days, but in electrical circuitry they're imperative. Of course, sometimes it's difficult to reconcile reliability with today's high speed fabrication techniques. Our ELECTRICAL PRODUCTS DIVISION has recently come up with a means of doing just that. It's the new "SCOTCHLOK" BRAND type UR connector. Although it's the functional equal of twist and solder jointing methods for communication cable, it's way out ahead on speed and convenience.

The whole secret lies in their unusual construction. They're made of a transparent thermoplastic material filled with silicone grease and use metal finger-like connector elements, built into a top closure button. The cut wires are inserted into the sleeve of the connector and the button closure is squeezed into the body of the unit, using a special crimping tool. Depressing the button removes the wire insulation, grips the conductors, insulates the joint, and provides a positive seal for the silicone grease. Thus, a complete splice is made in one operation, involving no stripping, twisting, soldering or insulating. And visual inspection of the joint speeds up quality control, too.

"SCOTCHLOK" UR connectors can handle any two or three wire combination of #19 to #26 AWG solid or #20 to #26 AWG stranded wire. They can be used virtually anywhere a splice is made and on nearly every type of wire used in the communications industry. This would include wires insulated with miscellaneous plastics, paper, enamel, rubber, Teflon, or other materials. Your local Electrical Products representative will be happy to show you how "SCOTCHLOK" connectors can literally put your operations on a push-button basis.

## ■ A case of non-support

A flame would have a tough time surviving if it had to depend on 3M's new printed circuit board construction. Designated as "CuCLAD" #6097, this newest member of a range of printed circuitry materials offers some really distinguishing (or perhaps we should say extinguishing) features. Containing special flame retardant additives in its laminated glass cloth-epoxy backing, this "CuCLAD" board offers a high degree of flame retardance without the usual brittleness. This means easy machining with little waste. In actual test, the flame extinguishes itself in one to two seconds after the torch is withdrawn.

No. 6097 includes qualification to Mil-P-18177B Type GEB and NEMA grade G-11; is available with one or two ounce electrolytic grade copper foil bonded to one or both sides. This bond offers a peel strength as high as 11 pounds per inch and is resistant to standard plating and etching solutions. What's more, it offers you the option to either standard dip or float solder the finished circuit. "CuCLAD" #6097, a versatile performer, is made more so by coming in a broad thickness range of from 1/64" to 2" in individual sheets, 36" x 42".

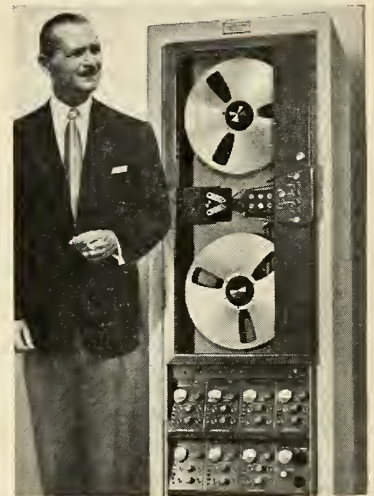
If printed circuitry is a burning issue with you, why not have your local MICA INSULATOR DIVISION representative give you more information on this exciting product—or fill in the coupon below.

## ■ Need a megacycle memory?

Are the high frequency requirements in telemetry and radar signal recording proving to be fast company for your current equipment? Our MINCOM Division's new model CM-100 recorder-reproducer permits you to think big in terms of band width, but not cost. Not a one-track memory by any means, the CM-100 can pack 7 channels of data on

a single 1/2" Scotch Brand magnetic tape. It literally permits you to stretch out these precious minutes of recording time by offering the capability of recording and reproducing greater band width at significantly slower speeds. For example, you enjoy 12 minutes of recording time in the one megacycle range running at 120 ips. You'll find that it pinches minutes for you like that at each of its 6 speeds. These speed variations, by the way, are available to you at the mere touch of a finger.

Our MINCOM Division proudly points to the fact that in addition to these virtues, the CM-100 represents somewhat of a first in versatility. It actually handles the work of two systems by storing both analog and pulse data with equal ease. This means that it's at home in practically any instrumentation application for telemetry or laboratory. For the full CM-100 story, contact your local MINCOM representative or clip the coupon.



3M Company, Missile Industry Liaison—Dept. VAB-70  
St. Paul 6, Minn.

Please send more information on  "CuCLAD" #6097  
Printed Circuitry Material  "SCOTCHLOK" BRAND type  
UR connectors  "MINCOM" CM-100 Recorder-Reproducer  
 3M Products for the Aerospace Age.

NAME \_\_\_\_\_

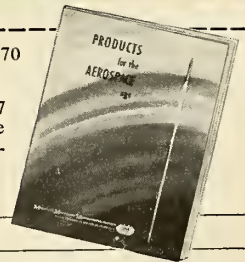
FIRM \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_

ZONE \_\_\_\_\_

STATE \_\_\_\_\_



"CuCLAD", "SCOTCHLOK" AND "MINCOM" ARE REGISTERED TRADEMARKS OF 3M CO.,  
ST. PAUL 6, MINN. EXPORT: 99 PARK AVENUE, NEW YORK 16, N.Y. CANADA: LONDDN, ONTARIO.

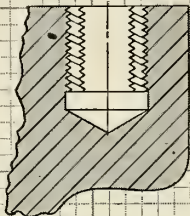
MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW

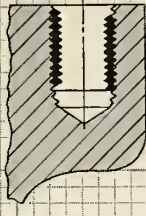


MISSILE  
INDUSTRY  
LIAISON

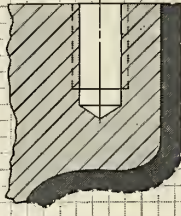
# How You Can Save Boss Space and Weight in Thread Design ...with HELI-COIL® Inserts



Solid bushing requires oversize boss



Heli-Coil Insert permits standard boss proportion



Space and weight saved by Heli-Coil Insert

As seen in the illustrations above, Heli-Coil Inserts save 56% in space, 63.5% in weight.

Heli-Coil stainless steel wire inserts have a smaller outside diameter than any solid bushing. Therefore, with Heli-Coil Inserts you can design boss radii to a minimum, yet stay with standard boss configurations. This means *savings in space and weight*, and material-savings as well.

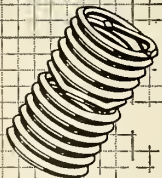
This feature is vitally important for miniaturization in aerospace design, in electrical and electronics equipment design, and for general industrial applications.

**NO OTHER TYPE OF INSERT OFFERS SUCH SAVINGS!**



## Heli-Coil Screw-Thread Insert

Permanently protects threads against wear, stripping, corrosion, galling, seizing, vibration and shock. Made of 18-8 stainless steel wire, cold-formed into a diamond-shaped cross section, work-hardened to a tensile strength of approximately 200,000 psi. Conforms to mil specs and all commercial and industrial thread forms.



## Heli-Coil Screw-Lock Insert

Provides same protection as Screw-Thread Insert, PLUS an exclusive *patented* resilient *internal* locking feature that eliminates protruding lock nuts, lock wiring and other supplementary locking devices, thus saving additional space and weight. Meets military specifications for locking torque and vibration.

The Heli-Coil line of products includes: inserts and related taps, tools and gages. Tables of boss radius and weight comparison are available.



**HELI-COIL CORPORATION**  
DANBURY, CONNECTICUT

HELI-COIL CORPORATION, 2807 Shelter Rock Lane, Danbury, Connecticut

I'd like more information on Heli-Coil Screw-Thread Inserts  Screw-Lock Inserts

NAME \_\_\_\_\_ TITLE \_\_\_\_\_

FIRM \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_ 2565

In Canada: ARMSTRONG BEVERLEY ENGINEERING LTD.  
6975 Jeanne Mance St., Montreal 15, Que., Crescent 4-3538

## PROPULSION

(Continued from p. 71)

advantage because the volume will reduce the unit cost of tooling up. But Mitchell said fiber glass and plastic cases are cheaper when small numbers are involved. He contended that the lightweight material could not be ruled out even for the largest conceivable solid rockets.

The NASA propulsion chief voiced enthusiasm for the Air Force Project 3059 plan to explore the feasibility of a very large solid motor, on the order of a million lbs. thrust. He said:

"We in NASA are extremely interested and fully understand the need of getting as much data as necessary to determine where a large solid booster fits into the space picture. We are following and participating in the Air Force plans very closely."

• **Nuclear rocketry**—"In the last year, we have seen the transition of nuclear rocket propulsion from essentially a loose research effort and a reactor program to a much firmer and essentially a defined program with a firm development objective—a flyable nuclear engine."

Mitchell recalled that NASA officials have said a test is scheduled for 1965. "This is becoming a major area of buildup of effort," he added.

Mitchell said the joint NASA-Atomic Energy Commission work is making excellent progress—particularly in work on the reactor, the feed systems and the hydrogen turbine pump.

• **Electrical propulsion**—The last year has seen marked increases in R&D efforts by government agencies, non-profit organizations and industry on electrical devices, Mitchell asserted. As a sign of the progress made, he cited decisions by both NASA and the Air Force to develop ion engines. "We hope that in a year or so these engines will have demonstrated a reasonable operating time."

The engines are to develop 0.1 lb. thrust and draw 30 kilowatts of current from a SNAP-8 nuclear powerplant. Total weight of the system, including the thrust device and powerplant, will be a few thousand lbs., he said.

Progress in ion devices has included reduction of interception of ions by accelerating and focusing electrodes, and increases in power conversion efficiency (ratio of Kinetic power in the thrust beam to total power input).

A critical problem still remaining is beam neutralization, he continued. "We are obtaining better insight on this problem but I don't think we have any clear experimental data as yet to indicate whether it can be accomplished."

# Pioneer V Found Radiation Peril Past Van Allen Belts

Radiation will be a major hazard for man throughout the zone between the earth and Venus—not just in the Van Allen belts.

This is the most important finding of *Pioneer V*, the U.S. space probe that was tracked and telemetered for 108 days to a distance of 22,462,740 miles from Britain's Jodrell Bank radio telescope.

Man in space beyond the Van Allen belt will need extensive protection from the radiation in solar flares, Dr. Abe Silverstein reported last week.

Silverstein, director of the Office of Space Flight Programs, National Aeronautics and Space Administration, made his estimate at a press conference called by NASA to report on the end of efforts to communicate with the 94.8-lb. planetoid now swinging in a solar orbit between those of the earth and Venus.

Silverstein gave no figures on radiation intensity. However, in a paper given before the American Geophysical Union on April 29, three physicists headed by J. R. Winckler of the University of Minnesota reported that in-

tensity can rise as high as 30 or 40 roentgens per hour during a magnetic storm.

Without shielding, a half-day's exposure at such a level would be lethal for about half of the persons exposed, according to the calculations of the National Committee on Radiation Protection.

The report on *Pioneer V* was given after NASA Administrator T. Keith Glennan presented a model of the space vehicle to Dr. A. C. B. Lovell, British astronomer and director of Jodrell Bank, in recognition of the cooperation of the staff of the 250-ft. dish antenna.

Silverstein listed these other scientific discoveries realized during the *Pioneer V* flight:

- An interplanetary magnetic field exists. Its intensity fluctuates in relation to solar flare activity.
- A ring current of five million amperes, 25,000 miles in diameter, exists at 40,000 miles from the earth.
- The earth's magnetic field extends at times out to 65,000 miles and oscillates with solar flare activity.

*Pioneer V*, launched from Cape Canaveral at 8 a.m. (EST) on March 11, sent intelligible signals with its 5-watt transmitter on command until 7:33 a.m. (EDT) on June 26, at which moment it was traveling away from the receiving antenna at 18,621 mph and had traveled 60% of the distance that separates the orbit of earth from the orbit of Venus. At the time, it was 78.9 million miles from the center of the sun.

• **A flock of firsts**—Silverstein said its technological firsts included the greatest range over which man has maintained control over an instrumented vehicle, the greatest range over which man has tracked a man-made object and the first instrumented space laboratory making measurements of the interplanetary magnetic field, the plane of the magnetic field and total flux and energy level of radiation in interplanetary space.

Also, Silverstein said, *Pioneer V* established a record in the distance at which an interplanetary guidance system was used. He explained that the vehicle had Doppler capability for measuring position in space, which are parts of advanced guidance systems to be used in future space vehicles.

Other scientific achievements, he continued, include the first measure-  
(Continued on page 95)

from the smallest to the  
largest missile part . . .

Glaco's nation-wide facilities and technical know-how have helped aircraft and missile manufacturers overcome product and production problems . . . from specialized coating applications on motor stators (for eliminating insulating wafers and tapes) to dispersion cast fluorocarbon covers for inflight protection of missile radomes!

No matter what your specific coating problem, Glaco will select the material (Teflon\*, Kel-F† and others) with the precise properties you need and apply it to your product as a thin film coating. The unique properties of custom-coatings include: excellent electrical qualities, wide-range temperature stability, chemical and corrosion resistance, dry lubrication and anti-stick characteristics.

*No problem is too big or too small for Glaco. Whether you require small experimental quantities or high-volume production, depend on Glaco's experienced technicians and coast-to-coast operation for fast, efficient service.*

**INDUSTRIAL COATINGS DIVISION**  
The NATIONAL GLACO CHEMICAL CORPORATION  
(A Subsidiary of *Exco Products Company*)

1949 N. CICERO AVE., CHICAGO 39, ILLINOIS BERKSHIRE 7-6000

\*Du Pont's trademark for its TFE-Fluorocarbon Resin Finishes. †Minnesota Mining & Mfg. Co. trademark.

**GLACO  
HANDLES  
ALL  
CUSTOM-  
COATING  
NEEDS!**

INDUSTRIAL COATINGS DIVISION  
THE NATIONAL GLACO CHEMICAL CORP.  
1949 N. Cicero Ave. • Chicago 39, Ill. MR-718

Send me a copy of your 12-page full color brochure on custom-engineered coatings, without obligation

Name \_\_\_\_\_  
Title \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_

**LACO**



## To Engineers Who Dream About the Future...

That every man **MUST** dream about the future is an established fact. For "dreaming" is a state of mind shared by everybody—man, woman, child . . . rich and poor . . . those who have failed as well as the few who have reached the **TOP** of the ladder.

By training and aptitude the engineering mind is above the average; it is inclined to want to know the answers—the **WHY**, **WHERE**, **HOW**, **WHAT**, **WHEN** and **WHO** of things. By and large, it is a *doer's* mind motivated by dreams.

To such men, **PHILCO**, the pioneer in electronic field services, offers new horizons to reach for in a variety of fields, including the research, engineering, design and systems modification associated with the nation's global communications network, world-wide defense works, missile systems and components.

Philco's flexible policy lets you choose your own field of interest . . . your work location . . . while, at the same time, providing constant career guidance, professional growth, top compensation and employee benefits.

**WRITE TODAY**

Mr. Clifford F. Graebe  
*Personnel Manager, Dept. B-3*

**PHILCO**  
**TECHREP DIVISION**  
P. O. Box 4730  
Philadelphia 34, Pa.

## CIRCUITRY

(Continued from p. 73)

### • Switching

I would further point out that, in order to perform these functions, we have found it convenient, if not necessary, to generate, transmit, control and store electrical energy in the forms of electrical current, electrical flux, magnetic flux, and electromagnetic wave flux.

Semiconductor devices provide control of current; magnetic and dielectric materials, such as thin magnetic metallic films, ferrite and ferroelectric ceramics, will provide the control of the other three forms. This fact adds to the incentive for inclusion of electronic ceramics and thin films in the four technologies mentioned in the introductory paragraphs.

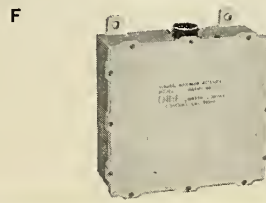
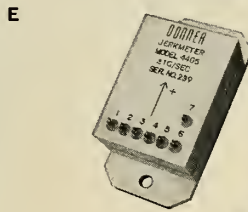
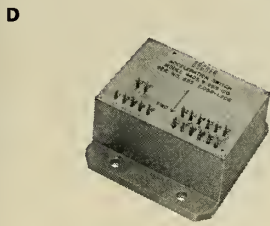
Substantial progress in integrated circuits will be achieved when we have performed all of the functions listed above over a range of frequencies, power levels, and environments. We must have succeeded in processing the four forms of electrical energy in a variety of circuits. The uninhibited approach of "Tell me the function you want performed and I'll invent a way to do it." is not practical for the accomplishment, in two or three years, of everything we have been able to accomplish in 40 years of development of the electronic art.

It is important to realize that we are not starting over but improving our techniques for production in order to meet the problems of greater restrictions on size, cost and power consumption, increased demands on reliability and speed, and new environments. The effect on the electronic materials, components, and equipment manufacturing industry will be far-reaching but gradual. We have ample time to act if we are alert to the new developments.

### 'Rotochutes' Will Attempt To Slow Re-entry Vehicles

Experiments with helicopter-like rotating wings to slow down and guide fast-moving re-entry vehicles to a landing will be conducted under a \$448,000 Wright Air Development Division award to Kaman Aircraft Corp.

In the first phase of the contract, Kaman will employ its "rotochute" to attempt to land a 200-lb. package released at subsonic speeds from 50,000 ft. Recovery of much larger packages released at supersonic speeds from extremely high altitudes will be tried later on. The rotochute has two spring-actuated rotor blades which are motor-driven after snapping into position.



A. Model 4310 0.1% Linear Accelerometer. B. Model 4525 Angular Accelerometer. C. Model 4710 Integrating Accelerometer. D. Model 4403 Acceleration Switch. E. Model 4405 Jerkmeter. F. Model 7005 Airborne Analog Computer.

## A Short Guide to Donner Scientific

### LINEAR, ANGULAR, AND INTEGRATING ACCELEROMETERS, ACCELERATION SWITCHES, JERKMETERS, AIRBORNE ANALOG COMPUTERS, and other systems

**Model 4310 0.1% Linear Accelerometer**—This high output, high resolution transistorized accelerometer is designed for demanding measurement and control applications met in telemetry, gyro-erection, programming, and short range inertial guidance.

*Key specifications: non-linearity plus hysteresis, within 0.05% deviation from best straight line; standard ranges, between  $\pm 0.05$  g full range and  $\pm 30$  g full range; resolution, better than 0.0002% full scale; weight, 3.5 ounces; standard output,  $\pm 7\frac{1}{2}$  v dc and/or  $\pm 1.5$  ma full scale; options, biased output, liquid filled units, and/or 28 v dc operation; 0 to 5 v dc output; price, standard unit, \$450.*

**Model 4525 Angular Accelerometer**—Chief applications for this unique force balance accurate angular accelerometer are closing the servo loop on ground launching equipment for missiles, detecting roll, pitch and yaw acceleration once they are airborne, and measuring induced angular acceleration when a missile is vibrated by a linear shaker.

*Key specifications: ranges, from  $\pm 2$  radians/sec<sup>2</sup> to 50 rad/sec<sup>2</sup> or any intermediate grouping; frequency responses, essentially the same as that of a linear second order system; nominal full scale output,  $\pm 20$  volts; resolution, 0.01% full scale or better; linearity, 0.1% of full scale; hysteresis, less than 0.01% full scale; damping,  $0.6 \pm 0.1$  of critical; size, 3.7" diameter x 3.7" high; available in nitrogen filled and liquid damped versions.*

**Model 4710 Integrating Accelerometer**—The all solid state Donner integrating accelerometer is used to both close a set of contacts at predetermined velocities and provide analog outputs relative to acceleration and

velocity. These outputs are used in turn to actuate various control dynamics in missiles and aircraft. Velocity contacts can be closed at any speed from a few feet per second to 50,000 feet per second, up to accuracies of 0.25 percent over extended operational periods.

*Key specifications: temperature range, 30° F to 150° F; vibration, will withstand  $\pm 15$  g through 2000 cps; acceleration ranges, from 1 g to 100 g; shock, will withstand short shock pulses of 75 g and long pulses of 50 g; weight, 2 pounds.*

**Model 4403 Acceleration Switch**—Donner acceleration switches are used to accurately determine the point of thrust termination in missile and satellite vehicles. Because of their high natural frequency, they offer excellent dynamic response.

*Key specifications: ranges, 0.05 g to 100 g; unregulated power, 28 v dc  $\pm 10\%$ ; temperature range, 30° F to 150° F; output, relay closure; weight, approximately 12 ounces.*

**Model 4405 Jerkmeter**—Unique Donner jerkmeters operate as subminiature servo-systems of the force-balance type responsive to jerk along the sensitive axis of the linear unit and about the sensitive axis of the angular unit. Basically, each system consists of a transistorized accelerometer with an integrator inserted into the servo-loop to generate a jerk signal. Applications include monitoring rate of change of g's in jet aircraft and using the signal to predict impending disaster, providing a velocity damping term, inertial indicator of first motion, and any other use where constant acceleration is required.

*Key specifications: ranges, acceleration  $\pm 1$  g full range to  $\pm 30$  g full range; jerk,*

*$\pm 0.5$  g/sec full range to  $\pm 20$  g/sec full range; output full scale, acceleration and jerk, 7.5 v dc; weight, 7.5 ounces.*

**Model 7005 Airborne Analog Computer**—Technically known as a "maximum altitude sensor," this all solid state system is a fixed purpose analog computer housed in a magnesium case only 5 inches long. It is used to actuate rescue devices in the capsule developed for the project Mercury.

Under abort conditions, the computer provides output information which fires the explosive bolts holding the escape tower onto the top of the capsule and energizes the system which causes the escape tower jettison rocket to fire.

#### OTHER DONNER SYSTEMS—

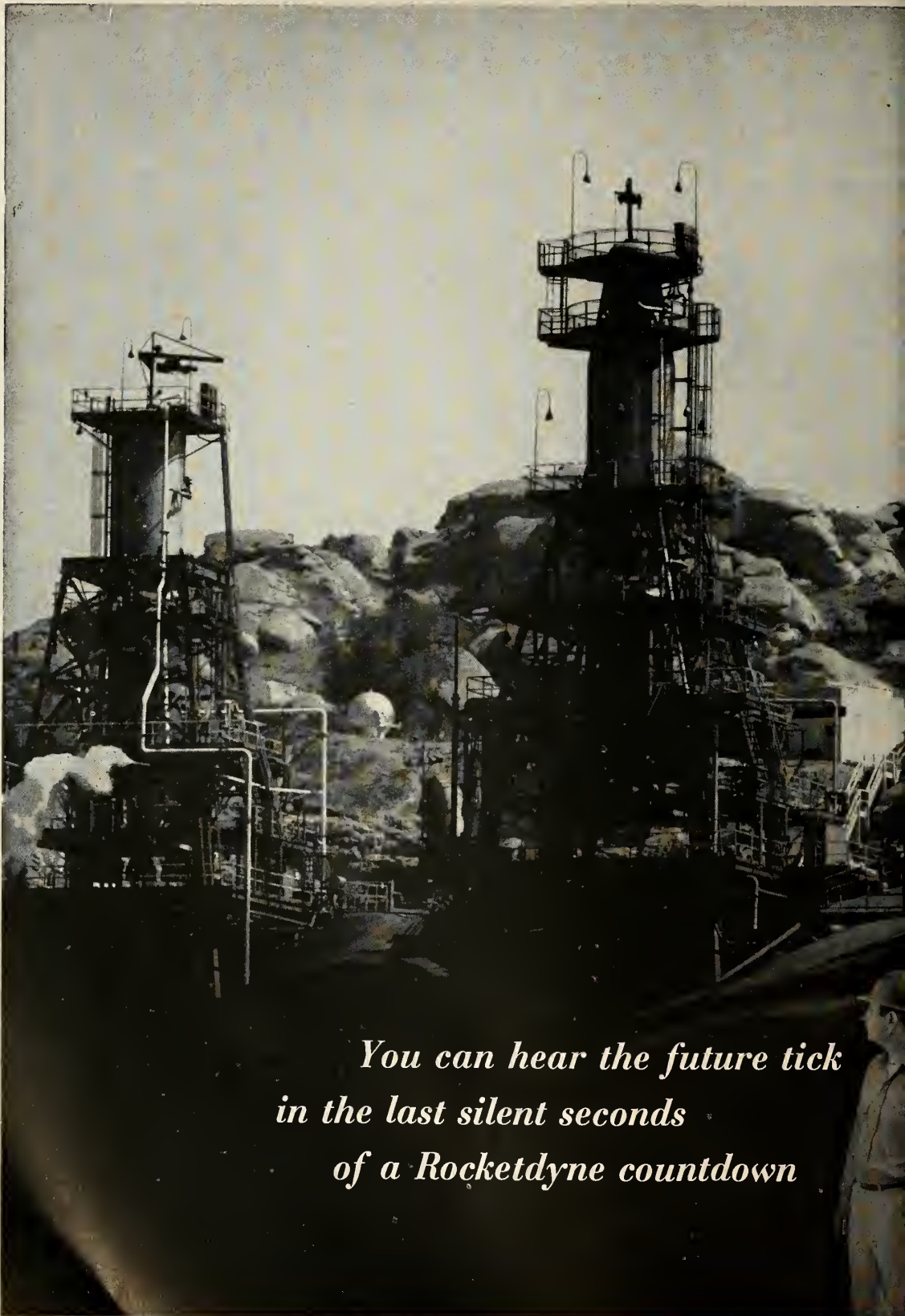
Donner Scientific specializes in the manufacture of accurate fixed and general purpose analog and digital systems designed to analyze, measure, and control inputs interlocking time, acceleration, jerk, velocity, and other dynamic inputs. Typical systems include accelerometer timer switches, airborne signal conditioner and event markers, escape and re-entry sub-systems, linear acceleration summing and storage devices, and peak reading vibration storage devices.

For more information, contact your nearby Donner engineering-sales representative or write Department 123.

28

## DONNER SCIENTIFIC COMPANY

a subsidiary of Systron-Donner Corporation  
Concord, California Phone: MUIberry 2-6161



*You can hear the future tick  
in the last silent seconds  
of a Rocketdyne countdown*





**F**OUR...THREE...TWO...ONE... a moment of silence. Then a giant speaks—and a bolt of man-made lightning flashes.

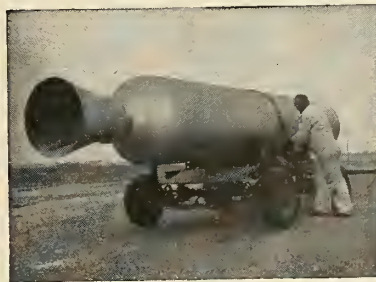
Nearly every hour of every day, Rocketdyne technicians near that dramatic moment as they test and tune the space engines of today.

The best-equipped test facilities for high thrust rocket engines in the nation are at their command. Rocketdyne's finely instrumented test structures are located in California's Santa Susana Mountains; Neosho, Missouri, and McGregor, Texas.

Rocketdyne engines have powered most of the military and scientific projects conducted by the Air Force, Army, and NASA. Now huge boosters of one and a half million pounds of thrust are emerging from the technical heritage of Atlas, Thor, Jupiter, and Redstone.

And even while today's countdowns go on, plans for tomorrow's assault on space are being made. At Rocketdyne, engineers and scientists are investigating such advanced forms of propulsion as ion engines, nuclear engines, plasma jets, and magnetohydrodynamic engines. Meanwhile other groups are at work on high-energy liquid and solid propellants, and dramatic new devices for both liquid and solid propulsion systems.

Rocketdyne, a 12-year pioneer in rocket technology, was first with power for America's long-range ballistic missiles—first with power for Outer Space.



**MEGABOOM**—a giant solid propellant rocket motor produced at Rocketdyne's McGregor, Texas, solid fuel facility—delivers 100,000 pounds of thrust, boosts test sled to 1,200 mph.

FIRST WITH POWER FOR OUTER SPACE

**ROCKETDYNE** 

A DIVISION OF NORTH AMERICAN AVIATION, INC.

Canoga Park, California; Neosho, Missouri; McGregor, Texas

Space probe reaches heights of over 500 miles— speeds of over Mach 10— with unprecedented reliability ...

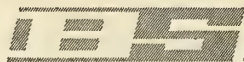


## ... AND BRISTOL SIDDELEY SUPPLY THE POWER

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce the Gamma. A liquid propellant rocket engine, the Gamma powers the Saunders-Roe Black Knight, Britain's highly successful space research vehicle. An extremely reliable powerplant, the Gamma produces a total sea-level thrust of 16,400 lb (7,438 kg) and nearly 19,000 lb (8,618 kg) outside the earth's atmosphere, for a total powerplant weight of under 700 lb.

At the Woomera rocket range in Australia, the Gamma has sent Black Knight over 500 miles into space at speeds in excess of Mach 10 with unprecedented reliability. For, to date, every Black Knight vehicle has been launched successfully.

Since Bristol Siddeley's rocket division began work in 1946, it has developed a wide range of components. *By combining these components in single or multi-chamber layouts, thrust requirements from 500 lb up to 100,000 lb can be met.*

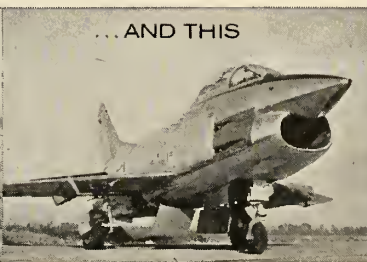


**BRISTOL SIDDELEY ENGINES LIMITED**

Bristol Aero-Industries Limited, 200 International Aviation Building, Montreal 3, Canada. Telephone: University 6-5471



**Bristol Siddeley Maybach** diesel engines power Britain's fastest express train.



**The Bristol Siddeley Orpheus** powers the Fiat G 91, NATO'S light fighter.



**The Bristol Siddeley Proteus** powers the Britannia airliner.

# Step-up Urged in Ocean Study

Oceanography must be increased by a factor of four over the next 10 years—both in participants and in the present \$36-million level of funding.

This statement came last week in a report on "Ocean Sciences and National Security," released by the House Committee on Science and Astronautics.

The committee pointed out the Soviet Union has accelerated its ocean research efforts in what may be a deliberate attempt to overtake and surpass oceanography in the United States.

In its recommendations, the committee stressed the threat manifested by the Soviet fleet of more than 500 submarines and said it is essential that we develop the capability in ASW for complete surveillance of the oceans to minimize the possibility of a surprise submarine attack.

It said the present level of scientific oceanic research and inventory of ships and shore facilities are evidence the field "has been badly neglected."

Examination of the Navy and National Science Foundation oceanic programs, the committee said, reveals that until Fiscal 1960, they appeared

lacking in emphasis, vigor and adequacy of funding.

• **One manager**—The committee said the Navy, until recently, has not pursued a broad program in oceanography, despite its relevance to the Navy's ASW mission. The committee said this has been true even though the Navy is now the largest single supporter of oceanic research.

To remove the disparity between the current level of effort and the needs for national security, the committee said it is necessary that the Federal Government organize, manage, and coordinate the necessary program. It said the responsibility should be:

• Development of a national program in oceanic research and identification of goals.

• Budgeting of funds for a balanced program embracing all elements of oceanic research both for peaceful and military applications.

• Implementation of the national program by both in-house and contract research.

• Deliberate fostering of education and training in oceanography.

The report, authored by Dr. Edward

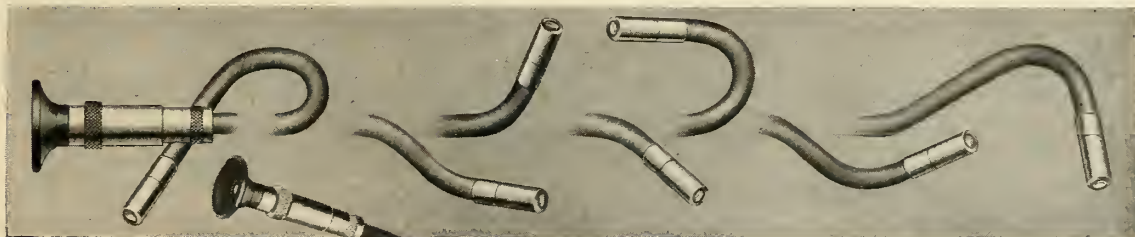
Wenk, Jr., senior specialist in science and technology, Library of Congress, contained these other highlights:

• Marine subjects are being investigated at nearly 100 establishments which are subordinate to some 16 USSR ministries and agencies. Leading oceanographic research institutions in the USSR are the Institute of Oceanology of the Academy of Sciences, the State Oceanographic Institute of the Main Administration of the Hydrometeorological Service, the Arctic and Antarctic Scientific Research Institute of the Main Administration of the Northern Sea Route and the All-Union Scientific Research Institute of Fish Economy and Oceanography.

• The number of professional oceanographers in the USSR is estimated as high as 800 to 900.

• The USSR's oceanic research fleet numbers between 50 and 75 non-military vessels with lengths greater than 50 ft. Included is the Severyansk, first submarine in the world to be used solely for oceanographic research.

The U.S., on the other hand, operates about 52 ships with an average age of 18 years, has about 500 to 600 professional oceanographers; and roughly 70 separate organizations engaged in oceanic research. Only 16, however, are large facilities.



*Focusing eyepiece provides clear definition at various working lengths.*

**For the ultimate  
in precision viewing of  
intricate, hard-to-reach areas . . .**

**A.C.M.I. Fiber Optic  
*Flexible*  
Borescopes**

**F**OR visualization in inaccessible curved areas where a flexible instrument capable of adapting itself to irregular contours is required.

Fiber Optic Borescopes are equipped with focusing eyepiece and fixed or movable objective as required. Illumination can be provided by a flexible fiber optic light carrier with an external light source or an annular fiber optic light carrier attached to the image carrier. Fiber optic light carriers are particularly advantageous for transmission of intense cold light to inaccessible or hazardous areas.

*Please send details and sketch  
of your requirements.*

**AMERICAN CYSTOSCOPE MAKERS, Inc.**

8 Pelham Parkway, Pelham Manor (Pelham), N. Y.

Engineering notes  
from the **SM/I**  
**REPORTER**

BY STANLEY M. INGERSOLL, Capabilities Engineer

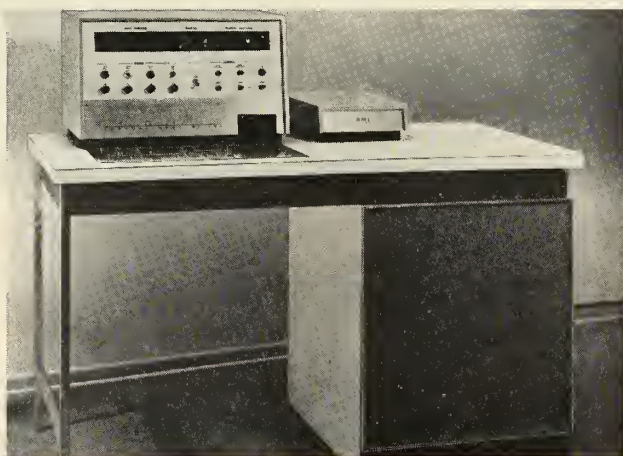


Report No. 8  
WR 2000 Computer Module Test Set

Our new WR 2000 test set automatically tests "black box" modules having electrical inputs and outputs. It is presently being used to test modules of several different computer systems. Input command functions to the modules are obtained from a 5-place ratio transformer and are automatically programmed through a unique programming patchboard, which provides the WR 2000 with the versatility required to test a wide range of airborne analog computer systems. Output transfer functions of the modules are automatically read out through a 4-place ratiometer. Up to 10 input command functions and up to 10 output transfer functions for each input command are possible for each module. This SM/I test set can be operated by relatively inexperienced personnel, and its overall accuracy of measurement ranges from 0.01 to 0.25% of full scale, depending on type of test performed.

Physical Characteristics

Size.....	48" L x 25" W x 29" H — Table Area
Weight.....	200 lbs.
Power Requirements:	
115V 60 cps.....	300 watts max.
115V 400 cps.....	150 watts max.
28V DC.....	150 watts max.
Accuracy.....	0.01% to 0.25% full scale



For more information and complete operating specifications, write or wire SM/I today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.



**SERVOMECHANISMS/INC.**  
Los Angeles Division  
12500 Aviation Boulevard  
Hawthorne, California

**SPACE MEDICINE**

(Continued from p. 79)

hazard posed by prolonged exposure to weightlessness received a partial answer in the seven-day "bathtub" water-immersion experiment of Dr. Duane Graveline at the Aerospace Medical Center this past January. Will prolonged weightlessness requiring no muscular effort to maintain body position against the pull of gravity result in serious muscle debilitation and weakness?

Spending only one hour in each 24-hour period out of the bathtub to permit skin care and replacement of electrodes, the subject noted, "each time I got out I was weaker and more eager to get back in." A startling observation was the fact that he averaged only about an hour's sleep in each 24-hour period.

Monitoring his brain waves (EEG) proved that most of this was light sleep, with very infrequent 10- to 20-second periods of deep sleep. A marked decrement in skilled performance occurred, easily noted after comparing the pre- and post-experiment tests. This experiment points up one of the most serious and challenging problems of extended manned space flight.

The specific advances reportable through this past year appear to be small compared to the progress that needs to be made. However, the year has been a period of organization and consolidation that should blossom into many worthwhile achievements in the coming 12 to 18 months.

*The opinions expressed are those of the authors and do not necessarily represent official USAF policy.*

**Rocket Power/Talco Pushes Studies of Oxidizing Salts**

Advanced studies in improvement of solid rocket propellants are being carried out at the research laboratories of Rocket Power/Talco, Pasadena, Calif. Efforts are aimed at incorporating desirable properties of propellant oxidizing salts, such as perchlorates and nitrates, into propellant binders.

Accomplishment of the objective would result in a substantially homogeneous compound having excellent physical properties and high specific impulse.

Rocket Power/Talco scientists point out that the best present solid propellants consist of a minor proportion of binder and light metals with a preponderance of oxidizing salts, suffering in performance because of the need for separate components of binder and granular ingredients.

## Daystrom Gets Award For Added Work on Julie

Bureau of Naval Weapons has awarded Daystrom, Inc. a contract of about \$2 million for continuing classified research and development work on the *Julie* system, an important part of Navy's anti-submarine warfare program.

Daystrom's Electric Division pioneered the *Julie* system for the Navy, beginning in 1953. The system makes use of the explosive echo ranging technique for the detection and location of submarines. Accurate timing between creation of the sound and receipt of its echo permits calculation of the distance between the submarine and the source of the sound.

In working on the system, the division developed a unique three-part set-up. Its new laboratory building at Poughkeepsie, N.Y., includes a 12-by-8 ft. indoor acoustical water tank and other facilities to simulate the ocean environment.

To handle tests too large for the laboratory and yet under controlled conditions, *Julie* utilizes an artificial lake 1800 ft. long, 900 ft. wide and 135 ft. deep. Originally an abandoned stone quarry, it is the largest underwater test range in the country maintained by private industry.

To do original work in oceanography and to test ideas and equipment in the sea itself, the division keeps an 86 foot research vessel, the *State Star*, especially equipped and instrumented. The vessel works off the East Coast and in the Caribbean, often in conjunction with Naval ships and aircraft.

## Martin to Develop Master Air Force Checkout Plan

A 15-year master plan of checkout systems for manned and unmanned weapons will be developed for the Air Force under a contract just awarded to Martin-Baltimore.

The study will set design standards and define checkout systems requirements up to 1975. It is also aimed at establishing methods of standardizing and integrating systems hardware to increase efficiency and save money.

Competition for the unfunded contract was unusually heavy: some 42 companies submitted bids. Martin estimates the work will cost them about \$100,000 and require about seven months to complete.

Checkout equipment of 17 different weapons systems will be evaluated in the study. These include eight produced by Martin: SM-68 *Titan*, *Perishing*, TM-76 *Mace* and TM-61 *Mata-*

missiles and rockets, July 18, 1960



As tall as a  
7-story  
building...  
but it uses  
tiny BRISTOL  
CHOPPER

More than 40,000 parts, each of which must meet the most stringent reliability standards, make up the U. S. *Atlas* intercontinental ballistic missile, built by prime contractor Convair (Astronautics) Division, General Dynamics Corporation.

Among these parts is the Bristol Syncroverter\* chopper . . . adding to its record of service in U. S. guided missile systems of almost every type since their very beginnings.

**Billions of operations.** To insure the reliability so necessary in aircraft and missile operations, Bristol Syncroverter choppers are constantly under test at Bristol, with and without contact load. One example: We've had five 400-cycle choppers operating with 12v, 1ma. resistive contact load, for more than 26,000 hours (2.96 years) *continuously* without failure—over 37-billion operations!

Many variations of Bristol Syncroverter choppers and high-speed relays are available—including external-coil, low-noise choppers. Write for full data. The Bristol Company, Aircraft Equipment Division, 173 Bristol Road, Waterbury 20, Conn.

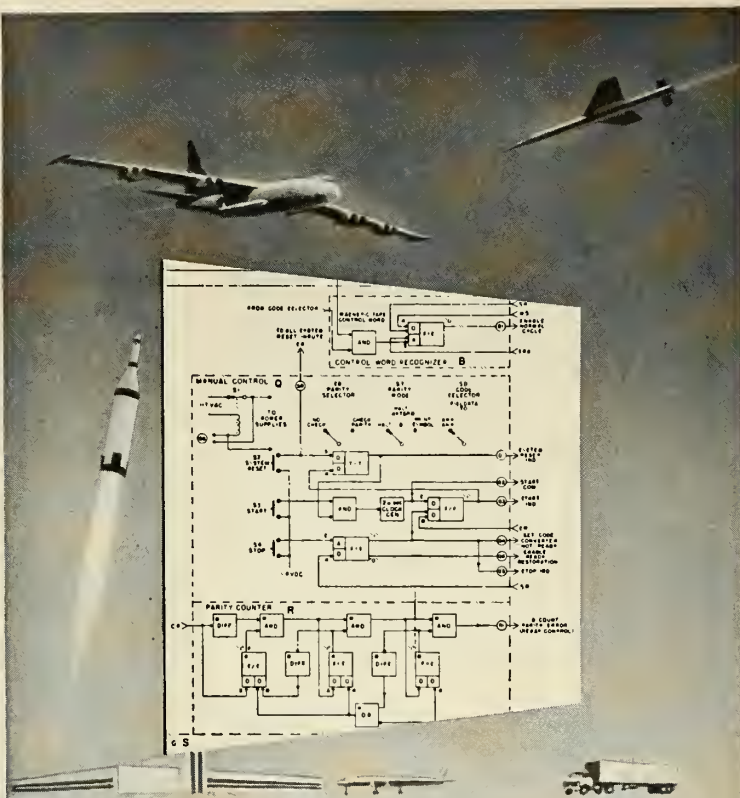
•••

\*T.M. Reg. U. S. Pat. Off.



actual size

**BRISTOL** FINE PRECISION INSTRUMENTS FOR OVER SEVENTY YEARS  
Circle No. 61 on Subscriber Service Card.



## The Application of DATA PROCESSING TECHNIQUES

• • • in tracking, timing, guidance and test systems is a familiar problem to Analex® Systems Division engineers.

For almost ten years, they have worked together in the development of logical solutions to special military problems of air, land and sea operations, including equipment for MIL Spec environments. During this time, they have also developed unusual systems for industrial and commercial applications.

Finished equipment required for these systems is produced by the Analex manufacturing facility under direct supervision of the engineering group. This division is staffed by technicians and skilled craftsmen who have specialized in the production of sophisticated data processing equipment.

We will be glad to tell you frankly and promptly whether your particular requirement is within the capabilities of our Systems Division.

for further information, write or telephone

# ANELEX CORPORATION

150-H CAUSEWAY ST., BOSTON 14, MASS.

ANELEX

Circle No. 53 on Subscriber Service Card.

dor, Bullpup, 199-B ALBM (ex-Bold Orion), Dyna-Soar, and the RB-57D SAC reconnaissance bomber.

Other checkout systems included: SM-80 Minuteman, GAM-77 Hound Dog, IM-99 Bomarc, Nike-Zeus, GAR Falcon, GAM-87 Skybolt, B-58 Hustler, Midas early-warning satellite, and the Samos reconnaissance satellite.

## IBM Demonstrates Its Mercury Tracking Network

A real-time teleprocessing system to serve as the connecting link between data input from widely scattered centers and central data processing was demonstrated in Washington recently for NASA and members of Congress.

Developed by International Business Machines Corp., the IBM 7281 Data Communications Channel will be installed soon at the Goddard Space Flight Center, Greenbelt, Md. Its 32 channels will tie the center's two IBM 7090's, also to be installed, to a worldwide network of tracking stations.

Transmitted information from any location in the network will be received by the 7281 which changes the impulses into a digital output. This can be stored and/or fed immediately into a computer for processing. Total elapsed time for teleprocessing, said IBM's Federal Systems Division, is measured in milliseconds.

Principally designed for Project Mercury, the tracking network inputs will be from radar, telemetry, and other related sources.

With the high-speed computers and the 7281, more reliable and precise control of the Mercury capsule is now possible. Real-time control obviates data delay in both directions—that is, to or from the capsule or the observing stations.

The equipment was demonstrated at the dedication of an impressive black-light display of U.S. space programs. Titled "Threshold of Space" the IBM exhibit dramatically shows what has been accomplished.

## Joint Contract to Develop Mobile Nuclear Powerplant

A highly compact 2-to-3-megawatt nuclear powerplant for military use in isolated areas will be developed jointly by Allison Div. of General Motors and Nuclear Development Corp. of America.

The contract, awarded by the Atomic Energy Commission, grew out of a Department of Defense request for such a mobile system. The Army's Corps of Engineers particularly needs a high-output powerplant which can operate for long periods of time with minimal service requirements.

missiles and rockets, July 18, 1960

## Pioneer V

(Continued from page 85)

ment of the interaction of solar wind and the earth's magnetic field, the first measurement of the size of the solar system by means of a space probe and a discovery that the so-called Forbush decrease in cosmic-ray intensity at the beginning of a solar flare is not confined to the region surrounding the earth.

*Pioneer V* exceeded the long-distance communication record by more than 55 times. The old record was held by *Pioneer IV*, the 13.4-lb. U.S. planetoid fired past the moon March 3, 1959, which was tracked out to a distance of 407,000 miles. Silverstein said the longest distance of communication claimed by the Soviets was 396,000 for *Lunik I*, their 3245-lb. vehicle fired past the moon Jan. 2, 1959.

Since last March, *Pioneer IV* has traveled 760 million miles in its orbit.

• **Failure analyzed**—Most of the communication from *Pioneer V* came from its five-watt transmitter. The probe also carried a 150-watt transmitter, which was left idle during the first four weeks of its journey. The larger transmitter responded promptly when commanded on for the first time on May 8. However, its use was limited because of the apparent deterioration of the spacecraft's 28 flashlight-sized batteries. The 5-watt transmitter is powered by batteries recharged by solar cells in four paddles stretching out from the body of the satellite.

NASA said any one or all of the three reasons might account for the failure of communication. They are:

• The spacecraft may be out of earth range of the 5-watt transmitter.

• Battery failure or leakage may have been induced by the extreme vacuum of interplanetary space.

• Some key component or system may have failed.

NASA and Space Technology Laboratories, which built the *Pioneer V* payload, are making a complete analysis of the performance, including the 138.9 hours of data transmission.

## First Missile Destroyer For Royal Navy Launched

LONDON—The Royal Navy has launched its first guided missile ship, the destroyer Devonshire. It should be ready for fleet service in early 1962.

Missile armament will include a *Seaslug* mounted on the quarter deck and two *Seacats* abaft the after funnel. The vessel will also have the latest ASW detection equipment.

Three sister ships—Hampshire, Kent and London—will be in service by 1963.

missiles and rockets, July 18, 1960

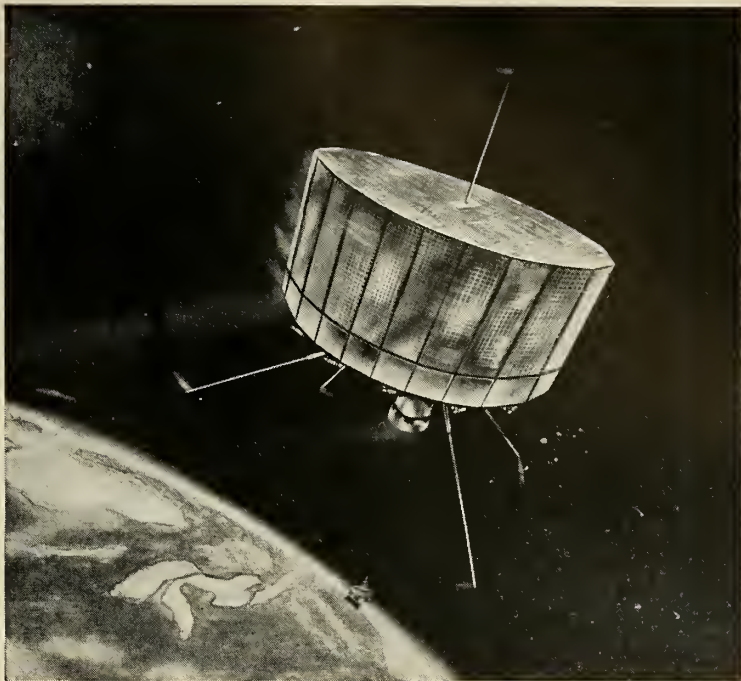


Photo courtesy Rodia Corporation of America

## aerospace

Components for RVX  
and TIROS Projects  
by LAVELLE

Major successes in the nation's accelerated space vehicle and missile programs include precision sheet metal components made by Lavelle. Among these is the fabrication by Lavelle of the structure of the new U. S. earth-circling TIROS weather observation satellite produced for the National Aeronautics and Space Administration by the Astro-Electronics Products Division, RCA. An artist's view of TIROS in orbit is shown above.

Pictured also is the recovery of the first successful RVX series re-entry vehicle after ICBM range flight. The aluminum alloy nose cone structure for this test was fabricated by Lavelle under sub-contract from the General Electric Company's Missile and Space Vehicle Department.

Some of the reasons why Lavelle has been selected to be a part of such dramatic projects are illustrated in a new brochure. Write for your copy.

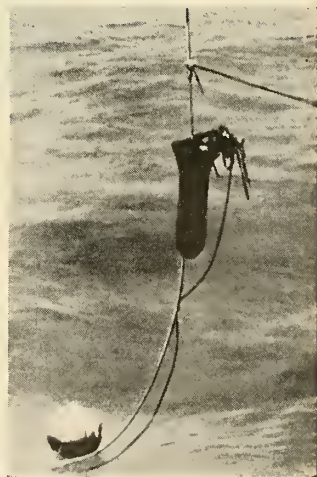


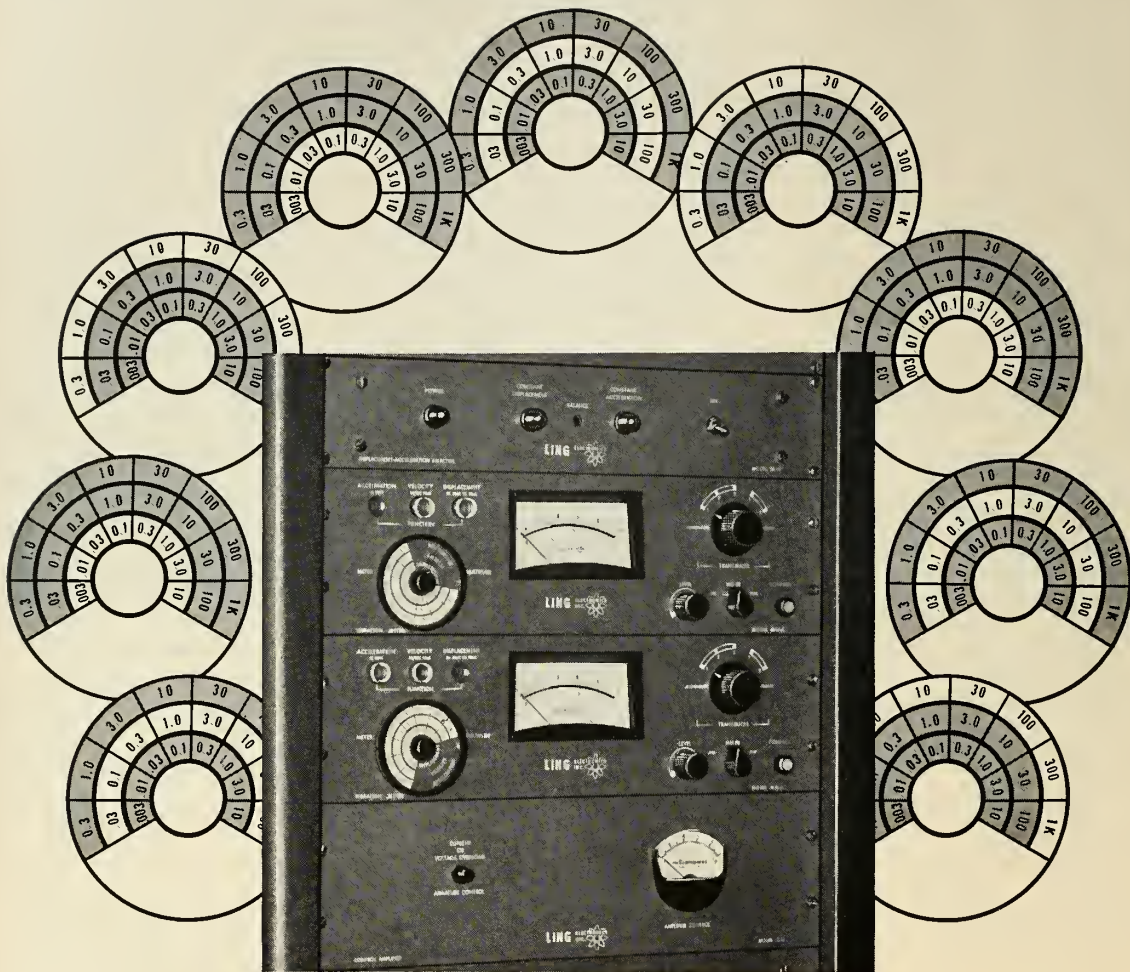
Photo courtesy World Wide Photos, Inc.

# Lavelle

LAVELLE AIRCRAFT CORPORATION • NEWTOWN, BUCKS COUNTY, PA.

Between Philadelphia, Pa., and Trenton, N.J.

Circle No. 62 on Subscriber Service Card.



## AUTOMATION IN VIBRATION—Vibration variations of 1000 to 1 automatically controlled by NEW LING S-14 SERVO

Ling introduces another advance in vibration testing—a new electronics servo system that offers a dynamic range of 60 db, plus remarkable accuracy and ease of control. This new variable response S-14 Servo System performs automatically, while frequency cycling with a sine-wave signal source. It simultaneously monitors any two values of acceleration, velocity or displacement, then automatically selects the larger as the controlling signal, and maintains it constant. Automatic thumpless transfer between the control functions takes place—you simply set the desired limits on the corresponding vibration meter. Reaction time is inversely proportional to frequency, and as a result, controlled levels of plus or minus 3% are attainable over a wide dynamic range. Like other Ling designs, the S-14 is flexible—the basic system can be expanded to handle 4 separate signals, or to permit automatic control from 3 or 4 control signals. For details, write Dept. MR-4 at our Anaheim address.



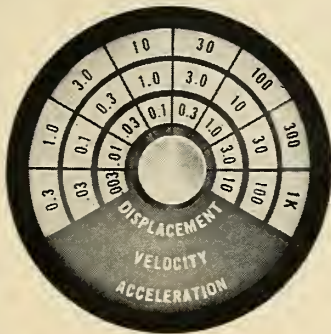
**L I N G**  
ELECTRONICS



The flexibility of the S-14 Servo System at the left, is just one more example of the way Ling design anticipates your needs of the future. Since the complete control package is made up of separate components, the system not only meets your present demands, but can readily be expanded. The basic two-level system includes 2 vibration meters, 1 control amplifier, 1 control selector,

By simply adding the appropriate number of meters and selectors, the system can be expanded to meter 3 or 4 separate signals with automatic transfer between control functions.

Transfer between control functions is handled by an electronic switch which automatically selects the correct crossover point. You merely set the desired limits on the corresponding vibration meter, shown close-up in the photo below. No thumps or other low frequency transients mar this smooth transfer.



This kind of flexibility, precision control and ease of operation begins with thoughtful consideration of basic operating requirements. And whatever your needs in high-power electronics—for vibration testing, acoustics or sonar—you'll find you can rely on Ling Electronics for the thoughtful design that leads to practical advances.

**L I N G**  
**E L E C T R O N I C S**  
 HIGH-POWER ELECTRONICS FOR  
 VIBRATION TESTING • ACOUSTICS • SONAR

'cocktail party effect . . .'

# New Sound Technique For Voice from Space

SANTA BARBARA, CALIF.—Astrometrics, Inc., has developed an entirely new sound reproducing system for voice transmission from space based on a principle observable at any cocktail party.

The system, called the "articulator," is designed to increase the intelligibility of an astronaut's voice under conditions of a high ambient noise level at the listening end, the transmitting end or in the transmission link itself.

It makes use of the fact that human ears are directional devices relying on both amplitude and arrival time differences for information. Sound emanating from in front and to the right of a listener will arrive at his right ear first, thus allowing the brain to decide where the source is. If two or more sounds are being generated at different locations, the listener has the ability to "tune up" the sound he wants and "tune down" the other.

This is what Astrometrics calls the "cocktail party" effect and it forms the basis for the Articulator, designed to make transmission from an astronaut more intelligible.

"This capability of the listener to tune in on one of the conversations and tune down all other conversations and noises in the room is dependent on his ability to locate the source of the sound he is after," company president W. M. Turner notes. "There's both a

physiological and a mental mechanism at work here."

Yet a tape recording taken in the same room will produce substantially unintelligible and confused sounds with only a few highlights coming through, Turner points out. This is attributed in large part to the fact that the tape-recorded sound emanates, in effect, from only one source.

• **Three frequencies used**—By feeding all desired and undesired signals from a single channel line into a phase shifter which has the characteristic of presenting two outputs with a constant phase difference relationship at all frequencies, (i.e., all frequencies from 20 to 20,000 cps are 90° apart at the two output terminals), a precise but different time delay from one output to the other results for every individual frequency component in the sound.

Ninety degrees represents 2.5 milliseconds difference at 100 cps, 250 microseconds at 1000 cps, and 25 microseconds at 10,000 cps. If these three frequencies are transmitted by two widely spaced speakers and the 90° phase relationship maintained, the three frequencies appear to the listener to be coming from three different locations between the two speakers.

Each voice has an attack transient containing a band of identifying frequencies. These become locating frequencies in a system of this type. If several voices, hum, and static all are

## Model 100 Articulator Specifications

Input Impedance:	greater than 47 K Ohms
Input Voltage: (required for rated power output)	1 Volt RMS
Input Signal Range:	0.1 to 5 Volts RMS
Output Power:	10 Watts (each channel)
Output Impedance:	4 Ohms (each channel)
Intermodulation Distortion:	} not applicable (function of speaker and ambient parameters)
Harmonic Distortion:	
Frequency Response:	
Improvement:	The average intelligence signal to noise ratio improvement is 3 db.
Power Required:	117 VAC 60 cps single phase at 1.25 amperes (nominal)
Physical Dimensions	
Amplifier and Control	
Unit:	5 1/4" H x 19" W x 13 1/2" D
Speaker Units:	5 1/4" H x 19" W x 7 1/2" D



Whether shooting for the moon or pinpointing an ICBM in the Atlantic, success or failure already has been determined before the button is pushed. Hit or miss depends upon the *reliability* of men, component parts, and support equipment.

Reliability of Hokanson missile support air conditioning has been proven in support of the Snark, Polaris, Thor, Titan, Minuteman, and Quail programs. Hokanson also has demonstrated its ingenuity by solving new and unusual air conditioning design and performance requirements.

If you have a missile air conditioning problem, let Hokanson solve it. Write today for our latest brochure.

*Designers and manufacturers of the H-35 airline mobile air conditioner now used throughout the world.*



**AIR CONDITIONING**  
**C. G. HOKANSON COMPANY, INC.**

2140 Pontius Avenue  
Los Angeles 25, California

Circle No. 66 on Subscriber Service Card.

being transmitted over one line, then, with the Articulator, the hum will seem to be coming from one point, one voice from another point and so on.

"The listener will subconsciously locate the desired sound and tune down all others, something that would be impossible if they were all following each other out of the same box," Turner says.

It is this which the company says greatly enhances the ability of the listener to extract the intelligence from a single channel sound transmission system. He can, in effect, "tune in" mentally on the astronaut's voice.

"Prior to the space age, important information in missile programs was derived from the radar, telemetry, and on board recording devices," says company president Turner. "Voice communications played a secondary role, only important at certain points in the countdown and during an occasional emergency transmission from a chase plane pilot. However, with the advent of men in space, we have in addition to the aforementioned sources of intelligence, the astronaut himself. What he says will be of great importance, so that the human voice as a source of data will be of primary or paramount importance as opposed to unmanned missile programs."

Turner points out that recovery of the human voice under conditions of space travel is a field on which very little effort has been expended.

Development of the Articulator is aimed at improving the intelligibility of man's voice under space conditions and is an effort to increase the useful range of transmission without further encumbering the vehicle or the astronaut himself.

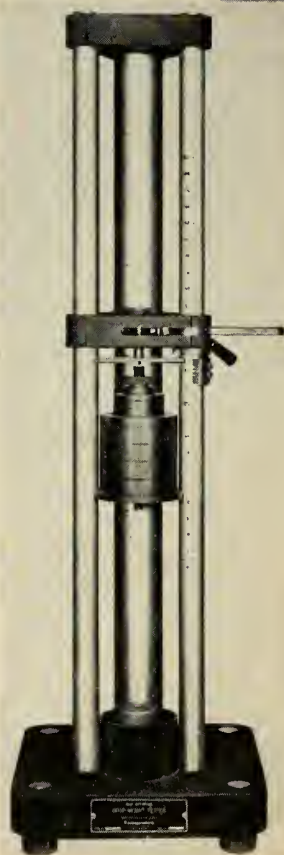
- **Used with telemetry**—The Articulator is added to the ground communication system between the final electrical voice output and the human receiver. The communications system up to the human receiver is immaterial to the Articulator. It can be AM, FM, single sideband, double sideband, constant level speech, narrow band FM, phase modulation or any other. It can be landline communications, it can be clipped, or it can be digitized and then reconstituted in an analog form.

Application of the Articulator is not limited to space programs but can be used in any communications system where intelligibility is important. It could be employed, for example, in playback of telemetry data where information for the annotation of records is derived from voice signals on the tape along with the telemeter information.

There are three separate units making up the Model 100 Articulator. The

## IMPACT TESTING Propellants and Explosives

WITH THE  
**OLIN MATHIESON\***  
**DROP-WEIGHT TESTER**



\* Developed by Olin Mathieson Chem. Corp.

**VERSATILE:** Particularly suitable for impact sensitivity testing all classes of materials, both solid and liquid, including slurries and low-boiling liquids.

**SAFE:** Convenient laboratory tool for determining the safety of handling new or unknown materials.

**RAPID:** One half-hour or less for a complete determination (20-30 tests).

**SIMPLE:** No special mount required. Operates at bench height on any table or laboratory work space.

**LOW COST:** Only a few cents per test.

Manufactured and Sold Under Exclusive License  
By

**Technoproducts**

INCORPORATED

P.O. BOX 5293—HAMDEN 18, CONNECTICUT

Circle No. 65 on Subscriber Service Card.

**BASIC  
BUILDING  
BLOCKS  
FROM KEARFOTT**



**NEW  
HIGH  
PERFORMANCE**

**Size 8 Motor Generator**

This new Size 8 high performance servo motor-generator features high signal output and extremely low null voltage. The signal-to-noise ratio of 100:1 and linearity of 0.2% make the application of this motor generator to light-weight integrator packages most desirable. Stainless steel construction and thermal stability of this component assure its reliability and long life in the most severe environments.

**ELECTRICAL  
CHARACTERISTICS**

Motor Section	Generator Section		
	Phase 1	Phase 2	Excitation
Voltage (volts)	26	40	26
Frequency (cps)	400	400	400
Current (ma)	110	77	72
Power Input (watts)	2.3	2.3	1.3

**GENERATOR SECTION  
OUTPUT**

Volts at RPM (mv)	10
Volts at 1000 RPM (volts)	1.1
Output Impedance (ohms)	21 + j2500
Rated Load (ohms)	100,000

**MECHANICAL  
CHARACTERISTICS**

No Load Speed (RPM)	6500
Stall Torque (In. Oz.)	0.25
Rotor Moment of Inertia (gm-cm <sup>2</sup> )	1.2
Theoretical Acceleration (Rad/Sec <sup>2</sup> )	14,400
Weight (Oz.)	3.9

Write for complete data.

**BASIC  
BUILDING  
BLOCKS  
FROM KEARFOTT**



**QUADRATURE  
REJECTION  
CIRCUIT**

Kearfott's quadrature rejection circuit is designed to operate from a pre-amplifier or gain controlled amplifier into a transistor servo amplifier. This small, light and rugged device rejects the component of the input wave which is 90° from the reference input. The component of the input sine wave which is in-phase with the reference will produce a square wave whose magnitude is proportional to load and magnitude of in-phase signal. Kearfott's high-performance rejection circuit is designed to operate in an ambient temperature range of -55°C to +115°C at unlimited altitudes.

**TYPICAL  
CHARACTERISTICS  
#D4816-01**

Input Impedance — In phase signal component (ohms)/5000  
+R<sub>L</sub> / Quadrature component (ohms)/5000 (min)

Signal Frequency (cps)/400  
Max. Signal Input (volts RMS)/6  
Bandwidth (cps)/6

Quadrature Rejection Ratio:  
Rejection Ratio (min)/50:1/  
35:1/35:1

Signal Input/0.15 to 4/4 to 6/  
0.005 to 0.15

Meets environmental requirements of MIL-E-5272.

Write for complete data.

**BASIC  
BUILDING  
BLOCKS  
FROM KEARFOTT**



**TWO  
AXIS  
ACCELER-  
OMETERS**



Highly precise and accurate, Kearfott two-axis accelerometers are pendulous devices which sense airframe acceleration forces acting on them in aircraft and missile guidance systems, navigational computers and wherever acceleration must be measured precisely and translated into electrical output signals.

The pendulum is anchored to a housing by means of a unique Hooke's joint type spring suspension. Whenever there is relative motion between pendulum and housing due to acceleration, an AC excited, air-core differential transformer type pickoff produces a voltage which is a servo error signal that is fed into an AC to DC amplifier. Feedback signal in form of a DC current transmitted to a restoring coil produces a force that exactly balances force of any accelerations acting on pendulous mass.

**TYPICAL  
CHARACTERISTICS**

Range of Measurement: ± 25g (can be adjusted upward within amplifier limits.)

Scale Factor (Output): 5.0000 MA/g of applied acceleration.

Operating Temperature: Performance is optimized within any 20°F range between +50°F and +150°F.

Linearity (Output): Within ± 0.005% of the applied acceleration.

Threshold: Less than 2 x 10<sup>-7</sup>g.

Zero Stability: ± .00005g day to day; less than ± .00002g over any continuous time interval.

Vibration: Up to ± 5g peak from 20 to 2000 CPS.

Storage Temperature: -60°F to +170°F.

Scale Factor Variation: ± 0.01% randomness.

Write for complete data.

**KEARFOTT DIVISION**  
Little Falls, New Jersey



**GENERAL PRECISION, INC.**  
Other Divisions: GPL, Librascope, Link

SPACE STATION



POLARIS FBM



PROJECT ARGUS

# EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

## ADVANCED PROJECTS AT LOCKHEED

**POLARIS FBM** Now in its advanced development status, the Navy-Lockheed POLARIS Fleet Ballistic Missile is scheduled to be fully operational and aboard its specially designed submarines late this year. Full-scale test vehicles have been successfully flown on a regular schedule of firings for months with only two failures, a remarkable achievement in view of the totally different environmental problems involved in its underwater launch. With nearly three-quarters of the earth's surface being water, practically no target in the world is outside the POLARIS' range of over 1200 nautical miles. The Division is systems manager for the POLARIS under the direction of the Special Projects Office of the Navy.

**SATELLITE PROGRAMS** The Air Force-Lockheed AGENA satellite is a versatile space vehicle capable of numerous assignments. In its present DISCOVERER program configuration, it is 19 feet long, 5 feet in diameter with an orbital weight of approximately 1700 pounds. Payload of several hundred pounds includes telemetry, instrumentation, guidance and attitude control systems, reentry vehicle and recovery capsule. The AGENA has accomplished several significant space "firsts." It was first to be placed on the difficult polar orbit; first to be placed on a precise, predicted, and nearly circular orbit; first to change its attitude on orbit, with a turn of 180 degrees and a downward tilt of 60 degrees; first to eject a capsule; and first to prove advanced space systems such as ground-space communications, instrumentation, attitude and guidance and life-sustaining devices. The AGENA can be modified for a variety of space missions such as navigation; geophysical investigations; lunar probes; long-range communications; and space probes.

In addition to the DISCOVERER program, the Division is developing advanced AGENA satellites for the MIDAS program (Missile Defense Alarm System) and the SAMOS strategic warning system. Lockheed is system manager and prime contractor for these projects under the direction of the Air Force Ballistic Missile Division (ARDC).

**SPACE STATION** An orbiting research facility to serve as an advanced base for space exploration, has been proposed in practical detail by Lockheed's research and development staff. The station would carry a 10-man crew. Prefabricated compartments for the rim of the wheel, the spokes, and the three hubs would be launched separately by ballistic missiles and assembled in space by means of the specially-designed, Lockheed Astrotug.

**X-17 KINGFISHER** The Air Force-Lockheed X-17 solid-propellant ballistic missile has pioneered many new techniques, and the valuable experience gained from this program facilitated development of other, inter-service projects, including the Navy POLARIS FBM. The Navy's Project Argus radiation explosion featured the X-17 as the vehicle. Developed for the Air Force, the Lockheed KINGFISHER is designed to simulate enemy attacks to test our nation's anti-bomber and anti-guided-missile defenses. The Air Force X-7 is a unique, recoverable ramjet-engine test vehicle designed to test new developments in advanced components for other missiles.

The successful completion of projects such as these requires a bold and imaginative approach to entirely new environments. Lockheed's programs reach far into the future. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. G-29A, 962 W. El Camino Real, Sunnyvale, California. U. S. citizenship or existing Department of Defense industrial security clearance required.



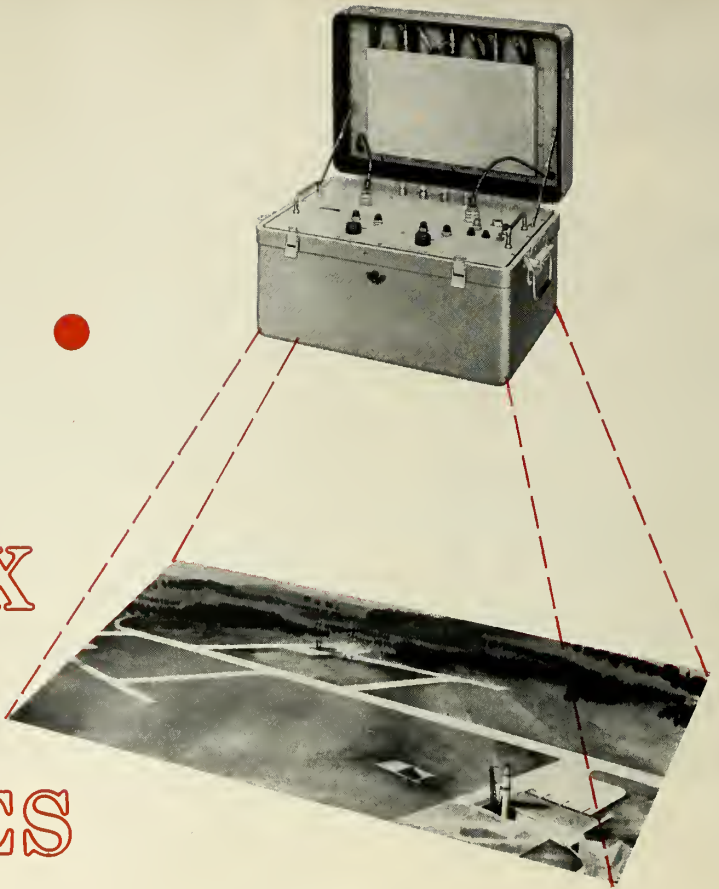
Lockheed

## MISSILES AND SPACE DIVISION

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA  
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII

# the new Giannini Portable Pressure Generator

A  
2 FT. BOX  
THAT  
COVERS  
10 ACRES



From 10 acres of launching area to a laboratory bench...in Ground Support, production or research...now you can find a compact, portable Giannini Pressure Generator to do any of these things:

- Obtain precise static and pitot pressure readings from two related electromechanical pneumatic systems.
- Inspect, production-test and calibrate such systems. Test them on the flight line. Furnish arbitrary pressure outputs as a function of voltage inputs (manually or remotely selected) for simulated flight of missiles, aircraft and other vehicles.
- Generate absolute, differential or gage pressures and pressure ratios. Direct digital readout. Select from a variety of accuracies, resolutions, pressure ranges, ratios, rates.

Designed for maximum utility, Giannini's new pressure generators are easily transported. Rugged

mechanically. Simple electronically. Give long, trouble-free life in lab or field.

**Proof of performance: this useful new Ground Support unit is currently being used to test the Giannini Variable Inlet Control System on a new supersonic jet interceptor.**

**WRITE FOR DETAILS OR FOR A DISCUSSION ON YOUR SPECIAL APPLICATION NEEDS.**

#### Specifications, Giannini Portable Pressure Generator

##### OPERATING MEDIUM

Dry (instrument) air

##### OPERATING INPUTS REQ'D.

Air Pressure: 20 to 30 PSIG

Vacuum Source: 0 to 2.0

inches of mercury (absolute)

##### OUTPUT PRESSURE RANGES

Static Pressure (P<sub>s</sub>): 2 to 70

inches of mercury (absolute)

Pitot Pressure (P<sub>t</sub>): Auto-

matically determined by P<sub>s</sub>

and P<sub>t</sub>/P<sub>s</sub> settings

P<sub>t</sub>/P<sub>s</sub> Ratio Range: 0.580 to

0.940

Other Static and Ratio

ranges available.

Differential Pressure range:

0 to 30 inches of mercury.

##### POWER REQUIREMENTS

110 volts, 400 CPS—275 watts

##### OVERALL DIMEN (Approx.)

Height: 14.5 inches

Width: 24 inches

Depth: 16 inches

##### AMBIENT TEMPERATURE

Range: -54°C (-65°F) to

+55°C (+130°F)

Weight: Approx. 80 pounds

**Giannini Controls Corporation** 1600 South Mountain, Duarte, California

A NAME TO PLAN WITH

A challenging new career awaits you at Giannini: Write to the Director of Technical Personnel

ccc 0-3

main chassis contains the controls, a 90° phase shifter, two separate audio servosound amplifiers and a DC power supply. The other two units are identical speaker enclosures with the exception of the location of barrier terminal strips on the rear section.

In use the two speaker enclosures are placed at the same height on the same plane with a center to center distance in the range of 6 to 20 ft. Cables 10 ft. in length are provided for connection of the speaker enclosures to the main chassis.

Astrometrics has determined, using series of random-number and other tests on listening groups under a variety of ambient listening conditions, that the average intelligence improvement under conditions of noise in the transmission link is 3 db. An improvement of this magnitude would, in the case of a moving aircraft, result in a range increase of 1.4 to 1.

The improvement in intelligibility under conditions of ambient room interference is said to be much more spectacular. Astrometrics explains the improvement this way:

Consider the case where a voice is emanating from a single speaker in a room with an interfering voice at a higher amplitude than the desired reproduced voice. If the amplitude peaks of the interfering voice are sufficiently high to override the desired voice, a listener can no longer keep his physical and mental machinery "tuned to" or "locked on" the desired voice and is thereby distracted by the interfering voice. In the case of the Articulator's two outputs with 90° phase difference, if the interfering voice peaks are coincident and override the peaks of the voice emanating from one speaker, it necessarily follows that they cannot interfere with all of the peaks coming from the other speaker—since the sounds from the other speaker arrive at a different time. All of the intelligence-containing components of the voice arrive at different times, so that even if the interfering voice were to be coincident with some frequencies, it cannot coincide with others because there is an arbitrary and varying difference in time delay between the two speakers.

• **Negative feedback**—If a rapid-speaking, interfering voice, such as a radio commercial, is turned on at a volume greatly exceeding that of a desired single channel signal reproduction, the desired signal is virtually unintelligible. The recovery ratio is approximately 10%. Addition of a second speaker, at no increase in volume, increases the intelligibility to 95 or 100%. Effectivity of the Articulator phase relationship is said to be even more pronounced with use of a stereo-

phonic headset because the phase relationships are retained in their pure state and therefore are not deteriorated by room reflections.

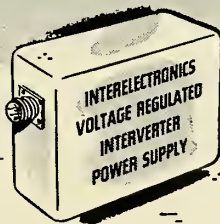
It is coincidence that the intelligence or fidelity increasing mechanism of each of the two channels considered separately in the Articulator also is a phase function. The Articulator has a novel feedback circuit which treats the speaker itself as a transducer and reflects variations from a pure resistive load back into the amplifier in a negative feedback sense. The particular feedback arrangement employed results

in essentially a "constant power" amplifier characteristic. The amplifier is neither constant voltage nor constant current, but constant power. The constant power relationship has been determined, through empirical study, to produce the highest auditory fidelity.

Harmonic distortion measurements made on speakers using this feedback versus pure voltage feedback in the conventional sense will yield a greater harmonic distortion reading. However, since the speaker is resistive only at two frequencies and is either capacitive or inductive at all other frequencies,

## PROVEN RELIABILITY— SOLID-STATE POWER INVERTERS

**over 260,000 logged hours— voltage-regulated,  
frequency-controlled, for missile, telemeter, ground-  
support, 135°C all-silicon units available now—**



Interelectronics all-silicon thyrotron-like gating elements and cubic-gyro toroidal magnetic components convert DC to any desired number of AC or DC outputs from 1 to 10,000 watts.

Ultra-reliable in operation (over 260,000 logged hours), no moving parts, unharmed by shorting output or reversing input polarity. Wide input range (18 to 32 volts DC), high conversion efficiency (to 92%, including voltage regulation by Interelectronics patented reflex high-efficiency magnetic amplifier circuitry).

Light weight (to 6 watts/oz.), compact (to 8 watts/cu. in.), low ripple (to 0.01 mv. p-p), excellent voltage regulation (to 0.1%), precise frequency control (to 0.2% with Interelectronics extreme environment magnetostrictive standards or to 0.0001% with fork or piezoelectric standards).

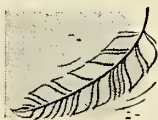
Complies with MIL specs. for shock (100G 11 mlsc.), acceleration (100G 15 min.), vibration (100G 5 to 5,000 cps.), temperature (to 150 degrees C), RF noise (I-26600).

AC single and polyphase units supply sine waveform output (to 2% harmonics), will deliver up to ten times rated line current into a short circuit or actuate MIL type magnetic circuit breakers or fuses, will start gyros and motors with starting current surges up to ten times normal operating line current.

Now in use in major missiles, powering telemeter transmitters, radar beacons, electronic equipment. Single and polyphase units now power airborne and marine missile gyros, synchros, servos, magnetic amplifiers.

Interelectronics—first and most experienced in the solid-state power supply field produces its own all-silicon solid-state gating elements, all high flux density magnetic components, high temperature ultra-reliable film capacitors and components, has complete facilities and know how—has designed and delivered more working KVA than any other firm!

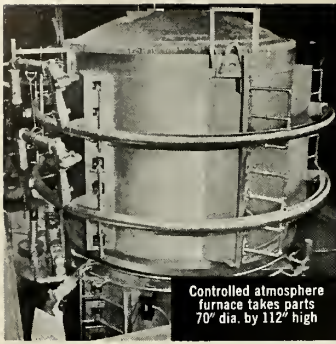
For complete engineering data, write Interelectronics today, or call Ludlaw 4-6200 in New York.



## INTERELECTRONICS CORPORATION

**2432 Grand Concourse, New York 58, N. Y.**

Circle No. 69 on Subscriber Service Card.



Controlled atmosphere furnace takes parts 70" dia. by 112" high

## Ask for Special Help When Brazing Stainless



Silver brazed titanium heat exchanger, done in a vacuum furnace

Ask us for help in deciding how to best braze your stainless alloy assemblies. We successfully braze almost every known stainless steel, superalloy, and aluminum or titanium bearing metal.

Ask us to choose the best brazing alloy from the massive array of copper, silver, and nickel base alloys available. We know and use them all.

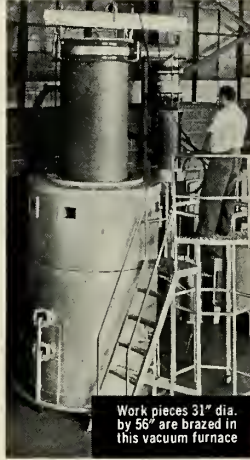
Ask us for a quotation on doing your stainless brazing or heat processing. Our pencils are sharp and so are the four furnace plants we operate to serve you.

### WALL COLMONOY CORPORATION Stainless Processing Division

19345 John R Street • Detroit 3, Michigan

Wall Colmonoy furnace plants are maintained in Michigan, Pennsylvania, Ohio, and California

Circle No. 70 on Subscriber Service Card.



Work pieces 31" dia. by 56" are brazed in this vacuum furnace

there is a phase difference between the cone movement at all different frequencies from a given speaker.

An example of this might be a 100 cps square wave wherein the speaker has a capacitive reactance at the fundamental frequency of 100 cycles, but is resistive at 300 cycles and highly inductive at 50° cycles. Under these conditions, a microphone picking up the same square wave reproduced by the speaker would display a waveform bearing little resemblance to a square wave.

Use of the Articulator feedback circuit reflects the speaker movement in a negative feedback sense, providing a great deal of phase correction such that the square wave components are reconstituted in their proper phase relationships.

There are circuits which have been employed to yield essentially perfect phase correction up to the piston point of speakers. However, these circuits, in the past, have resulted in a prohibitive amount of complexity. Additionally, it is Astrometrics' opinion that all of the practical circuits used to obtain this result leave much to be desired in the sense of actual listening fidelity. The unique constant power circuit employed by Astrometrics reflects speaker load variations back into the amplifier and results in what has been empirically determined to be the optimum reproducing condition for any particular transducer.

Astrometrics believes there is an important delineation which should be made between the mechanism of phase delay or constant phase shift as employed in the Articulator and the time delay mechanism used in the past by the military.

In the case of the time delay, which has been found to increase intelligibility in aircraft, the principle is this: if a sound generated at the right ear is interfered with, by some ambient noise peak, that same noise sound arrives at the left ear later in time and may, by coincidence, not be interfered with at all.

It is certain that the same peak that interfered with the sound in the right ear will not affect the left. However, in the case of the Articulator, since there is a varying time delay for all of the different frequency components of the desired signal, an interfering sound at the right ear cannot interfere with any of the components from the left ear. An additional interfering sound that might affect one component of the left ear can necessarily not interfere with all of the components since they are distributed in time.

# DELTA-COUPLES

MINIATURE THERMOCOUPLES  
PRECISION JUNCTION LOCATION  
MINIMUM HEAT FLUX DISTORTION  
RAPID - ACCURATE RESPONSE  
SURFACE & IN-WALL TEMPERATURE SENSING

DELTA-COUPLES are precision thermocouples engineered for accurate, pinpoint temperature measurements in steel or aluminum structures. Available in five basic types, DELTA-COUPLES are being successfully applied in the field of missiles and rockets to combustion chambers, blast deflectors, launching structures, injection nozzles, missile skins, and in thermodynamic model studies. Pictured are the W1 and W2 types, ideally suited for instrumentation of thin steel and aluminum structures.

Write for DELTA-COUPLE Catalog ATL-903

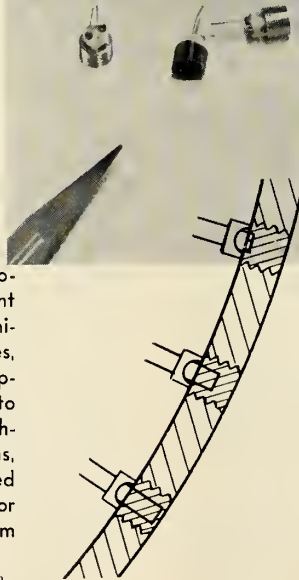


ADVANCED Technology LABORATORIES

A DIVISION OF AMERICAN Standard

Dept. AE-1, Whisman Road, Mountain View, California

Circle No. 71 on Subscriber Service Card.





**SIE** Airborne Electronics  
 for the MARTIN COMPANY,  
 Prime Contractor for the  
 U. S. Army Pershing Missile

# PERSHING

**AIRBORNE TELEMETRY  
 SIGNAL CONDITIONING  
 SYSTEMS**

from

**SIE**



SIE provides airborne telemetry, signal conditioning systems—using solid state electronics—for the U. S. Army's new Pershing Missile, recently successfully test-fired at Cape Canaveral. SIE measurement equipment delivers unexcelled reliability under extreme airborne environmental conditions—providing the Martin Company with advanced, precise electronic missile measurements.

For detailed information about SIE telemetry, signal conditioning systems, please contact LIGHT MILITARY PRODUCT MANAGER.



AC-3A  
AC Amplifier



TPC-27  
Transistorized  
Power Supply



D-8A  
DC Amplifier



DL-12A  
Phase-Sensitive  
Demodulator



FMC-1  
Flow Meter  
Converter



TPC-35  
Transistorized  
Power Supply



**SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.**  
 A DIVISION OF DRESSER INDUSTRIES, INC.

10201 Westheimer • P. O. Box 22187 • Houston 27, Texas • HO mesteod 5-3471

CABLE: SIECO HOUSTON

TWX: HO-1185





# A HISTORY OF ROCKETRY

1892  
RUDITZKY'S  
ROCKET-BOAT  
WHICH EXPLODED  
ON THE VOLGA  
EARLY IN 1893



1885 BRYCE-BETTANCOURT ASCEND  
IN A ROCKET-POWERED BALLOON  
CLAIM THE ALTITUDE RECORD FOR  
THE ROYAL "BALOONATICS" CLUB

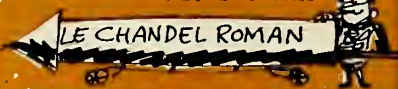


1887  
PRAISED HIGHLY BY HIS PHYSICS  
MASTER FOR HIS ADVANCED WORK  
IN FUELS, VLADIMIR POPOWSKI  
DISCOVERED MANY PITFALLS—  
WHICH HELPED PAVE THE WAY  
FOR ROCKETRY, AS WE KNOW IT.

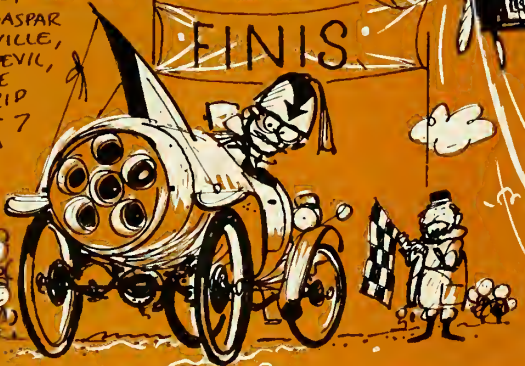


1902  
ADOLF ZIMMER  
SOMETIMES CALLED  
THE ICARUS OF ROCKETRY  
IN AN EARLY MODEL,  
THE ZIMMER "ZOOMER"

AN EARLY ROCKET



A RARE SHOT  
OF ETIEN GASPAR  
DE BOURBONVILLE,  
NOTED DAREDEVIL,  
WHO WON THE  
PARIS TO MADRID  
RACE AGAINST 7  
HORSES AND A  
MULE.



JOACHIM  
PULLIZANZOF -22  
PROBABLY THE WORLD'S  
MOST FAMOUS MASTER  
SPY, USED THE ROCKET  
TO CONVEY MESSAGES TO  
BELGRAVIA, ACROSS THE  
MESOPOTAMIAN FRONTIER

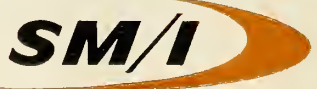
COURTESY OF THE FRENCH PICTORIAL  
"LES INVENTEURS CRACKPOTIQUE DE 1913"

-COLIN BAILEY.

©1960 SERVOMECHANISMS/INC.



1960— Fuel Management: Propellant utilization...accurate tanking of missile  
...thrust control. These are some of the areas in which SM/I has demonstrate  
fuel management capabilities. More advanced measuring and control system  
for the new generation of missiles and spacecraft are in development at SM  
to solve your fuel management problems. Write for information and literatur



**SERVOMECHANISMS/INC**

LOS ANGELES DIVISION:  
12500 Aviation Boulevard, Hawthorne, California  
MECHATROL DIVISION: Westbury, New York  
RESEARCH DIVISION: Goleta, California  
SERVOMECHANISMS (Canada) Ltd.: Toronto

Subcontractors to leading system managers...Aircraft and Missile Instrumentation...Ground Support and Test Equipment...Fuel Management...Systems, Subsystems and Component