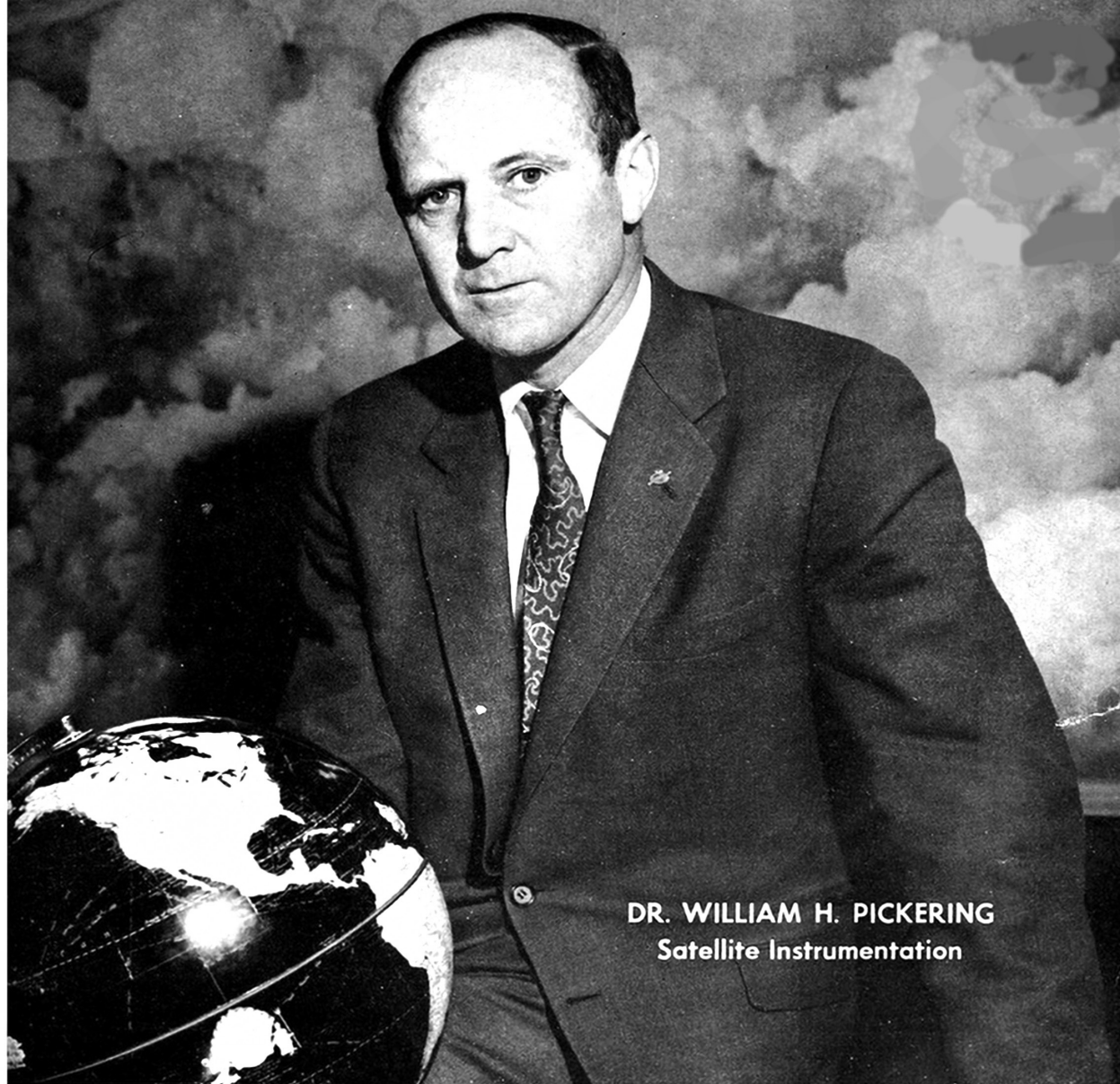


DECEMBER 29, 1958



DR. WILLIAM H. PICKERING  
Satellite Instrumentation



# missiles and rockets

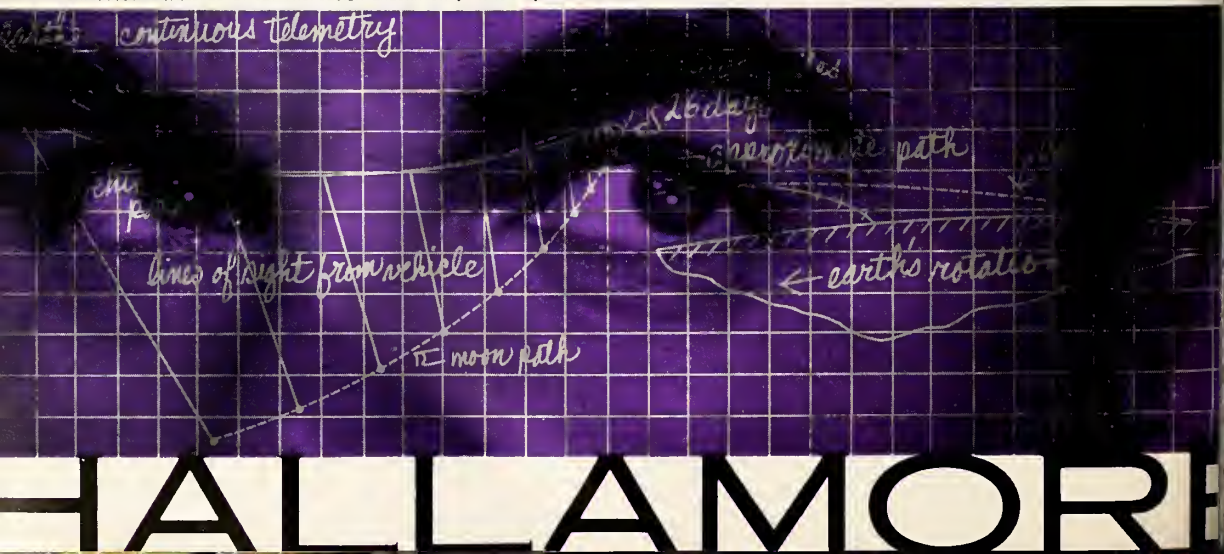
MAGAZINE OF WORLD ASTRONAUTICS

**Engineering and Electronics Edition**

AN AMERICAN AVIATION PUBLICATION

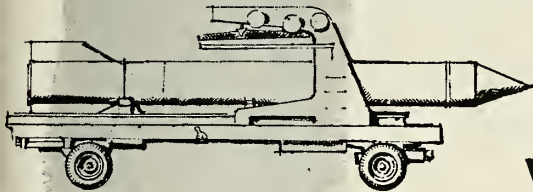
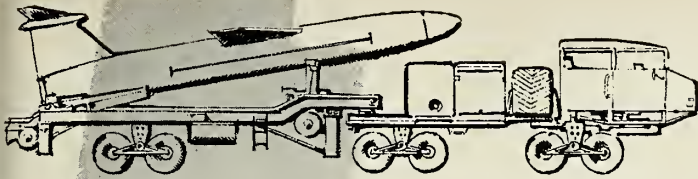
**INTELLIGENCE**—Hallamore Microlock\* provides the all-important link of intelligible communication between space vehicles and earth. Six Hallamore developed Microlock tracking stations monitor positions and receive intelligence from Vanguard and Explorer satellites...stand watch, with full capability, on U.S. Airforce and U.S. Army Lunar Probes. Microlock "locks" on fractional signals from tiny transmitters to bring in messages free of noise distortion. Hallamore developments in audio-visual telemetry, versatile automatic checkout systems, and guidance are speeding man's mastery of missilery and space technology. For systems capability, plug-in building blocks and C.C.T.V., write Hallamore Electronics Company, 8352 Brookhurst Avenue, Anaheim, California / TWX: AH 9079: a division of The Siegler Corporation.

\*ORIGINALLY DEVELOPED BY JET PROPULSION LABORATORY, PASADENA, CALIF.

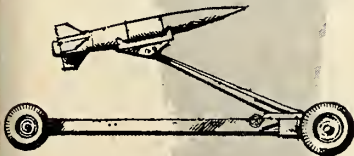
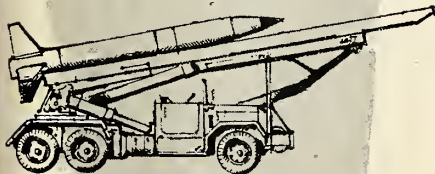
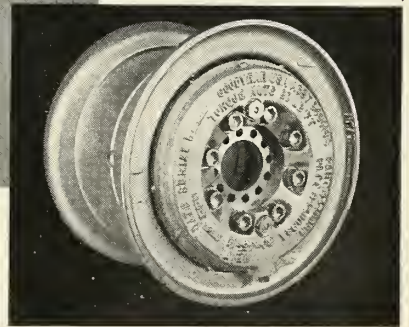
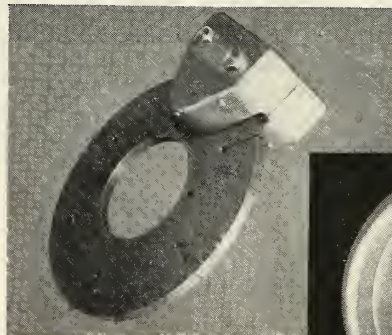
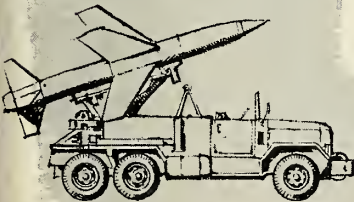


# HALLAMORE





Got a  
**brake or  
wheel problem?**



## Trust an old name to solve something new

If ground support equipment is your business, you can count on Goodyear to supply brakes and wheels to meet the most rigid specifications.

*Goodyear Industrial Disc Brakes* are custom-engineered for difficult applications where torque, energy, weight, space and corrosion are major problems.

*Goodyear Lightweight Aircraft Type Wheels* of cast or forged magnesium or aluminum assure top performance for today's highly specialized ground support equipment. Combined with Goodyear Aircraft Tires, they are the solution to the minimum weight and maximum strength requirements.

Why not put Goodyear's long aeronautics experience to work in solving your problems in this new and growing field? Address your inquiries to Goodyear, Aviation Products Division, Industrial Disc Brake Dept. S-1730, Akron 16, Ohio.

THE SOUND ANSWERS COME FROM

**GOODYEAR**  **60th ANNIVERSARY**  
**AVIATION PRODUCTS**

TO ADVANCE YOUR PROJECT'S COMPLETION DATE

missiles and rockets, December 29, 1958

Circle No. 1 on Subscriber Service Card.



"SPACE CHESS," a painting by Simpson-Middleman, a doubly-gifted team of artists with a scientist's penetrating insight. They portray here "a chess-like game played in a segment of space on a skewed board with pieces of uncertain value against an unknown antagonist. The next move is unforeseen—it will come out of the dark—it will be history's most fateful gambit."

## Space-age openings at Boeing

Advanced projects under contract at Boeing include Minuteman, a solid-propellant intercontinental ballistic missile, and Bomarc, America's longest-range area-defense supersonic guided missile system. Also underway at Boeing are studies for orbital, lunar and interplanetary systems.

These programs, along with extensive advanced research efforts at the frontiers of science, have created some of the nation's truly outstanding career opportunities for engineers and scientists.

There are openings at Boeing, now, in research, design, manufacturing and development, in such advanced areas as celestial mechanics, glide vehicles, space trajectories, high speed drag and heating effects

in space flight and re-entry, anti-submarine warfare techniques, gas dynamics, nuclear physics, solid-propellant rocket engines, infrared techniques, anti-missile missiles, advanced electronics, and ion and plasma production and manipulation.

Boeing's space-age orientation, exemplified by advanced studies now underway in ballistic, orbital, lunar, interplanetary and advanced defense systems, has already laid a foundation for continuing leadership in the future. Engineers and scientists of all categories find at Boeing the kind of forward-striding environment that means dynamic career growth. Drop a note now to Mr. Stanley M. Little, Dept. R-83, Boeing Airplane Company, Seattle 24, Washington.

**BOEING**





**COVER:** Dr. William Pickering, head of Jet Propulsion Laboratory, has new assignments awaiting him with transfer of the California facility to the National Aeronautics and Space Administration. (Page 17)

**Editor** .....ERIK BERGAUST  
**Executive Editor** .....CLARKE NEWLON  
**News Editor** .....DONALD E. PERRY

**ASSOCIATE EDITORS:**

NORMAN L. BAKER ....Engineering & Production  
 RAYMOND M. NOLAN ....Electronics & Guidance  
 PEER FOSSEN .....Tracking & Ground Support  
 WILLIAM O. MILLER .....Military & Defense  
 ALFRED J. ZAEHRINGER ...Propulsion & Chemistry  
 E. M. CROMLEY .....Congress & Government

**ASSISTANT EDITORS:**

REED BUNDY .....Business News  
 PAUL MEANS .....ARPA & NASA

**CONTRIBUTING EDITORS:**

F. I. ORDWAY III, H. CANNEY and  
 R. C. WAKEFORD .....Research  
 DR. ALBERT PARRY .....Soviet Affairs  
 DR. HUBERTUS STRUGHOLD .....Space Medicine  
 DR. I. M. LEVITT .....Astrophysics  
 K. W. GATLAND and  
 G. V. E. THOMPSON .....Great Britain

**EDITORIAL ADVISORY BOARD:**

DR. WERNHER VON BRAUN ROBERT P. HAVILAND  
 DR. PETER CASTRUCCIO DR. ARTHUR KANTROWITZ  
 KRAFFT A. EHRLICHE DR. EUGEN SAENGER  
 RICHARD P. GOMPERTZ ALEXANDER SATIN

**REGIONAL EDITORS:**

F. S. HUNTER, FRANK MCGUIRE, R. VAN OSTEN ....  
 Beverly Hills, Calif., 8929 Wilshire Blvd.  
 ANTHONY VANDYK .....Geneva, Switzerland  
 10 Rue Grenus, Phone 321044  
 JEAN-MARIE RICHE ....11 Rue Condorcet, Paris 9e

**PRODUCTION:**

WILLIAM H. MARTIN .....Art Director  
 COLLIS CAMPBELL .....Asst. Art Director  
 JOHN WALLEN .....Production Manager  
 ELSIE GRAY .....Asst. Production Manager

WAYNE W. PARRISH  
 President & Publisher

LEONARD A. EISERER .....General Manager  
 O. A. HURT .....Assistant Publisher  
 EDWARD D. MUHLFELD .....Advertising Sales Manager  
 LAWRENCE BRETTNER .....Circulation Director  
 STEPHEN A. RYNAS .....Advertising Promotion Mgr.  
 DAGFINN T. FOSSEN .....Research Manager  
 GLADYS BUSSELL .....Advertising Service Mgr.

missiles and rockets Vol. 4, No. 26, Dec. 29, 1958

Published every week by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C. Printed at the Telegraph Press, Harrisburg, Pa. Second class postage paid at Harrisburg, Pa., and at additional mailing offices. Copyright 1958, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Postal Union Nations—1 year, \$8.00; 2 years, \$12.00; 3 years, \$14.00. Foreign—1 year, \$20.00; 2 years, \$30.00; 3 years, \$40.00. Single copy rate—\$.75. Subscriptions are solicited only from persons with identifiable commercial or professional interests in missiles and rockets. All subscription orders and changes of address should be referred to: the circulation fulfillment department.

## in this issue

### ▶ DECEMBER 29 HEADLINES

#### Space Communications Greatest Feat of SCORE

Messages relayed from the big *Atlas* satellite mark a great new step in man's exploration of space .....13

#### 1958: The Year of Space Awakening for U.S.

Despite a somewhat creaking start, nation has made progress in the world's competition for solar supremacy .....14

#### Pickering Takes His JPL Team to NASA

With CalTech, he will continue to operate laboratory, including the design of instrumentation for future space probes .....17

### ▶ ASTRONICS ENGINEERING

#### Wanted: Metals to Withstand 20,000 Degrees

Space vehicles will require products with temperature factors far exceeding those known today, but industry is accepting the challenge .....18

### ▶ MISSILE ELECTRONICS

#### Test Engineer Must Be a Make-Believe Artist .....28

#### Los Alamos Scientists Study Solar Sail .....32

### ▶ NEW MISSILE PRODUCTS

#### Connectors operate in acids up to 450 degrees .....25

#### Compact Encoder Reports More Precisely .....25

#### New Seals Provide Mechanical Operation .....26

### ▶ DEPARTMENTS

Washington Countdown ... 7  
 Industry Countdown .....11  
 Astrionics .....21  
 Contract Awards .....21  
 West Coast Industry .....23  
 When and Where .....33  
 Editorial .....34





## DESTRUCTIVE TESTING MISSILE MOTOR CASES

These random samples of Falcon motor cases were tested to destruction as proof of product reliability. In addition to extensive Scoife "in-process" quality control procedures—beginning with metallurgical examination of incoming materials and subsequent hardness-testing, harmonic thickness gauging, magnetic particle and dye penetrant inspection, radiographic examination and hydrostatic testing—Scoife "proof-tests" random product samples, where practical, to insure product reliability. In supplying missile motor cases for nearly a decade, Scoife's primary considerations have been to produce cases which meet contract obligations with a maximum of safety, performance, and design. For further information on Scoife "know-how" for application to your missile programs write, or phone EMerson 2-2100.

# SCAIFE

FOUNDED IN 1802 • OAKMONT (PITTSBURGH), PA. • A DIVISION OF WILSON BROTHERS

**PRODUCERS OF THE GREATEST NUMBER OF HIGH PERFORMANCE MISSILE MOTOR CASES IN AMERICA**



## washington countdown

### A portable atomic warhead . . .

for use by infantry now is near final feasibility studies. Sometimes referred to as **Davy Crocket**, the weapon is a mortar type. A three-man team will employ the weapon whose warhead yield is below one kiloton. It will fill in the Army's battlefield mobility concept arsenal between the 155mm howitzer and nuclear weapons of 20 kilotons, such as was used at Hiroshima. **Davy Crocket**, one Army spokesman said, "is the greatest thing to come along since they gave the Army wheels."

### Navy tests of packaged liquid . . .

power plant recently in an air-to-air missile—possibly *Sidewinder*, are reported highly successful. Tests were carried out at the Naval Ordnance Test Station, Inyokern, at China Lake, Calif.

### Defense requirements, not budget . . .

should be the deciding factor in military spending, according to Senator Stuart Symington, former AF secretary. Commenting on the cancellation of *Rascal* and *Goose*, he claimed the public is being misled as to the reasons for some of the cutbacks.

### To cut excessive lead time . . .

Senator Leverett Saltonstall will reintroduce legislation calling for major procurement changes in weapons systems programs and in renegotiation. One provision would extend the management system to all major weapons system projects, with a manager assigned responsibility for development. A second provision would be to exempt from renegotiation all incentive, fixed-price contracts.

### Increase importance for PMR . . .

is seen by Senator Francis Case (R-SD), because of geographic limitations of the Atlantic Missile Test Range. Case, while at Vandenberg AFB, predicted a \$41 billion defense budget for fiscal 1960, and said Congress will take a very close look at all elements of the U.S. missile program.

### Briefings for Congressmen . . .

are being prepared by all military services. Army's modernization argument will

lean heavily on the word "mobility." Current trouble finding overseas bases for *Thor* and *Jupiter* squadrons, Army believes, is sounding the death knell for non-mobile systems.

### France may balk at IRBM bases . . .

but the French Consultative Committee for Scientific and Technical Research, made up of government members and scientists whose function it is to guide and coordinate national efforts in scientific research, recently moved to create a Commission for Space Research.

### "Monkey business" is a serious affair

in Washington. Navy and Army medics say recent sending of first primate into space was 98% successful from a biological research viewpoint. The monkey, was in a negative gravity environment for 500 seconds. Telemetered data was received on temperature, pulse, heart, breath, and animal motions.

### Pressure from the "troops" . . .

was one big reason President Eisenhower decided to reverse himself on an earlier plan to transfer ABMA to NASA. Pressure from Army Secretary Brucker or Chief of Staff Taylor was conspicuous by its absence—for the good reason that Ike had warned them not to oppose the move, publicly, that is. A powerful ground swell from the ranks reportedly was a major factor in the change of mind.

### Pentagon circles . . .

are saying production money for *Nike-Zeus* will be held in abeyance for at least a year, despite some tough opposition from Army.

### RAND did not scuttle Titan . . .

despite reports that the AF Research & Development Corporation recommended against the missile. On the contrary, RAND gave it an excellent rating in the AF's missile family.

**LOOK WHAT'S BEHIND—**







# → **HEXCEL HONEYCOMB**

## **The No. 1 Technical Service Staff in the Industry:**

Honeycomb experts—Hexcel Engineers—ready to solve your design and application problems wherever and whenever needed.

## **Research Staff and Facilities Unmatched by Any Other Honeycomb Manufacturer:**

Men and equipment devoted to the problems of tomorrow, not the accomplishments of today.

## **Patented Processes and Machinery:**

Special equipment and manufacturing know-how which have established Hexcel product superiority in the most demanding applications.

## **Largest Manufacturing Capacity of all Honeycomb Producers:**

A "production line" source of supply for aluminum, stainless, glass fabric, cotton and paper honeycomb. Quality in Quantity.

*HEXCEL—never content to be a "to spec" source... constantly probing in R&D and manufacturing. The result: Over 10 years of constant product improvement and technical help to honeycomb users.*



**HEXCEL<sup>®</sup> PRODUCTS INC.**

*World leader in honeycomb*

Executive Offices: 2332 Fourth Street, Berkeley 10, Calif.

Plants: Oakland and Berkeley, Calif.; Havre de Grace, Md.

Sales Offices: Long Island City, N.Y.; Fort Worth, Texas; Inglewood, Calif.

Technical Service Bulletins containing Honeycomb basic data are mailed periodically. If you are not now receiving them, please write Department LA 11 at Hexcel executive offices.

5185



*A TALENT FOR  
SYSTEMS MANAGEMENT*

**STROMBERG-CARLSON**



A DIVISION OF GENERAL DYNAMICS CORPORATION  
1463 NORTH GOODMAN STREET • ROCHESTER 3, N. Y.  
ELECTRONICS AND COMMUNICATION FOR HOME, INDUSTRY AND DEFENSE

Firm central control...  
over interlocking functions of  
Engineering and Finance...  
under a member of  
top management whose  
authority is undiluted—  
this, the Stromberg-Carlson  
concept of Systems Management,  
is a definite departure from  
conventional methods.  
It's working extremely well.  
Unified direction of all our own  
divisions, leading consultants  
and qualified subcontractors  
assures a tight control of costs  
and more efficient utilization  
of facilities.  
Currently, this concept is  
helping develop an electronic  
countermeasures system vital to  
the defense of the free world.

Our talent is equally  
applicable to  
Communication,  
Navigation, Test  
Equipment and  
other complex  
electronic systems.  
Our brochure 709  
would be of interest.





## industry countdown

### **Atlas SCORE satellite . . .**

was responsible for a major boost in stocks. Rocket and missile companies made tremendous strides with some firms scoring gains as high as 7 points. Greatest upswing was with Thiokol, Eastman Kodak, North American Aviation, General Dynamics, Burroughs, Reichhold Chemicals, Goodyear and General Tire.

### **Texas missile industries . . .**

have suffered a major setback with the missile and aircraft contract cancellations at Chance Vought Aircraft. Cancellation of the *Regulus II* contract will alone cause an immediate layoff of 1,500 workers. Losing out to McDonnell on the all-weather fighter competition put another 1,500 employees out of work with eventual layoff as a result of the contracts loss expected to total 5,000. Fred O. Detweiler, president of Chance Vought, charges, . . . "Budgetary rather than technical considerations dominated the decision to retire these two outstanding weapon systems."

### **Chance Vought's backlog . . .**

of approximately \$500 million includes study and research and development contracts on the Boeing team for the *Dyna-Soar* competition, anti-submarine systems, and nuclear and rocket-powered space vehicles. It also has teamed with Boeing on a manned space capsule.

### **McDonnell's F4H-1 all-weather fighter**

selected over Chance Vought's F8U-3 *Crusader* will be armed with four *Sparrow III* air-to-air missiles. It can also be equipped with the *Sidewinder* air-launched weapon. The F4H-1 is scheduled for operation in the fleet by early 1960. J. S. McDonnell, president of McDonnell Aircraft, said the Navy award will prevent an immediate layoff of 6,000 employees, an employment figure that will rise to 10,000 by the end of 1960.

### **One million-pound rocket . . .**

engine contract to the Rocketdyne division of North American Aviation could easily make NAA first on the list of industries holding military research contracts for fiscal year 1959. Following top contract holder General Electric by approximately \$15 million at the end of past fiscal year, NAA may easily take the lead in the next few months with the latest \$200 million rocket engine contract. Although the contract covers a 4-6 year period,

major spending is expected during the first year's operation.

### **Rocket engine companies . . .**

are deeply concerned over rumors that the recent 1-1.5 million-pound thrust single chambered engine contract has given some NASA officials a new interest in canceling the contract for the clustered 1.3 million-pound thrust system under development by the Army and Rocketdyne.

### **Clustered engine proponents . . .**

point out that the 8-engine package could be ready for flight years ahead of the single chamber. In addition, even the single unit must eventually be clustered if profitable manned payloads are to be put into space. Meanwhile, clustering of the already proven engines would pave the way for grouping the one million plus units when they are available.

### **Titan launching system . . .**

will be developed by American Machine and Foundry Company at its Cheektowaga, N.Y. plant. About \$37 million will be expended on the *Titan* system at Cheektowaga where the launch complex will be produced after the development program is completed.

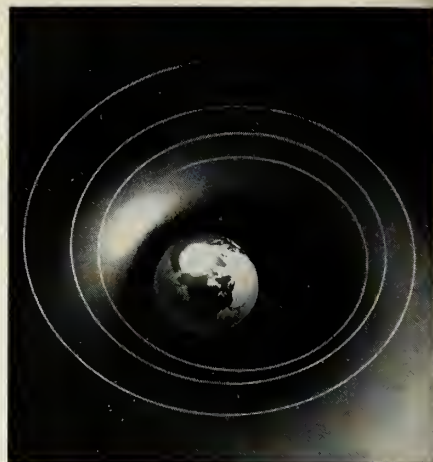
### **First Bomarc training site . . .**

became operational last week at Eglin AFB in Florida. It is the first manned by ADC personnel for teaching Air Force missilemen to handle and fire the surface-to-air missile. Operational and engineering evaluation of the missile and launching complex will start in a few weeks.

### **Cooperation in development . . .**

and production of missile equipment will result from an agreement between the Dana Corp. and Aircraft Armaments, Inc. The agreement will combine Dana's production, production engineering, and mechanical manufacturing experience and facilities with Aircraft Armaments' systems engineering, electronic and electro-mechanical manufacturing facilities. Dana's contributions to the rocket and missile field include JATO assists for the *Matador*, *Lacrosse* solid propellant motor cases, and special drop forgings. Aircraft Armaments' most recent product is the *Redstone* missile trainer. Other products include rocket sleds, cartridge-actuated devices, aircraft and missile ground handling equipment, and missile electronic test equipment.

**For Peaceful Purposes and the Benefit  
of All Mankind The National Aeronautics  
and Space Administration Announces  
its Authorization by the Congress  
of the United States**



**To Direct and Implement U.S. Research Efforts  
In Aeronautics and the Exploration  
of Space**

"The aeronautical and space activities of the United States shall be conducted so as to contribute materially to one or more of the following objectives:

- (1) The expansion of human knowledge of phenomena in the atmosphere and space;
- (2) The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles;
- (3) The development and operation of vehicles capable of carrying instruments, equipment, supplies and living organisms through space;
- (4) The establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes;
- (5) The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere;
- (6) The making available to agencies directly concerned with national defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian agency established to direct and control nonmilitary aeronautical and space activities, of information as to

discoveries which have value or significance to that agency;

- (7) Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof; and
- (8) The most effective utilization of the scientific and engineering resources of the United States, with close cooperation among all interested agencies of the United States in order to avoid unnecessary duplication of effort, facilities, and equipment..."\*

The excitement, the importance, and the scope of the National Aeronautics and Space Administration are apparent, we believe, from our enabling act. Career opportunities at NASA are as unlimited as the scope of the organization itself.

**Please address your inquiry to the Personnel Director of any of the following NASA research centers. Your inquiry will be answered immediately, and will be treated in the strictest confidence.**

**Langley Research Center, Hampton, Virginia  
Ames Research Center, Mountain View, California  
Lewis Research Center, Cleveland, Ohio  
High-Speed Flight Station, Edwards, California**

\*Quoted from the National Aeronautics and Space Act of 1958.

(Positions are filled in accordance with Aeronautical Research Scientist Announcement 61B)

**NASA** National Aeronautics and Space Administration



## Atlas Scores Again in Project SCORE

WASHINGTON—After several days in orbit the *Atlas* satellite has proven itself as an instrument to measure U.S. technological break-throughs and victories.

The major triumphs probably are those of in-flight guidance and the use of satellites for communication. Experts claim that *Atlas*' performance "to a great extent balances the argument that the project is a big boxcar with a small load."

• **Guidance**—Maj. Gen. Bernard A. Shriever, head of USAF Ballistic Missiles Division, says the *Atlas* space program scored a first in the field of in-flight guidance of an artificial moon. No previous U.S. satellite has had this type of guidance, and industry spokesmen say the lack of in-flight guidance caused the lunar shot to get off course.

The ARPA satellite carrier was under continuous electronic guidance the entire time the engines were burning, by means of radio signals transmitted back and forth between the missile and ground stations. Correction could be made immediately when the vehicle veered off course.

General Electric Co. and Burroughs Corp. jointly developed the radio command guidance system. The system was checked out by new equipment developed by Varo Manufacturing Co., Inc.

• **Communication System**—The most significant gain from ARPA's project SCORE is the break-through in the use of artificial moons for communication relay stations. Although the system in *Atlas* is only an experimental relay station, it undoubtedly will go down in the history of communication as one of the greatest achievements to date.

Three or possibly four such relay station satellites spaced in an orbit 22,500 miles high could service every point on earth through radio communications.

At this altitude, the satellites would appear never to move, for their periods would be the same as the earth's, 24 hours.

If orbits at this altitude cannot be achieved with current satellite carriers, then nine satellites placed in a 257-mile-high orbit would suffice to ring the globe. World-wide radio coverage would still be assured, with signals being relayed from one satellite to another until every receiving was serviced.

Circling the earth every 101 minutes at a velocity of 17,000 mph, the SCORE communication package can receive messages from earth and return them to ground stations on command. And communication is not limited to single channel operation. On the 40th pass around the globe, the satellite payload was fed seven teletype messages simultaneously. On the 41st pass, it return them to earth, on command.

This marks the first successful multi-channel teletype transmission by the delayed repeater technique on a ground-satellite-ground relay system, according to Pentagon spokesmen.

The satellite relay system was developed for SCORE by the Army Signal Corps' research and development laboratory at Fort Monmouth, N.J., in

cooperation with a series of electronics companies. Some of these are:

Communications components: Radio Corporation of America

*Atlas* antennas: Convair-Astronautics

Ground station antennas: Radiation, Inc.

Communication system batteries: The Eagle-Picher Co.

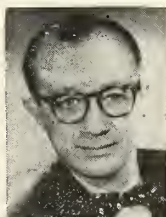
Special relays: Potter and Brumfield, Inc.

Teletype multiplex (ground stations): Radio Frequency Laboratories, Inc.

• **Future SCORE Plans**—According to the Pentagon, the military have plans for a permanent communication system involving ground stations and satellite relay stations. Such a system would greatly reduce the crowding of the nation's airwaves. The military now occupy approximately half of all available airwaves.

Although no plans have been revealed regarding commercial use of space relay stations, such plans will come before long.

### M/R Welcomes New Members to its Staff



Dr. I. M. Levitt

Well-known Astronomer Dr. I. M. Levitt, Director of Fels Planetarium, Franklin Institute, Philadelphia, becomes Contributing Editor for astrophysics.

Within the present staff, Frank McGuire, formerly assistant editor for *Legislature and International news*, moves to our Los Angeles office as Regional Editor to strengthen our West Coast coverage.

Erica Cromley is promoted from Assistant Editor to Associate Editor to cover *Legislative Affairs*.

Associate Editor Peer Fossen will continue to cover the fields of tracking and communications but will broaden his coverage to include missile support equipment of all categories.

And, with that news . . . very best wishes for the new year from the staff of *m/r* to all of our 30 thousand-plus readers.



*Jupiter-C vehicle which launched the Western nation's first satellite.*

# 1958 Was Year of Space Awakening for Nation

After a somewhat creaking start the U.S. has made a great start in the world competition for space supremacy

by Norman L. Baker  
and  
Raymond M. Nolan

WASHINGTON—In the missile and space business, 1958 was the year of awakening. Following the rude shock of *Sputnik*, the U.S. began to creak slowly into gear on a broad array of programs. Within the year, new missiles continued to be authorized, ARPA and NASA were formed, and satellite and space programs took on new importance.

As the year closes—for better or for worse—there are three ICBM and three IRBM programs, two agencies calling the shots for outer space experiments, and a “space-minded” Congress and national administration.

But while no one can deny that the U.S. made progress in 1958, there is still a prevalent thought that perhaps the nation did not come as far as capabilities would have permitted. Let us review the year.

## ICBM Program

*Atlas*—The year began with U.S. military planners and Convair jubilant over the first limited success flight of December 17. There were two disheartening failures earlier in 1957. But then it still was impossible to estimate—with any degree of reliability—an operational date.

To date, *Atlas* has completed 15 missions—the last the most important of all—a full-range flight of 6325 miles. Now it appears that the missile will be operational by the end of 1959, barring any major set backs in the testing program.

Air Force will attempt to fire at least one missile a month throughout the remainder of the development program. But most important, *Atlas*, before the end of next year, is expected to be sufficiently advanced to allow

transfer of some vehicles to ARPA's man-in-space program. First evidence of this is Project *Score*. The second phase of Project *Discoverer*, will utilize the *Atlas* as the first stage of a two-stage vehicle for eventually orbiting man and a total satellite weight of 10,000 pounds.

*Titan*—The back-up ICBM, *Titan*, several months ago was reported to be only one year behind the *Atlas*. Now the time is reportedly 18 months, if the date for initiating the test program

is used as a guide line. But the first flight vehicle is at Cape Canaveral waiting launch. A static-test vehicle has been on the pad for several weeks.

The first operational site for *Titan* probably will be available long before the missile is ready to be installed. Construction on this “hard” site is progressing at Vandenberg AFB.

*Minuteman*—On February 27, DOD Guided Missile Director William Holaday announced the second generation ICBM would be powered by

## ‘Top’ 1958 Space Achievements

These missile and satellite launchings, in order of their importance, are considered by m/r editors to be the United States' most outstanding research and development achievements during the first year of the space age.

- 1) *Explorer I*—The U.S. entry into the space age. Launched at 10:48 P.M. January 31, it discovered the Van Allen radiation belt. Still in orbit and silent.
- 2) Project *SCORE*, 8700-lb *Atlas* satellite total payload, launched into 20-day orbit on December 18 from Cape Canaveral. One hundred fifty pound payload investigation of satellite relay communications.
- 3) *Vanguard I*—Launched at 7:16 A.M. March 17. The 3.5-pound baby satellite has an estimated orbit life of 200 years. Solar batteries still supplying energy to a transmitter which is broadcasting temperatures and pressures.
- 4) *Atlas* full range shot launched November 28. Highly successful. Traveled 6325 miles and impacted in pre-selected target area.
- 5) *Pioneer I* reached 71,300 miles from the earth in an attempt to orbit the moon. Launched October 11. Success reported in relaying transoceanic radio signals via *Pioneer* from Cape Canaveral to Jodrell Bank in England.
- 6) *Pioneer III*—Army's *Juno II* rocket vehicle—launched in an effort to hit or bypass the moon on December 6. Reached 65,000 miles. Payload landed in Africa.
- 7) *Explorer IV*—Launched into an estimated six-year orbit at 11 A.M. July 26. Loaded with radiation counters for investigating the belt sampled by *Explorer I* and *Explorer III*.
- 8) First successful launching of *Atlas* with full propulsion system. Launched August 2. Traveled 2500 miles.
- 9) *Pioneer* attempt of August 17. First recorded attempt to reach the moon. Fired within 14 minutes of the optimum launch time. Failed after 77 seconds of flight time.
- 10) Nose cone of operational *Jupiter* recovered after completely successful full-range test. Launched May 18.



solid propellants. On March 3, Air Force received DOD approval to start development and requested that the Navy's *Polaris* configuration be used as a design criteria.

*Minuteman*, which may be available in late 1960, should be a relatively inexpensive system (one-seventh the cost of *Titan* or *Atlas*). Launch sites will be in hard positions and the lengthy countdowns of liquid rockets should be eliminated.

*Dyna-Soar*—With a deliberate look at the future, Air Force backed up *Minuteman* by awarding competing design study contracts to Boeing and Martin for *Dyna-Soar* the third generation missile system, or the last manned aircraft.

This boost-glide rocket system will put man into the missile and bring the first true space weapon system into reality. Study contracts for the systems were awarded June 16, an R&D contract probably will be let before a July 1 deadline.

#### • Missiles with strategic capabilities

—Drastic changes were made in the strategic air-to-surface missile systems during 1958. *Rascal*, a short range (100 miles) rocket-powered bird designed for drop from B-47 and B-52 was given the economy axe a few weeks ago.

The Bell Aircraft developed *Rascal* was dropped while in the final stages of R&D, undoubtedly in favor of *Hound Dog*, the successor.

NAA's *Hound Dog*, unlike the *Rascal*, will have a jet sustainer and longer range. By year's end *Hound Dog* was weeks away from flight testing. But, Boeing too is in the picture, reportedly on a successor to *Hound Dog*.

Latest missile to be cancelled, was the Air Force *Goose*, designed for decoying the enemy's air defenses away from strategic bombers. *Goose* was in advance development when the slash came with a few successful flights to its credit, and a first base under construction. *Green Quail*, an air-launched decoy still under development will probably fill the gap left by the *Goose* cancellations.

#### • End to IC cruise missiles?—

*Snark*, the nation's only intercontinental missile, starts the new year with an uncertain future. The missile still continues its flights down range from Cape Canaveral with reasonable results. Meager production awards and site construction indicates the missile will not get past the one squadron now planned.

#### IRBM Program

The year 1958 has been one of great achievement in the IRBM program. After three years of development *Jupiter* and *Thor* reached the big pay-off—operational deployment.

Both of the liquid-fueled IRBMs have remained neck-and-neck throughout their development programs and it is almost impossible to properly assess the relative merits of the two systems.

Although both systems are in production and crews are in training, only *Thor* is actually being deployed in operational sites. Deployment of *Jupiter* must await agreements from France and Italy—two countries slated to receive the weapon.

The first firing of an operational *Thor* by a SAC crew was from Vandenberg AFB on December 16. It was also the first IRBM launch by service personnel.

*Jupiter* and *Thor*, two of the costliest weapons systems in existence, may not survive beyond *Atlas* and *Titan* operational dates. The capabilities of the ICBMs, plus the possible existence of foreign IRBMs at the same time (Britain has an IRBM under development), will probably cancel the operational value of the systems.

The flight records of *Jupiter* and *Thor* have been beset with disappointments, but in the final tally, successful missions overshadow the failures. Operational nose cones have been flown on both weapons while nose cone recovery has been made only with *Jupiter*.

*Polaris*—The Navy's IRBM, the *Polaris* fleet ballistic missile, suffered two disheartening failures in the closing months of 1958 after an impressive flight record that began late in 1957.

The missile flight test program con-

ducted at Cape Canaveral has chalked up an impressive score. Out of 24 test flights, 21 have been termed successes. First 22 flights were modified *Sergeant* missiles equipped with the eight-nozzled second stage power plant.

#### Surface-to-Surface

Except for the ICBM and IRBM areas, the Army dominates in the surface-to-surface missile picture. They begin (in size and range) with the *Pershing* and continue down through the artillery rockets. Air Force entries are the *Matador* and *Mace*, and Navy surface-to-surface unit is the *Regulus*.

*Pershing* marks the Army's first departure from the arsenal concept of procurement with the Martin Company as prime contractor. Prototype and test vehicle components have reached the hardware stage and component test of some hardware is in progress. If the program continues, and there have been no rumors to the contrary, this will probably mark the last effort of the Army into longer-range missiles.

In the longer-range birds, *Redstone* continues to plod along and rack up almost incredible firing records. Latest information is there were two failures in 41 firings over a period of five and one-half years. Production of *Redstone* continued throughout 1958 and the missile became fully operational.

Production models of the *Sergeant* began to appear this year but it seems like it will be a while before *Sergeant* replaces the *Corporal* and reaches troops. The Army is banking on its inertial guidance and solid motor to give a commander the storability, mobility and accuracy considered necessary.

In the 10-to-20 mile range, Army has the *Lacrosse*, *Little John* and *Honest John*. Production of the *Lacrosse*, started in 1957, continues and the weapon is now considered operational by the Army. The capability of being airlifted is considered one of its outstanding features.

In the artillery rockets, the most spectacular achievement of the year was the *Chopper John* exercise carried on at White Sands early last summer.

Cancellation of the *Dart* leaves the Army without an anti-tank weapon, but Army may purchase the Vickers 891 or the German Kobra.

The Air Force has two entries in this category—the *Matador* and the *Mace*, the *Mace* being an advanced version of the *Matador*. The *Matador*, operational for the last four years, is being supplied for use in the TM-61B version. Two versions of the *Mace* are now in production—the TM-76A, an ATRAN (map-matching) guided missile and the TM-76B, an inertial guided unit. The *Mace* is in production and troops are now being trained



*Atlas* went 6352 miles; later boosted self into orbit.



**ILL-FATED Pioneer 1, probably first attempt to reach earth's natural satellite.**

in its use.

During 1958 the Navy began its switchover from *Regulus I* to *Regulus II*. However, the Navy now has cancelled the *Regulus* program at Chance Vought. First firings were made during the year from a submarine and another from the LST King County, operational mockup of a *Regulus II* launching submarine.

#### Surface-to-Air

The *Nike-Hercules-Bomarc* controversy was the big news during 1958 in the surface-to-air category. Actually, most of the controversy was in the newspapers and not in DOD. DOD stopped most of the talk with the clarifying announcement that 400-mile *Bomarc B* would be used for area defense and the *Nike-Hercules* for point defense.

*Nike-Hercules* continued replacing the *Nike-Ajax* during the year at the various city defense sites and will soon be installed at all *Nike* bases. *Nike-Zeus*, the anti-missile missile of the *Plato* anti-missile system, seems to have a clear field in missile defense—at least for the foreseeable future. Development is coming along on schedule and some hardware testing is being done.

The Army's *Hawk* made quite a showing at the Army Missile Mobility Orientation show in White Sands this year, blasting off and making a target kill exactly as programmed. Raytheon is showing a model of the 36-missile emplacement which is soon to be installed in the Washington D.C. and New York City areas. Status of the missile during 1958 was listed as development production.

The Navy lists four missiles in this category—*Terrier I* and *Terrier II*, *Tartar* and *Talos*. *Terrier I* is being supplied to the fleet and *Terrier II* is planned for replacement. The second version will be larger than the first and will have radar homing installed. The first is listed as "service use" and the second is listed as "development."

The *Tartar* is smaller than the *Terrier*, but otherwise somewhat similar. It is in development production with the Applied Physics Laboratory of Johns Hopkins having systems responsibility. Convair-Pomona is the prime contractor.

The *Talos* was installed this year on the newly-commissioned USS *Galveston*, the first of five missile cruisers to be *Talos*-equipped by 1960. The missile is in production and will be available as each of the missile cruisers are available. Army cancelled its *Talos* program during 1958.

#### Air-to-Surface

In the air-to-surface category, the Navy has a bewildering array of missiles either operational, in development or planned.

Outstanding missile in production is the *Bullpup*. Martin reportedly is going on in *Bullpup* development to a new version with a nuclear warhead and a packaged liquid engine. This is the same missile as the recently-announced USAF *White Lance* soon to be in use with the Tactical Air Command. Other Navy missiles still in the development cycle are the *Corvus*, the *Crossbow*, the just-awarded *Eagle*, the *Hopi* and the hot-gas propelled *Raven*.

The Air Force has another air-to-surface bird called the *Wagtail*. Reportedly in development production by Minneapolis-Honeywell, it employs a new concept in air warfare, being fired over mountains and other obstructions.

#### Air-to-Air

In the air-to-air category, the Navy apparently is leagues ahead because of the outstanding performance of the *Sidewinder* used with such devastating effect during the off-shore islands crisis. However, the Navy is not resting. A successor to the *Sidewinder*, called the *Diamondback*, is now under development by NOTS at China Lake, California. The Navy has two other air-to-air missiles in production,—the *Sparrow III* and the unguided *Zuni*.

Air Force efforts in this area have concentrated on the *Falcon* and the *Genie*. Two models of the *Falcon* are in service use, the GAR-1D and the GAR-2A. However, there are reports that Hughes Aircraft is now up to GAR-9 in their designations. The *Genie* is also listed as in service use. The present model is unguided but a

guided version is in development.

#### Space Experiments

While the United States' experiments in space research were meager weightwise, when compared with Russian satellites, results obtained and diversification practiced were perhaps more significant and impressive. Experiments ranged from cosmic ray, solar power, and magnetic field investigation to animal flights and feasibility tests of space probes. Here is a chronological listing of the United States 1958 space research efforts.

1) *Explorer I* satellite launched on January 31. Discovered radiation belt. Still in orbit.

2) *Explorer II* launched on March 5 failed to achieve orbit due to failure of last stage to ignite.

3) *Vanguard* baby satellite launched into 200-year orbit. Equipped with solar batteries.

4) *Explorer III* launched into orbit on March 26. Fell to earth on June 27.

5) *Thor-Able* re-entry test vehicle launched on April 23 with mouse in nose cone. No recovery made.

6) *Vanguard* 20-inch satellite failed to orbit on April 28.

7) Two men rode balloon on May 6 to 40,000 feet to study stars and planets.

8) *Vanguard* launched on May 28 failed to orbit.

9) *Thor-Able II* with mouse in nose cone traveled 6000 miles on July 9. Recovery failed.

10) *Thor-Able III* with mouse in nose cone traveled 6000 miles on July 23. Recovery failed.

11) *Explorer IV* launched into six-year orbit on July 26.

12) First Air Force lunar probe failed after 77 seconds on August 17.

13) Army failed on August 24 to launch *Explorer V*.

14) Navy failed to orbit *Vanguard* on September 26.

15) *Pioneer I* reached 71,300 miles in unsuccessful attempt to orbit the moon on October 11.

16) Army failed to launch *Explorer VI* on October 23 balloon satellite.

17) Air Force *Pioneer II* on November 8 failed to achieve sufficient velocity to leave the earth's gravity field.

18) Army failed to reach the moon with *Pioneer III* attempt on December 6. Payload traveled 63,000 miles.

19) Squirrel monkey traveled 300 miles out and 1500 miles distance in nose cone of *Jupiter* IRBM on December 13. Recovery failed.

20) ARPA Project SCORE *Atlas* satellite launched into orbit on December 18 from Cape Canaveral.



# Dr. Pickering Takes His JPL Team to NASA

With CalTech he will continue to operate laboratory, to include designing instrumentation for future space probes

by Frank G. McGuire

WASHINGTON—Dr. William Pickering and his team, the Jet Propulsion Laboratory of the California Institute of Technology, will finish the second year of the space age under NASA and thus will carry out "a step well calculated to advance the best interests of the nation." JPL, responsible for the instrumentation in the *Explorer* satellites, will continue under contractual arrangements with the Army throughout 1959.

Programs underway at JPL relating to military operations will remain under Army jurisdiction. This includes the *Sergeant* program and "special intelligence investigations" plus communications, aerodynamic testing and research.

Dr. Pickering and CalTech will continue to operate JPL under existing contracts, utilizing the laboratory's potential to design instrumentation for future space probes. JPL designed the payload instruments for the Army's *Juno II* lunar shoot of December 5 and the instrumentation for the *Explorer* satellites.

One question remaining unanswered is this: now that JPL is an official agency of NASA, who will design and produce payloads for future space probes (under NASA cognizance) assigned to USAF—JPL or Space Technology Laboratories? Past instrumentation in AF probes has been by STL, and NASA may either continue to utilize that firm, or may prefer to have its own arm, JPL, work on future projects.

It has been estimated by NASA Administrator T. Keith Glennan that if NASA constructed its own research facility comparable to JPL, it would cost \$60 million and require a staff of 2000 to 3000. JPL is now valued at \$55 million and employs about 2300.

Since Army funding of JPL has been on a calendar year rather than a fiscal year basis, Army funds amounting to \$4,078,250 will be turned over to NASA to finance the laboratory until the beginning of FY 1960, when it will be funded through the NASA budget.

While looking forward to a productive association with NASA, Pickering and his team "view with some nostalgia the termination of a long and happy association with the U.S. Army." The *WAC Corporal*, the *Bumper WAC*, the *Corporal* missile, the *Explorer* satellites and the *Sergeant* are but a few of the products of this association.

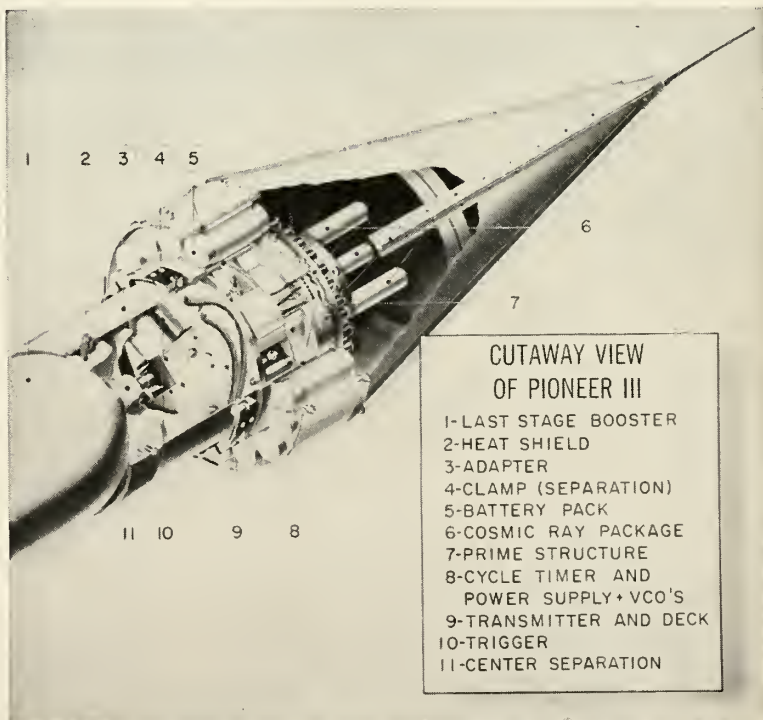
NASA is expected to request, and the Army has agreed to furnish, administrative and logistical support on a non-reimbursable basis for servicing contract activities at JPL for calendar year 1959. This includes such assistance as pre-award contractual activities like negotiation, price analysis, financial and legal services, contract clauses and conditions.

The Army may also establish a liaison group at JPL to provide an

exchange of information on supporting research in the missile and space fields. This should enable Army to carry out its responsibility for various projects by providing a continuing flow of data from JPL.

The agreement on the transfer sets a target date of December 31, 1959 for completion of the switchover. Army and NASA have designated Maj. Gen. John H. Hinrichs, Chief of Ordnance, and Albert F. Siepert, Director of Business Administration for NASA, to form necessary teams to effectuate the agreement.

NASA has accepted the Army's invitation to place a staff in residence at the Army Ordnance Missile Command in Huntsville in connection with NASA's need for direct and continuing access to AOMC, for technical contact.

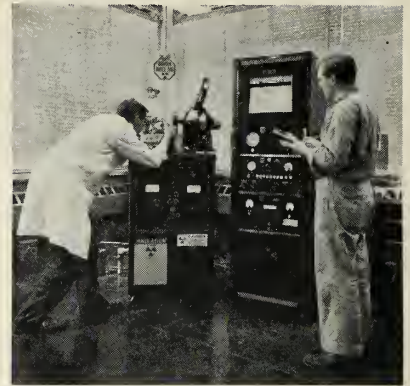


ARMY'S *Juno* PAYLOAD was instrumented by JPL.



**HEAT TREATING** furnaces at Nuclear Metals, Inc., where "exotic" metals are investigated for high temperature resistivity.

**METAL POWDERS**, ceramics and cermets are compacted in hooded 270-ton vertical hydraulic presses in R&D laboratory.



**STAFF METALLURGIST** makes precision optical alignment of uranium specimen before crystal study with X-ray.

## Wanted: 20,000 Degree Metals

by Norman L. Baker

WASHINGTON—Space vehicles of the future may require the development of materials that will withstand temperatures as high as 20,000° F for short periods of time—temperatures with a factor of 10 above those commonly encountered in structural applications.

These temperatures exceed the melting point of any single material known, forcing an intensive search for new material fabrication metals and techniques.

Engineers are hopeful that space vehicles can be designed so that the highest temperatures encountered at critical phases of flight will not exceed 5000° F. Even this temperature requires extension of present engineering knowhow for the highest melting points of any substances now known to exist are only about 7000° F. These materials are still behind in fabrication development.

One of the largest and most diversi-

fied research and development organizations to accept the high temperature materials challenge is Nuclear Metals, Inc., of Concord, Mass. The company, originally constituted as the Metallurgical Project at MIT, is striving to bring many of the rare and exotic metals into usage for the Atomic Energy Commission and the missile weapon program.

Nuclear Metals has handled or investigated almost every metal in the periodic table. Some of the metals, and alloys and compounds of the metals, have been researched and developed are beryllium, aluminum, vanadium, chromium, gallium, yttrium, zirconium, niobium, molybdenum, hafnium, tantalum, tungsten, thorium, uranium, and a number of the rare earth metals. One assignment has been the development of materials for ballistic missile nose cones.

• **Solution in composite materials**—Nuclear Metals reports that the development of a single material which

will provide all the desired properties is highly improbable. Successful solutions to the problems, therefore, lie in the development of composite materials.

Composites could either take the form of a combination where one material provides a protective surface layer against corrosion while the underbody supplies the necessary strength. Another combination would be the lamination of various materials with varying temperature levels. Materials of this latter combination may be constructed by mixing metals and refractory compounds. Such mixtures, of which several are known, is commonly described as cermets.

• **Metal compounds**—High-melting oxides are expected to be useful in the 2000° to 4000° F temperature range, with a combination of carbides and borides with high-melting metals for still higher temperatures.

Graphite, a material lacking in strength and ductility at low tempera-

missiles and rockets, December 29, 1958



...NEWS IS HAPPENING AT NORTHROP



## RADIOPLANE RP-76 SIMULATES NEAR-SONIC ENEMY ...ARMY MISSILEMEN SCORE HIT IN FIRST FIRING!

Place: Red Canyon Range, New Mexico. Time: minutes after an RP-76 high-altitude air-launching by Radioplane personnel. Event: Army missilemen sight RP-76 simulating an enemy weapon system approaching at Mach 0.9. They fire—for the first time against an RP-76—score a direct hit.

Responsible: the men of Battery C, 1st Missile Battalion (Nike-Ajax), 56th Artillery, U.S. Army Defense Command; the men of Radioplane's contractor-operated flight service program, backed by the more than 2,500 Radioplane drone specialists who designed and produced the RP-76.

This Army-Radioplane achievement typifies the result of Radioplane teamwork with all of the U.S. Armed Forces. Other current examples in development: the supersonic USAF-XQ-4A weapon evaluation target drone and the U.S. Navy's XKD4R-1 rocket target, two more members of Radioplane's complete drone family.



**RADIOPLANE**

VAN NUYS, CALIFORNIA, AND EL PASO, TEXAS  
A Division of Northrop Aircraft, Inc.



tures, becomes increasingly attractive at temperatures above 3000° F. Oxidation at the high temperatures is the major problem confronted with graphite structures.

There are many metals, such as tungsten, molybdenum, and tantalum, which remain solid to much higher temperatures than most of the ceramic materials but need extensive development in order to reach the high temperatures required. In addition these metals and their alloys will be needed in large sheet and bar stock sizes not available at the present time.

• **Beryllium in demand**—The properties of low weight and high temperature resistance has focused increasing attention on the metal beryllium. Although it has the short-coming of being relatively brittle, it has many attractive properties for structural applications.

Currently, beryllium's major missile application is providing re-entry shields for ballistic missile nose cones. Warheads of the *Thor* and *Atlas* are examples of this application.

The AEC has supported work on beryllium for a number of years, although government agencies interested in space weapons and vehicles are now supporting research on the metal to a greater extent.

AEC is interested in the metal for reactor structures. For instance, materials having melting points up to 5000° F are needed in nuclear rocket engines. For such applications, the high-melting metals and compounds mentioned may be required in special regions of the reactor. For example, *Kiwi-A*, the first nuclear rocket reactor, is reported to be a graphite core loaded with uranium and surrounded by a beryllium oxide reflector (m/r, Nov. 17, 58, p. 40). Temperatures in the *Kiwi-A* reactor are expected to be in the 4000° to 5000° F range.

Nuclear Metals recently dedicated a new research and development laboratory at Concord for expansion of its metallurgical program. The \$2 million structure is reported to be the largest metallurgical research and development laboratory in the world.

An example of the research and development projects continuously being conducted at Nuclear Metals is illustrated by its fabrication activities. A partial list includes:

- 1) Development of original melting and casting techniques for beryllium and uranium alloy systems.
- 2) Primary hot and cold working techniques for beryllium, uranium, and zirconium.
- 3) Gathering of basic extrusion data on the refractory metals including tungsten, columbium, vanadium, and chromium.

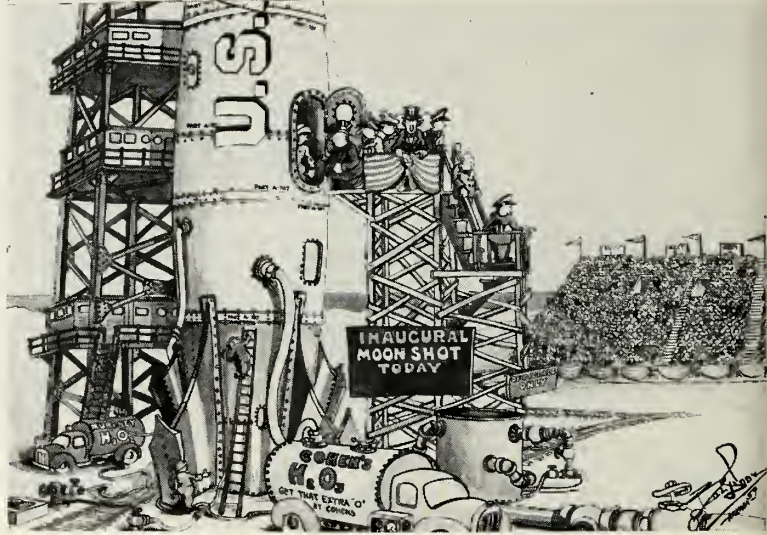
## The Space Age—Viewed satirically

Bill Eddy, who has been coming up with satirical cartoons for the Brown Instrument Division of Minneapolis-Honeywell since 1938, has turned out a new batch of twelve for the annual calendar, two of which are reproduced here.

Eddy's lampoons are always kindly, his characters the victims of a machine-age fate. He pokes gentle fun at his

colleagues, space suits, moon shoots and electronic brains with equal facility.

Cartooning is a hobby for Eddy, executed in the spare time from his own business, Television Associates, Inc. in Michigan City, Ind. One of those shown here was drawn in Karachi and another in Ankara. M-H distributes more than 70,000 of the calendars each year.



"Frankly, Ludlow, this is no time for you to come down with mumps."



"Lieutenant—you should have done *that* before you got into your space suit."



## ARMY

## astrionics



by Raymond M. Nolan

By U.S. Army Engineer District, Los Angeles, Calif.:

\$345,765—**Amco Electric**, Altadena, Calif., for expansion of 70 KV transmission system at Vandenberg AFB.

\$569,413—**Fredericksen & Kasler and Stolte Inc.**, Sacramento, for test tracking station, Phase II, Vandenberg AFB.

\$374,267—**Robinson & Wilson**, San Bernardino, for technical supply warehouses and contractor's maintenance facility at Vandenberg AFB.

By U.S. Army Engineer District, Mobile, Ala.:

\$182,487—**Aerojet-General Corp.**, for architect-engineer services for missiles systems test facility, solid propellants, at Redstone Arsenal, Huntsville.

By District Engineer, U.S. Army Engineer District, Albuquerque:

\$561,231—**J. W. Rateson Co., Inc.**, Dallas, for shock and vibration laboratory, White Sands Missile Range.

\$216,000—**C. H. Leavell & Co.**, El Paso, for *Hawk* prototype, White Sands Missile Range.

\$38,127—**George A. Rutherford**, Albuquerque, for *Hawk* prototype, White Sands Missile Range.

\$1,874,780—**C. H. Leavell & Co.**, El Paso, for guided missile range training facilities, Fort Bliss.

\$966,232—**Farnsworth & Chambers Co., Inc.**, Houston, for guided missile range training facilities, Fort Bliss.

By U.S. Army Ordnance District, Philadelphia, Pa.:

\$12,393—**National Electric Products Corp.**, Pittsburgh, Pa. for development and fabrication of rocket research vehicles.

\$1,014,550—**Western Electric Co., Inc.**, New York, N.Y. for *Nike* spare parts and components.

\$11,487—**Douglas Aircraft Co., Inc.**, Charlotte, N.C., Ordnance missile plant, for *Nike* spare parts and components.

By U.S. Army Signal Supply Agency, Philadelphia:

\$260,000—**National Academy of Sciences**, Washington for materials research.

Officials in AMBA's Guidance and Control Laboratory were upset by the interpretation of Dr. Wernher von Braun's remarks during the American Rocket Society convention in New York.

Von Braun was quoted as saying the U.S. does not have guidance adequate to hit the moon. What he really meant, say laboratory spokesmen, is that the size of the instrument packages we are sending aloft precludes installation of internal guidance, and probes must be spun to achieve stabilization.

**Propulsion, not guidance**, is the limiting factor here, ABMA personnel say. If a vehicle large enough to boost a sizeable object into space is developed, the internal guidance necessary to stabilize that object is available.

When guidance is installed internally by ABMA, you can bet that the first sets will be LEV-3s with probably an AB-7 air bearing gyro on the pitch axis. The versatile LEV-3 has been used by Redstone's Germans since V-2 days and is produced by Waste King Corp. on a production line similar to its appliance production lines. In U.S. missile programs, it has been used on the *Redstone* and *Jupiter*, and is programmed for use on test models of the *Pershing*.

*Pershing*, by the way, will use a guidance and control set similar to the *Jupiter*, except that components will be considerably smaller. The Eclipse-Pioneer division of Bendix, sub-contractors for *Pershing* guidance, expect to miniaturize the slant-range and lateral guidance computers. Stabilizing gyros will be the same size as the accelerometers on the *Redstone* and the accelerometers should be the smallest air bearing instruments yet manufactured. Bendix will become the second U.S. manufacturer of air bearing gyros and accelerometers, along with Ford Instrument, manufacturer of the guidance and control for *Redstone* and *Jupiter*.

In a recent space symposium at Parks Air College of St. Louis University, one speaker made the interesting point that, as we progressed from earth and near-earth flight to ballistic flight the emphasis shifted from excellent gyros and good accelerometers to good gyros and excellent accelerometers. Now, as we enter the realm of space flight, the emphasis will again shift—this time to extreme reliance on the computer in the system. Reason, of course, is that the memory device in a guidance system will become important because of the near-zero accelerations to be measured over long periods of time.

Another point made was that, although the near absence of gravity in space would reduce gyro drift, the drift on the complete platform (caused by frictional torques) could best be minimized by locking its coordinate system to the planets through the use of line-of-sight optical trackers. Thus, it was reasoned, foreseeable space vehicles will have guidance systems that will include a balanced combination of inertial and line-of-sight components. Having both systems will create a redundancy in the navigational equipment which is desirable from a reliability standpoint.

And an official of a top defense agency made the comment about manned space flight: "If we send a man into space over a ballistic course, at the end of 30 minutes he'll either be dead or on-board ship." After a moment of thought, he added, "or both."

# WORK WITH THE MEN

## WHO WROTE THE BOOK!

When it comes to controls  
for missile propulsion systems,  
you can make use of  
the experience and knowledge  
of the men who practically wrote the book.

Bendix has a matchless record  
in fuel metering and controls—  
from the earliest developments  
in carburetion for aircraft engines  
to the last word in complete controls  
for advanced turbine engines.

Today, this long experience  
is proving to be a natural  
for related problems in missile propulsion systems  
—ram jets, rockets or nuclear power!

### ENGINE CONTROLS

Exhaustive knowledge of engine controls is essential for the design of missile propulsion systems. This book covers the latest developments in engine controls, including the design of carburetors, fuel injectors, and fuel pumps. It also discusses the latest advances in engine controls, including the design of fuel control systems, fuel metering systems, and fuel distribution systems.



Exhaustive knowledge of engine controls is essential for the design of missile propulsion systems. This book covers the latest developments in engine controls, including the design of carburetors, fuel injectors, and fuel pumps. It also discusses the latest advances in engine controls, including the design of fuel control systems, fuel metering systems, and fuel distribution systems.



Exhaustive knowledge of engine controls is essential for the design of missile propulsion systems. This book covers the latest developments in engine controls, including the design of carburetors, fuel injectors, and fuel pumps. It also discusses the latest advances in engine controls, including the design of fuel control systems, fuel metering systems, and fuel distribution systems.



Exhaustive knowledge of engine controls is essential for the design of missile propulsion systems. This book covers the latest developments in engine controls, including the design of carburetors, fuel injectors, and fuel pumps. It also discusses the latest advances in engine controls, including the design of fuel control systems, fuel metering systems, and fuel distribution systems.

### FUEL SYSTEMS

Exhaustive knowledge of engine controls is essential for the design of missile propulsion systems. This book covers the latest developments in engine controls, including the design of carburetors, fuel injectors, and fuel pumps. It also discusses the latest advances in engine controls, including the design of fuel control systems, fuel metering systems, and fuel distribution systems.



Exhaustive knowledge of engine controls is essential for the design of missile propulsion systems. This book covers the latest developments in engine controls, including the design of carburetors, fuel injectors, and fuel pumps. It also discusses the latest advances in engine controls, including the design of fuel control systems, fuel metering systems, and fuel distribution systems.



Exhaustive knowledge of engine controls is essential for the design of missile propulsion systems. This book covers the latest developments in engine controls, including the design of carburetors, fuel injectors, and fuel pumps. It also discusses the latest advances in engine controls, including the design of fuel control systems, fuel metering systems, and fuel distribution systems.



Exhaustive knowledge of engine controls is essential for the design of missile propulsion systems. This book covers the latest developments in engine controls, including the design of carburetors, fuel injectors, and fuel pumps. It also discusses the latest advances in engine controls, including the design of fuel control systems, fuel metering systems, and fuel distribution systems.

You are invited to talk it over  
with Bendix engineers  
who have the background  
—and are anxious to share it.

**BENDIX PRODUCTS SOUTH BEND, IND.**

Circle No. 8 on Subscriber Service Card.





## Astronautics Tests

Dec. 16—*Thor* launched from Vandenberg AFB. Traveled 1,500 miles. Landed within five miles of pre-selected impact area. Flight was 28th firing.

Dec. 16—*Thor* launched from Cape Canaveral. Traveled 1500 miles. Landed within pre-selected impact area. Flight was 29th firing.

Dec. 16—*Snark* launched on successful 6,000-mile round-trip flight from Cape Canaveral. More than 60 *Snarks* have been fired since test program began.

Dec. 16—*Bold Orion* WS-199B ASM tested for second stage ignition at Cape Canaveral. Martin project went 700 miles.

Dec. 18—WS-199C ASM tested at Cape Canaveral. Convair-Lockheed project launched from B-58.

Dec. 18—6:02 PM, *Atlas SCORE* satellite launched into 20-day orbit. Payload weight—150 pounds. Total satellite weight—8,500-8,700 pounds. Flight was 16th *Atlas* firing.

Dec. 19—*Bomarc* makes successful intercept with jet drone after 9th launch of SAGE series of tests.

Dec. 20—*Titan* failed to clear pad on first attempt to launch the two-stage ICBM. Second stage was a dummy configuration. First stage engine shut off after 15 seconds of burning.

## Norway Speculates on Sputnik-Relayed TV

WASHINGTON — *Aftenposten*, Norway's largest daily newspaper, has published reports from its correspondent in the small coastal town of Larvik, that the Soviet Union possibly may be receiving television transmissions or relayed transmissions from an artificial satellite. The story was reported in this country by the Office of Technical Services at the Department of Commerce.

The correspondent, Kaare Pettersen, who has seen the suspected image, says the signals always appear on Channel 2, are twice repeated at 0830, 0930, and 1230 hours, and are of varying strength, increasing to a maximum, and then decreasing gradually. No sound accompanies the poor quality pictures.

Up to five "ghosts" appear at times on the screen, which is not the case with other Soviet transmission received in Larvik. For reception of the signals, the antenna must be turned toward the west, also in contrast to what is the case with other Russian broadcasts.

Test patterns and letters of the Cyrillic alphabet appear between the two short films in the transmissions.



## west coast industry

by Fred S. Hunter

Some viewpoints on missile management as they were expressed by a panel of Southern California industry executives monitored by Dr. Lee DuBridge, president of Caltech:

**Dr. E. B. Doll**, project director, Space Technology Laboratories—Supervision of technical personnel should be by technical personnel, and the use of nontechnical personnel skilled in administration to supervise engineers and scientists cannot be called a good arrangement . . . We are eating up our storehouse of basic research and there should be more government funds for fundamental research, but not necessarily for companies producing the hardware.

**W. M. Hawkins**, assistant general manager, Missile System Division, Lockheed Aircraft Corp.—Let competition work in the R&D effort. Give people more freedom. Set up milestones to measure performance on R&D projects, but monitor them for evaluation in the early stages. Discard those which do not measure up. Let a guy go broke, if he can't do the job. In that way, we can have more projects of a competitive nature, and make more progress.

**S. K. Hoffman**, vice-president and general manager, Rocketdyne Division, North American Aviation—Better profit incentives would be a better way to encourage more basic or fundamental research, necessary to bring about the technical "break-throughs," than the allocation of a certain percentage of development contracts (for example, 5%) for this specific purpose. The best way to improve the profit incentive for companies capable of performing basic research would be through tax reform . . . It's a horse race between liquid and solid propellants, but both have applications. The future will depend upon the effort put into each.

**W. L. Rogers**, vice-president-Azusa Operations, Aerojet-General Corp.—More integration of skills both within a company and between companies is needed to make more effective use of our technically and scientifically-trained people. Remember, company policy is making a profit, and a company has to establish manpower policies on this basis . . . Rotation of personnel, wherever it is possible, provides the opportunity to better appreciate the other fellow's problems . . . Better communications are necessary . . . We have a long way to go to truly control projects.

**Don L. Walter**, vice-president-engineering and Van Nuys operations, Marquardt Aircraft Co.—It is difficult for nontechnical personnel to lead technical personnel, so if we are to have leadership in management, we must have supervision of technical personnel by technical personnel rather than nontechnical personnel skilled in administration . . . Managements do all they can to keep from over-burdening technical personnel. But a "standard" overhead or burden rate for all companies in a similar business would be quite impossible because no two accounting departments are able to agree on methods or policies. It is general management's job to get the most out of all of its manpower.

**Elmer P. Wheaton**, vice-president-Missile and Space Aircraft Systems, Douglas Aircraft Co.—The function of a reliability group in engineering is to assist the design group, just as a stress group does, and it should not be set up with the same status and power inspection departments have in manufacturing . . . Outfits capable of performing basic research often are forced into product development because this is where funding is available . . . One of our biggest problems management-wise is handling our customers. Keep the fringe kibitzers out and we can do a better job . . . A revision of our nomenclature for technical personnel is in order. A janitor is a maintenance engineer.

Major Southern California  
missile operation has  
**immediate openings**  
for qualified graduate  
engineers with experience in

**Instrumentation Systems**

with general knowledge of missile systems, including propulsion, guidance, structures and electrical systems.

**Guidance Systems**

Experienced in research and testing of practical hardware, and with mathematical background for systems analysis.

**Flight Test**

Background should qualify for planning and formulating entire flight test programs.

**Aerodynamics**

Must be able to analyze missile configuration to determine aerodynamic performance and stability and control characteristics.

*For information on these and other engineering positions, write:*

Mr. H. B. Richards, Dept. 451  
Missile Division  
North American Aviation, Inc.  
12214 Lakewood Blvd., Downey, California

**MISSILE DIVISION**

NORTH AMERICAN AVIATION, INC.



**Regulus Cancellation  
Ends 10-Year Program**

WASHINGTON—Termination of the *Regulus II* program brought an end to the Navy's missile work on this series which began with Chance Vought over 10 years ago with the *Regulus I*.

The termination of the production of *Regulus II* has resulted in changes in the weaponry to be utilized on a number of the fleet's ships and submarines.

The Navy presently has on hand some 250 *Regulus I* missiles which will be utilized on four submarines. These are the *Tunny* and the *Barbero* which have been equipped with the missile for several years, and the *Growler* and the *Grayback* which originally were planned to handle both *Regulus I* and *II*. The *Halibut*, which would have been the first nuclear submarine to employ the *Regulus* missiles will be completed as a fleet type submarine without missiles. Plans also had called for employment of the *Regulus* missiles on other nuclear-powered boats, but these also will be completed as fleet type boats.

The only surface ship scheduled to use *Regulus II* was the *Long Beach*, the Navy's first nuclear-powered cruiser. *Long Beach* now will be completed to use only the *Talos* and the *Terrier* systems.

Secretary of the Navy Thomas S. Gates, Jr., explained that the *Regulus* program was being ended because of the rapid strides which have been made in the ballistic missile field which he said has a greater growth potential in the overall military effectiveness than do the air-breathing missile. This would indicate a heightened optimism in the success of the *Polaris* system and that the Navy is putting full emphasis on *Polaris* for submarine launchings.

The Navy said it anticipated saving more than \$100 million by the cancellation of the program. This money, the announcement continued, will be applied to the newer Navy weapon systems, ships and aircraft.

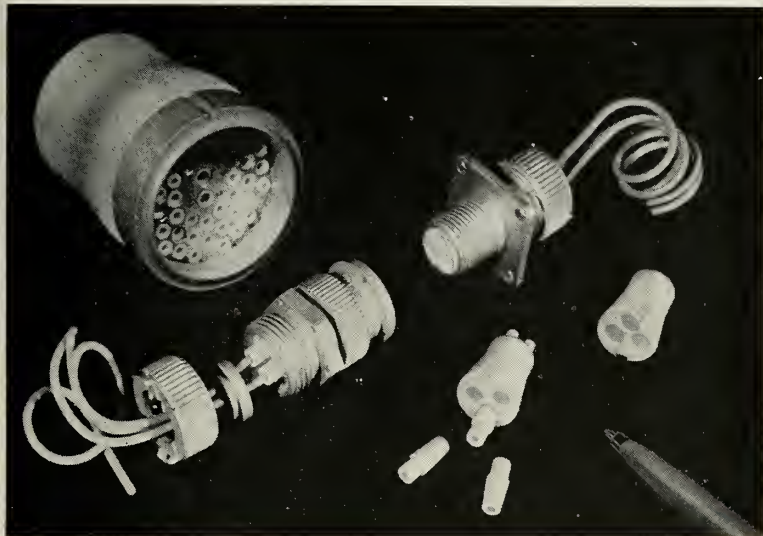
The last *Regulus II* missile, in which the Navy has invested about \$78 million, rolled off the Chance Vought lines this month.

Cancellation of *Regulus* on the heels of the dropping of the *Crusader III* aircraft touched off a series of economic and political shock waves. Senatorial and Congressional representatives from Texas protested while Chance Vought announced it was furloughing employees, bringing what may be a critical employment problem to the Fort Worth-Dallas area.



# new missile products

## Connectors Operate in Acids up to 450°



A new missile connector design, developed by **Tri-Point Plastics, Inc.**, reportedly prevents invasion of contact cavity even when lead-in wire disintegrates. Each individual wire has its own, tapered "packing-gland."

Compact Titeflex connectors operate submerged in fuming nitric acid fuel, ignitors and at temperatures up to 450° F. on HF systems. Male and female insulating parts are machined to precision tapers, and become a sealed, integral unit when compressed on installation.

Tri-Point Plastics has machined some parts to tolerances of less than .001", from high-density "TSI" TFE resin stock to provide the required performance.

One connector is a "standard" three-wire type; while another special connector handles 50 leads. Both connectors utilize the "taper-compression-seal" design based on precision-machined TFE insulators. Pencil point gives approximate size of parts.

Circle No. 225 on Subscriber Service Card.

## Compact Encoder For Precise Reporting

Precise, multi-positional reporting can be accomplished with a new, miniaturized, 10-bit shaft position-to-digital encoder manufactured by **Librascope Inc.**, Glendale, Calif. The new encoder translates analog shaft position to true binary digital information.

Ten-bit resolution is obtained with only a 3½ inch disc that yields 1024 discrete position representations per turn.

The overall size of the encoder is 4¾ inches in diameter by 1¼ inches thick. The shaft is fitted with a synchro-type mount to facilitate precise loca-

tion of the input shaft. Voltage requirements for the transistors are -6 volts DC. Life of more than one million revolutions can be expected with an input shaft speed of up to 25 rpm. The instrument will operate over a temperature range of -50 to 150°F.

Circle No. 226 on Subscriber Service Card.

## Absolute Pressure Regulator Developed for Fuel Tanks

A high-flor pressure regulator for fuel and hydraulic tanks which maintains pressures from 18½ to 20 psia with wide variations in inlet pressure and flow has been developed by the **Clary Dynamics Div. of Clary Corp.**

The valve is able to maintain absolute outlet pressure with variations in flow rate from 3 to 32— scfm under 3— to 100 psia inlet pressure and minus 65 to plus 350 degrees Fahrenheit.

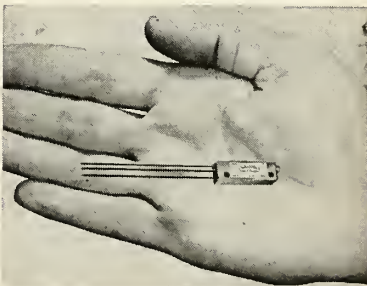
Weighing 2.1 lbs. and 8.55 inches in length, the valve has a 1½-inch tube-size inlet and 2-inch outlet.

Circle No. 227 on Subscriber Service Card.

## Miniature Trimmer Rated at 2 Watts

A new super-miniature wire wound trimmer potentiometer, designated the "750", rated at 2 watts up to 70°C. ambient, has been announced by **Dale Products, Inc.**, Columbus, Nebraska.

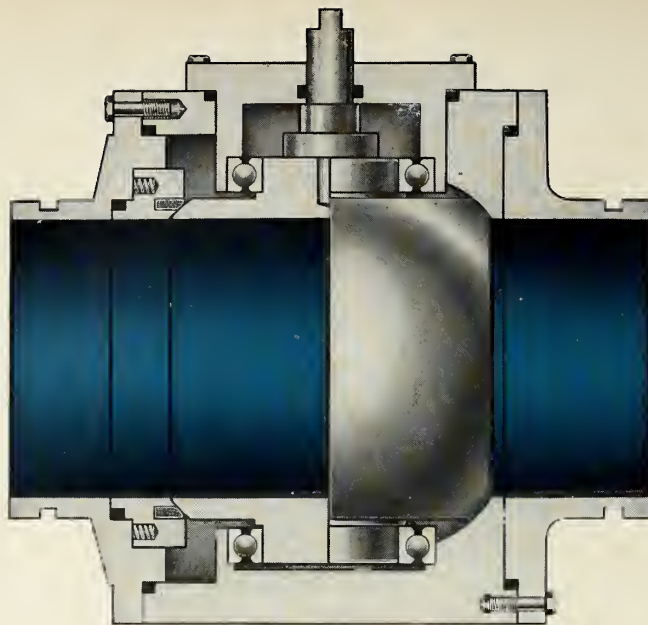
The new "750" is a precision trimmer potentiometer with rugged construction and completely sealed case. One model has wire leads terminating from the end; the other has leads terminating from the side for printed circuit application. This trimmer has been



**NOTE:** For additional information about any product mentioned in this section of Missiles and Rockets use the attached prepaid reply cards. Circle numbers shown on the reply card that correspond with numbers appearing beneath items described. If no circle number accompanies the article or advertisement, give page number (and advertiser's name) on line provided at bottom of the card.

Your requests for information will be forwarded promptly to the companies concerned.

The Editor



# HYDROMATICS *FLO-BALL*<sup>®</sup> VALVES

The accepted standard of maximum performance and reliability

## 100% FLOW EFFICIENCY

Hydromatics' exclusive FLO-BALL design provides a straight-thru unrestricted fluid path, exactly equal to the pipe line diameter.

## PERFECT SEALING

Zero leakage is assured through the use of a precision ball—the ideal geometric form for perfect sealing contact.

## LOW OPERATING TORQUE

Ball rotates in precision bearings which absorb all pressure loads. Pressure balanced valve seat further minimizes forces on ball, reducing frictional drag.

## LONG LIFE

Seat is always in sealing contact with the ball surface, resulting in a self-wiping, self-lapping action that insures long, trouble-free life.

## HIGH SPEED ACTION

Only 90-degree rotation is required to fully open or close valve. Full travel as fast as 5 milliseconds.

## RELIABILITY

Simple construction, with only one rotating part, provides built-in reliability and rugged, dependable operation.

## CRYOGENIC AND CORROSIVE APPLICATIONS

Hydromatics' FLO-BALL valves, with new diaphragm sealing and unrestricted fluid path, have been proved the best valves for operation with LOX, Liquid Nitrogen, Helium, Hydrogen Peroxide, Red Fuming Nitric Acid and Hydrazine.

## MODULAR ARRANGEMENT

Only FLO-BALL design, with its rotating valve action, permits side-by-side grouping of several valves, all driven simultaneously by a single actuator.

## VERSATILITY

Only FLO-BALL design makes possible the interchanging of manual, motor or pressure actuators without changing the valve body.

*HYDROMATICS, the world's leading designer and manufacturer of high performance ball valves for military and industrial applications, offers the most extensive selection of designs to meet all your requirements; Manual, motor or pressure operated. For cryogenic, corrosive or general service media. Pressures from vacuum to 10,000 psi. Sizes from 1/4 inch to 12 inches.*

**Hydromatics, Inc.**

**70 Okner Parkway, Livingston, New Jersey**

## Hydromatics, Inc.

HYDROMATICS FIELD ENGINEERING OFFICES:

Pasadena, 35 N. Arroyo Pkwy., RYon 1-7448 / Denver, 829 15th St., AMherst 6-2714 / Washington, 1413 K St. N. W., STerling 3-3612

Circle No. 9 on Subscriber Service Card.

missiles and rockets, December 29, 1958



## ... new missile products

designed to meet applicable paragraphs of MIL-R-19A, MIL-R-12934A, Mil-E-5272A and Mil-STD-202A.

The "750" has an 18 turn trimming adjustment screw. Clutch arrangement prevents breakage due to overexcursion. Shaft torque: 5 inch/ounces maximum. Eleven standard resistance values provide a selection from 100 ohms to 30K ohms. Standard tolerance is  $\pm 5\%$ , closer tolerance available.

Resolution is .1% to 1%, depending on resistance value. Temperature coefficient of wire is  $\pm 20$  parts per million, standard. Temperature coefficient of trimmer unit is within  $\pm 50$  parts million. Operating temperature range is  $-55^\circ\text{C}$ . to  $+175^\circ\text{C}$ . with outstanding stability.

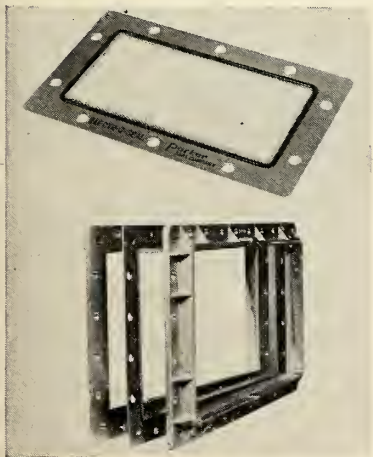
The case measures .180 x .300 x 1,000 inches and the complete unit weighs only 2 grams.

Circle No. 228 on Subscriber Service Card.

## New Seals Provide Mechanical Operation

A complete line of seals for W-series and X-brand wave guides, which provide no-leakage fluid sealing, prevent R/F leakage and eliminate burning and/or arcing, has been developed by Parker Seal Co., a division of Parker-Hannifin Corp.

Called Electr-O-Seals, the new seals are made to fit EIA (RETMA) standard



guides and, in addition to positive sealing, provide savings by making special machining of flanges unnecessary. The inside metal mating edges of the seal are knurled to assure positive electrical contact. They are also reusable.

The design is an extension of the company's Gask-O-Seal, which consists of a formed seal ring surrounded by the metal retainer. A proper mass to

void ratio is maintained, which gives controlled confinement of the seal "gland", with metal to metal contact.

Circle No. 229 on Subscriber Service Card.

## Vacuum Pump System For Silicon Deposition

This pumping system, designed by Bon-De Electronic Labs, is used primarily for silicon and germanium deposition and vacuum metalizing. It is



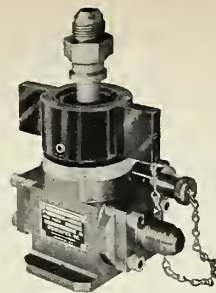
a 3 inch system throughout including: 3 inch diffusion pump, main valve, cold trap and port.

As soon as the Bell Jar is evacuated to 25 microns (approximately 5 minutes) the diffusion pump line may be opened. The roughing pump included has a free air capacity of 140 liters/minutes. System will pump down to  $1 \times 10^{-5}$  mm. Hg. within 20 minutes. Ultimate pressure of  $5 \times 10^{-6}$  mm. Hg.

Gauging elements include, the Bon-De: BD-21, 2 filament ionization gauge, two thermo-couples, and one Borden Gauge. The Bon-De Amplifier, BD-20C, will accommodate two thermo-couples and one ionization gauge.

Overall dimensions are  $54\frac{1}{2}$ " high x 22" wide x 18" deep.

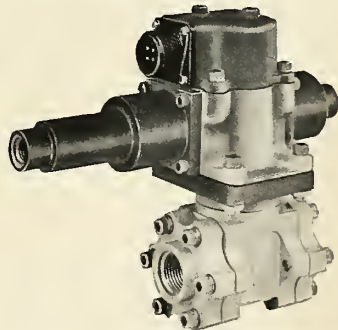
Circle No. 230 on Subscriber Service Card.



## SELF-SEALING DISCONNECT Fast, safe uncoupling of 3000 psi pneumatic lines

Incorporating Hydramatics' exclusive FLO-BALL valve design with 100% flow efficiency, this quick disconnect is manually operated by a low-torque 90 degree rotation of its handle. Upstream pressure is immediately checked by the integral FLO-BALL valve and trapped pressure is automatically bled, allowing quick uncoupling without any dangerous line "kick". For added safety, the fitting cannot be uncoupled while the valve handle is in open position with pressure in the line — nor can the handle be inadvertently turned to open position while the line is uncoupled. A snap-in protective plug is provided for the open part while the line is uncoupled.

Available in line sizes from  $\frac{1}{4}$ " to  $\frac{3}{4}$ ", disconnect is leak-proof at pressures up to 3000 psi, temperatures from  $-65$  to  $200^\circ\text{F}$ .



## $\frac{1}{2}$ " CRYOGENIC FLO-BALL VALVE 100% flow efficiency,

zero leakage at 1000 psi,  $-350^\circ\text{F}$

Pressure actuated ball valve of extremely compact design, weighing only 1.9 lbs. For airborne and ground support applications with cryogenic media, such as LOX bleed, dump or vent control. Valve is operated by a sealed double-acting actuator with spring biased closing. Actuator is thermally isolated from the valve body to guarantee fast positive action at cryogenic temperatures. Operating times available from 25 milliseconds to 2 seconds.

Valve includes a sealed, rotary action snap switch for remote observation of valve position. The switch may be externally adjusted. Flanges, which are removable and interchangeable, may be specified per AND10050, AND10056, NPT or ASA.

**Hydramatics, Inc.**

70 Okner Parkway, Livingston, New Jersey

Circle No. 9 on Subscriber Service Card.

## Test Engineer Must Be Make-Believe Artist

**Devises equipment which simulates actual conditions under which apparatus would operate, such as heat rise at altitude**

by Frank H. Gardner

WASHINGTON—Prior to the development of environmental test equipment, the component design engineer must determine the actual conditions that a component will encounter. Then, test specifications must be developed. Now, it becomes the test engineer's responsibility to make equipment specifications and procure a test facility capable of simulating the desired conditions.

Let us assume that a missile has been developed and specifications call for a test specimen rise of 100° F./min. to +1200° F. at altitudes from 80,000 feet to 250,000 feet.

From test specifications, the test engineer determines that existing test equipment is unsuitable and a set of equipment specifications are devised. These equipment specifications define the size and material of the test object, the types of instrumentation required, and the test program that must be simulated.

The environmental test equipment manufacturer must then design a reliable test facility capable of meeting the requirements of the equipment specifications.

Because of the high altitudes involved, the conventional means of heating by convection are disregarded and a radiant heat test facility is developed.

• **Selection of elements**—The key to the design of a practical radiant heat facility is the selection of the heating elements. Radiant heat is a function of the temperature of the element, and it is desirable to select a heater capable of operating at extremely high temperatures. Presently there are three commercially available types of heaters capable of operating at temperatures in excess of 2000° F. These are open wire nichrome V elements, silica carbide rod-type elements, and quartz tube-tungsten filament elements. The maximum temperatures are 2150° F.,

*Frank Gardner, development engineer of Tenney Engineering, Inc., is one of the country's leading authorities on environmental testing. He is currently engaged in the development of a test chamber to simulate all conditions encountered by missiles in launching and flight. When completed some time next year, the chamber is expected to eliminate as much as 50 per cent of recurring missile failures and sharply accelerate our missile and space programs.*

*In this article Mr. Gardner discusses the basic considerations for the design of a high temperature-altitude test facility for missiles.*

2800° F., and 3000° F., respectively.

The criteria for the selection of a heater element are maximum heater surface temperature, reliability, initial cost, and ease of assembly and maintenance.

The reliability of the heater element is determined by its ruggedness, its resistance to oxidation, and its resistance to "boil off" at low pressure.

The ease of assembly and maintenance are primarily determined by the number of supports required and whether or not special design is necessary to cool the element terminals.

Nichrome V wire has an extremely high electrical resistance, and heater elements are constructed of inherently rugged heavy gage wire. The wire may be brazed to nickel terminals, eliminating water cooling. Nichrome V wire will oxidize at elevated temperatures, and the life of the wire under certain conditions is limited.

However, with proper design, wire life can be extended sufficiently to jus-

tify the consideration of Nichrome V heater elements.

• **Temperature is factor**—Prime factor in limiting the life of a Nichrome V heater element is the wire surface temperature. Other factors are the alternate forming and flaking of oxides as the element heats and cools, and the "boil off" of the element at reduced pressure.

Since maximum wire surface temperature is necessary only when rapid temperature changes are required, the element life may be extended by reducing the power input during steady state periods. The resultant lower surface temperature greatly extends the life of the wire.

A reduction in temperature from the maximum of 2150° F. to 1800° F. increases the wire life by a factor of 40. The reduced power input also permits control of test specimen temperature without on-off cycling of the heater elements.

This eliminates the alternate forming and flaking of oxides and further increases the wire life by a factor of 3. The vapor pressure of Nichrome V at temperatures to 2150° F. is sufficiently low to render negligible the "boil-off" at low pressure of the element on its life. In actual practice, the life of the wire increases at low pressures because of decreased amount of oxygen present and resultant reduced rate of oxide formation.

Wire elements have a tendency to sag at elevated temperatures, and suitable insulated supports must be installed on close centers. This hinders installation and removal of individual elements, but is more than offset by the simple terminal construction possible with wire elements.

Silica carbide rod type heaters, although capable of operating at higher surface temperatures than Nichrome wire elements, are extremely fragile



and have a high coefficient of expansion. Care must be taken in the design of the heater supports and terminal connections to allow heater movement during temperature changes. This loose construction and the fragility of the heater itself detracts from the overall ruggedness of the assembly.

• **Vaporization high**—Although oxides do not form at elevated temperatures to reduce the life of a silica carbide heater, the vaporization rate is high at reduced pressures because of the relatively high vapor pressure of the element. This results in shortened heater life.

Quartz tube heater elements utilizing tungsten filaments have the highest safe operating temperature of the three types of heaters considered. This temperature is determined solely by the tungsten filament melting point and the quartz softening point.

Tests have shown that as long as the quartz tube is maintained at or below the safe limit of 3000° F., the tungsten filament will have a life equivalent to that of the ordinary light bulb. The quartz itself is extremely stable at both high temperature and low pressure, and has no effect on the life of the element.

Commercially available quartz tube heaters have a limiting temperature at the terminals of 650° F., and water cooling must be utilized. This may easily be achieved by jacketing the unheated ends of the heater with water cooled tubes. These tubes may also serve as heater supports so that only a fixed and a floating clip at each terminal need be used to permanently fasten the heater in place.

Because of the few supports required, quartz tube elements may easily be removed and installed.

From the considerations of reli-

ability and ease of installation and maintenance, Nichrome V open wire elements and quartz tube elements are selected as suitable for use on the project under discussion.

• **Safe temperature**—From an economic viewpoint, the Nichrome V wire elements are most desirable. However, before selecting Nichrome V wire heater elements, the facility design engineer must determine if sufficient heat can be concentrated on the test specimen to achieve the required rate of temperature rise without exceeding the maximum safe surface temperature of 2150° F.

With 16 gage Nichrome V wire, approximately 20" of wire/kw is required to limit the surface temperature of the wire to 2150° F. with a test specimen temperature of 1200° F. A 10" quartz tube will develop 1 kw without exceeding its maximum safe surface temperature of 3000° F. Assuming equivalent mounting centers, twice as much heat may be concentrated over a given area with quartz tubes as compared with Nichrome V elements.

The additional cost of the quartz tube elements could be justified if future requirements indicate a need for higher ultimate temperatures where a higher temperature heater would be necessary.

The second phase of design is the determination of a suitable arrangement of the heaters to insure the maximum concentration of heat to the test specimen.

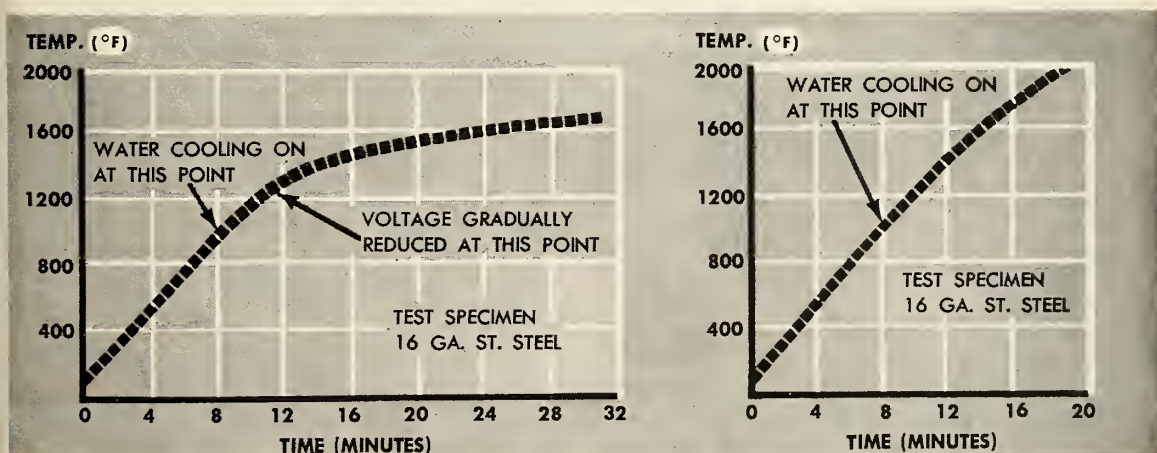
• **Reflector panels**—The heat may best be concentrated on the test specimen by installing reflector panels between the heaters and the chamber walls. No reflector is perfect, and some heat will be absorbed and the reflector will heat up. The reflector material

must then be capable of withstanding this temperature without losing its reflectivity, or be water cooled. If tests at sea level pressure are required, some convection heating will result and the reflectors will be relatively ineffective. Under these conditions, the chamber should be constructed to withstand the high temperature in question and the reflector panels eliminated. Additional heat must be installed to compensate for the convection losses to the chamber walls.

To be repeatedly efficient, the reflector must be of a material that will not oxidize at the elevated temperatures. Suitable materials such as gold and platinum are obviously extremely costly.

• **Aluminum as a reflector**—Polished aluminum is a suitable reflector but must be maintained below 600° F. If Nichrome V elements are utilized, this may best be accomplished by lining the chamber walls with the aluminum and cooling the exterior of the wall. If quartz tube elements are utilized, the reflector panel should be a part of the heater assembly and designed such that the terminals of the element are on the chamber wall side of the reflector. For simplicity, the reflector cooling circuit should be connected to the heater terminal cooling circuit.

The overall radiant heat test facility should be assembled from small panels so that test objects of varying shapes and sizes may be closely surrounded by the assembly. All connections should be simple and reliable. Water connections must be of the flange and "O"-ring type to insure repeated vacuum type joints. They should be located on the wall side of the reflector panels with flexible metallic tubing for panel inter-connection.

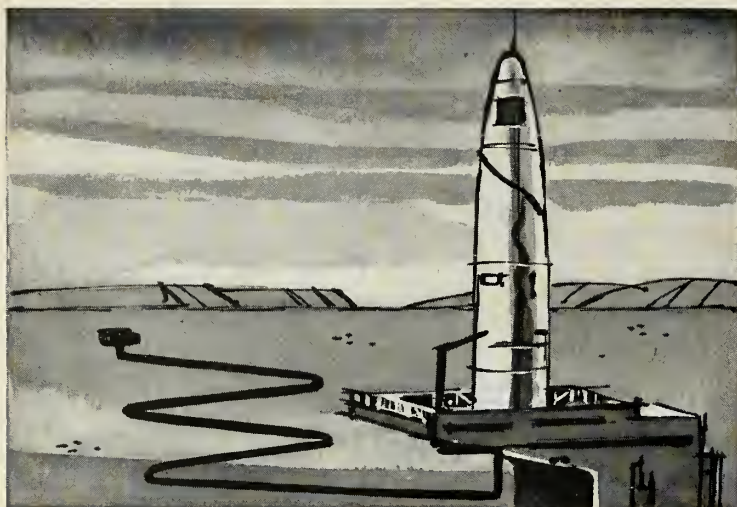


THESE CURVES illustrate the rate of test specimen temperature rise obtained in experimental tests with Nichrome V open wire (left) and quartz tube (right) heater elements. A cylindrical stainless steel test object was chosen as the test specimen.



project:

## FUELING MISSILES — FASTER



### ***FRI develops successful automated hookup and couplings for fast LOX and fuel transfer***

**Here, the problem was 5-fold.** (1) Develop a flexible coupling for automated hookup. (2) Prevent leakage. (3) Protect vital internal parts from icing. (4) Provide high flow with minimum pressure drop. (5) Keep weight to a minimum.

**Flight Refueling, Inc. solved it.** The long experience of Flight Refueling, Inc. in developing, testing and manufacturing lightweight aerial systems, and the recent experience of designing components for the transfer of hydrocarbon fuels, LOX,  $H_2O_2$ ,  $N_2$ , mercury and other nuclear reactor coolants, as well as heated gases, has resulted in the successful completion of many unusual projects.

If you are concerned with *fast fluid transfer*, remember this—FRI has the engineering imagination to design complete lightweight systems, and manufacturing facilities to produce in quantities such components as valves, couplings, nozzles, fittings and portable tanks. Write for literature.



***Flight Refueling, Inc.***

FRIENDSHIP INTERNATIONAL AIRPORT • BALTIMORE 3, MD.

West Coast Representative: William E. Davis, Box 642, Inglewood, Calif.

Circle No. 10 on Subscriber Service Card.

## ***... missile electronics***

Nichrome V open wire elements have terminals exposed to the high temperature, and the interconnection of individual circuits should be accomplished by high temperature brazed wire joints. Each panel should terminate with nickel buss bars. Panel interconnection would be achieved by bolting the buss bars together.

The interconnected radiant heat facility is then connected to feed-throughs at the chamber walls with bolted nickel buss bars.

To avoid arc-over at low pressure, the voltage input to the heaters should not exceed 240 volts. To obtain a practical vacuum seal, the current per conductor through the chamber wall should not exceed 600 amperes. The number of conductors must be determined by the size of the test facility.

Once the radiant heat facility has been designed, there are several alternate means of control open to the design engineer.

• **Cycling heaters**—The simplest means of merely cycling banks of heaters on and off in accordance with temperature demand is satisfactory if the facility is small. When the ultimate temperature is reached, the heaters should be switched into series circuits, then cycled on a percentage on basis with a suitable manual or automatic time-proportioning interrupter. This provides for uniform distribution of the heat and reduced operating heater surface temperatures.

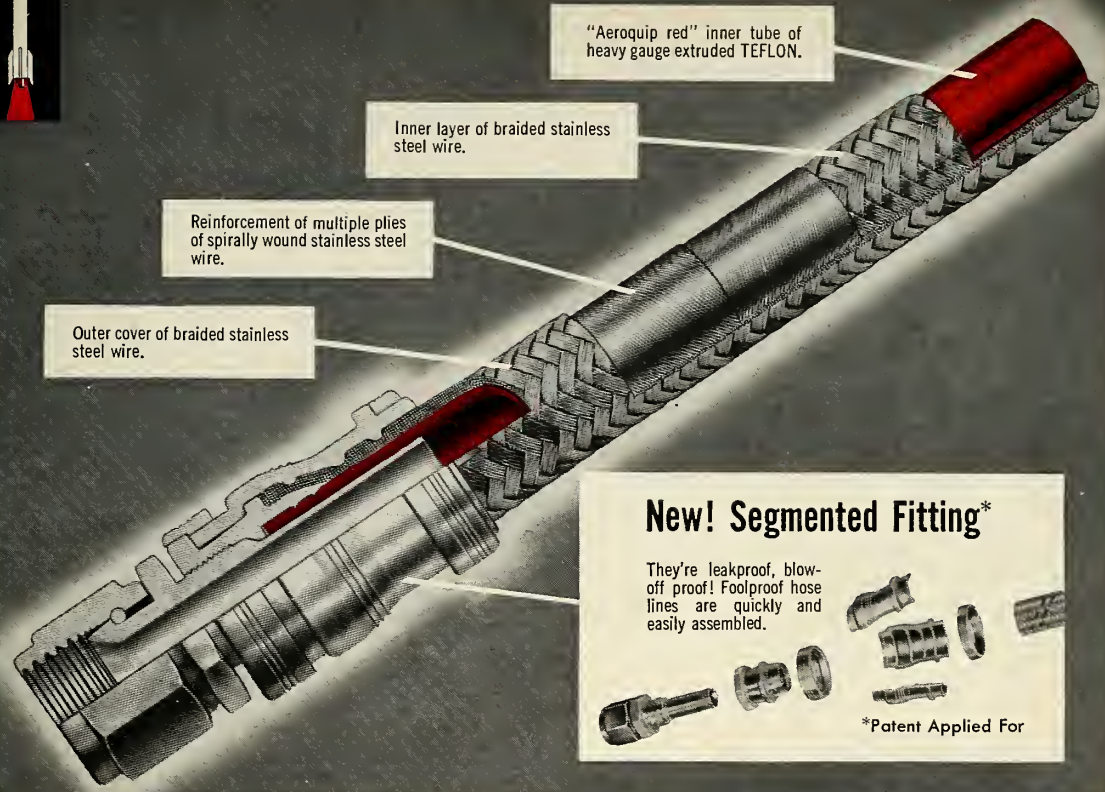
On larger facilities, it becomes impractical to cycle on and off because of the high currents involved. Control should then be obtained by limiting the power input to the heaters with a suitable variable voltage device, such as a motor-positioned variable transformer, a motor-alternator set, or an ignitron assembly.

The most economical usage of either the variable transformer or the ignitron assembly can be obtained by limiting the maximum current to 300-500 amperes. The voltage supplied should be determined to limit the current to this range and a fixed transformer utilized to reduce the output voltage of the control device to the operating voltage of the heaters.

The primary control device should be a potentiometer controller utilizing a chrome-alumel thermocouple. The thermocouple should be brazed to the test specimen and suitably shielded so that actual test specimen temperature is measured and controlled.

In the near future, temperature far in excess of the 1200° F. requirement of this discussion will be required.





"Aeroquip red" inner tube of heavy gauge extruded TEFLON.

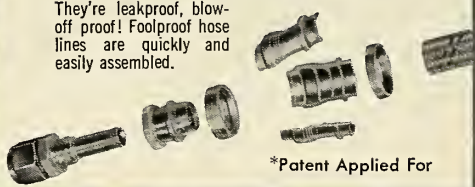
Inner layer of braided stainless steel wire.

Reinforcement of multiple plies of spirally wound stainless steel wire.

Outer cover of braided stainless steel wire.

### New! Segmented Fitting\*

They're leakproof, blow-off proof! Foolproof hose lines are quickly and easily assembled.



\*Patent Applied For

# BURST PRESSURE

# 24,000 psi.!

## OPERATING PRESSURE: 6000 psi.

### AEROQUIP ANNOUNCES VERY HIGH PRESSURE 678 PNEUMATIC HOSE LINES OF TEFLON

Aeroquip makes a major contribution to safety in the handling of very high pressure air, helium, nitrogen and other gases for missile charging systems. Newly developed and now available is rugged 678 Hose of TEFLON, rated for 6000 psi. service . . . with a 4-to-1 safety factor!

With an inner tube of TEFLON, which has zero moisture absorption and an anti-adhesive surface, Aeroquip 678 Hose allows fast, easy purging and dehydration. The hose has superior resistance to vibration, low volumetric expansion and high temperature resistance. Return the coupon for complete information.

Aeroquip 678 Pneumatic Hose of Teflon		
Hose part number	678-6	678-8
Hose size I.D.	.312	.437
Hose size O.D.	.609	.812
Oper. press., psi.	6,000	6,000
Burst press., psi.	24,000	24,000
Bend radius at pressure	5	10

All dimensions in inches



**AEROQUIP CORPORATION, JACKSON, MICHIGAN**  
**AEROQUIP CORPORATION, WESTERN DIVISION, BURBANK, CALIFORNIA**  
**AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO**  
AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN CANADA, U.S.A. & ABROAD  
Teflon is DuPont's trade name for its tetrafluoroethylene resin

**Aeroquip Corporation, Jackson, Michigan**  
 Please send me a copy of Engineering Bulletin AEB-23. MR-12

Name

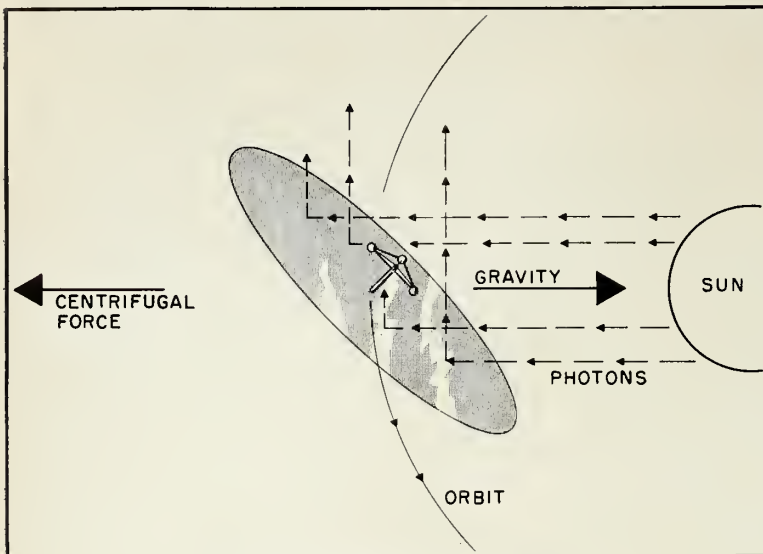
Title

Company

Address

City  Zone  State

## Los Alamos Scientists Study Solar Sail



HOW SOLAR sail utilizes photon propulsion.

LOS ALAMOS, N. M.—A space vehicle propelled through space by a solar sail, using photon propulsion, is being studied by the Los Alamos Scientific Laboratory of the University of California.

The idea of using pressure of solar radiation for extra-orbital propulsion is not new. However, a small group of Los Alamos scientists, headed by Theodore Cotter, have devised means for spreading the sail once in outer space, for holding the sail in place, and for maneuvering the space ship and sail in relation to the sun and gravitational force.

Solar sailing is based on the use of the pressure of sunlight (photons) reflected by a large thin sail in much the same manner as sailboats use the wind. Sun pressure is pretty small—about 1/100th pound per acre—but since space is almost a perfect vacuum, there is no resistance and the sun pressure is free.

• **Two parts**—The space vehicle devised by Los Alamos would be in two parts—a large flat sail of equal weight with the attached payload. The two parts would be connected by a universal-like gear for maneuvering. The sail would be made from an extremely thin material such as a mylar-aluminum combination and could be put into orbit by a vehicle about the size of a *Vanguard* launcher.

Total weight would be around 50 pounds—25 pounds for the payload

and 25 pounds for a sail 50 yards in diameter. The resulting device should do what satellites can never do—sample space at all distances from the earth. Satellites can only sample space from fixed orbits.

A solar sailing space ship would first be put into orbit around the earth, then the sail opened. Constant pressure of the sun on the sail would increase the orbit of the space ship. This maneuvering would continue for a matter of months until the solar sailing vehicle had gained enough distance from the earth to go into planetary orbit, and thus navigate in space without worrying about the gravitational fields of the earth or other planets.

A solar vessel would not be able to tack into the sun as a sailboat tacks into the wind; rather the solar sailing vehicle, now in planetary orbit, would play the sun's gravity against the centrifugal force of the space ship in orbit. Return to the earth would be made in the same way. It would decrease its orbital speed, and thus decrease its centrifugal force, and allow the sun to pull the vehicle towards the earth.

• **Centrifugal opening**—The solar sail may be opened by centrifugal force from spin given to it on leaving the rocket and would need no structural support, or it may be opened by using foam plastic which would be formed in ribs of the sail once the space ship leaves the rocket. In either

case, the sails would be extremely fragile, but there are no stresses in space, so they would actually be overly strong for the mission to be performed. Once in space, mere meteoritic punctures to the solar sail are insignificant to the sail's function. Los Alamos feels that this indicates that a solar sailing space ship might remain serviceable for many years.

## Device Switches Current Fast as Speed of Light

Sperry-Rand's Semiconductor Division recently announced details of a tiny semiconductor device that switches current off and on faster than light can travel one inch.

Time interval for switching is equal to or better than the speed measured by the best instruments available today—about 0.1 milli-microseconds, according to the company. Sperry scientists estimate that the speed of the switch is something around 0.05 milli-microseconds. Semiconductors in use today as switches operate about 100 times slower.

Working element of the switch is a semiconductor alloy junction formed by fusing aluminum to a tiny piece of silicon. The entire switching action takes place within the junction layer's diameter of two-thousandths of an inch and a thickness of four-millionths of an inch.

The atoms in the junction layer provide the mechanism for the switch. Operation depends on controlling the conditions for penetrating the lattice of the atoms and knocking planetary electrons out of the atom's shells.

• **Electrons accelerated**—The atomic mechanism in the layer blocks the flow of current until triggered by a "bit" of computer information in the form of a voltage pulse. The slight increase in voltage accelerates one or more electrons to speeds sufficient to knock new electrons out of their atomic shells. These in turn accelerate and knock more electrons free and so on. Each electron creates a chain reaction or "microplasma" which almost instantly spreads throughout the layer and carries current across the junction. In this condition, the switch is "ON."

Sperry calls this phenomenon the "avalanche effect" because the first electron is like the pebble that starts a landslide.

A slight decrease in voltage reduces the speed of the electrons so that the avalanche effect stops and the current-carrying plasma is swept out of the layer. In this condition, the switch is "OFF."



# MANUFACTURER'S AGENTS WANTED

... by Michigan producer of air- and vacuum-melted, high-temperature and specialty alloys — primarily for aircraft and missile applications. Sheet, wire and bar stock forms. Reply with information on experience, present products, area and type of company served.

Write Box 121,

Missiles & Rockets Magazine,  
1001 Vermont Ave., N.W.,  
Washington, D.C.

## when and where

### JANUARY

**Fifth National Symposium on Reliability and Quality Control in Electronics**, Bellevue-Stratford Hotel, Philadelphia, Jan. 12-14.

**Southwest Electronic Exhibit**, Arizona State Fairgrounds, Phoenix, Jan. 21-23.

**Institute of the Aeronautical Sciences**, 27th Annual Meeting, Sheraton-Astor Hotel, New York. Honors Night Dinner, Jan. 27.

**Fifth Annual Radar Symposium** (classified), Rackham Bldg., University of Michigan, Ann Arbor, Jan. 27-29.

**Society of Plastics Engineers**, 15th Annual Technical Conference, Hotel Commodore, New York, Jan. 27-30.

**Armour Research Foundation**, Fifth Annual Midwest Welding Conference, Illinois Institute of Technology, Chicago, Jan. 28-29.

### FEBRUARY

**14th Annual Technical and Management Conference**, Reinforced Plastics Division, Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Feb. 3-5.

**IRE, AIEE 1959 Solid Circuits Conference**, University of Pennsylvania, Philadelphia, Feb. 12-13.

**1959 Engineering Exposition**, Balboa Park, San Diego, Feb. 26-March 1.

### MARCH

**IRE, AIEE and Association for Computing Machinery**, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco, March 3-5.

**Institute of the Aeronautical Sciences**, Flight Propulsion Meeting (classified), Hotel Carter, Cleveland, March 5-6.

missiles and rockets, December 29, 1958

## PROFESSIONAL PERSONNEL REQUISITION

### Group Leader—

## CYCLE ANALYSIS AND MISSION STUDIES

Responsible for analytical studies of advanced engine cycles in support of hypersonic ramjet engine research program. Will also be responsible for vehicle mission studies in hypersonic speed ranges. Requires extensive experience in high speed aerodynamics and propulsion cycle analysis.

Position is in ASTRO, Marquardt's research division. Small, enterprising group offers excellent potential for individual contribution. Requires degree plus 7 years experience. Needs combination of strong technical background and leadership ability.

Marquardt is growing fast through expansion and acquisitions. Located in sunny Southern California, it offers the advantages of pleasant climate, summer and winter sports, a relaxed way of life. Salary and company benefits rank among the highest in the industry.

**Contact: Floyd E. Hargiss, Manager, Professional Personnel**  
16552 Saticoy Street, Van Nuys, California

Advanced power and weapons support  
systems for air and space

VAN NUYS AND POMONA, CALIFORNIA • OGDEN, UTAH

*Marquardt*  
AIRCRAFT CO.

Advertising correspondence should be addressed to Advertising Sales Manager, Missiles and Rockets, 17 East 48th Street, New York 17, N.Y.

### REGIONAL OFFICES:

**New York City:** 17 E. 48th St., New York 17. Edward D. Muhlfeld, Advertising Sales Manager; P. B. Kinney and G. T. O'Mara, regional adv. mgrs. Phone: PLaza 3-1100.

**West Coast:** 8929 Wilshire Blvd., Beverly Hills, Calif. Fred S. Hunter, manager; Walton Brown, regional adv. mgr.; James W. Claar, regional adv. mgr. Phones: OLeander 5-9161 or OLeander 7-1555.

**Chicago:** 139 N. Clark St., Chicago 2, Ill. George E. Yonan, regional adv. mgr. Phone: CEntral 6-5804.

**Cleveland:** 244 Hanna Bldg., 1422 Euclid Ave., Cleveland 15, Ohio. Douglas H. Boynton, regional advertising manager. Phone: PProspect 1-2420.

**Detroit:** 201 Stephenson Bldg., Detroit 2, Mich. Kenneth J. Wells, regional advertising manager. Phone: TRinity 5-2555.

**Florida:** 208 Almeria Ave., Coral Gables, Fla. Richard D. Hager, advertising sales representative. Phone: Highland 4-8326.

**Canada:** Allin Associates, 12 Richmond Street East, Toronto 1, Ontario. Phone: EMpire 4-2001. Allin Associates, 1487 Mountain St., Suite 4, Montreal, Que. Geneva: American Aviation Pubs., 10

Rue Grenus, Geneva, Switzerland. Anthony Vandyk, European Director.

**London:** The AAP Company, 17 Drayton Road, Boreham Wood, Hertfordshire, England. Phone: Elstree 2688. Cable address: STEVAIR, London.

**Paris:** Jean-Marie Riche, 11 Rue Condorcet, Paris (9e), France. Phone: TRUdaine, 15-39, Cable address: NEWS AIR PARIS.

## Advertiser's Index

Aeroquip Corp.	31
Agency—Fred M. Randall Co.	
Bendix Aviation Corp., Bendix Products Div.	22
Agency—MacManus, John & Adams, Inc.	
Boeing Airplane Co.	4
Agency—Calkins & Holden, Inc.	
Electro-Instruments, Inc.	36
Agency—Clyde D. Graham Adv.	
Flight Refueling, Inc.	30
Agency—Emery Adv. Corp.	
Goodyear Tire & Rubber Co., Aviation Products	3
Agency—Kudner Agency, Inc.	
Grove Valve & Regulator Co.	35
Agency—L. C. Cole Co.	
Hallamere Electronics Co., Div.—The Siegler Corp.	2
Agency—Cole, Fischer & Rogow, Inc.	
Hexcel Products, Inc.	8, 9
Agency—L. C. Cole Co.	
Hydromatics, Inc.	26, 27
Agency—Industrial Marketing Associates Adv.	
National Aeronautics & Space Administration	12
Agency—M. Belmont Ver Standig, Inc.	
North American Aviation, Inc., Missile Development Div.	24
Agency—Batten, Barton, Durstine & Osborn, Inc.	
Northrop Aircraft, Inc., Radioplane Div.	19
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.	
Scaife Co.	6
Agency—E. A. Korchnoy, Ltd.	
Stromberg-Carlson Co., Div.—General Dynamics Corp.	10
Agency—The Rumrill Co., Inc.	

### EMPLOYMENT SECTION

Marquardt Aircraft Co.	33
Agency—Grant Adv., Inc.	

## Pax Universum—More Than Latin Phrase

Our government has gone to considerable pains in the past months to separate our civilian and military space activities, but the fact remains that to date there have been no space projects attempted or proposed in this country which do not have conceivable military applications.

On this page two weeks ago, m/r observed that while the U.S. was rather frantically moving off in all directions toward hopeful space conquest, we were doing so with no defined goal, no established program and no clear leadership or organization. M/r suggested, clearly mindful that it had a militaristic ring, that the U.S. goal should be:

"Until the world is guaranteed that space occupation of our solar system is for peaceful purposes, the United States can take no chance on its being dominated by someone else."

It also has a realistic ring. If the Soviets, under any guise, should gain dominance in the space envelope around the earth, they could blackmail the free world into abject submission—and quite happily would.

General Thomas D. White is a tough-minded military man. With a few peers he shares the lonely responsibility of being certain that the United States never drops its guard for that fatal moment which would permit a successful attack. Quoting General White, AF Chief of Staff:

"The few relatively brief periods of universal peace enjoyed by mankind in the past have been underwritten by potent national instruments. The British Navy, in the days of Pax Britannica, guaranteed an era of peace and progress by commanding the world's oceans. Today, the United States maintains a similar decisive force which operates in the now decisive medium of air. The natural extension of this decisive force into space is upon us—and we must meet this challenge to assure peace in the future. We must grow apace with the possibilities before us or perish for lack of what it takes to survive."

Most certainly his colleagues on the Joint Chiefs of Staff would agree that we must grow apace with the possibilities before us (in space) or perish for

the lack of what it takes to survive. For no matter what the extent of civilian control imposed over them, these military leaders today bear a responsibility that is perhaps as great as any similar group in history ever faced. The land and the sea and the struggles for the control thereof have always been with us. Combat techniques in the air immediately above us came gradually, during and between two world wars. Space and its foreboding—if fascinating—challenge burst upon us with the speed of a Russian *Sputnik* orbiting around the earth every two hours.

It is pretty doubtful that the civilian leadership of the country is giving the service chiefs and their organizations the help which might reasonably be expected.

The gentlemen of the budget normally cut too deeply into all government programs knowing that the agencies involved will find ways of circumventing some part of the incisions. In the old, well-established programs, these budget cuts can be finessed because the very momentum of bulk—the Air Force \$18 billion program, for instance—will carry them along. In the budgets for space projects there is no bulk, no backlog and no room to maneuver. Cuts there dig into the muscle. (ARPA's budget is and probably will be for 1960, woefully inadequate).

Our attitude before the world that the U.S. exploration of space is for peaceful purposes is part wistfulness and part the creation of a national posture. We must not go into space swinging a sword.

But both Congress and the National Space Council, which is headed by the President, should never lose sight of the fact that this peaceful space exploration will only be possible if the United States and the world's other free nations make it free; if we have a military capability in space which will prevent its domination by anyone else.

Again, m/r proposes that we must have a goal, a program and an organization for our space operation. From this can come the strength to help create a PAX UNIVERSUM, which may help to solve some of the nation's problems.



# SUBSCRIBER SERVICE

## missiles and rockets

For additional information about any product or service advertised or mentioned in the editorial pages of this issue of Missiles and Rockets:

Use the attached prepaid reply cards. Circle numbers shown on the reply card that correspond with numbers appearing beneath items described. If no circle number accompanies the article or advertisement, give page number (and advertiser's name) on line provided at bottom of the card.

Your requests for information will be forwarded promptly to the companies concerned.

## NEW PRODUCT BRIEFS

**PROCESSOR.** A new, 35mm processor, second in a line of portable processors has been announced by Industrial Products Division of Fairchild Camera and Instrument Corporation. The "Mini-Rapid 35" will process film automatically. It is designed to operate at speeds up to six feet per minute. Four hundred feet of leaderless film can be processed at one loading. The unit is designed to operate under light conditions and use any size spool.

Circle No. 231 on Subscriber Service Card.

**POTENTIOMETERS.** A 4-page brochure summarizing key information on trimpot and trimit lead screw actuated potentiometers has been published by Bourns Laboratories, Inc. The brochure features a specification table listing available resistances, terminal types, end settings, power ratings, operating temperatures, and dimensions of the models.

Circle No. 232 on Subscriber Service Card.

**DATA-PROCESSING SYSTEM.** Features of Univac II data-processing system are described in a folder published by Remington Rand Division of Sperry Corporation. The Univac II computer offers a high-speed memory system—the magnetic-core memory, which Remington Rand first introduced. It provides access to 4,000 alphabetic or numeric characters. It operates either on 80 or 90 punch cards, and provides direct recording of information on magnetic tape. It can also translate punched-tape directly to magnetic tape output. Output can be either on magnetic tape, punched cards, hard copy paper tape. It reads and records information at a pulse density of 250 characters per recording inch on magnetic tape. Univac II handles either Univac I or Univac II programs.

Circle No. 233 on Subscriber Service Card.

**COMPONENTS.** A set of basis transistor digital computer circuit package has been developed by the Communications Division of Aeronutronic Systems, Inc. Individual circuits include flip-flops, logic logic boards, read amplifiers, and amplifiers and blocking oscillators. The component board contains two logical circuits except the logic board. This contains 2-1, 2-2, 2-3, 1-4, 2-5 union "and" gates, and nine "or" gates. DC pulse gating techniques permit operation of 75 pulse gates from the output of the flip-flop and read amplifier, at frequencies up to 500 kc.

Circle No. 234 on Subscriber Service Card.

**RATIOMETER.** An ac-dc digital ratiometer, model 1594, for computers and control system applications has been announced by Performance Measurement Co. Range of ratios that can be measured directly in numerical values is 0 to 1,000. Input voltages range from 0 to 6.3 volts ac and 0 to 6 volts dc. With a high impedance input, this instrument measures ac and dc voltage ratios with a rated accuracy of  $\pm 0.10\%$  full scale. For measuring ac ratios, the digital ratiometer accepts input voltage at a nominal frequency of 400 cps. Frequency variations as high as  $\pm 20$  cps and resultant phase shift have no effect on the ratiometer output reading. Readability of the model 1594 digital ratiometer is one part in 1000. Reference input impedance for both ac and dc ratios is 1000 ohms. The signal input impedance for the ac section of the ratiometer is 20 megohms minimum, and for the dc section it is 10 megohms. Power input to the instrument is 115 volts, 60 cps and 50 watts.

Circle No. 235 on Subscriber Service Card.

**TRANSISTOR.** A germanium p-n-p alloy-junction transistor (RCA-2N331) for audio-frequency amplifier service has been announced by the RCA Semiconductor and Materials Division. The 2N331 has a current-transfer-ratio characteristic which is essentially constant over the useful operating current range for the device. This feature, in addition to low collector-and-emitter-cutoff currents, low base resistance, a typical power gain of 44 decibels, and a typical noise factor of 9 decibels, gives low-power audio-frequency amplifier service.

Circle No. 236 on Subscriber Service Card.

**ACCELEROMETERS.** A line of 30, ungrounded piezoelectric accelerometers, designed to eliminate circulating ground currents, has been announced by Gulton Industries, Inc. The ungrounded units are produced in four classes including unidirectional, tridirectional, high temperature and extra high temperature. Normal temperature units, Series A, Glennite Accelerometers, operate from  $-65^{\circ}$  to  $+250^{\circ}$ F. Series AHT, high temperature units operate from  $-65^{\circ}$  to  $+350^{\circ}$ F. The AXT series, extra high temperature units operate from  $-100^{\circ}$  to  $+525^{\circ}$ F. Featuring extremely high sensitivity, small size and weight and wide temperature ranges, all units reportedly operate with an accuracy of  $\pm 5\%$  or better and a linearity of  $\pm 1\%$ .

Circle No. 237 on Subscriber Service Card.

MISSILES AND  
ROCKETS

DEC. 29, 1958

Expires Three Weeks  
After Above Date

NAME \_\_\_\_\_ TITLE/POSITION \_\_\_\_\_  
COMPANY \_\_\_\_\_  
Product Mfg./Service Offered \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ STATE \_\_\_\_\_  
ZONE \_\_\_\_\_  
Card cannot be processed unless all information is given.  
Please limit requests to ten items.

POSTAGE  
WILL BE  
PAID BY  
ADDRESSEE

BUSINESS REPLY CARD  
First Class Permit No. 2455-R (Sec. 510 P.L.R.) Washington, D. C.

MISSILES and ROCKETS

17 EAST 48th STREET

NEW YORK 17, N.Y.

SUBSCRIBER SERVICE DEPT.

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• Advertisements

• Missiles Literature

• New Missile Products

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

For Other Information Give Page Numbers.

NO  
POSTAGE  
NECESSARY  
IF MAILED  
IN THE  
UNITED  
STATES

## MISSILE LITERATURE

**CERAMIC TRANSDUCERS.** Publication of a technical brochure on the subject of a new series of Glennite high temperature, piezoelectric ceramic transducers, is announced by Gulton Industries, Inc. Described in the brochure are the exceptionally high Curie points of these transducers, that have made it possible to reach higher output voltages per unit input pressure than can be reached with conventional ceramics. Because no cooling is required, applications for the transducers highlight uses in ordnance systems and high temperature electro-mechanical sensors. The eight-page, two-color, illustrated brochure also describes other applications.

Circle No. 200 on Subscriber Service Card.

**DATA SYSTEM.** A brochure is now available from the Epsco Systems Division. It describes the new Mark I basic short delivery automatic PDM-to-Digital Computer Format Telemetry Data System. Among the many features in this production type data system is the unparalleled absolute accuracies in excess of 0.1%, and the fact that the entire PDM data to computer format process is completely automatic.

Circle No. 201 on Subscriber Service Card.

**ALLOY.** An alloy that combines the advantages of excellent resistance to corrosion with good strength at high temperatures is the subject of a new 12-page booklet. Latest information on hastelloy Alloy B, one of a group of nickel-base alloys bearing this trade mark, has been consolidated. The alloy was developed primarily to offer chemical processors and excellent resistance to hydrochloric acid over a wide range of concentrations and temperatures. In addition, Alloy B has become a valuable high-temperature material because it retains over two-thirds of its room temperature yield strength at 1600 deg. F. It is a product of Haynes Stellite Company, Division of Union Carbide Corp.

**DESKTOP COMPUTER.** Data File 340 describing Donner Scientific Company's new Model 3400 desktop analog computer is now available. The model 3400 performs the functions of general purpose analog equipment. In design, analysis, or control problems, it is a time-saving model of an arbitrary physical system. Easily measured varying voltages represent the physical variables of the problems. Measurement of the voltage yields complete information on the system. Parameters can be altered with the twist of a dial.

Circle No. 203 on Subscriber Service Card.

**CARBON-GRAPHITE.** A informative reference on the composition, qualities and applications of carbon-graphite is offered by the Ohio Carbon Company in an 8-page brochure. The brochure serves as an idea book for carbon-graphite applications. Charts and tables provide data on qualities of scleroscope hardness, density, transverse and compressive strength, oxidizing temperature limitations, performance in sliding contact with various modern bearing metals, tensile strength-to-specific gravity, and thermal conductivity. Special development and testing facilities are outlined.

Circle No. 204 on Subscriber Service Card.

**BROCHURE.** A 36-page brochure covering a complete range of services in rocket and missile systems is available from Cooper Development Corporation. The brochure details the company work in propulsion, electronics, telemetry, instrumentation, ground support, upper atmospheric research, meteorological studies, target systems and related activities. Engineering, production, and quality control facilities are described and a special section is devoted to systems and components.

Circle No. 210 on Subscriber Service Card.

**ANALYZER.** Theoretical and practical analysis of FM is the subject of the latest issue of "The Panoramic Analyzer," publication devoted to application data by Panoramic Radio Products, Inc. Basic FM theory, modulation, FM spectrum measurements, and combined AM and FM are discussed. This issue outlines the uses of FM commercially as well as in the missile and aircraft field. FM background, and methods of monitoring and maintenance. Common types of measurements are covered—FM deviation calibration, monitoring channel utilization, malfunction analysis, etc.

Circle No. 209 on Subscriber Service Card.

**PULSE TRANSFORMERS.** A technical bulletin describing a series of miniature encapsulated pulse transformers wound on high permeability ferromagnetic cores has been published by Technirol Engineering Company. The bulletin describes the T series pulse transformer having a range of pulse widths from 0.1 to 25 microseconds for vacuum tube transistor blocking oscillator and interstage coupling applications. The bulletin gives electrical and environmental specifications and includes drawings of different case styles with dimensions.

Circle No. 208 on Subscriber Service Card.

**DUTY LIMIT SWITCHES.** 16-page catalog, Number 84, covering a complete line of heavy duty limit switches, has been published by Micro Switch, a division of Minneapolis-Honeywell Regulator Company. The catalog gives details of three types of micro switch heavy-duty limit switches for industrial uses—the plug-in "200LS" series, the "LS" series, and the "ML" switches.

Circle No. 207 on Subscriber Service Card.

**MISSILE SYSTEM CAPABILITIES.** An 8-page two-color brochure covers the firm's work and facilities in missile system development and production. The brochure illustrates and describes systems, subsystems and components for many advanced missiles. It lists the company's current projects such as guidance and control systems, missile-borne sub systems, ground support equipment, production test equipment and specialized components.

Circle No. 206 on Subscriber Service Card.

**SERVICES AND FACILITIES.** New 6-page Bulletin 5801 describes laboratory and field testing facilities and services available from United States Testing Company, Inc. Included is a description of the company's engineering facilities and services—environmental studies in electronics, instrument calibration, reliability testing and failure analysis.

Circle No. 205 on Subscriber Service Card.

**BUSINESS REPLY CARD**  
First Class Permit No. 2455-R (Sec. 510 P.L.R.) Washington, D. C.

### MISSILES and ROCKETS

17 EAST 48th STREET

NEW YORK 17, N.Y.

POSTAGE  
WILL BE  
PAID BY  
ADDRESSEE

NAME \_\_\_\_\_  
TITLE/POSITION \_\_\_\_\_  
COMPANY \_\_\_\_\_  
Product Mfg./Service Offered \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_  
Card cannot be processed unless all information is given.  
Please limit requests to ten items.

MISSILES AND  
ROCKETS

DEC. 29, 1958

Expires Three Weeks  
After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

#### ● Advertisements

- 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
- 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75
- 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100
- 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125
- 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
- 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175

#### ● Missile Literature

- 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224
- 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
- 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274
- 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299

#### ● New Missile Products

- 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224
- 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
- 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274
- 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299





## REVOLUTION IN DESIGN

**Grove Regulators...** As revolutionary in design and engineering as the technological transition from flying machine to space vehicle... Achieved a quarter of a century ago, the only regulators which could be used in the early space labs of Annapolis... still today the standard for the critical control of high pressure fluids... Now on the threshold of space, Grove is uniquely prepared—through advance research and development—to meet the challenge of even higher pressures ahead.

GROVE POWREACTOR DOME REGULATOR MODEL GH-408—50-6000 PSI INLET...5-3000 PSI REDUCED PRESSURE

**GROVE VALVE and REGULATOR COMPANY**

6529 Hollis St., Oakland 8, California • 2559 W. Olympic Blvd., Los Angeles 6, California  
Offices in other principal cities



# NEW! all electronic A-D converters and digital voltmeters for medium and high speed applications

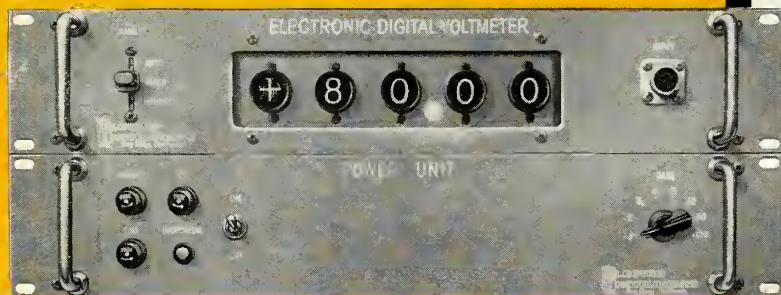
# 2

new series  
of advanced  
instruments



## The 7000 Series

for *high-speed* conversions.  
Up to 1000/second • 1  
megohm input impedance  
• Automatic polarity • 3-  
and 4-digit models • Sensi-  
tivity and resolution 0.01%  
• Transistorized logic  
circuits • Transistorized  
direct-reading indicators.



## The 8000 Series

for *medium-speed* conver-  
sions • Maximum balance  
time 100 milliseconds • 1000  
megohms input impedance  
at balance • Automatic  
ranging • Automatic polarity  
• 4-digits • Sensitivity  
and resolution 0.01% •  
Totally transistorized.

Both the 7000 and 8000 Series develop voltage state BCD  
outputs for data recorder entry. Standard code is 2, 4, 2, 1;  
other codes available on special order.

Write today for complete engineering specifications

## Electro Instruments, Inc.



3540 Aero Court  
San Diego 11, California

9526