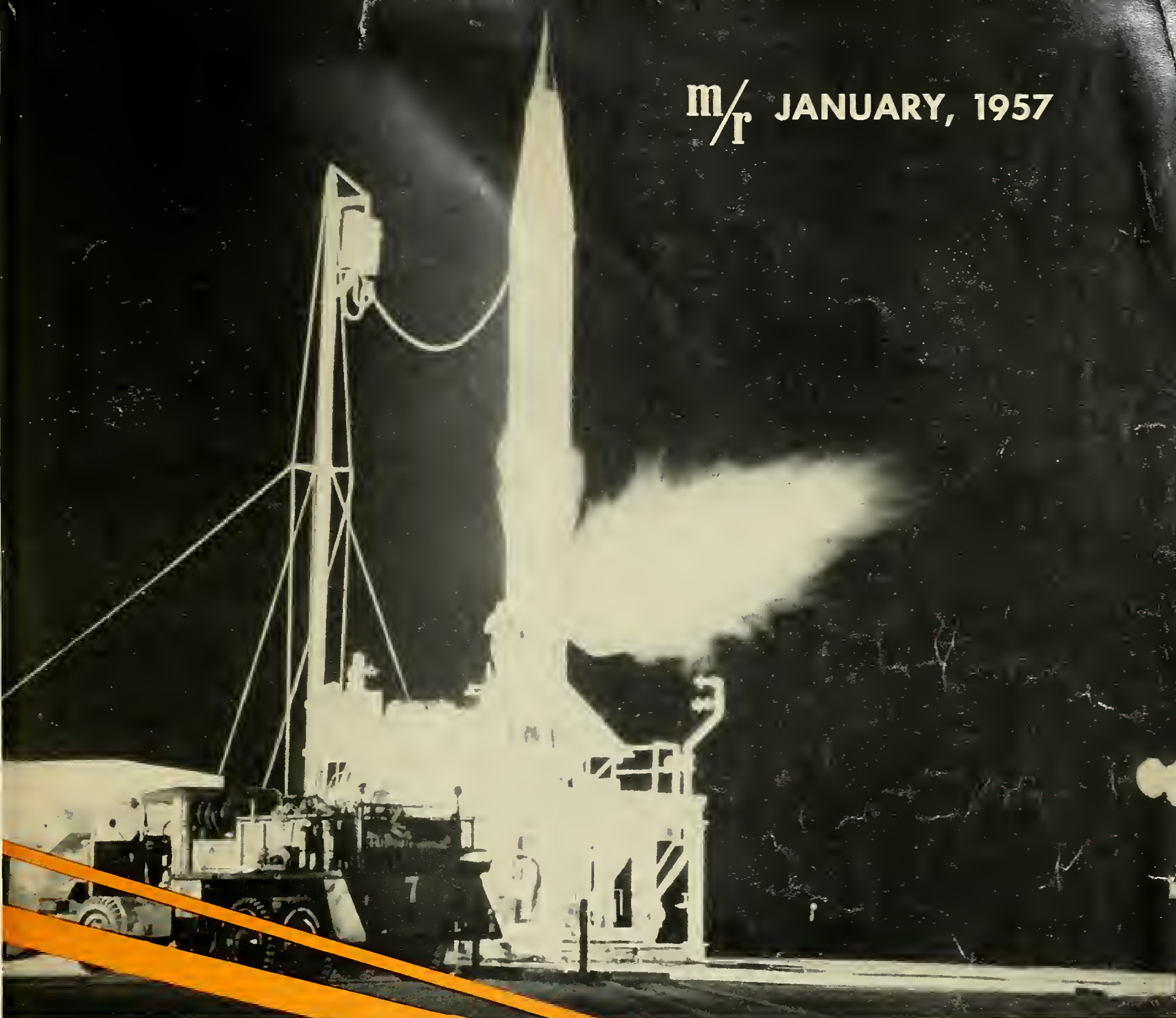
m/r JANUARY, 1957





# missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

*In This Issue:*

**U.S. NAVY MISSILE POWER AND SATELLITE PROGRESS**


WIGGINS' NEWEST!
an automatic connection
SMALL SPACE REQUIREMENT
LOW PRESSURE DROP
NO AIR INCLUSION
Wiggins
connect-O-matic
Trademark
COUPLING
SURE
POSITIVE
SAFE AND DOUBLE SAFE
ANY DESIRED SERVICE
PUSH...it's connected!
SINGLE, SIMPLE, MOTION
If it's got to connect
...connect with
WIGGINS
Manufacturers of
WIG-O-FLEX Coupling
INST-O-MATIC Coupling
CONNECT-O-MATIC Coupling
Wiggins
E. B. WIGGINS OIL TOOL COMPANY, IN
3424 East Olympic Boulevard, Los Angeles 23, Califor

**missiles and rockets**

Magazine of World Astronautics

January, 1957 Volume II, No. 1

*MISSILES AND ROCKETS is published monthly by American Aviation Publications, Inc., 1001 Vermont Avenue, N.W., Washington 5, D.C., U.S.A., Telephone: Sterling 3-5400. Cable: AMERAV.*

**Subscription Rates:**

| Domestic | | Foreign | |
|---|---|---|---|
| 1 year | $ 8.00 | 1 year | $ 9.00 |
| 2 years | $12.00 | 2 years | $14.00 |

Single copies $ .75

**Subscription Service:** All subscription orders, correspondence, and change of address should be sent to:
Subscription Service Manager
Missiles and Rockets
1001 Vermont Avenue, N.W.
Washington 5, D.C.

**Changes of Address:** Send old address exactly as imprinted on mailing label of your magazine copy, and new address with zone number if any, to above address and allow two weeks for change-over.

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

REGIONAL OFFICES:

**New York City:** 17 E. 48th St., New York 17, William H. Pearson, director of advertising; Edward D. Muhlfeld, assistant director of advertising; M. Michael Cerick, Paul Kinney, and Robert Weston, regional adv. mgrs. Phone: Templeton 8-5446.

**West Coast:** 8943 Wilshire Blvd., Beverly Hills, Calif., Fred S. Hunter, manager. John Ball, Jr., and Walton Brown, regional adv. mgrs. Phones: Bradshaw 2-6561 and Crestview 6-6605.

**Chicago:** 139 N. Clark St., Chicago 2, Ill., Laurie S. Seward, regional adv. mgr. Phone: Central 6-5804.

**Dallas:** 8924 Greenville Avenue, Dallas 6, Texas. Phone: EMerson 1-4507. Richard A. Worthington, regional advertising manager.

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

**Canada:** Allin Associates, 12 Richmond Street, East Toronto, Ontario. Phone: Empire 4-2001. Allin Associates, 2226 Dorchester Street West, Montreal, Quebec.

**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.

Other American Aviation Publications:

American Aviation Magazine
American Aviation Daily
Official Airline Guide
(North American, World-Wide Editions)
World-Wide Aviation Directory
Who's Who In World Aviation
Air Traffic News
Airports

*PUBLISHING CORPORATION: Wayne W. Parrish, president; Leonard Eiserer, executive vice president and treasurer; William H. Pearson, vice president and director of advertising; Albert H. Stackpole, and Eric Bramley, vice presidents; E. J. Stackpole, Jr., secretary.*

*To engineers interested in entering the field of*

# INERTIAL GUIDANCE

E. V. Stearns (left), head of the Inertial Guidance Department, discusses navigation systems mechanization with Inertial Guidance Scientist R. L. McKenzie (center) and Senior Electronics Scientist D. G. Peterson.

Here is a field whose potential is equalled by the magnitude of its problems. The development of components with extraordinary precision alone offers unmatched scope for achievement.

At Lockheed's Research Center in Palo Alto, engineers and scientists are working on a number of different inertial guidance systems. They are involved in all phases of inertial guidance and navigation.

Their expanding activities have created new positions for those possessing backgrounds in:

- **Mathematics**
- **Physics**
- **Electronics (such as magnetic amplifiers)**
- **Servomechanisms**
- **Flight Controls**
- **Precision mechanical and instrumentation development**
- **Special purpose computer design**

Engineers and scientists possessing experience or keen interest in advanced applications of inertial guidance are invited to write.

*Lockheed*

**MISSILE SYSTEMS DIVISION**

*research and engineering staff*

LOCKHEED AIRCRAFT CORPORATION

**VAN NUYS · PALO ALTO · SUNNYVALE**

**CALIFORNIA**

**missiles and rockets**

*Magazine of World Astronautics*

WAYNE W. PARRISH, *Editor and Publisher*

ROBERT H. WOOD, *Editorial Director*

ERIK BERGAUST, *Managing Editor*

SEABROOK HULL, *Assistant Editor*

• •

*Department Editors*

ENGINEERING: Joseph S. Murphy
ELECTRONICS: Henry P. Steier
MILITARY: Henry T. Simmons
PROPULSION: Alfred J. Zaehringer
ASTRONAUTICS: Heyward E. Canney and Frederick I. Ordway III
MANUFACTURING: Fred S. Hunter
INTERNATIONAL: Anthony Vandyk
LONDON: James H. Stevens
PARIS: Jean-Marie Riche

ART DIRECTOR: William H. Martin
PRODUCTION MANAGER: John Walen
RESEARCH DIRECTOR: A. J. Newfield

*Manuscripts that are not negotiated should be submitted to the Managing Editor for consideration. In the event the subject matter of the manuscript is considered to be in a classified area, the manuscript must be cleared by the proper security review office of the Department of Defense. Responsibility for security clearance rests with the author.*

LEONARD EISERER, *General Manager*

WILLIAM H. PEARSON, *Director of Advertising*

LARRY BRETTNER, *Manager, Publication Sales*

ELSIE GRAY, *Advertising Service Manager*

**Publishing Information:** Published every month by American Aviation Publications, Inc., Washington, D.C. Printed at The Telegraph Press, Harrisburg, Pa. Second class mail privileges authorized at Washington, D.C., with additional entry at Harrisburg, Pennsylvania.



# For the Orphaned ABMA --Independence!

The most experienced ballistic missile research and development group in the world is hanging in the balance.

By an extraordinary stroke of irony, Defense Secretary Wilson's controversial memorandum on missile assignments has orphaned the Army Ballistic Missile Agency.

If by any unlikely chance there is any doubt about the value of ABMA, let the record state that this is the group headed by the talented Wernher von Braun. Let the record show that ABMA is without peer in the world among research or military organizations in its experience in ballistic missile development.

Now that Secretary Wilson has decreed that the Army should have nothing to do with long range ballistic missiles, what is to become of ABMA?

The Navy well may provide the answer. In an exclusive interview in this issue of m/r, with Assistant Secretary of the Navy for Air, Garrison Norton, a gratifying statement occurs: The Navy hopes to make the fullest possible use of ABMA. This is in spite of the fact that the Army and the Navy now are going in separate directions for development of intermediate range ballistic missiles.

We commend the Navy for its foresightedness. Although the technological requirement for a fleet ballistic missile is somewhat different than for the Army's long range ballistic missile, the fact remains that 1200-mile or 1500-mile range ballistic rockets must be based on one and the same design concept.

We think the best solution to the ABMA problem, however, would be to establish this talented group as a separate and independent *national ballistic missile research agency*, somewhat similar in scope to the highly successful National Advisory Committee for Aeronautics.

Meanwhile, the furor over the Wilson memorandum is far from over. It is gaining momentum now that Congress has convened with a number of Senators and Congressmen insisting upon a full-scale review of the Wilson action. There will be a strong demand, based both on the Army's proven record of achievement and on definitions of weapons in tomorrow's world, that the Army be permitted the right to incorporate intermediate range ballistic missiles in its weapon arsenal.

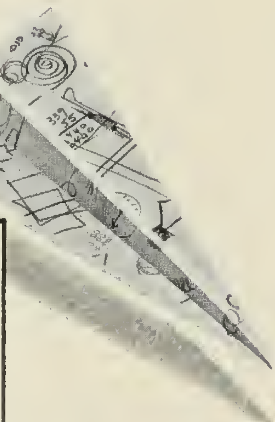
The immediate problem is to save the ABMA team whose morale is understandably at a very low point. At a time when our ballistic missile race is on in the world arena, it is tragic that ABMA is a victim (temporarily, at least) of inter-service competition and squabbles.

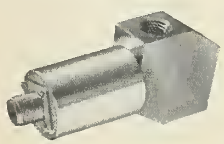
WAYNE W. PARRISH.

# Giannini Instruments and Controls for almost every airborne application

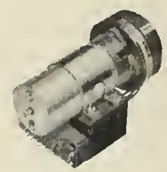
Whether single components or complex packaged systems, virtually all operational military aircraft (and civilian, too) use reliable Giannini precision-crafted instruments and controls.

When performance demands precision, specify Giannini products—they're available for *almost* every airborne application.

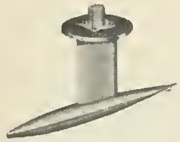




Hydraulic Valves

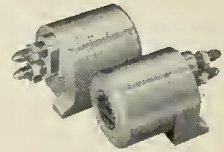


Rotary Sampling Switches

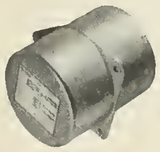


Temperature Probes

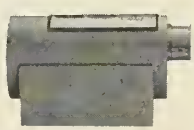
Differential Pressure Flight Angle Computers



Low Pressure Transducers

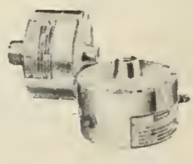


Gyro Instruments



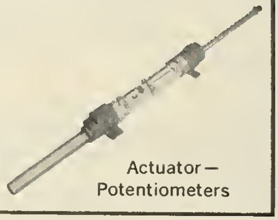
Accelerometers

Aerodynamic Angle of Attack Transducers



High Pressure Transducers

Air Data Systems



Actuator—Potentiometers

*Engineering positions are open for career-minded young men at several locations—write for details.*

**Giannini**

INSTRUMENTS · CONTROLS

REGIONAL SALES OFFICES: NEW YORK 1, N.Y., Empire State Bldg., CHickering 4-4700 • CHICAGO, ILL., 8 S. Michigan Ave., ANdover 3-5272
PASADENA, CALIF., 918 E. Green St., RYan 1-7152

FOREIGN SALES OFFICES: LONDON W. 8, ENGLAND, Giannini Limited, 31, Pembroke Gardens

G. M. GIANNINI & COMPANY, INC. • 918 EAST GREEN STREET • PASADENA, CALIF.

Circle No. 17 on Subscriber Service Card.

# features



# news & trends



# rocket engineering



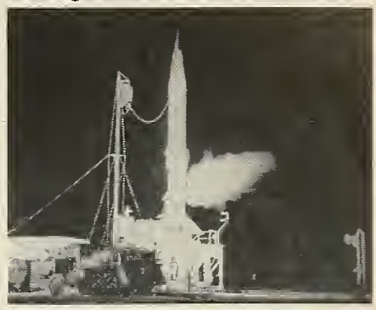
# industry spotlight



# next issue:

**ROCKETRY AND ASTRONAUTICS BEHIND THE IRON CURTAIN.**

**cover picture:**



*M/R's cover shows Viking 13 just before it was fired last month from Patrick AFB. The Navy research rocket plays an important part in the step-by-step approach to Project Vanguard and the artificial earth satellite that is to be placed in its orbit during the International Geophysical Year. The white flare-out from the missile is oxygen bleeding off, signaling that the fuel tanks have been topped and that the missile is ready to go.*

# columns



# departments



**photo credits:**

*Toy Manufacturing USA Inc. p. 21; U.S. Army, pp. 22, 27; U.S. Navy, pp. 39, 40, 50, 52, 53, 57, 58; E. Hull, pp. 44, 45, 51, 112, 113; General Electric, pp. 54, 55, 56; NAA, p. 60; Fulton Irgon, pp. 62, 63; Northrop, p. 26; Ankers, pp. 66, 67, 68; NACA, pp. 65, 76; SNECMA, p. 81; AAI, pp. 82, 84.*

## when and where

**JANUARY**

**Third National Symposium of Reliability and Quality Control in Electronics,** sponsored by IRE, AIEE, RETMA, and ASQC, Wash., D. C., Jan. 14-15.

**SAE Annual Meeting and Engineering Display,** Detroit, Mich., Jan. 14-18.

**American Society for Metals,** Albuquerque and Los Alamos Chapters, "Heat Tolerant Metals for Aerodynamic Applications," Albuquerque, N. M., Jan. 27-28.

**Symposium on Microwave Ferrite Devices & Applications,** sponsored by IRE, Engineering Societies Bldg., New York City, Jan. 28-29.

**Eighth Annual Plant Maintenance Show,** Public Aud., Cleveland, Ohio, Jan. 28-31.

**Institute of the Aeronautical Sciences' 25th annual meeting,** Sheraton Astor Hotel, New York City, Jan. 28-Feb. 1.

**FEBRUARY**

**Instrument Society of America,** Aeronautical Div. of New York Section, midwinter conference, Garden City, L. I., Feb. 7.

**IRE Operations Research Symposium,** University of Pa., Museum Lecture Hall, Phila., Pa., Feb. 7.

**AFA Jet Age Conference,** Sheraton-Park Hotel, Wash., D. C., Feb. 14-15.

**Conference on Transistor Circuits,** sponsored by IRE, AIEE, Phila., Pa., Feb. 14-15.

**Joint Military-Industrial Guided Missile Electronic Test Instrument Symposium,** Redstone Arsenal, Huntsville, Ala., Feb. 26-28.

**Western Joint Computer Conference,** sponsored by IRE. AIEE and ACM, Hotel Statler, Los Angeles, Feb. 26-28.

**MARCH**

**Nat'l Conference on Aviation Education,** Mayflower Hotel, Wash., D. C., Mar. 7-9.

**Nuclear Congress and Int'l Exposition,** Phila., Pa., Mar. 11-15.

**IAS Flight Propulsion Mtg.** (classified), Cleveland, Ohio, Mar. 14-15.

**IRE National Convention,** Waldorf Astoria Hotel and New York Coliseum, New York City, Mar. 18-21.

**151st National Meeting of the American Meteorological Society,** University of Chicago, Mar. 19-21.

**American Society of Tool Engineers,** Silver Anniversary annual meeting, Shamrock Hilton Hotel, Houston, Tex., Mar. 25-27.

**10th Western Metal Exposition & Congress,** American Society for Metals and others, Ambassador Hotel and Pan-Pacific Auditorium, Los Angeles, Mar. 25-29.

**Educational Colloquium on Radiation Effects on Materials,** sponsored by ONR and Glenn L. Martin Co., Johns-Hopkins University, Baltimore, Md., Mar. 27-29.

**APRIL**

**SAE Aeronautic Meeting and Production Forum,** New York City, Apr. 2-5.

**Spring meeting, American Rocket Society,** Sheraton-Park Hotel, Wash., D. C., Apr. 3-6.

**British Radio and Electronic Component Show,** Grosvenor House and Park Lane House, London, England, Apr. 8-11.

**IRE PGTRC National Symposium on Telemetering,** Phila., Pa., Apr. 14-16.

# letters

## Satellite Orbit Still Questioned

*To the editor:*

. . . Thank you for publishing my letter, SATELLITE VS. EARTH ROTATION, p. 18, December 1956 issue MISSILE & ROCKETS, with the NRL comment. Rather than debate the question on theoretical grounds, permit me to offer familiar empirical proof.

If two boys position themselves 100 feet apart on the parade ground at Patrick AFB (Cape Carnaveral, Florida) on a north-south line, and one throws a ball into the air toward the other, the ball will be (neglecting atmospheric friction) in a free orbit just as will the satellite (although a very elliptical one which intersects the surface of the earth). If the earth "turns beneath it" while in orbit, the ball would promptly disappear to the west at some 900 miles per hour upon leaving the boy's hand; if thrown so as to remain in the air for four seconds, it would fall to the ground one mile away! Obviously the ball—and the satellite—will retain the eastward motion which it had while resting on the surface, and into whatever orbit it is dispatched, will return to the same point on the surface of the earth from which it was launched, whatever motion this point has in space. In doing so, the plane of the orbits must rotate with the rotating earth.

This argument appears to have been anticipated in only one public exposition of Vanguard motion: on page 495, April 1956 issue of NATIONAL GEOGRAPHIC MAGAZINE the following statement is made: "Any object in the grip of the air follows earth's rotation—approximately 1,000 miles per hour at the Equator. But a man-made satellite beyond the atmosphere, like the moon itself, will remain independent of earth's spin." If this idea that a satellite at 300 miles altitude will behave differently than a "satellite" baseball at 50 feet because the latter is "in the grip of the atmosphere" is taken seriously by anyone, let him disprove it by recreating the baseball experiment in miniature without the presence of an atmosphere, i.e., with a lead pellet in an evacuated bell jar. I assure him that the pellet will not crash through the west side of the jar with the speed of a rifle bullet!

Various secondary corrections have been prepared for the calculations as published in the latter part of my December letter; a limited number of copies are available upon request . . .

Charles C. Littell, Jr.
Engineering Associates
434 Patterson Rd.
Dayton 9, Ohio

## Battery Output Discussion

*To the editor:*

. . . I have recently had an opportunity to look through your December 1956 issue of MISSILES & ROCKETS.

Three citations taken from this issue illustrate the difficulty of getting correct information these days. I refer to the figures given for energy outputs for dry cells in connection with missile operations. On page 82 Dr. S. Fred Singer includes tabular material which shows dry cells as giving out 14 watt hours per pound. Turning now to page 103, Mr. Henry P. Steier gives a figure of 50 watt hours per pound for dry cells. Finally, in his article on a case for reliable missile batteries, Joseph S. Murphy cites figures on page 112 which give four watt hours per pound for common dry cells. Obviously, there must be additional factors in all these cases which are not reflected in the text material.

While I do not expect that you have answers to this question immediately, it might be worth a small amount of research to clarify the matter . . .

J. W. Joyce
6641 32nd Street, N. W.
Washington 15, D. C.

*P. R. Mallory & Co., large producer of batteries, points out rate of discharge should be part of statements on battery power per unit of weight. The company says 40-50 watt-hours/lb at 20 hour rate is correct for mercuric oxide batteries. For zinc-carbon batteries figure could run down to 4 watt-hours/lb at high discharge rate. Editor Steier was referring to mercury cells. Editor Murphy gave figures related to "missile discharge rates."* *ed.*

## More Talk About m/r

*To the editor:*

. . . Your office must be perpetually flooded with complimentary letters these days, if only a small fraction of your readers write to tell you that they think, as I do, that your publication is most literally tops. Again, my heartiest congratulations. The December issue of MISSILES & ROCKETS arrived this morning and I have heard more talk about it among our scientists, engineers and technicians than about any of the many other magazines our people read . . .

Bliss K. Thorne
Public Relations Director
Avco Research and Advanced Development Division
20 South Union Street
Lawrence, Massachusetts

## Another Contractor For Mighty Mouse

*To the editor:*

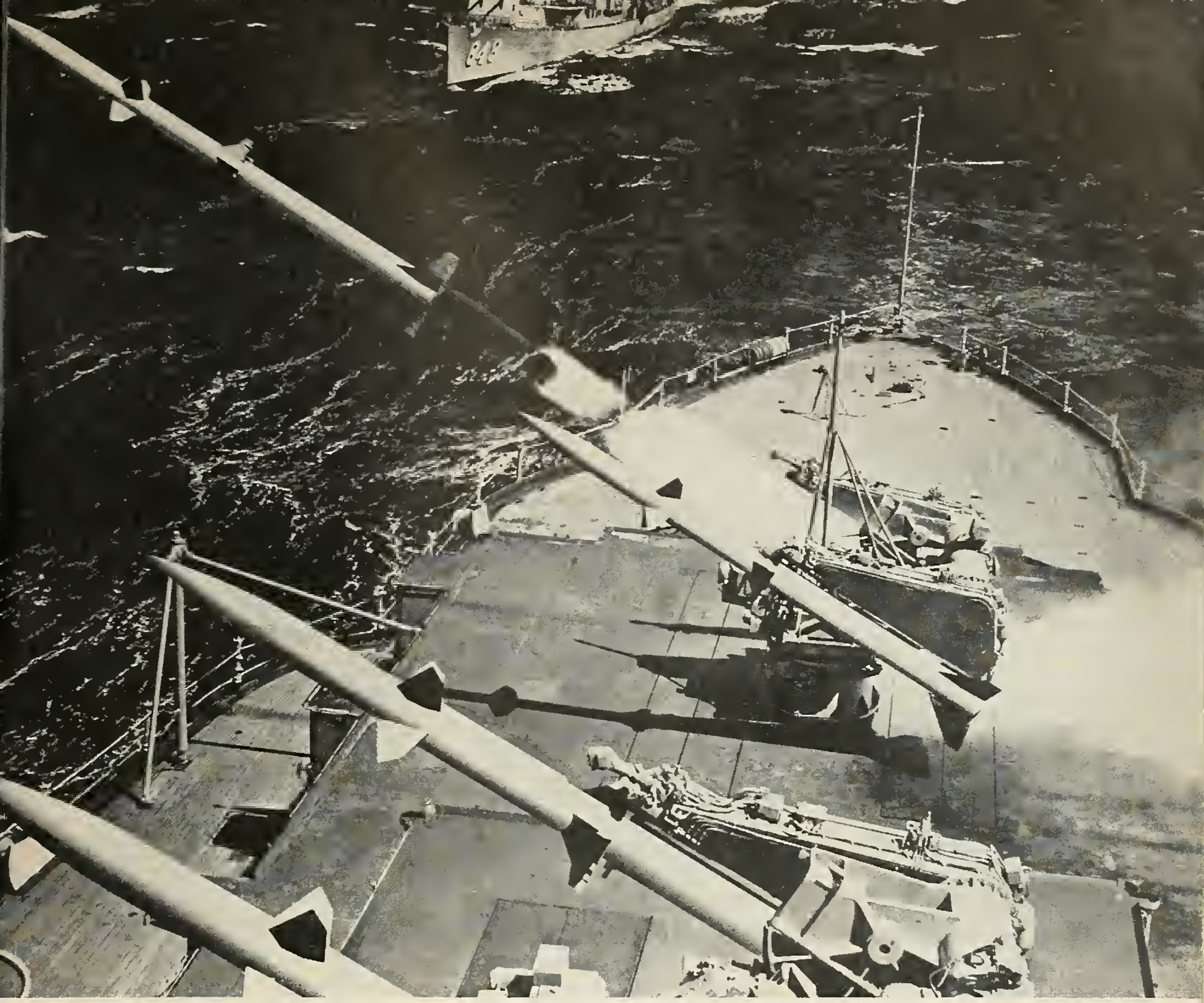
. . . We were very much interested to read the article "U.S. Aircraft Rockets—How Good?" on pages 13-14-15 of your November issue, regarding the 2.75 Mighty Mouse Rocket.

However, on page 14, we were somewhat disturbed to read the information "the only three principal contractors slated to remain in the program according to the Navy are Aerojet-General Corp., Azusa, California; Hunter Douglas Aluminum Co., Riverside, California; Heintz Manufacturing Co., Philadelphia."

The Colson Corporation received the *only* contract which was awarded in November 1955 for "the rocket motor and ingenious folding fin assembly." This was for production in early 1956 which was not completed until early fall. Aerojet General Corporation received a contract, I believe in August 1956, for production in 1957.

A contract has just been awarded to the Colson Corporation for production of rocket motor assembly for 1957 . . .

J. M. Spooner
Director of Marketing
The Colson Corporation
Elyria, Ohio



Terriers are launched from the Navy's guided-missile ship, U.S.S. *Boston*. In flight, Terrier homes unerringly on target. Missile is providing Navy with up-to-date air defense against attack.

# AIR FLASK FOR A TERRIER

For the "Terrier" – the Navy's surface-to-air guided missile – ALCO produces the critical air flask which supplies pressure to guide the missile's flight-control surfaces. With this aid, the Terrier tracks and kills no matter what evasive action is taken. ALCO also builds Jato shells for the Army's "Honest John," and rocket boosters for the Air Force "Snark."

**ALCO's success in missile components** is drawn in large part from its broad experience in defense production – over $700 million in the past five years alone. Metal-fabricating skill from over 100 years' experience, and thermal and mechanical know-how that have made ALCO a leader in power products, also play key roles in the company's missile production.

**ALCO can help in your missile program** with this broad experience and with its extensive manufacturing facilities. We'd like to send you a copy of our brochure, "What Does it Take to Make a Missile?" which outlines ALCO's qualifications fully. Write Defense Products, Dept. ONM-1, P.O. Box 1065, Schenectady 1, N. Y.

ALCO

**ALCO PRODUCTS, INC.**

NEW YORK

Sales Offices in Principal Cities

*Locomotives · Diesel Engines · Nuclear Reactors · Heat Exchangers · Springs · Steel Pipe · Forgings · Weldments · Oil-Field Equipment*

# you get proved reliability in

# MRC magnetic components

*A complete line of compact, high-performance, components and systems for aircraft and missiles.*

MRC components and systems are daily playing vital roles in automation, computer, electronic, instrumentation, aviation and guided missile applications, where critical specs, reliability, long life and compactness are especially important.

**AIRBORNE INSTRUMENT POWER SOURCE MRP-5-1S**

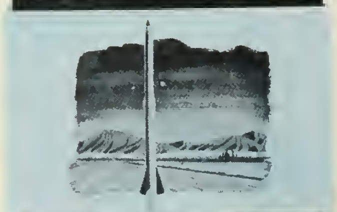
used in connection with North America's "Navajo" missile program

Exclusive flux oscillator circuitry provides smooth, transient-free 5VDC output. Regulates to 0.1% accuracy. Current capacity, 1 amp. Hermetically sealed, cast in thermosetting plastic. Short circuit-proof. Meets MIL-T-27 and MIL-E-5272-A specs. Operates on 115V-400 cycle aircraft supply mains.

**AIRBORNE PULSE GENERATOR MP 414**

used in RCA AVQ-10 Weather Mapping Radar

Use only 1 watt of power to provide 250V pulses into 500 ohms at a rate of 400 pps. Pulse width, 4.5 microseconds. Hermetically sealed. Operates on 115V-400 cycle aircraft supply. Weighs only 14 oz. Excellent also in digital computer applications. Units available from .1 to 10 megawatts and from .2 to 5 microseconds pulse width.

**LOW-LEVEL D.C. SIGNAL AMPLIFIER**

used in Redstone Missiles

A drift-free amplifier for aircraft and missile telemetering use. Provides 5VDC ripple-free output from 1 millivolt thermocouple or strain gauge D.C. input signals. Gain change is less than 2% for 100°C temperature change, and less than ½% for line changes from 105V to 125V. Response time, 40 milliseconds. Requires no shielding. Approx. weight 7 oz.


**MAGNETIC SERVO AMPLIFIER SERIES**

MA-40-400 model used in every Douglas F4D, A3D & RB-66

A complete series is available from stock, beginning at 3 watts with 0-30 cps frequency response, to the large 40-watt model with a response of 0-10 cps. These units have sinusoidal phase reversing output with transistor or tube control.

"SPECIALS"—MRC is staffed to develop fast solutions to unique problems requiring precise, specially engineered magnetic components or systems. For further technical information on MRC products and services, request bulletin GB 101

**magnetic research corp.**

*200 Center Street, El Segundo, California, U.S.A. • Phone: ORegon 8-8921*

M R C



Circle No. 6 on Subscriber Service Card

# Break-up in Army-Navy *Jupiter* Program

## *Polaris* Fleet Ballistic Missile Project Started; Nuclear Missile Submarines Part of Program

By Erik Bergaust

**The world's newest and most sophisticated underwater vessels are being planned by top Navy officials in the Pentagon. Needless to say, these submarines are nuclear-powered guided missile carriers. And they will be built to launch the solid-propellant, high-punch, intermediate-range *Polaris* Fleet Ballistic Missile.**

**The submarines—possibly two prototypes on order at first—are part of the *Polaris* project, which has just been confirmed to m/r by Assistant Secretary of the Navy for Air, Garrison Norton (see page 43).**

**Possibly the biggest missile and most complex weapons system the Navy has ever attempted, the *Polaris* will be a high-energy solid-propellant stubby 40-50-foot missile approximately 100 inches in diameter. Range is believed to be better than 800 miles. The atomic warhead in the *Polaris* will be quite sizeable, 1,000 pounds might be a fair guess. Most interesting fact about the *Polaris*, however, is that it will be a jelly- or solid-propellant rocket designed to be launched from submerged submarines as well as from surface vessels or surface installations.**

Both liquid and solid-propellant rockets can be fired from underwater. But handling of liquid propellants at sea (or land, for that matter) involves several hazards that the Navy doesn't care for too much. And in view of recent progress in the field of high-energy solid propellants the Navy has pulled away from the joint Army/Navy *Jupiter* program and set out to develop its own intermediate-range guided rocket.

The Army's remarkable ballistic rocket team under the direction of Dr. Wernher von Braun is understood to have helped the Navy create this fabulous weapon. As a matter of fact, members of this team built underwater solid rockets 13 years ago. They mounted a launching rack holding six solid-propellant rockets on the deck of a submarine. From as deep as 100 feet the stubby *Borsig* rockets zoomed to the surface at an angle of 45 degrees and then streaked aloft into the blue skies over Peenemunde. The German Admiralty turned the weapons system down—because it was developed for them by a competing service—the Army.

Nevertheless, the technical reports on underwater-launched missiles have been available in this country ever since Dr. Wernher von Braun and his missile team came to the United States. Not until recently, however, did our own Navy realize the potentials that this principle offers.

Liquid-propellant sub missiles also have been studied in recent years. Such missiles must be placed inside a container or watertight shell.

Once the vehicle pops out of the water, the outer shell or container will throw away the nose cone, and the actual missile will roar aloft without having been in touch with water, and leaving the container behind. Because of the buoyancy the missile might ascend in a straight line to the surface and take off vertically.

Fueling of a liquid propellant submarine missile must take place at dockside before the sub sets out on its mission, and the art of keeping liquid fuel vaporization at a minimum—and keeping liquid oxygen at the required minus 297 degrees Fahrenheit—is tricky, indeed. Secondly, the underwater missile container adds to the complexity of the system.

While our liquid-propellant rockets are more efficient than solid units—pound for pound, and sizewise, the solid-propellant underwater rocket has many advantages.

The solid rocket doesn't require the outer shell or container. It doesn't require the propellant insulation gear, nor any additional booster or torpedo-type powerplant. Pressurization requirement is insignificant.

## Russia Has Polaris-type Rockets

Russia is understood to have developed solid-propellant 650-mile rockets already. These missiles can be launched from submarines; they can also be fired from land installations. Reports say these rockets already make up part of the Russian military set-up in Europe. Alfred J. Zaehringer, m/r Propulsion Editor, and recognized solid-propellant expert, says the Russians have advanced rapidly in the field of Powder rockets, as a matter of fact, Zaehringer says, Russia has put more emphasis on solid rather than on liquid propellants. This means Russian ballistic rockets are larger in size—and possibly clumsy to handle—but their fire power and efficiency must not be underestimated. A round-up on Russian rocketry, including their efforts in the field of solids, will be presented in the February issue of m/r.

A liquid-propellant underwater missile could be carried to the surface in torpedo-type container. Both solid and liquid rockets could be launched this way, but . . .

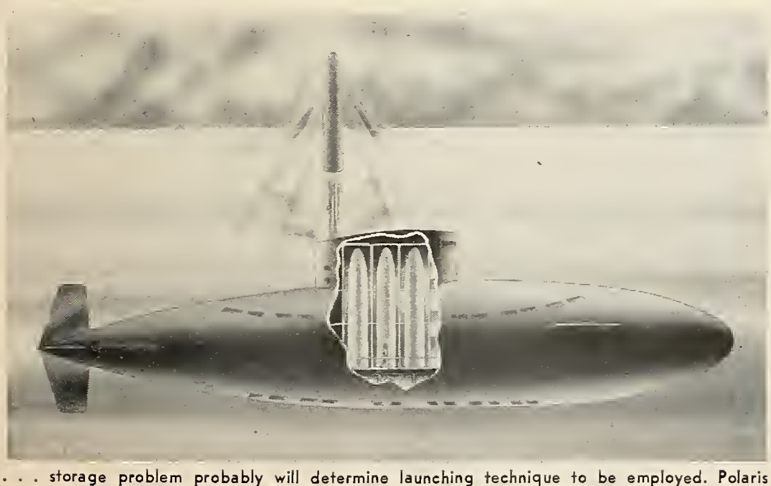
Furthermore, because of the water resistance, a missile moves rather slowly under water. It burns only a small amount of propellants before popping out of the sea; the water back pressure on the combustion holds the burning back.

So the Navy picked the solid-propellant version. And, of course, this missile may be launched from surface vessels as well; from cruisers, battleships and carriers, and from any beach head. The range, however, will probably be considerably less than if liquid propellants were employed.

Missiles Systems Division of Lockheed Aircraft Corporation is to build the *Polaris*. Aerojet-General Corporation will be responsible for the propulsion system, and General Electric and Massachusetts Institute of Technology will be in charge of guidance and fire control.

The submarines must necessarily be large, and since the advantage of this weapons system lies in the fact that the ships may hide off an enemy's coast for months, they are to be fitted with nuclear powerplants. The first atomic powered *Polaris* sub probably will slide down the ways in 1961-2. A whole fleet of them could be available by 1965. It is understood that the *Polaris* subs will employ the *Albacore* fast hull, giving the vessels a speed of about 50 knots underwater.

Unofficial reports from Russia have hinted that the Soviets have developed their submarine missiles to the point where the 600-unit Red submarine fleet now is in position to launch deadly underwater missiles over distances of 650 miles or more from submerged positions and close to 1,500 miles from surface positions.



. . . storage problem probably will determine launching technique to be employed. Polaris sub-carrier supposedly will be blimp-shaped like the U.S.S. Albacore.

# Scientists Discuss Mars Observation

Extensive astronomical observations of Mars during its close approach late last summer and early fall formed the basis for a recent symposium held jointly by the American Astronomical Society and the American Association for the Advancement of Science in New York City. Conferees pointed out much work still had to be done before a full assessment of the close approach of Mars could be made. The international Mars committee, with headquarters at Lowell Observatory, Flagstaff, Arizona, coordinated the various phases of the close approach. Participants promised that reports on the occasion would be forthcoming.

Chairman of the symposium was Fred L. Whipple, Director of the Harvard Observatory. Participants included G. P. Kuiper of McDonald Observatory, Seth B. Nickolson (speaking for R. S. Richardson) of Palomar-Mt. Wilson Observatories, S. L. Hess of Florida State University and Lowell Observatory, C. C. Kiess of the U.S. Bureau of Standards, and C. H. Meyer of the Naval Research Laboratory. In addition to the papers presented at the symposium, two other Mars reports were given during the four-day AAS session, one by W. N. Sinton of Harvard Observatory on "A Spectroscopic Search for Vegetation on Mars," and one by S. L. Hess entitled "Blue Haze and the Vertical Structure of the Martian Atmosphere."

The color of Mars drew some attention during the symposium. Polarcaps are probably almost pure white, with perhaps a faint tinge of ivory. Investigation of the color of the desert areas have been made. Dark ochre to red yellow are characteristically reported when the planet is submerged into red light, but large contrasts are common. Possible tie-ins between the characteristics of the atmosphere and surface colorings were mentioned. Dr. Kuiper, for example, suggested that the "canals" may be streaks, caused by varying albedos.

The possibility that the dark areas are essentially lava fields, perhaps partially covered with some sort of vegetation, was introduced.

Periodic color changes might be caused by dust settling on these fields, only to be subsequently blown away. Dr. Kuiper's studies also covered the oblateness of Mars, tidal friction effects on Phobos (one of its moons) and infrared investigations.

*Engineers Seeking —*

# continued professional development . . .

This is McDonnell's partially completed "Engineering Campus", where engineers will find an ideal atmosphere for their continued professional development. But these ultra-modern, completely equipped engineering facilities are only part of the picture.

We have a well planned, organized program for improving the professional status of each member of our engineering staff. This program includes counseling by a special staff of Career Analysts, and advanced engineering training in our complete in-plant training program or at one of our two local universities.

How about your own "professional development"? Engineers of all types are invited to investigate employment opportunities at MAC by writing:

RAYMOND F. KALETTA
Technical Placement Supervisor
P. O. Box 516 • St. Louis 3, Mo.

*MACareers Are Successful Careers*

**McDONNELL** *Aircraft Corporation*

# US Air Force To Begin ICBM Training

Air Force will introduce long-range ballistic missile capability into the strategic Air Command late in fiscal 1958, according to present plans. While the plans do not encompass actual operational wings, they do provide for acquisition of sufficient hardware on which to start an intensive training program. First construction on ICBM batteries may also take place.

Under the present timetable, ICBM missile wings will be integrated into SAC within the next five years. Fiscal 1958 training on hardware will be carried out at Western Development Command's newly acquired Camp Cooke, Calif., site, as well as at SAC itself. Personnel will be indoctrinated on components, assembly, parts identification, fueling, etc.

The missile wings will be similar in composition to the heavy SAC bomber wings. First missile wings will not, it has been strongly asserted, replace the bombers. They will initially be used as an adjunct in a program to determine where missiles properly fit in the SAC mission picture. It is now estimated that missile wings probably will have to be manned by more than the 3,000 personnel now attached to heavy bomber wings.

Missile battery sites will be located according to a dispersal plan but in proximity to SAC bases, which will provide necessary support.

The plan ties in closely with upcoming considerations on the Defense Budget. In budget research and development requests both President Eisenhower and Defense Secretary Wilson have put an untouchable priority on ICBM *Titan* and *Atlas* projects. Other projects have been robbed to fulfill the order, including *Navaho.*

Reliable sources have revealed that the ICBM is now close to the same time schedule as the older *Navaho* project. *Navaho,* however, which boasts a more accurate guidance system, will be kept in tact. AF is not overlooking the possibility that bugs may develop in ICBM testing and that *Navaho* will then become more attractive.

But as the budget now stands, pessimism prevails as to *Navaho's* production future. AF will go down fighting, however, to preserve its status and retain it as a research missile if it cannot get a big enough budget to support both.

Maximum effort will be directed in the coming months to pulling the ICBM programs forward to the point of production for training. One top official noted: "We won't see missiles standing on gantries in fiscal 1958, but we will need some for training to establish count-down procedures and so forth."

The admittedly optimistic time-schedule is felt to be mandatory to get the missile capability out of the talking stage.

The Convair *Atlas* was recently described by the British magazine *Flight* as a vehicle standing about 100 feet in height and weighing about 90,000 lbs., presumably empty. The periodical described the *Atlas* as a single-stage missile employing a liquid-propellant sustainer motor of 135,000 lbs. thrust plus two booster motors of 100,000 lbs. thrust each mounted in jettisonable nacelles at the base of the rocket. It is further understood that the *Atlas* prototype is now being assembled at Patrick AFB, Fla., for firing sometime this year.

While the *Navaho* can carry a heavier warhead than its ballistic competitors, this feature is no longer of much significance in view of the appalling energy yield of modern thermonuclear explosives. But it does have the advantage of greater accuracy in guidance since it theoretically can be controlled all the way to target. For this reason, the AF believes it has a place in the combat inventory alongside ICBM—provided sufficient funds are available, but economy will dictate the final solution.

## In the Age of Missiles and Rockets

*It may be Delphic that a national toy catalogue lists bows and arrows immediately after atomic submarines, electronic ray guns and Inter-Continental Missiles. But be that as it may, in the toyland world of children, the age of tomorrow is here today.*

*Almost every electronic, supersonic and remote controlled vehicle the adult world strives to perfect was already operational under the Christmas tree the night St. Nicholas was last abroad. And all had a singular advantage over their grown-up counterparts: They are not lethal.*

*Sales of radar rocket cannon, air pressure propelled rockets, space ships, guided missile bases and the like have grown to a $10 million business, up 100% in the last year, according to the Toy Manufacturers of the U.S.A., Inc. And there's no sign that the trend is about to reverse itself anytime in the near future . . .*


One day these children who now play at space flight may well participate in the real thing, the beginning of the exploration of outer space.

# Wilson's Missile Program Far From Settled

**By Seabrook Hull**

As m/r went to press, no decision had yet been reached on how to follow up Defense Secretary C. E. Wilson's November Memorandum on roles and missions. This was particularly true where missiles were concerned. Very much up in the air, for example, was the future—if any—of the Army Ballistic Missile Agency.

But some things were clear:

—— Air Force's first-choice solution was to take over ABMA lock, stock and barrel and transfer it bodily to the AF. Barring that, AF may want the heart of ABMA—the Wernher von Braun team—broken up, with its experts filtering off into industry, preferably to firms with AF ballistics missile contracts.

—— As for the Army, parts of it anyhow seemed ready for a fight: At stake was one of the world's most proved ballistic missile research and development groups and a 1650-mile Intermediate Range Ballistic Missile, *Jupiter*, which Army figured it had every tactical and strategic reason for using at will in combat.

—— The Navy, in its quiet, sophisticated way, had won the biggest victory of all. The sea-going service was no longer a junior partner in somebody else's IRBM program, but instead had Wilson's official go ahead to develop its own Fleet Ballistic Missile, *Polaris*. Moreover, once it was working, the Navy had assurance it would be able to use it operationally.

—— Interservice politics seemed to be playing a bigger role in the Army-Air Force squabble than basic considerations of national security. For that reason Congress—determined to find out what all the fuss is about—would probably have the biggest say in the final outcome.

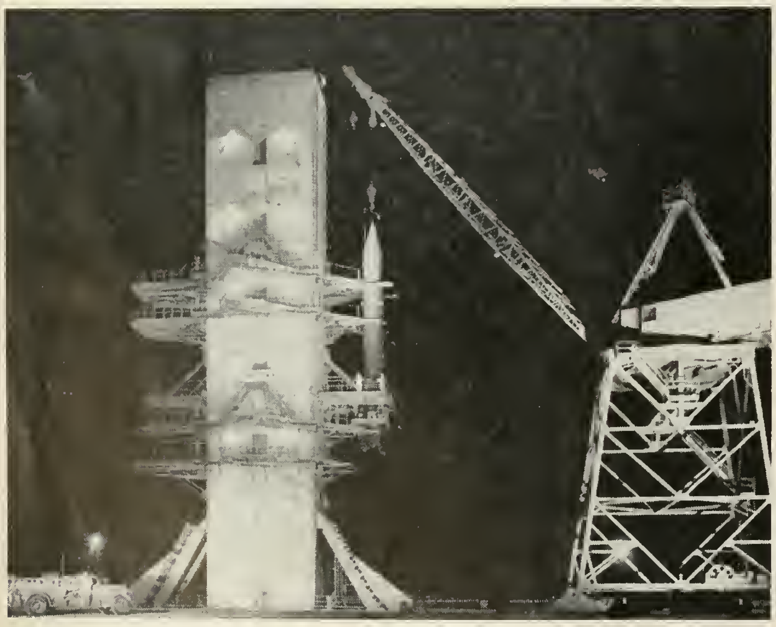
The basic ruckus seems to date clearly from the 1947 Key West roles and missions directive that gave the newly-formed U.S. Air Force sole responsibility for the strategic delivery of nuclear weapons. It was then that AF and Navy slugged it out in the headlines, the latter determined to discredit the B-36 superbomber and the former bent on sinking the supercarriers.

After a lot of noise and foolish talk, this squabble was "compromised" by allowing both services to keep their "sitting ducks." It is interesting to note, however, that then, as now, it was the AF that hit first.

This is all history, and defining the generalities of the course and conclusion of events a decade back is a relatively simple matter.

However, sorting out a Pentagon fight that's only beginning and on which Wilson has clamped the tightest censorship is not so easy. Honest convictions abound. So do "facts". But rationalizing these "facts" and convictions into truth and good judgement is something else again. Top Army echelons, for example, seemed inclined to do just as the boss—Wilson—directs.

Sorting this one out to the interests of the country will take the trained politician's intuitive knowledge of, and long experience with people. That's a proper job for Congress.



This test stand at ABMA's Redstone Arsenal, Huntsville, Ala., is capable of conducting two full-scale JUPITER test runs simultaneously. For an idea of the scale, note the man and truck at lower left. The missile in place is a REDSTONE.

### Facts and Appearances

Meanwhile, the honest reporter's task is to report the few real facts that finally came to light and what various situations *appear to be*, after the best possible job of reporting. After checking top officials of Army, Navy, Air Force and Defense, these are the facts and appearances:

The first thing to make clear is that Wilson issued his now-famous November memorandum without having first decided even in general terms how the directive was to be carried out. Towards this end, repeated studies, meetings and investigations are now being undertaken. Additionally, plans had already been made to conduct an objective, "non-partisan" comparative analysis of the Army *Jupiter* and the AF *Thor*—the two IRBM principles of the current dispute.

The makings of this particular interservice fight date from the fall of 1955 when both the AF and Army were given official IRBM go-ahead. Army set up ABMA and put *Jupiter* development under Wernher von Braun. With the famous German V-2 developer were some 130 former German missile experts. In partnership with ABMA was Jet Propulsion Laboratories, of California Institute of Technology. AF contracted out *Thor* development to Douglas Aircraft Co., Bell Telephone Laboratories and the AC Sparkplug division of General Motors.

Both were announced as IRBM projects. Like the Intercontinental Ballistics Missile (ICBM), they posed unprecedented challenges to science and industry. Not the least of these was the requirement for very accurate guidance.

Considering information released

"...and a star
to steer her by."

the P-E Azimuth Alignment Theodolite

# New Directional Accuracy for Automatic Navigation Systems

To give exact directional alignment to an automatic navigation system, the P-E Automatic Azimuth Alignment Monitoring Theodolite takes a "fix" on a navigational star and transfers the resulting angular data to the controlling mechanism. The accuracy of this astral bench mark to a great extent determines subsequent directional accuracy. *So precise is this instrument that it makes possible automatic alignment of the system to within a few seconds of arc under day or night conditions.*

Where extremely fine angular data must be established, the P-E Azimuth Theodolite offers a level of performance never previously available. Accuracy, as indicated by a "no correction" output of the monitored equipment, is ±2 seconds of arc. Standard production models are available with working distances from 1 to 1500 feet. For further information on the Azimuth Theodolite, write to –

*Career opportunities are open to creative engineers and designers. Send resumé to:*

ENGINEERING AND OPTICAL DIVISION
**Perkin-Elmer** *Corporation*
NORWALK, CONNECTICUT



Circle No. 20 on Subscriber Service Card.

NEW

# VICKERS®

## *Miniaturized*

# PISTON TYPE HYDRAULIC PUMPS

***3000 psi . . . CONSTANT DISPLACEMENT***

These new miniaturized hydraulic pumps were developed by Vickers for limited life applications such as missile and ram air turbine driven hydraulic systems . . . also for motorpump assemblies supplying emergency power on aircraft.

A distinctive feature is adaptability to manifolding and special mounting. This permits integration with the balance of a "packaged" hydraulic system to provide hydraulic power in the most compact and lightweight form yet devised. Some sizes are capable of delivering more than five horsepower per pound of weight.

Available in four size series, this miniaturized pump has the same basic characteristics as the standard Vickers piston type pump which has been establishing outstanding performance records on aircraft since 1940. Ask nearest Vickers Aircraft Application Engineer for further information.

7469


**VICKERS INCORPORATED**

*DIVISION OF SPERRY RAND CORPORATION*

**ADMINISTRATIVE and ENGINEERING CENTER**

**DEPARTMENT 1470 • DETROIT 32, MICH.**

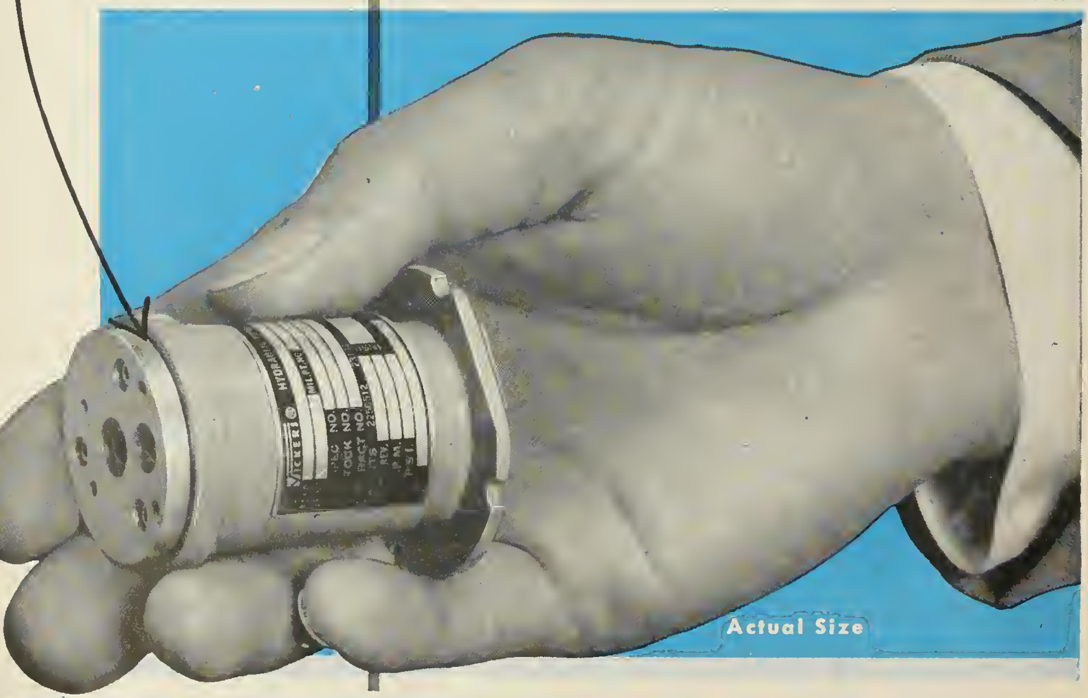
*Application Engineering and Service Offices:* El Segundo, California, 2160 E. Imperial Highway • Detroit 32, Michigan, 1400 Oakman Blvd. (Service Only) • Arlington, Texas, P. O. Box 213 • Washington 5, D.C., 624-7, Wyatt Bldg. • *Additional Service facilities at:* Miami Springs, Florida, 641 De Soto Drive

TELEGRAMS: Vickers WUX Detroit • TELETYPE "ROY" 1149 CABLE: Videt

OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd.—Great West Road, Brentford, Middx., England


*Engineers and Builders of Oil Hydraulic Equipment Since 1921*

This Hydraulic Pump has 4.3 hp output @ 3000 psi and 12,000 rpm. Weight 0.9 lb.




*A large expansion program now in its early stages means large opportunities for additional engineers at Vickers. Write for information.*

so far on the destruction radius of nuclear warheads from ground zero, this would probably mean coming within a mile or two of a target 1500 miles away, or a guidance accuracy of well under 1%. Both must be able to carry thermo-nuclear warheads. And with it all, an over-riding sense of urgency, for there could be no doubt that Russian ballistic missiles got maximum effort.

Trouble brewed beneath the surface almost from the beginning. AF considered the IRBM a Tactical Air weapon and saw *Jupiter* in the hands of the Army as a threat to AF roles and missions. Army argued that with advances made in high-speed land mobility, the missile extension of artillery range to 1500 miles was not only logical but vital to a field commander in planning and covering day-to-day troop movements. Both services figured then, and still do, that much of their future importance in the missile age depended on developing and being able to use their own IRBM weapons.

Furthermore, except for the Navy with its special problems, AF insists that it have exclusive IRBM operational responsibility; that Army not be allowed to use anything over 200 miles. Navy, perhaps as part of its campaign to win the right to independent IRBM development, supports the AF stand.

Other facts undoubtedly contribute to the situation, such as the traditional jealousy between government and private industry in the field of development. *Jupiter* is primarily the product of a government team. *Thor* development, on the other hand, though paid for by AF, is the job primarily of private industry.

In the bitterness and rancor that's boiling up, you hear other comments too —that Wilson's General Motors background may have influenced his decision against the Army. Chrysler, who now manufactures the 300-mile *Redstone,* has long been thought to be the logical *Jupiter* contractor, whereas GM, through AC Sparkplug, has a very important *Thor* contract. A few scattered people will even tell you that the number of Germans on the *Jupiter* team prejudice the Army's position.

Meanwhile, both the Army and AF programs have made unexpected, rapid progress. Both the *Thor* and *Jupiter* missiles are scheduled to make their first test flights within the next few weeks. *Thor* appears to be at Patrick AFB already. *Jupiter's* reported to be en route. Once first prototypes have been fired, the normal procedure is to follow up with a number of test launchings. Then the real job of evaluating the two missiles really begins.

There are persistent reports around the rambling halls of the Pentagon that some top AF civilians as well as Defense Department missile czar E. V. Murphree have already conceded privately that *Jupiter* has the edge, particularly in the all-important field of inertial guidance.

Thus, not only was the AF threatened with having an unwelcome helpmate in what it considers its exclusive responsibility — TACAIR — but insult was to be added to injury by having that partner better equipped. Suggestions have been made at high levels that *Thor* should be dropped, but they do not appear to have gotten very far. There's every indication instead that, unless Congress steps in, the best of *Jupiter* will be lifted for the *Thor* and the former dropped. An Army suggestion is that, considering the importance of "getting there firstest with the mostest," development on both missiles should continue full tilt.

**ICBM Duplication**

An AF answer to this view is that the country cannot afford the expense in money and manpower of two duplicate IRBM projects. AF appears to feel that it waters down possible maximum effort on other high priority projects. The question may be raised: What about the AF's two ICBM projects?

Though the Navy reports excellent technical liaison with ABMA during the life of their joint venture, there's little doubt that Navy's glad to be out on its own—free of the liquid propelled *Jupiter* with all its unpleasant shipboard handling problems, and able to concentrate 100% on the solid rocket *Polaris.* Navy's also grateful, however, for having had ABMA help in getting *Polaris* off to a flying start.

The puzzling thing about Wilson's November memorandum remains that it was promulgated and released to the public without any clear idea of what to do next.

The assumption appears to have been in both the Air Force and Wilson's shop that this directive would be accepted as a matter of course; that neither private dispute nor public debate would ensue. This would seem to indicate not only a critical lack of awareness of the specific situation but of human psychology as well. For the Army reaction at the working level has not been placid acceptance. It's doubtful if tempers will be held in check during the hearings on Capitol Hill.

Most rancorous will be the restrictions reportedly imposed by Wilson on the imparting of full views and information. It is a characteristic of the Defense Secretary that he likes his department to present a composed, solid front to both the Congress and the general public. It's liable, however, to be quite a raucous show before it's over, one that may ultimately show sharp splits even within the Army itself.

Though nothing has been specifically decided, AF fully intends to get Wilson's approval and Congressional appropriations for taking over ABMA intact. If it can't do that, according to a top AF spokesman, "It will be better for the country if the ABMA team were broken up and the individuals filtered out into industry and other organizations." This view seems to ignore the fact that individual talent and ability is only one aspect of ABMA's success. The other, every bit as vital, is the ability of these men to work together.

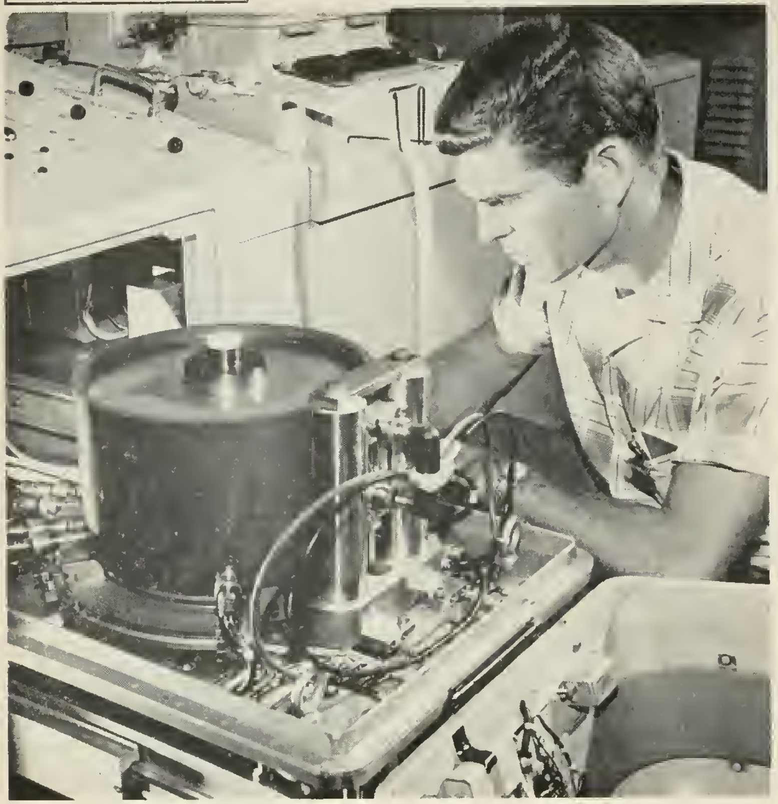
Meanwhile, Army isn't giving up without a fight. The first battle will be to try to keep *Jupiter* development in the Army budget for at least another year. The Defense Department apparently has already decided against this. But the odds are that Congress will prevail upon Pentagon authorities to change their mind, or at least defer action until the fiscal 1959 budget is debated 12 months hence.

Army will also put up strong arguments for being given roles and missions responsibility for using IRBM's. This field, however, is one the legislators tend to shy away from, figuring that the determination of roles and missions is indeed the responsibility of the executive branch of government.

The case for retaining the ABMA-JPL team as an active ballistic missile development organization will be based on performance to date—namely a whole family of *operational* ballistic missiles with useful ranges from eight to 300 miles. They will cite *Jupiter-C* performance and the fact that Redstone Arsenal at Huntsville, Ala, has the know-how and the basic hardware for launching an earth satellite into an orbit.

An obvious question will be: Is it good business to just throw up the some $200 million that's already been spent on *Jupiter* development? In this connection Congress will be bound to ask just why the Defense Department first said "go ahead" and then a scant two years later said "stop".

On the face of it, no matter what the best decision on roles and missions might be for the country, the proof of ABMA-JPL performance is something that is neither easily discredited nor readily ignored. Leaving interservice politics, roles and missions differences and possible budget limitations out of it entirely, it may well be that Congress will see merit to the proposal m/r offers in this issue—that ABMA be established as an entirely separate agency, like NACA, free to continue its research unfettered by service rivalries. After all, the vital thing is to preserve our weapons superiority over Russia.



The first successful application of a moving pick-off head to a new, medium speed digital computer has been reported by engineers of Northrop Aircraft, Inc. With the device it is possible to record or read on 64 magnetic memory drum channels using only two pick-off heads. While the drum revolves at 1,800 rpm, the moving heads make one full up-down cycle every two seconds. Previously, 64 separated heads, one for each channel, were required, resulting in greater weight and complexity. Pick-off hid circuitry requirements, for example, have been reduced by over 95% by Northrop's new development.

## $8 Million Computer to Aid Missile Test

Rapid reduction of flight test data using a powerful new computation facility is expected to permit one test missile to do the work of many during development programs.

A General Electric Co. Missile and Ordnance Systems Department engineer, A. W. Robinson, disclosed plans for the new facility in a talk before the International Congress on Rockets and Guided Missiles held in Paris, France last month.

Known as a "real time" closed-loop analysis system, two high speed "Univac" computers comprise part of the system. The computers will be installed by the USAF at Holloman AF Base in 1958. Cost will be $8 million.

The new technique is intended to allow rapid data reduction during missile flight. Reduction will take place in a few seconds and enable new instructions to be sent to the missile to obtain a wider scope of information.

Official announcement that an International Business Machines Corp. computer will calculate and predict the orbit of the *Vanguard* satellite has been made by the Navy Department.

The IBM 704 computer and 740 Cathode Ray Tube Output Recorder to be used will be located in Washington, D. C. It will first receive and process data from the *Vanguard* vehicle as the rocket reaches third-stage burnout and then will be switched to make calculations on the satellite's orbit based on data from Minitrack radio tracking stations located in the Western Hemisphere.

Dr. Paul Herget, Director of the Cincinnati Observatory will head the staff of the Washington facility to be known as the *Vanguard* Computer Center.

Construction of a building to house the Center is reportedly underway in Washington. A computer at another location will be available as a back-up facility for emergency use.

Defense Secretary Wilson's word as to who shall build and fire what missiles may not be so final as he would wish. An m/r check of Congressional sentiment on the November Memorandum on roles and missions reveals that all is not peace and acquiescence on Capitol Hill.

If the reaction at the recent American Rocket Society annual meeting (m/r, Dec., p. 24) was one of shock and consternation, that of the nation's legislators is one of astonishment and confusion, highlighted by a firm determination to "get to the bottom of things" early in session.

At stake is not only the Army's claim to a long-range artillery weapon—the Intermediate Range Ballistics Missile—but the future of what is reputed to be the hottest ballistics development team in the nation—perhaps in the world, the Army's 12,000-man Redstone Arsenal at Huntsville, Ala., including 130 former German rocket experts under Wernher von Braun.

Concentrating mainly on the members of the Senate and House Armed Services Committees—who have the biggest say in deciding who gets how much money for what—m/r found Democrats cautiously vocal; Republicans, strangely silent. One view was virtually unanimous:

"We want to know a lot more than we do now about the details leading up to this decision, and what it portends for the future."

Senator John J. Sparkman (D., Ala.), for example, has this to say:

"I think the Army is entitled to continue development of the *Jupiter*—undoubtedly, they are further along than anybody else. To stop this program now is to penalize our missile programs and already accomplished industry efficiency. It would be extremely wasteful.

"Secondly, the Army has developed the strongest possible team, and one that has shown results in course of the one year it has been operating.

"I think as a matter of military tactics the Army is entitled to the use of missiles such as the *Jupiter*, or others, wherever they can accomplish the mission for which the Army is intended.

"All services should be allowed to do all they can toward development of missiles. Let the Air Force develop their *Thor*, let the Army develop the *Jupiter*, let the Navy develop the *Polaris*. If another war should come we'll need all of them...

"It is unthinkable that the United States Government would

# Capitol Hill Wants Facts on Wilson Memorandum

do such a foolhardy and wasteful thing as to throw away many millions of dollars that have already been invested in the work done by the Army. It would be little short of *criminal* to waste the tremendous brainpower and scientific knowhow the Army has been able to bring together for this program.

House Armed Services Chairman Carl Vinson would not commit himself either way, but the emphasis he gave to his no comment was significent in itself. He said:

"I shall have nothing to say until Congress reconvenes. First I want an opportunity to study the Wilson directive.

"As chairman, I don't think it behooves me to comment on the directive put out by Secretary Wilson. It is his responsibility to assign roles and missions to the armed services. This responsibility naturally includes the problems of rockets and guided missiles.

"Until the Defense Department comes before my committee to explain itself fully as to its intent, I, for one, shall withhold any comment."

And from Rep. Arthur Winstead (D., Miss.), this statement:

"I want to talk to those folks before I make up my mind. I want to talk to everybody. We have to have some executive sessions and some open sessions of our committee. I want to see us explore the whole kit and kiboodle.

"Those folks across the river will just have to come up here and explain to us what they have in mind."

Rep. Paul Kilday (D., Texas):

"I have a fear and a disappointment in this regard of the assignment of roles and missions. But it occurs to me in my fear and disappointment that we might see a new B-36 fight arising out of this new directive.

"I intend to do my best now that Congress has convened again and demand a complete review of the wasteful policy stipulated in the Wilson directive."

That there seems to be a good chance of another knock-down, drag-out fight brewing seems apparent. You hear the same kind of rumbling you did just after World War II when as a result of the 1947 Key West Roles and Missions directive, Air Force and Navy, using headlines as their big calibre ammunition tried respectively to sink the super-carrier and shoot down the B-36 "super-bomber." One member of the House Armed Services Committee put it this way:

"The Army will fight like hell to keep Dr. von Braun and its Redstone Arsenal."

The AF, it appears, is just as determined to see Redstone either eliminated or absorbed into the AF structure.

"Of course I need more time to study this question, lest I be accused of hasty ill-founded opinion. I'm a great believer in the need for strong airpower. I'm lacking in knowledge. I'm not sure the Army should be so limited. We have already limited them in the weight of their aircraft. Now limiting them in the range of their missiles and rockets makes me pause and wonder about the plans behind the Secretary's directive.

"I would like him to explain more clearly how he plans to limit distance. Personally, I feel a logical distance for these new weapons would be 500 miles.

"There are other factors I want to talk about. First of all I feel that we in the legislative branch have to allow these directives to be made by the executive branch. In this case something had to be done. It was.

"I'm in favor of doing. But that doesn't mean I'm in accord with the directive. What I'm saying is simply this: It is the role of the executive office to handle the broad overall policy as it affects the strength of our country.

"We are engaged in creating new instrumentalities for the defense of the nation. I can understand, of course, the Army must be bitterly disappointed. Undoubtedly they fear that in the complex assignments for the defense of the nation, they will have a minor role.

"I'm not prepared to discuss that aspect at this time. After all there must be the opportunity for discussion. But there is one thing I shall have my say on. Congress must stay out of the conflict, if any, on strategy and tactics. That is the role of the military men.

"In a relatively short time we shall find out the full significance of the directive. If it develops that one of our services is prejudiced, we shall, in our own way, discharge our proper duty to the people."

Rep. Victor Wickersham (D., Okla.):

"If this directive has the approval of the Joint Chiefs, that is one thing. If there is disagreement, that is something else. If there is over-lapping in the field of guided missiles, it won't hurt. Competition is good. The Russians are in this thing for keeps. So duplication will do no one any harm.

"I think Wilson is trying to do a job of coordination. But in practice, those things don't always work out as they did on paper. I can only hope that Wilson is not trying to hold down technological development.

"Another thing I'm wondering about is where the Budget Bureau fits into the directive. They have the last word over there because all they have to do is withhold funds, even funds which have been appropriated by Congress."

Maj. Gen. John B. Maderis, ABMA Commanding General, The Senator from Alabama, The Right Honorable John J. Sparkman (D.) and Maj. Gen. H. N. Toftoy, Commanding General, Redstone, Arsenal, during a visit of the Alabama Congressional delegation to the Huntsville facility last month.

# Twenty-five Nations Meet in Paris For Congress on Missiles

**From our correspondent**

PARIS—Twenty-five nations were represented at the International Congress on Rockets and Missiles which took place in Paris last month. The meeting was organized by the Association pour l'Encouragement a la Recherche Aeronautique and its success was largely due to the work of the association's president, Jean Venturini. The 125 delegates attending the Paris meeting heard talks in several different languages on all aspects of missile and rocket activities.

G. Bory, a former French naval engineer, discussed rocket-powered missiles with special reference to development efforts between 1917 and 1947. Dr. M. Lebrun, French scientist, talked about meteorites and "flying saucers." A paper on international astronautics was read by Germany's F. L. Neher, historian of the Gesellschaft fur Weltraumforschung. He also discussed Germany's 30-year period of work on rocket development.

A. W. Robinson, of International General Electric, talked on guided missile development work in the U.S. A. Ducrocq, head of Societe Francaise d'Electronique et de Cybernetique, discussed atom-powered rockets. This subject was also discussed by Dr. F. Winterberg, a German specialist, and by two French engineers, Th. Reis and M. Gauzit.

General Electric's contribution to Vanguard was the subject of a paper by R. E. Small. Dr. G. S. James told the meeting about the Rocket Research Institute, which he heads, and also discussed the International Geophysical Year. J. Persch of U.S. Navy Ordnance, talked on the calculation of turbulent boundary-layer heat transfer in supersonic and hypersonic nozzles. Three Belgian scientists—P. Glansdorff, P. Jaumotte and S. Passelecq—discussed rocket performance. The "Litergolici" system of propulsion was described by Professor Corellli of Rome University. J. A. Vandenkerckhove of Brussels University spoke on erosive combustion of a double-base propellant. Dr. C. Belmondo, of Turin, Italy, discussed solid propellants. Propulsion problems were the subject of a paper by Captain G. Partel of Rome. Professor H. J. Zucrow and A. R. Graham of Purdue University discussed the cooling of rocket motors.

H. Bednarczyk of the Vienna Institute of Technology spoke on water vaporisation's contribution to the theory of the rocket. Professor M. J. Zucrow and J. R. Osborn of Purdue University discussed determination of the dynamic response of pressure transducers by means of the high-pressure shock tube.

In the field of ballistics and flight mechanics speakers included: J. Hely, deputy chief of France's Ecole Nationale Superieure du Genie Maritime; E. Sanger, head of Germany's Forschungsinstitut fur Physik der Strahlenantrieb; J. J. Gait of the Royal Aircraft Establishment, Farnborough; Dr. G. Fellner, of Achen, Germany; P. S. J. Vernotte of Paris; L. C. Frager of Paris; Max Plan of France's Laboratoire d'Aerothermodynamique; Dr. F. H. Devienne of France's Laboratoire Mediterraneen de Recherches Thermodynamiques; E. Finkel of France's Societe Matra; I. Rind and Jean Casteil of the French IBM company; I. Dreyfus of France's Compagnies des Machines Bull; F. H. Reynst of the Netherlands; Prof. A. Bartocci of Italy's Terni company; Dr. W. Trommsdorf of Deutsche Versuchsanstalt fur Luftfahrt; Dr. James Heyda, Allison Division, General Motors; and H. R. Voellmy of Zurich, Switzerland.

Guidance problems were discussed by the following: Colonel P. Gaudillere of France's SFT company; F. Muller of Gottingen, Germany; P. Devergne of France's Societe de Fabrication d'Instruments de Measures; Dr. W. C. Hodgson and J. N. Ryon of the Naval Research Laboratory, Washington; I. Guanella of Baden, Switzerland; and E. Perret of Zurich, Switzerland.

Ground installations and special techniques were the subject of papers by: Dr. A. Gerber of Zurich, Switzerland; General W. W. Hohener of the U.S. Navy's Bureau of Ordnance; B. Winandy, of Paris; H. Gelly of France; R. Syre of France's Pechiney company; A. Ferchaud of Paris; Dr. B. Langnecker, of Vienna; Dr. G. Golubovic of Paris; Major F. Violette of the French Air Force; and J. Duflos, head of France's Tcxtiglass company.

Papers on the legal and economic aspects of astronautics were read by: E. Winandy; Andrew Haley of the American Rocket Society; and M. O. Maquenne of the French Societe d'Economie Politique.

A MATRA air-to-air missile has been installed underneath the prototype of the Dassault Mirage, France's Mach 1.5 fighter prototype.

## *Aero Digest* Readers May Choose m/r

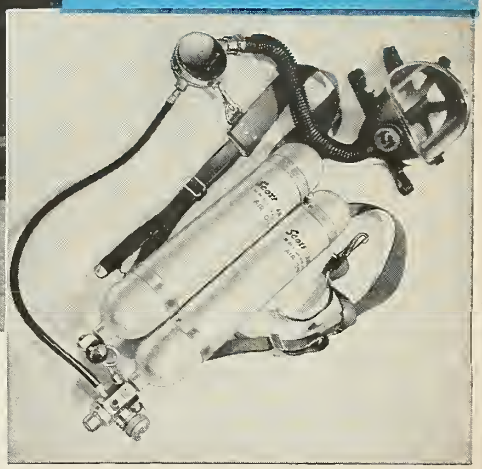
Subscribers to *Aero Digest,* which suspended publication with the December issue, will be given their choice of receiving MISSILES AND ROCKETS or AMERICAN AVIATION Magazine.

American Aviation Publications announced that it has agreed to fulfill all unexpired subscriptions to *Aero Digest*. In the event that the *Aero Digest* reader already receives the American Aviation publication of his choice, he will be given equivalent credit for extension of his subscription.

Founded in 1937 by President and publisher Wayne W. Parrish, AAP is the world's largest aviation publishing organization. In addition to the 20-year-old AMERICAN AVIATION Magazine, with a circulation of 46,000, and MISSILES AND ROCKETS, which already has attained a paid circulation of 8,500 in less than six months, the company publishes *American Aviation Daily, American Aviation World-Wide Directory,* the *Official Airline Guide,* the daily *Air Traffic News, Airports* weekly newsletter, and *Who's Who in World Aviation.* In addition, the Air Information Division provides a specialized service that digests time tables, fares and charges for scheduled airlines. Company headquarters are at 1001 Vermont Avenue, N.W., Washington, D.C.

# Scott AIR-PAK

## as much a part of the Weapons System as the Rocket



Fueling is one of the most important operations in the successful launching of a rocket. Since propellants are poisonous, breathing protection equipment must be worn. The Scott Air-Pak Model 8100-A2 has been designed to meet the exacting requirements of this hazardous operation. It delivers pure, fresh air, instantaneously "on demand" as required by the wearer regardless of the degree of exertion.

Special attention has been given to the metallurgy of the component parts to insure unfailing service in atmospheres of dangerous propellants such as fuming red nitric acid and unsymmetrical dimethyl-hydrazine.

The Scott Air-Pak has been established as standard equipment by Army Chemical Corps and Army Ordnance for launching crew protection.

Write for complete information.

The Scott 8100-A2 Air Pak incorporates the latest advances in chemical resisting materials. Two small compressed air cylinders are used instead of one large cylinder. This reduces bulk and makes the unit easier to wear with protective clothing.

The Scottoramic Mask which is standard equipment completely protects the eyes and face. It provides unlimited vision in all directions and helps the wearer to spot danger zones for maximum safety.

SINCE 1932 Scott FOR SAFETY—FOR SERVICE

**SCOTT AVIATION CORP.**

8333 ERIE STREET LANCASTER, N. Y.

Export: Southern Oxygen Co., 15 West 57th Street, New York 19, N. Y

# *Titan* Configuration Revealed by Glenn L. Martin?

A Martin Company ICBM ad, in the January issue of the American Rocket Society's *Jet Propulsion* shows a more or less conventionally appearing two-stage, triple-finned rocket. A check with the Pentagon indicates that the configuration is a "bit too close" to the actual *Titan* Inter-Continental Ballistics Missile now being developed by Martin for the AF. A close replica of the missile in the ad appears below.

A Martin Co. spokesman when asked to comment on their ICBM ad and its similarity to *Titan* said only: "I can neither confirm nor deny . . ." The British magazine *Flight*, however, in its December 7 issue reports that *Titan* is a two-stage weapon with the sustainer rocket mounted directly over the booster. General indications are that the length of the missile mounted and ready to fire approximate 100 feet with the diameter of the booster maybe 10-to-12 feet; that of the warhead and final stage, 6-to-8 feet. Fueled weight is undoubtedly well over 100,000 pounds.

These reports plus the fact that AF may shelve the *Navaho* project in order to be able to concentrate even more on ICBM development indicate that the state of the art is a lot more advanced than most people thought it would be two or three years ago. The advanced state of the ICBM's could be the main reason Defense Secretary Wilson is so willing to limit research and development money.

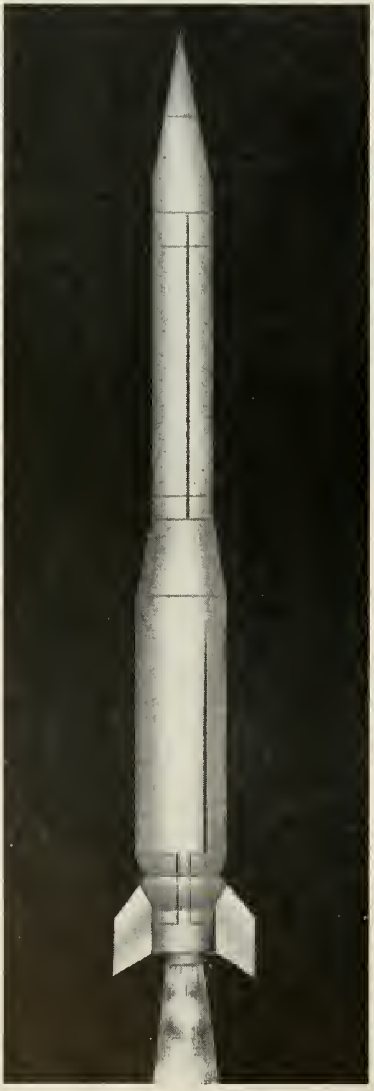
Puzzling on the accompanying artist's conception is the clear indentation in the missile body near the tail section, unless it is that the aerodynamic guidance fins are dropped off before the booster has burnt out.

Also, the warhead is similar to pictures of Martin test cones for the Vanguard satellite launching project. More probably, Titan's nose cone will be a compromise between the blunt, high-drag-to-weight ratio configuration and the sharply tapered high-speed reentry design, i.e., both tapered and blunted.

*Flight* reports that Aerojet-General Corp. is responsible for *Titan's* stage one motor, with Reaction Motors, Inc., responsible for chambers. Nothing specific has been released as regards the thrust of the first stage booster, but it is reported to be on the order of 250,000 pounds, or at least that's some kind of design target.

Another indication of the advanced state of the ICBM programs is a recent report that considerable Convair *Atlas* staff are moving to Patrick AFB "permanently." Meanwhile, Martin's rocket engine and systems test facility at Denver, Col., has reached an advanced stage of completion.

It begins to look increasingly as though AF placed its bets well when it contracted for ICBM development.



TITAN?

## news briefs

NORTH AMERICAN AVIATION now has three IBM 704 electronic data processing machines in operation to help speed research and development of supersonic aircraft, missiles and rocket engines. Two are at its main Los Angeles plant, the third at NAA's Rocketdyne Div. at Canoga Park, Calif.

BENDIX AVIATION CORP. has acquired assets of Sheffield Corp., Dayton, Ohio producer of precision gauging and measuring instruments. Current Sheffield sales run about $24 million annually.

TEXAS INSTRUMENTS, INC., transistor producer, expects final 1956 earnings will reach $2,100,000, up almost 30% from $1,582,000 in 1955. Sales are estimated at $44 million against $28,685,000 last year.

ELECTRONIC CONTROL SYSTEMS, INC., Stromberg-Carlson affiliate, has leased a fourth building in West Los Angeles area at 2205 Stoner Ave.

ACF INDUSTRIES, INC. earned $3,758,000 on sales of $129,589,000 for its first six months ended October 31 compared to $3,875,000 on sales of $117,274,000 for like period last year.

AUTONETICS DIVISION, North American Aviation, Inc. has purchased a 15½ acre plot of land adjoining present division headquarters to be used for future expansion.

DOUGLAS AIRCRAFT CO. and United Auto Workers have agreed on an initial contract covering workers at its Charlotte, N. C. *Nike* missile plant. It expires early in 1958.

AGREEMENT SIGNED between Hughes Aircraft Co. and Aircraft Industries Workers at company's Culver City plant calls for wage increase of 7¢ to 15¢ an hour. It also provides hike next year of 6¢ to 11¢ and institutes a cost of living clause. Hughes recently signed a similar contract with International Assn. of Machinists at its Tucson plant.

SMALL BUSINESS WON at least a half-share of the $624,700,692 in purchase orders issued by North American Aviation during its fiscal year 1956. Some 11,028 firms having less than 500 employes each received contracts worth $312,399,366, up from $275,725,886 in 1955.

CONVAIR ASTRONAUTICS new $40 million plant being built near San Diego for *Atlas* intercontinental ballistic missile production is reported on schedule. Engineering laboratory is the first building slated for completion.

LITTON INDUSTRIES registered sales of $6,230,000 for quarter ended October 31, exactly double the $3,115,000 for same period in 1955. Profits were $401,000 compared to $212,000 a year ago. Litton backlog reached $36 million and assets exceeded $13 million.

INTERNATIONAL NICKLE CO. OF CANADA, LTD. has announced a joint government-company financed $175 million expansion which will increase its annual output approximately 50% by 1960. Firm recently raised nickle prices 9.5¢ per pound to 74¢, first hike since November 1954.

# Rocket Trends

By Erik Bergaust

Army still hasn't said anything about their record-breaking rocket flight four months ago. A favorite topic of conversation at the American Rocket Society annual meeting in New York a few weeks ago, it appears Drew Pearson predicted last July the Army was about to shoot a missile some 3,000 miles. The firing took place September 20. *Life* magazine was first to tell the story (October), newspapers picked it up and people started to talk about the venture. The outstanding Army missile firing was discussed in barber shops at Cocoa Beach near Patrick and at Huntsville and wherever rocketeers get together.

The public might have been led to believe that this Army missile was the *Jupiter* prototype. However, industry people refer to the record-breaking missile as a *Jupiter* "C," not a *Jupiter* IRBM. In its November write-up m/r indicated the *Jupiter* "C" consists of a modified *Redstone* as a booster, a cluster of scaled-down *Sergeants* for the second stage and another scaled-down *Sergeant* cluster for the third stage. The *Jupiter* "C" launched on September 20 supposedly went as high as 650 miles, according to some—others say 680 miles. Maximum velocity of 15,000 mph and range of 3,300 miles have been mentioned. It remains a strange phenomenon—if these figures are true—that the Army will not claim officially the world's speed and altitude records for rockets.

Meanwhile, the Air Force is closing in on the Army ballistic missile lead. Big payoff for Air Force missile planners stems from their wisdom in running two parallel ICBM programs—*Atlas* and *Titan*—and using the skillful planning experience of ARDC. Result: Air Force *Titan* and *Atlas* are far more advanced than was contemplated a year ago. We predict the recent Army ballistic rocket publicity will look like peanuts compared to what Air Force will get, for only the Air Force can send a rocket to the moon . . . This will happen sooner than you think . . .

Beyond that Air Force is understood to be thinking in terms of nuclear-powered rockets. And the airmen soon will learn that this earth of ours is much too small as a proving ground for such high-punch stuff. So the United States Air Force might have to become the United States Space Force—whether anyone else likes it or not.

So you'll hear more and more about the Air Force planning to send a rocket to the moon. And you'll be hearing more about the fact that we're racing the Russians in this respect too. Some ace WDD planners and top notch scientists will see to it that we get there first, we predict. Furthermore, we have a feeling one particular name, eventually, will stand out in this connection—that of Krafft A. Ehricke. When we asked a high-ranking AF officer recently whether the AF was interested in space flight, he said: "Not only are we interested, but note that when man goes into space, it will be an air force venture, and the guy in the driver's seat will be an Air Force pilot!" There's no question the AF is a logical choice for pursuit of the space flight goal. Nevertheless, we feel certain the Navy wants to get into the act too . . .

# Washington Spotlight

By Henry T. Simmons

The Navy has assembled a team of four top contractors to carry out the development of the Fleet Ballistic Missile, this column has learned. Responsible for the airframe is the Missile Systems Div. of Lockheed Aircraft Corp. Aerojet-General Corp. has been assigned the propulsion unit, while General Electric Co. and Massachusetts Institute of Technology will work on the guidance and fire control features.

•

Selection of the contractors means that the Navy will be relatively little affected by the transfer of control over the development of the *Jupiter* IRBM from the Army to the Air Force. Although the *Jupiter* was originally set up as a joint Army-Navy project, the sailors some time back worked out a revised program which called for a solid rather than a liquid-propellant weapon and accordingly proceeded with its development. Thanks to this preliminary effort, it will only be necessary to increase the scope of some of the earlier work to assure the Navy of a full-fledged FBM development program of its own.

•

Fate of the Army Ballistic Missiles Agency and its cadre of *Jupiter* scientists and contractors may well prove to be one of the knottiest administrative problems in the entire missile picture during the next few months. In theory, the Air Force is free to finance continued development of the weapon after next July 1, but Pentagon insiders are dubious about the prospects of this in view of the pinch on funds available to the Air Force for research and development. They believe the airmen will abandon almost all of the *Jupiter* work, with the result that an experienced scientific and industrial team will be lost. But so far, no one in the administration has come forward with any solution to the problem (see m/r editorial page 7).

•

The simplicity and low cost of the infra-red guidance system of the Navy's *Sidewinder* air-to-air missile has so impressed the Air Force that it has ordered an IR version of the Hughes *Falcon*. Unlike their radar-guided counterparts, the heat-seeking *Falcons* will require no external fire control. Since most of the aircraft which might use them will come equipped with a half a ton of radar fire control apparatus, it appears likely that the new birds will be mixed in with radar *Falcons* to offset countermeasures.

•

Navy budget request for Fiscal 1958 includes funds to assure a "modest growth" of the Point Mugu missile flight test range off the coast of California. It will provide for vessels to serve as down-range tracking stations as an interim measure, although ultimately the range might extend to the Galapagos Islands and beyond.

•

So-called "zip" fuels may provide a spectacular performance boost for the Navy's air-breathing missiles when they become available. Although the high-energy fuels are presently slated for ramjet-powered birds, it is likely they will also be feasible for turbojet-powered weapons. Their big advantage: a 40% boost in fuel energy for a given volume, with consequent range and speed increases. The Navy has started work on a $33 million zip fuel production plant at Muskogee, Okla.

## book reviews

**Reference Data for Radio Engineers.** *By International Telephone and Telegraph Corp., 4th edition. Published by IT&T, Publication Dept., 67 Broad St., New York 4, N. Y. 1121 pp. $6.00.*

An improved and expanded edition of a reference data handbook which has been popular since 1943. The book was designed to save time spent by radio engineers in finding data to solve a wide variety of problems needing equation, curve, table and monograph information.

The new version contains new and completely revised information to meet current requirements in the radio engineering field. These include such subjects as semiconductors and transistors, helical antennas, nuclear physics, scattering matrixes in waveguides, etc. A tremendous quantity of data is packed in this one volume. H.P.S.

**Jane's All the World's Aircraft 1956-57.** *Compiled and edited by Leonard Bridgman. Published by McGraw-Hill. $25.*

For the first time in this renowned aviation annual there is a missile section. Mention is made of the Russian T-7A medium-range artillery rocket, a SAM developed from the German Rheintochter, "an improved V-2 type" ballistic missile, a winged jet-powered medium-range, bombardment missile, and the T-4A supersonic glide-bomb.

The missile section describes Vanguard and shows it diagramically. USAF, US Navy and Army designation systems are explained and all Western missiles are tabulated on four pages faced by the same number of familiar photographs. Although 42 U.S., 13 French, 10 British and one Swiss operational and research missiles are listed. The table includes the following items which the British Ministry of Supply states are not official:

(1) Armstrong-Whitworth Sea Slug, Royal Navy SAM, has four concentric booster rockets, measures 20 ft. long, resembles model shown in company's supersonic tunnel and has English Electric guidance system.

(2) A de Havilland infra-red AAM is to be standard for the Royal Air Force. It resembles a test vehicle revealed at the 1954 SBAC Farnborough show.

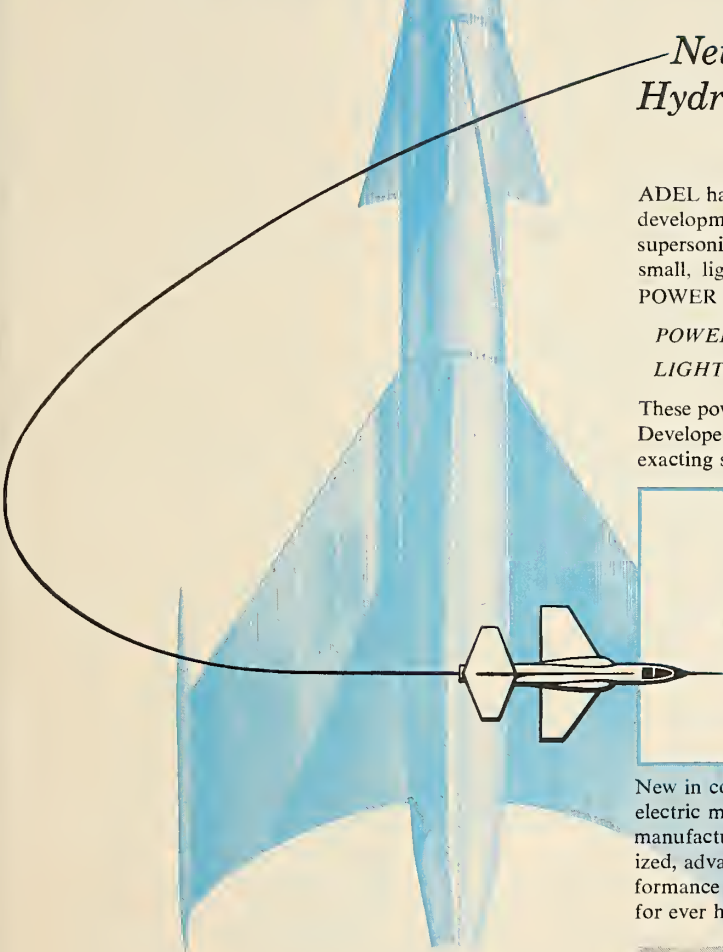
(3) English Electric SAM is a beamrider with either Napier liquid rocket or Napier ramjet and Marconi guidance.

(4) Fairey has an enlarged development of the Fireflash AAM, 10 ft. long (without booster) which was the missile shown anonymously at the 1955 Farnborough show.

The 1956-57 edition of Jane's carries 13 more pages than did the 1955 volume on U.S. aircraft (121 in all)—more than one-third of the total and double the second entry, the United Kingdom. The Soviet Union is up from nine to fourteen pages although there is nothing not previously published elsewhere.

This is the 47th issue of Jane's and it follows close upon the award of a Paul Tissandier diploma by the FAI to Leonard Bridgman for his work as compiler and editor for 36 years. These diplomas have but rarely been accorded to aviation writers: Wayne W. Parrish, president and publisher of m/r received one last year, and only one other British writer—the late C. G. Grey—has ever been given one.

# ADEL ANNOUNCING ANOTHER R&D ACHIEVEMENT

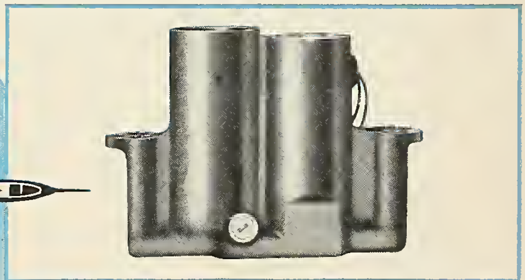


## *New Electric Motor Driven Hydraulic POWER PACKAGE For Guided Missiles*

ADEL has long been engaged in power unit research and development programs for guided missiles and piloted supersonic aircraft. This has resulted in the production of small, lightweight, reliable and self-contained auxiliary POWER PACKAGES.

*POWERFUL • SMALL • COMPACT • RELIABLE*
*LIGHTWEIGHT • SUPERIOR PERFORMANCE*

These power units permit wide latitude in systems design. Developed, qualified and produced to meet or exceed exacting specifications.



New in concept and development, envelope incorporates electric motor, hydraulic pump, valves and reservoir, all manufactured in our own plant. Proven through specialized, advanced engineering under complete, in-plant performance and environmental testing facilities required for ever higher product quality.

*REMEMBER . . . ADEL can design, develop and manufacture other airborne components to meet your requirements. Investigate the complete ADEL facilities for qualification testing which can contribute greatly to accelerate the progress of your engineering development projects.*

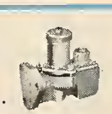
ADEL
PRECISION PRODUCTS
A DIVISION OF GENERAL METALS CORPORATION

BURBANK, CALIFORNIA • HUNTINGTON, WEST VIRGINIA

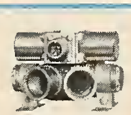
*ADEL designs and manufactures aircraft products in the following major categories:*

Hydraulic & Pneumatic Control Equipment

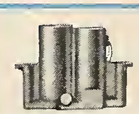
Anti-Icing, Heater & Fuel System Equipment



Engine Accessories

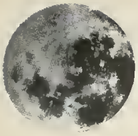


Hi-Temp Manual & Solenoid Operated Valves



Electric Motor Driven Hydraulic Power Packages

Circle No. 1 on Subscriber Service Card.



# Missile Miscellany

This page, to be a regular m/r feature, considers itself a kind of swap-shop for ideas. Like the mind, it abides no limits to its scope. Its objects are manifold. It's a meeting and mixing place for ideas, off-chance remarks and queries that might otherwise pass unexamined. But mainly, it aims to keep people thinking.

★ ★ ★

Shot through with bitterness, this remark from a man on the Jupiter team at Redstone: "We're all getting two-to-three-job offers a day from industry...good pay, too." From a Bomarc engineer: "Bust up the von Braun team, and U.S. ballistics missiles lose five years."

Then, at dinner the other night, this page heard a liquid propellant salesman toss out: "What the missile business needs is its own basic R&D agency, free from profit motives, politics, inter-service squabbles and annual budget fights. Maybe Congress ought to take ABMA from Defense and give it protected status like NACA."

★ ★ ★

Space is neither "free" nor "empty." Plus all the bits and pieces of matter flying about, it's a massive energy spectrometer, including not only light and heat but also strong magnetic, electrical and gravitic (and who knows yet what other) energy gradients.

In the mellower hours of the annual ARS meeting, an aerodynamicist asked: "Why don't we ride these gradients? Carry just enough fuel to gather and convert space energy for propulsion—like a heat pump uses comparatively little power to concentrate a lot of vagrant outdoor heat inside where it'll do some good."

And a quip: "Make Newton's apple fall up, as well as down." But out of the past, this comment by Nobel prize winner Robert A. Millikan (founder of Cal. Tech.) to a student in 1922 is more provoking: "Man will discover the secret of gravity in work with very high voltages and heavy masses..."

★ ★ ★

Some recent unofficial Navy reasoning this page jotted down goes thus: "Return TACAIR to Army; perfect the pilotless interceptor; make MATS an independent all-service operation; and after ICBM kills off SAC, you certainly won't need a whole T. O. of men in uniform to carry out White House orders for an intercontinental count-down."

★ ★ ★

This page feels there must be some mistake but: Navy missed a publicity bet when it didn't claim World War II's sonar-directed torpedo as the country's first guided missile. And it heard an AF planner and programmer say Army is "very happy" with the now-famous November Memorandum wherein AF trades Army even-Steven, Talos for Jupiter.

★ ★ ★

An NACA structures engineer, weary of cantilevering all manner of stores, engines, wings, etc., on both manned and unmanned fuselages, wants to know what's the matter with the aerodynamics of a disc . . . . . . Picked up in passing: An H-bomb dropped on Los Angeles airport would knock out one quarter of this country's missile capacity . . . This page hears increasing demands for a degree in missile engineering . . . From a top Pentagon civilian when assured Wilson would soon quit: "I wonder if Bob Lovett would be willing to come back?" . . . And to the right, a Chinese "fire arrow" as it was launched around the year 1,000 A.D., which is about the time all this began . . .

Circle No. 7 on Reader Service Card.

VOL. 2 NO. 1
JANUARY, 1957

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

# Navy Missiles Roles and Missions

**By Rear Adm. James S. Russell, USN**

*Chief, Bureau of Aeronautics*

THE IMPACT of guided missiles and rocket power is bringing basic and far-reaching changes to naval aviation. Changes in tactical concepts, changes in equipment, and changes in the efficiency with which the mission is performed are operational facts today. More is on the way.

Although these implications of guided missile and rockets to the air systems of the fleet are already immense, they are not yet seen as the total end in themselves. Although their influence upon concepts of sea-based airpower is almost immeasurable, they will in the foreseeable future fit into basic patterns of Navy air requirements.

These exciting new families of unmanned weapons will extend the striking and defensive arms of naval aviation in the same way that aviation itself extends the arm of total seapower, including surface and undersea forces.

We should perhaps note the past before discussing future influences of missiles and rockets on naval aviation.

The Navy has consistently advanced the art of missilry and rocketry from the start. Rocket power was first applied to naval aircraft as the well-known Jet-Assisted-Take-Off (JATO). Historically compelled by the restricted space available on ships at sea, the Navy has pioneered the development and use of assisted take-off devices, such as the catapult and JATO.

Today JATO is used more than ever, and its use in the future is assured, to extend our launching capabilities and literally to get us out of tight spots. A seaplane flying across the United States in 1944 was forced down in a pond. It was flown out with JATO. The Navy's initial capability to deliver the atomic bomb—before we had our modern planes and when the bomb was an awkward gadget—depended on a jet-assisted-take-off. Currently, all our seaplanes and heavy attack planes have provisions for JATO use.

During and after World War II, development brought turbo-jet and rocket engines and with them aircraft of greatly increased speeds and altitudes. Flight potentials went beyond the testing capacity of existing wind tunnels. To obtain design information and data in this era of high speed and high altitude flight, research vehicles, both manned and unmanned, were powered by rockets. These projects were joint service efforts among the Air Force, the National Advisory Committee for Aeronautics, and the Navy. A series of rocket propelled airplanes and smaller free flight research vehicles were flown in a program participated in by many interested agencies. For instance, the Bell X-1 flown by the Air Force was powered by a Navy-Reaction Motors, Inc., developed engine which delivered 6000 pounds of rocket thrust.

The Navy's Douglas SKYROCKET, the D558-2, another rocket-powered research aircraft, was clocked at 1065 knots at 79,000 feet, back in 1951.

Highly instrumented rockets, with or without a pilot, flying from such different places as Muroc, California, and Wallops Island, Virginia, have augmented and confirmed a usable pattern of much needed data.

Today's high performance airplanes owe much of their success to the knowledge gained from the flight of rocket-powered research vehicles.

### Many Firsts For Navy

There are many "firsts" in missile development on record which are the direct result of the efforts of the Bureau of Aeronautics. Among these are the first surface-to-air missiles known to have destroyed a target aircraft, the *Lark;* the first all-weather air-to-air missile system to become operational, the *Sparrow I;* the first ship-launched surface-to-surface missile to become operational, the *Regulus I;* and one of the first guided missile test and evaluation centers, the Naval Air Missile Test Center at Point Mugu, California.

In all of this past effort, the aim has been to take the conjecture out of design, to experiment and document, to refine and improve, and to put missiles and rockets to work on a practical basis.

To realize the advances, one only has to look at some of the early contractual documents. So little was known about the art as little as fifteen years ago that development contracts were written loosely, and in vague, nebulous terms. Combustion chamber geometry was more "plastic art" than engineering. Performance calculations were educated guesses. In both guided missiles and rocket power applications the flight article was largely a product of fortunate estimates and the particular skills of artisan machinists.

Today's development contract is a good indicator of the progress achieved; specifications are called out with engineering precision and with a scientific know-how which reflects the testing and documentation experience typical of an established science.

In discussing the role of unmanned vehicles in future fleet aviation, we must also assess the present.

Within the organization of the Navy Department, the work and responsibilities for Navy missilry is shared between the Bureau of Aeronautics and the Bureau of Ordnance. Each of us has defense missiles—those used to destroy attacking aircraft, and attack missiles—those guided to enemy ships, submarines, and shore bases.

Modern rockets as weapons were founded, nurtured and firmly established in our arsenal by the Naval Ordnance Test Station (NOTS) at Inyokern, or China Lake, California. The present staff of over a hundred scientific personnel, plus many engineers and technicians grew from a cadre originally started by the Navy's Bureau of Ordnance at the California Institute of Technology. At China Lake the rocket is supreme. There it is the objective and also the means to the objective.

The Naval Ordnance Test Station has, as a result, an outstanding know-how in rocketry. In their work they recognize that the weak point in the ballistic rocket system was accuracy. The result of their staff work has been a milestone in air defense progress—a five inch rocket with a small guidance section added. Having been born in the desert and quite deadly, it was named the *Sidewinder*. Possibly because of its novel conception in the field of missilry, *Sidewinder* has two characteristics which stand out in this day of complex technology and complicated logistics. It is **simple** and it is **cheap.** There are an unbelievably small number of parts and a power supply weighing less than an ounce. It is the only missile whose cost compares to the price of a load of aircraft cannon bullets.

To round out the Navy air-to-air missiles, the Bureau of Aeronautics has developed and put into the Fleet the *Sparrow* missile. You might ask "Why have the *Sparrow* if we have an economical and effective *Sidewinder?*" It is not a question of buying a Ford when you already have a Chevrolet. We are faced with the problem of having to be ready for anything and everything which an enemy might bring to bear—and to date no missile does everything.

The *Sparrow* line of missiles is incorporated in air weapon systems involving transonic and supersonic interceptors. In modern task force operations, the fleet's air defense is heavily dependent upon the ability to destroy attacking aircraft at long ranges and under all weather conditions.

*Sparrow* missiles have added considerable reach to the intercepting aircraft, under blind firing situations, and from a wide variety of firing angles. Further developments underway will give *Sparrow* increased capability for breaking up enemy air attacks at even greater distances, and again under all weather conditions. Both *Sparrow I* and *Sidewinder* are operational.

Many think that missiles will supplant manned aircraft. Be that as it may, it is very clear that in many areas missiles will certainly take over. The Navy attack missile, the *Regulus,* is a good and possibly first example of a missile becoming a partner rather than a tool of conventional aviation. This missile can carry a nuclear warhead and can be launched from ships. In fact, we have ten ships, including submarines, ready now.

The *Regulus* can be best described in the words of Chance Vought, its manufacturer, "It takes shore leave 500 miles at sea." Great mobility in dispersing and in hiding the launching ship in the immense waterways of the world provides a strongly desired element of surprise in the adaptation of *Regulus* to seagoing vessels.

There was a touch of genius involved in *Regulus* when someone conceived the idea of equipping it with landing gear in lieu of warhead during the development program—thus tremendously decreasing the program cost, the development time, and the cost of training. A short while ago at Chincoteague, a *Regulus* was boosted into the air with two rocket motors; then, after a programmed flight, it returned to the base for the fifteenth time.

The supersonic *Regulus II,* which is currently being tested, is also using wheels so it can return to be studied and analyzed and to fly again. It is a pity that we cannot shorten and cheapen all of our missile programs by recovering the spent birds intact.

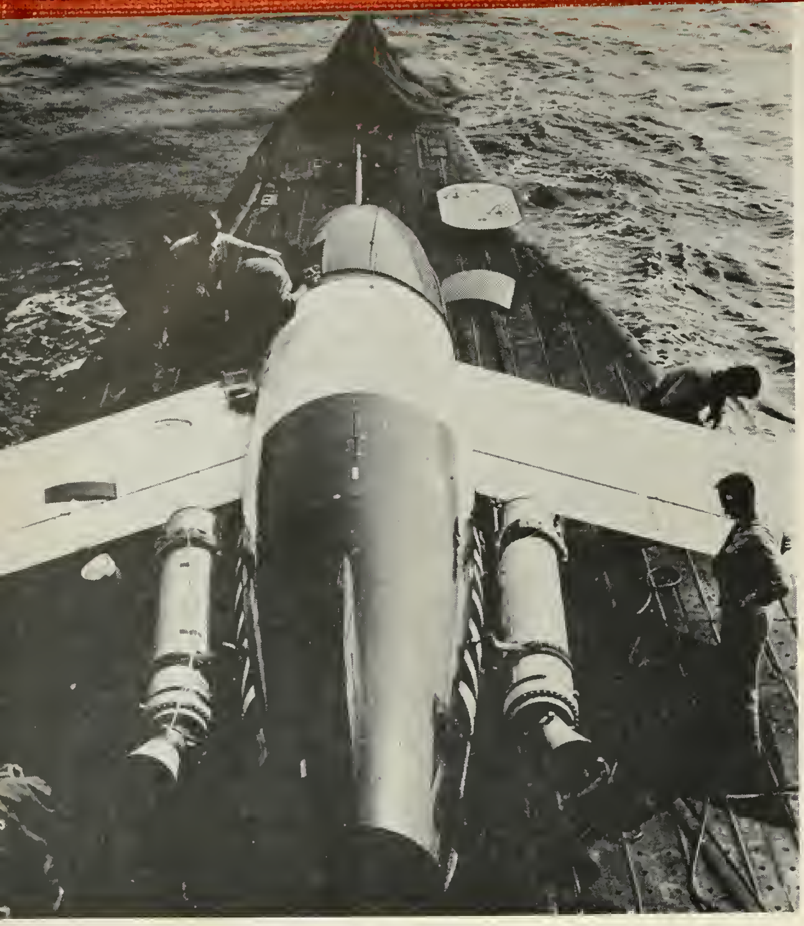
Missiles also extend and complement the air defense capabilities of ships. Navy missiles devoted to this purpose are the *Terrier,* boosted into flight and sustained by rocket engines; and the *Tartar,* in which a single motor does both the boosting and the sustain-

## James S. Russell
## Rear Adm., USN

*Young (53), energetic Rear Admiral James S. Russell is a man well suited to his job. To intelligent imagination and tolerance he adds a long and varied career in the Navy, including combat duty in the Aleutians, Palau, Philippine Islands, Iwo Jima and Okinawa. Since the war he has commanded some of America's biggest aircraft carriers.*

*In addition, Admiral Russell has a Bachelor of Science from the U.S. Naval Academy and a Masters degree from California Institute of Technology. He is a fellow of the Institute of Aeronautical Sciences and is vigorously optimistic over the Navy's future in the age of missiles and rockets.*

*He is intensely interested in the transition from aeronautics to astronautics, and in fact at the recent American Rocket Society meeting in New York predicted that practical nuclear propulsion for space flight would come sooner than we expect (m/r, Dec., p. 29). The Admiral, however, is officially silent on whether the roles and missions responsibility for patrolling the infinite seas of space should fall to the Navy or Air Force.*



Out of its deck hangar and ready to go, REGULUS I gets a final check before being launched from the deck of the Navy missile submarine USS TUNNY.

ing. These surface-to-air missiles are quite a bit different from those one sees at our laboratories and testing grounds. There is no count-down, no waiting for computations. One presses a button and in rapid succession and with complete automation, the missiles are fed from the magazines, loaded, and then fired by an electronic device.

The cruisers *Boston* and *Canberra* are now in service firing *Terriers*. We are building our first *Talos* ship to be ready in '58. *Tartar* will be put on ships in the 1957 building program. Five years from now, we will have at least eight *Talos* cruisers, twenty-two *Terrier* ships, and seventeen *Tartar* ships.

Another air-to-surface missile is the *Petrel*, developed by the Navy's Bureau of Ordnance. It is designed to attack ship targets, and combines the features of a guided missile plus underwater torpedo. Attacking aircraft can launch the *Petrel* well out of range of ship defenses without running the gauntlet of conventional flak and machine gun fire.

A large part of Naval air's striking capability is centered around missile-airplane combinations. One of the air-to-surface missiles is designed to give the attack pilot capability to destroy pinpointed targets such as submarines and small shipping. In addition, it has land interdiction capabilities, and can be used in the type of close support work at the front lines, such as knocking out enemy pill boxes and hill-top strong points, which is the particular forte of Naval and Marine aviation.

A new adaptation of guided missiles to air defense is for the defense of large patrol or bomber type planes. Such a missile will have the versatility effectively to seek out fighter and intercept aircraft making runs on the larger Navy airplanes.

**Missiles to Replace Bombers**

In the basic attack mission of carrier-based aircraft, a general concept is shaping up involving the "stand-off" use of guided missiles. This is anticipating the possibility that the enemy's defenses of industrial and submarine pen types of targets may be so well developed that manned aircraft cannot make a conventional bombing run.

Away from the front lines at sea, or the shooting dynamics of task force air defense and attack missions, a most important work has always been fostered by naval aviation. This is the design and use of target drone aircraft.

The relationship of the automatic airplane to the guided missile is fairly obvious. Guided missiles and target drones are blood cousins. There has been much interchange and two-way flow between the design arts in both machines. This carry-over of knowhow and technique has been of mutual advantage to each.

We in the Bureau of Aeronautics consider the target drone of great importance, first in providing a reasonably fast and maneuverable target for missile test firing and for maintaining combat readiness at sea, and secondly for the techniques in the art of drone design which are applicable to missile design. Although some say that it's not the most glamorous part of the business, the true value of the target drone cannot be overemphasized.

**Navy Missile Budget Up**

A revealing insight as to the growth of guided missiles and the increasing weight being placed upon them by the Navy is seen by a quick look at the administrative side of the picture. In the past six years, the funding for research and development, test and evaluation facilities, and procurement of flight articles have all steadily increased. The proportion of this increase is much greater than the increase for like considerations of conventional airplanes over the same period. In the fiscal year 1951, the Navy budgeted $5 million for guided missiles. It is estimated that in fiscal 1957 $209 million will be available. This is a rate of increase of almost 21 to one. In conventional aircraft, the increase rate has been roughly only three to one, for the same period.

Perhaps the real proof of the importance of missiles to national defense is the fact that a Special Assistant to the Secretary of Defense was recently appointed to administer the overall guided missile program.

While on the thought of overall administration it might be well to point out that most of the considerations given to guided missiles and rocket applications fit well into the normal scheme of things for those in the airplane business.

Indeed, a thesis could be fashioned drawing out the similarities of airplanes to guided missiles or vice versa in all the design, manufacture and procurement phases. Much of the procedure and knowhow applies in either case.

There are inherent differences, of course. For one thing, the missile can be designed for optimum flight conditions. Since it has a boost for take-off, and is usually thought of as expendable, the design penalties for carrier take-off and landings, and round trip radii are not there. Neither is the guided missile subject to the ills of the human pilot factor; and conversely, neither does it have the advantages of the human brain.

Military aviation is under constant pressure to maintain or gain advantage over potential enemies. This has forced aircraft up higher and faster, until one enters the true realm of the rocket engine. With a practical air defense mission to perform, the aircraft must have reasonable endurance and meet other design parameters. The manifest answer is to blend the capabilities of the turbo-jet and the rocket engine in a combination power plant.

The future of the unmanned air vehicle in the fleet must be viewed from the vantage point of all these things: the past, those presently operational, and how we manage administratively.

First, we expect to see, as far out as the next fifteen years, an orderly and progressive improvement in all the guided missile types that are now operational. This would mean that basic missions of the guided machine would remain intact, such as air-to-air, air-to-surface, surface-to-surface, and surface-to-air. In all those categories, better guidance, longer range, greater reliability, and more effective warheads tailored to the target will be the trend and the objective.

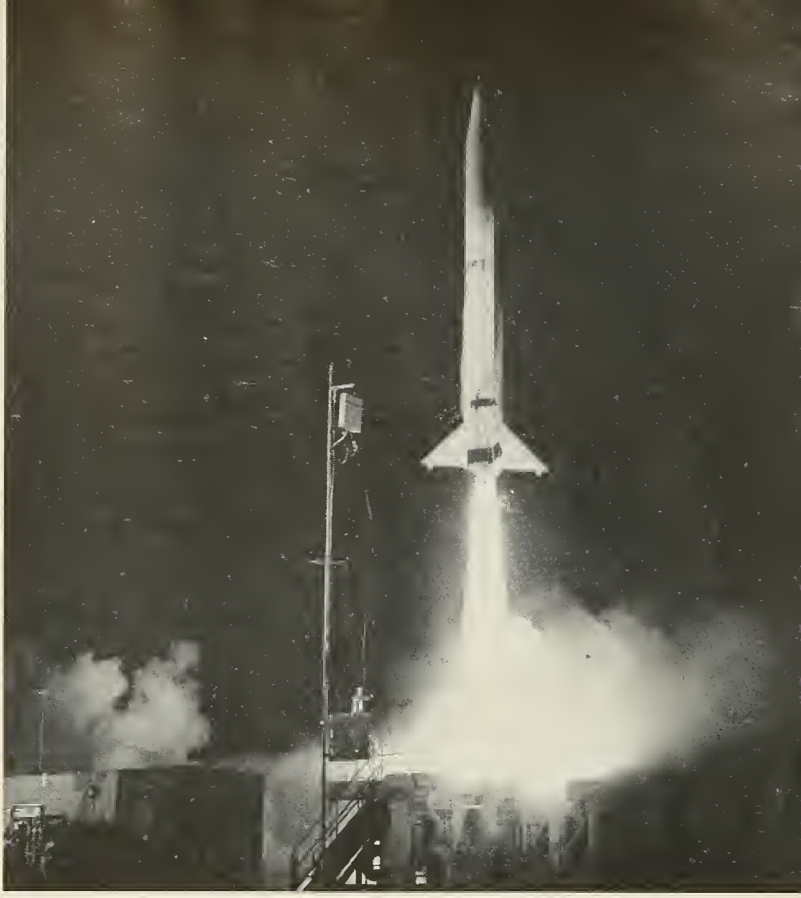
Secondly, the increased use of guided missiles of better performance will to some extent affect now standard Naval air tactical concepts. The exact extent can only be determined in actual operation at the time and place of a missile's introduction into the fleet.

Then, too, for any bold and sweeping change in fleet air defense, for example, we must look to the enemy's capability. If he comes up with substantial stand-off missile potentials, then we must project our intercept capability to greater distances accordingly. Here longer range air-to-air missile armament for our own interceptors would be in order.

Or, from within our own family, if the surface-to-air capability of our task forces is good, then these missiles will push farther out the fighter and intercept screens, requiring better range in both planes and missile armament.

**Mobile Force Immune to Ballistic Missile**

At present the Navy is working on development of a 1,500 mile missile which we can call the Fleet Ballistic Missile. I am sure that the ballistic missiles, as well as the earth satellite rocket now nearing its first development flights, *Vanguard,* mean to many of us that the door to rocketry has swung fully open and that we are on the threshhold of space travel.



Research rocket VIKING-13 a few seconds after leaving its mat on a preliminary IGY research flight from Patrick Air Force Base last month. The VIKING reached 125 miles.

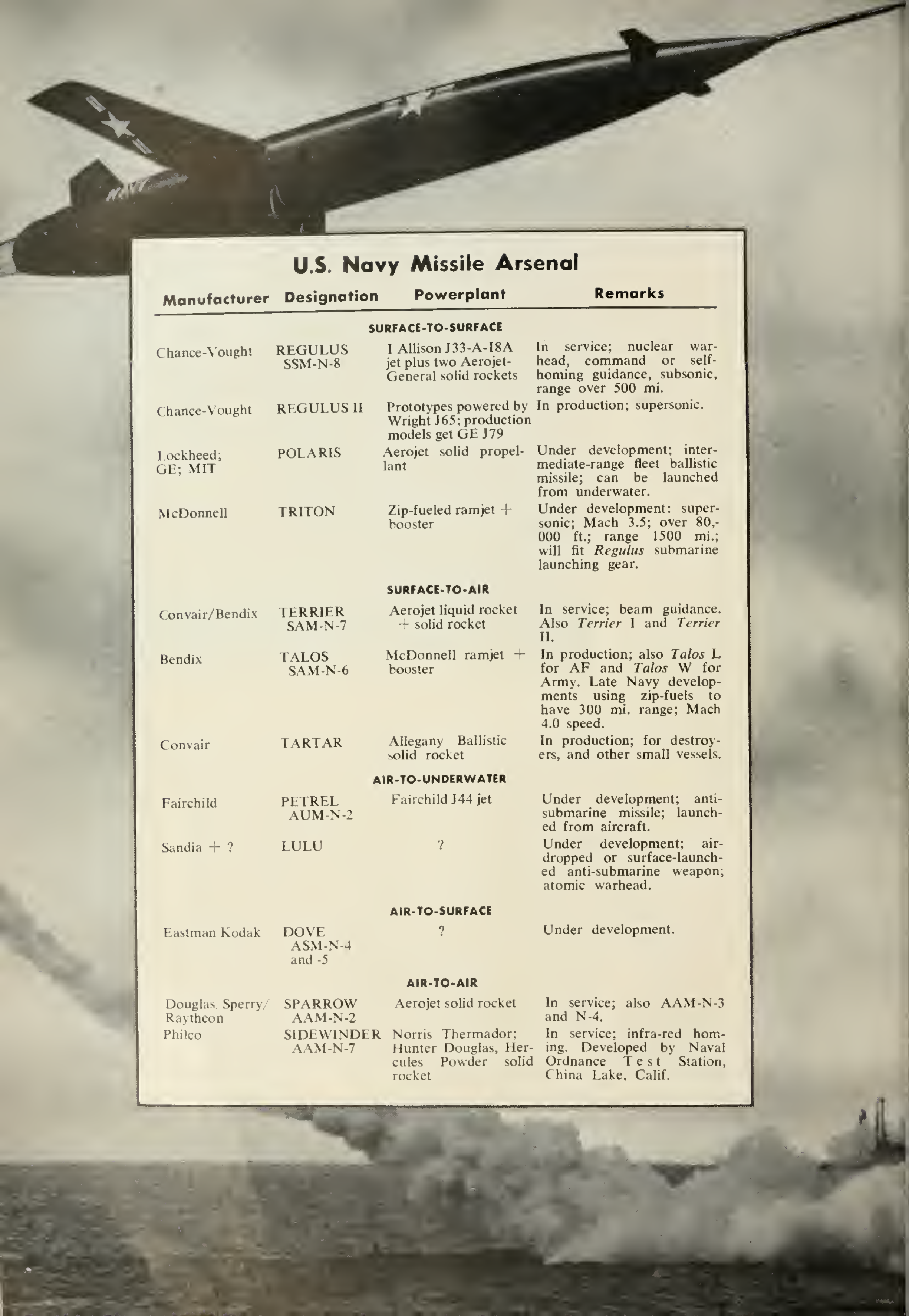
To the Navy, entrusted for its part of the National Defense, the Fleet Ballistic Missile fits in another picture. Whether it be a weapon of retaliation or a deterrent to attack, the Navy will be prepared to launch it from an infinite number of locations—at sea within reach of most any potential target in the world. Conversely, the mobility of a Naval force renders it relatively immune from attack by the ballistic missile, leaving the advantages of this overwhelming retaliatory weapon to the Naval force.

Any conjecture as to the possibility of guided missiles taking over the job of task force air defense completely must be tempered by an awareness of the state of the art in missile design. The "when and if" of an all missile air defense is the when and if of a very long range ballistic missile which has the proven capability of successfully attacking moving sea targets.

Should such a ballistic missile appear, it is not unreasonable to anticipate that manned aircraft would give way certainly, for this element of defense, to anti-missile guided missiles.

For the future, the man in the laboratory today increasingly assumes the role of the man behind the gun. More than ever before the outcome in another war would depend on what went on in a test-tube, betatron or the quiet of a mathematician's study three, five or ten years before.

The age of missiles and rockets is the age of the scientist and engineer. Progress in the development of new materials, fuels and design concepts continues to be good, better in some cases than we had anticipated two or three years earlier. The real advances, of course, come with major technological break-throughs as well as in the difficult-but-vital day-to-day development of safe, reliable operational missile systems. In the latter, the Navy has done well. In the case of the former we, the U.S. as a whole, excell but we can always do better by improving cooperation and liaison between three services, other agencies of Government, private universities and industry ★



## U.S. Navy Missile Arsenal

| Manufacturer | Designation | Powerplant | Remarks |
|---|---|---|---|
| | | **SURFACE-TO-SURFACE** | |
| Chance-Vought | REGULUS SSM-N-8 | I Allison J33-A-18A jet plus two Aerojet-General solid rockets | In service; nuclear warhead, command or self-homing guidance, subsonic, range over 500 mi. |
| Chance-Vought | REGULUS II | Prototypes powered by Wright J65; production models get GE J79 | In production; supersonic. |
| Lockheed; GE; MIT | POLARIS | Aerojet solid propellant | Under development; intermediate-range fleet ballistic missile; can be launched from underwater. |
| McDonnell | TRITON | Zip-fueled ramjet + booster | Under development: supersonic; Mach 3.5; over 80,000 ft.; range 1500 mi.; will fit *Regulus* submarine launching gear. |
| | | **SURFACE-TO-AIR** | |
| Convair/Bendix | TERRIER SAM-N-7 | Aerojet liquid rocket + solid rocket | In service; beam guidance. Also *Terrier* I and *Terrier* II. |
| Bendix | TALOS SAM-N-6 | McDonnell ramjet + booster | In production; also *Talos* L for AF and *Talos* W for Army. Late Navy developments using zip-fuels to have 300 mi. range; Mach 4.0 speed. |
| Convair | TARTAR | Allegany Ballistic solid rocket | In production; for destroyers, and other small vessels. |
| | | **AIR-TO-UNDERWATER** | |
| Fairchild | PETREL AUM-N-2 | Fairchild J44 jet | Under development; anti-submarine missile; launched from aircraft. |
| Sandia + ? | LULU | ? | Under development; air-dropped or surface-launched anti-submarine weapon; atomic warhead. |
| | | **AIR-TO-SURFACE** | |
| Eastman Kodak | DOVE ASM-N-4 and -5 | ? | Under development. |
| | | **AIR-TO-AIR** | |
| Douglas/Sperry/Raytheon | SPARROW AAM-N-2 | Aerojet solid rocket | In service; also AAM-N-3 and N-4. |
| Philco | SIDEWINDER AAM-N-7 | Norris Thermador; Hunter Douglas, Hercules Powder solid rocket | In service; infra-red homing. Developed by Naval Ordnance Test Station, China Lake, Calif. |

## *m/r's personal report from . . .*

# Navy Air Secretary Norton...

### . . . reveals All-Navy FBM *Polaris* To Be Launched From Nuclear Submarine; Balanced Spending Rise For Navy Missile Program; High Praise for ABMA


*Assistant Secretary of the Navy for Air Garrison Norton told* m/r's *editor as he sat down for this personal report: "I'm new at the job and really don't have a great deal of experience." His background, however, belies this. Harvard graduate, Certified Public Accountant, reserve Naval aviator and former Assistant CAA Chairman, Assistant Secretary of State, Chairman of the Air Coordinating Committee, Special Research and Development Consultant to the Secretary of the Air Force and U.S. delegate to many international aviation conferences, the Navy's 56-year old Air Secretary has as good a grasp of his responsibilities in his job as anyone we've encountered in Government.* m/r *considers this* personal report *a vital service to the missiles and rockets industry and plans more like it in the future.* The Editor.

**Q.** Mr. Secretary, what roles do missiles play in the Navy today?

**A.** The soundness of the planning that we did over five years ago is becoming evident. We now have in service as operational weapons guided missiles in all categories, air-to-air, surface-to-air, air-to-surface and surface-to-surface. In the field of air defense, we have two *Terrier* cruisers. We have just commissioned a *Terrier* destroyer, and we have more surface-to-air missile ships in various stages of completion. These missiles have increased our anti-aircraft range from a few thousand yards to over ten miles. In the realm of air-to-air missiles we have missile-armed fighter squadrons employed in the Atlantic, the Pacific and the Mediterranean. These squadrons are equipped with *Sparrow I* and *Sidewinder*. These weapons increase not only the range at which our fighters can knock down enemy planes, but they permit us to get shots at planes we could not otherwise reach at all, such as those we detect at much higher or lower altitudes. All our air defense weapons are supersonic as they must be to cope with high performance aircraft we may expect to encounter. Anti-aircraft guns are nearly useless against modern aircraft and our airborne guns are becoming very limited in this respect. In the field of offensive missiles we have submarines, carriers and cruisers in both fleets that can launch the *Regulus*, which can carry a nuclear warhead under any weather conditions to targets as much as 500 miles away. The *Regulus*, launched from a submarine, gives us a very powerful capability to attack completely undetected. The *Regulus I* is a transonic weapon, but already we have *Regulus II* flying and that one is supersonic. For attack of surface ships we have the *Petrel*, which when launched by a patrol plane can deliver its payload from so great a distance that the launching plane is not faced with destruction by enemy surface forces.

**Q.** What about Navy missiles in the near future, say, five years from now?

**A.** Well, five years from now, we will see very considerable changes in the Navy, not only because our missiles will be faster, more effective and will have longer ranges, but because many of our ships and planes will be missile equipped. In five years, we will have the *Talos* longer-range anti-aircraft weapons in many ships. We will have the *Intermediate Range Ballistic Missile*, the FBM, in operation. We will have vastly improved missiles in all other categories.

**Q.** You mean to say the fleet ballistic missile will be in operation within five years?

**A.** That's what we expect.

**Q.** From submarines as well as surface ships?

**A.** Well, we have hopes it will be operational off submarines in that period too.

**Q.** Will you have to build new submarines for that one or can you use existing types?

**A.** No, we have to build new submarines for the ballistic missile.

**Q.** That's an acceleration of your program, isn't it? You must have gotten more optimistic quite recently.

**A.** Yes, we have reason to feel that we are closer to an operational Fleet Ballistic Missile now than we felt we were a year ago.

**Q.** In that connection, Mr. Secretary, just how does Defense Secretary Wilson's November 26 "roles and missions" Memorandum affect the Navy's ballistics missile program? Does this mean that the Navy will give its FBM development to another company or to a private agency? Or will the Navy continue to work with the Army Ballistics Missile Agency (ABMA) and Jet Propulsion Laboratories in this project?

**A.** Secretary Wilson's memorandum of the 26th of November of this year applied primarily to the roles of the Army and the Air Force. It restated the policy of Navy employment of all categories of missiles, including the Intermediate Range Ballistic Missile. The Fleet Ballistic Missile has requirements that are unique to the Navy. For example, submarine-launched or underwater-launched weapons have special problems, as you can well imagine. Because of the proximity of crew to launching platform we need safer and extremely reliable missiles. Restrictions as to space and size of our ships affect missile design and of course we have very strange navigation requirements. During the past year and a half the Navy has been studying these missile requirements. As a result of these studies the Navy has now revised its program objective. It is still too early to define the contractual structure that the Navy may employ in this revised program.

**Q.** The revision that you mentioned indicates that the Navy will go out on its own, rather than work with the Army.

**A.** Yes, that is correct. However, the Navy hopes to make fullest possible use of the ABMA Huntsville facility. As you know, there's great talent there and we have good hopes of running certain parallel approaches in our programs.

**Q.** You might give them a contract, then?

**A.** Yes, but basically the Navy is now free to approach this problem on its own.

**Q.** You don't contemplate that ABMA will be dissolved then?

**A.** No. We don't know what the plans are for ABMA, but we do know that it is the intention as far as fiscal '57 money is concerned to carry on the present *Jupiter* program, and we certainly hope that the very real talents and ability available there will continue to be available in some form because we think we can make good use of them.

**Q.** As of now, then, there is no joint Army-Navy *Jupiter* program?

**A.** That's correct.

**Q.** Is the main reason for this the technological differences in the missile itself?

**A.** Yes, I would say so. What we want is a device that is operational when we get it. We want one we know we can go to sea with and use. There have been breakthroughs in this business, and we have now come upon a configuration which looks very good to us, and which is compatible with sea-launching from both surface ships and submarines. This missile has been named *Polaris*.

**Q.** You mean under-water launching?

**A.** Yes. That is a possibility.

**Q.** Dr. Murphree confirmed some time ago that the Navy was interested in a solid propellants Fleet Ballistic Missile.

**A.** Yes. There are obvious advantages to it.

**Q.** Are missiles entirely supplementary in the Navy today, or have they begun to replace other weapons types, such as big guns?

**A.** The position of missiles in the Navy today is very clear. We are committed to converting the Navy to nuclear propulsion and guided missiles for a large number of our tasks. This, of course, takes time and money, but in order to effectively accomplish our mission we must continue this effort with high priority. It would not be accurate to say that missiles play only a supplementary role, since they are able to do many things which other weapons cannot do. In some cases they will supplement, and in other cases they will replace current armament. However, until we are able to complete the conversion of the Navy to missiles, we will see the old weapons side by side with missiles for a number of years. Guns are being replaced, especially for air defense. In addition, certain of our surface-launched air defense missiles will soon be given the capability of hitting targets on the surface as well as in the air. Then the need for surface guns will be very small. We are already planning missile-only cruisers.

**Q.** Have you stopped buying big guns—heavy rifles such as 16-in. guns?

**A.** As far as I know we have, yes.

**Q.** This applies to aircraft carriers as well as other surface ships?

**A.** Well, I do know that missile anti-aircraft defense is definitely contemplated for our carriers.

**Q.** You won't see carriers coming off the ways with 5-inch, 38-cal. guns sticking out of the side?

**A.** I think those days are numbered. Missiles do pose some structural problems. You've got to have little bigger spaces for the missile launching area and devices than you do for the guns. The question of arming our carriers with missiles may still be one that is not yet fully decided. In other words, there may be some advantages in having missile defense on cruisers and so on, around the carrier itself, although I would think that the carrier would be bound to be equipped with some anti-aircraft missile defense. But the mounting of the missile battery is not necessarily the same problem as the gun battery. Of course, a carrier, as you know, is such a specialized affair and every inch of space on it is so important, both on the hangar deck and on the flight deck, that there is still some question as to how far they go in missile launching on carriers themselves.

**Q.** Looking into the future a bit, how will roles and missions, tactics and strategies of Naval warfare be changed by the advent and development of whole families of guided missile types? For example, insofar as strategic missions are concerned, do missiles presage the day when the surface carrier groups will be superfluous as a strategic concept? Presumably it will be tactically important for some time.

**A.** This is looking at the future. The basic mission of the Navy is to control the seas and the air above and adjacent

In five years . . . an operational POLARIS.

We need safer, more reliable missiles.

No joint Army-Navy IRBM program any more.

to the seas. You mention both strategic and tactical missions. I would like to point out that the U.S. Navy has a very important requirement to maintain a strong element of air power capable of conducting strategic bombing of not only sea targets, but land targets of Naval interest. Therefore, carrier air groups will be required for a long time, backed up by land and sea based patrol and heavy attack aircraft. In the event of a non-nuclear war the use of missiles for bombardment purposes will be far less than in a nuclear war. The higher degree of accuracy necessary in non-nuclear war will make the Naval air-striking forces indispensable in any such conflict. In nuclear war, it must be remembered, that all land bases will be extremely vulnerable to enemy attack by long-range missiles, enemy bombers, or sabotage. A mobile task force, in a position which is unknown to the enemy will be a much more difficult target to knock out. It might well be that the carrier task force would be our greatest retaliatory force in the event of a surprise enemy nuclear attack.

**Q.** The beginning of the incorporation of missiles into the Navy on a wide scale must be raising a number of rather worrisome problems: for example, stability in the trained military work-force. The cost in turn-over (failure to re-enlist) must be much greater in the age of the *Regulus, Terrier, Triton,* etc., than it was in the day of the gun. Does not this become increasingly true now that industry's need for men with the same training is so great? How does the Navy view this problem? What's it doing about it?

**A.** The introduction of any new weapon or any new device always creates a host of problems. The problem of manpower that you mentioned is a great one to the Navy as it is for all the services. In the Navy we strive to develop missiles which can be operated by our sailors. We have succeeded in this to a large degree. We have no contractor's representatives or PhD's on any of our missile ships but we do need a very high level of skill among our enlisted men. It is remarkable how competent some of our Navy men can become. This, of course, is recognized by industry and we do have a competition problem. Recently the Navy has instituted career appraisal teams that have shown results in pointing out to our men the advantages of making a career out of the Navy. We also hope that some of the studies being conducted on military pay and manpower by groups such as the Cordiner Committee will help us in this problem.

**Q.** Are there any special logistical problems posed by missiles? If so, what are they? What can industry do to help solve them?

**A.** The logistic problems that accompany the introduction of missiles to the fleet are not unique but are similar to problems faced with aircraft, electronics gear and other complex machinery. The replacement of missiles at sea pose many technical problems that are being successfully worked out. I might add that the aspects of handling, resupplying and supporting a missile are not neglected until the time we get the missile to the fleet. These factors are given considerable attention from the very inception of a missile program, and problems relating to packaging, maintenance, resupplying, so forth, are solved as the missile is being developed. Industry has been concerned with these items concurrently with the evolution of the missiles.

**Q.** Would you conceivably reach the point where you would be transferring missiles to ships the way you now transfer oil? In other words, pull a supply ship right up alongside and, under way, sling them across?

**A.** Oh, I think that is not only entirely possible, it is mandatory. I think the ruggedizing of these missiles, for example, is one of the main features. I happen to be acquainted with the *Terrier* development. That's a remarkable case in point. That missile, when it first became operational was still a very delicate affair which had to be handled with great care. Now, thanks to the use of potting compounds in the missile itself plus much more rugged components, the missile can be handled almost the way you handle a five-inch shell. And this will probably be the general trend. It usually is.

**Q.** Would you say this concept will apply to all kinds of Navy missiles, the larger one as well as smaller surface-to-air missiles?

**A.** You mean the concept of making them more rugged? Yes, indeed. We are, of course, trying to produce a weapon here that has a long shelf life and that can be handled under sea conditions, under battle conditions and that can be handled by sailors. All of these things require tremendous inherent reliability.

**Q.** Do you have any special facilities for inactivating shipboard stores of missiles? All these propellants, which are highly explosive seem to constitute a considerable hazard. Do you have, for example, any special arrangement for dumping these things in case a ship gets hit?

**A.** I just don't know the answer to that. I should think that it might conceivably be that we at least would have to make arrangements for flooding things.

**Q.** Are they stored the way you used to store your aviation fuels, in a shell of inert gas?

**A.** We are trying to get away from these exotic and difficult fuels that require special handling. Of course, liquid oxygen is a dreadful thing to handle under any circumstances, particularly so on shipboard. If you have a good reliable solid propellant that can be stored in the same environment with conventional high explosive, etc., you would still be in pretty good shape, I would think.

**Q.** Aside from absolute, no-defense weapons like the ICBM, it seems that special evaluation procedures must

Red submarine threat cannot be exaggerated.

In some cases . . . no choice but missiles.

My guess is the dollar curve goes up.

be required to determine when a missile weapons system is "worth more" than a conventional weapons system. First, servicing and firing costs would be one yardstick, for example. Has the Navy formalized this relative evaluation procedure? Can you say in general terms what form it takes?

A. Before answering this question, I would like to take exception to your "no-defense" statement concerning the ICBM. This is an extremely difficult problem, but we are working on it and don't forget that the mobility I mentioned before gives a fleet an all-important passive defense to begin with, in that a moving object is not a suitable target for a ballistic missile. The question of evaluation is extremely important not only from the point of view of costs but from the point of view of whether or not the new weapons system meets the requirements. Let me briefly outline how the Navy gets a new weapons system. First, an operational requirement is issued by the Office of Chief of Naval Operations calling for the development of a certain type of device. This is done only after exhaustive consideration of the problems by both Naval officers and various study groups, either agencies of the Navy, such as the Operations Evaluation Group, or organizations under contract to the Navy. Secondly, when this operations requirement is issued to the technical bureaus telling them what to produce, the bureaus themselves have continuous evaluation programs during and after the development of the weapon. Finally, when the missile is ready for production, it is turned over to the Operational Development Force, which is a fleet unit. This force gives the missile a rugged test under actual fleet conditions but with better evaluation facilities. All these evaluation processes consider costs, manpower required, use of vital materials and so forth. We never build missiles just to have missiles. They must do a certain job and do it better. In some cases, however, we have no choice but to adopt missiles such as in the case of the anti-aircraft missiles I mentioned previously.

Q. Can you give us some idea, Mr. Secretary, just how, over the next few years, the advent of missiles will effect the various titles under Category II (military hardware) procurement? We'd like not only to get some percentage idea of how missile procurement will increase, but also how other things like manned aircraft, surface ships, submarines, electronics, big guns, etc., are expected to vary.

A. This is a question I can answer only in general terms at the present time. I can say that the missile procurement will increase over the next few years. Procurement of weapons displaced by missiles such as anti-aircraft guns will obviously decrease. Weapons supplemented by missiles may decrease in number. Within the available funds, as determined by higher authority, we will do our best to procure and maintain the best balanced force possible for carrying out the Navy's missions and tasks, At the present state of the art, there are too many variables involved to state the exact form that such a force will take.

Q. Air Force estimates 35% of their budget will be for missiles shortly. How does the Navy compare?

A. I'm fairly conversant with Benny Schriever's activity in the Western Development Division and what's involved there alone. And it's a fantastic effort. Of course, there you have the entire ICBM program and one of the ultimate IRBM programs. I would think that at least over the immediate future, the next two or three fiscal years, that the Navy's missile percentage would not be as high; however, you do have to look down the road a little bit, and you come to the submarine missile program, which is an IRBM program. Taking submarines and missiles altogether, they will represent a very substantial percentage of the Navy's total money. The Navy is working along, you might say, a triple threat program here, of seaplanes, missile launching submarines and fast carrier task forces, and I would think that looking further into the future, it is unlikely that any one of those programs would be more than a third of the total over a period of years.

Q. Will the FBM subs be atomic submarines?

A. Yes, nuclear propelled.

Q. Just looking at the budget generally, looking at missiles, their striking power, or whatever term you want to use—do you think you will get more punch per budget dollar? Or do you think your budget is going to go up sharply also?

A. That's a very hard question to answer. It is one that Bob Lovett was greatly interested in when he was Secretary of Defense. He had a number of studies cranked up to try and find out whether we were heading into a fantastically high military cost, as some people said, or whether we were actually, by virtue of all the new developments, coming to a point where the curve would go down. My general impression is that the curve is going up and will continue to go up. The complexity of these weapons is so tremendous that even though one weapon can deliver, for example, the entire explosive force which was exerted in World War II, it doesn't follow that you reduce your defense dollar. My personal view is that the defense dollar will continue to increase as long as we have to have defense dollars at all.

Q. Will missiles alone have any material affect on the number of men under arms, all other things being equal?

A. I believe the introduction of missiles to the fleet will have negligible effect on total manpower requirements in the Navy. If we resort to weapons of greater efficiency, we may possibly need fewer fire control units. However, the complexity of the missile systems may require a few more people. In effect, I see little change in total numbers, rather, a reorientation in the employing of our men. Our problem is one of highly-trained, competent personnel.

Q. In other words, you can't say you're streamlining the Navy, like the Army is, because of these new weapons; that won't apply to the Navy?

A. It certainly will apply in the sense that you have fewer numbers of ships . . . That's logical, if the fire power of one ship is equivalent to the fire power of a hundred ships that we had in World War II—well, there are chances that we have fewer ships. The same is true of aircraft. The same might very well be true in numbers of missile launchers compared with 15-inch rifles and so on . . . but the dollar is another story. My guess is the dollar curve goes up.

Q. I'd like to throw in a final question, if I may . . . about the Russian submarine threat. Supposedly, they have 400 submarines and supposedly they have been building missiles for their submarines. Do you feel that the Russian submarine fleet is as great a threat as has been indicated in the press lately?

A. I don't think you can exaggerate the threat. The number of Russian submarines is somewhere between 500 and 600. They are producing submarines at the rate of two new ones every three weeks. They are concentrating, for the most part, as far as we know, on the so-called W-class submarines which are the long-range submarines capable of operating in the Western Atlantic, for example. We have no reason to think that the Russians are not also working hard on nuclear propelled submarines and missile launching submarines. We feel that the Russian submarine threat to the United States, as I say, cannot be exaggerated.

Q. Do you think that the Russians are ahead of us in missile launching submarine development?

A. We'd like to know much more about the Russian submarine fleet than we do, along with the rest of the Russian military effort. Personally, based on what I have heard, I'm inclined to think that we are ahead of the Russians in submarine construction and in missile launching capability in submarines.★

# Need for Space Flight Know-how

## *Vital Unknowns of Flight Beyond the Atmosphere Can Only Come from New Research Methods*

By Cdr. George W. Hoover, USN

Behind the production of ships and planes and weapons is a vast research and development program. Paralleling this type of research is an almost equally large program to keep the fighting men alive, not only in the face of enemy weapons, but against the adverse effects of nature as well.

These adverse effects are some of nature's stumbling blocks placed in the path of man's progress, such as his conquest of high speed, high altitude flight. The results of this type of research are not only advantageous to military knowledge, but are equally effective in the advancement of civil aviation. This is particularly true now with the advent of jet transport aircraft, and will be even more so as aircraft begin to fly beyond the atmosphere.

Out of these research programs have come many test aircraft, each a little faster than its predecessor and each capable of reaching a higher altitude.

In August 1947, the Douglas Skystreak set two records at Muroc, California; the first 640.7 mph and the second five days later, 650.6 mph. December of 1947 brought forth the Bell X-1 which set several records in excess of the speed of sound.

Douglas came back in August of 1951 with the Skyrocket, D558-II, which established a speed of 1238 mph and an altitude of 79,000 feet. In August of 1953 this record was exceeded by the same Skyrocket which reached an altitude of 83,235 feet and in November 1953 a new speed record of 1327 mph was made.

The Bell X-1A followed the Douglas flights by setting a record of 1650 mph in December 1953. The X-2, the successor of the X-1A crashed in September 1956, but not before setting records of over 2100 mph and an altitude of 126,000 feet. Recently the announcement was made of a new research aircraft which will be capable of even higher speeds and altitudes.

As you can see from the record, man is definitely outward bound—but not before some means is developed to give us the vital answers to the multitude of unknowns required to make manned space flight possible.

Technological advances in power plants and in aerodynamics have indicated that aircraft capable of carrying men completely beyond the earth's protective atmosphere are not only feasible but probable within a very short time. One feasibility study, made to determine the possibility of an aircraft capable of such performance, indicated that altitudes in excess of 500,000 feet were possible with speeds approaching 4,000 mph. Such an aircraft could be used to study methods of re-entering the atmosphere, study insulating coatings, provide experience in space flight, and stimulate development of better rocket engines.

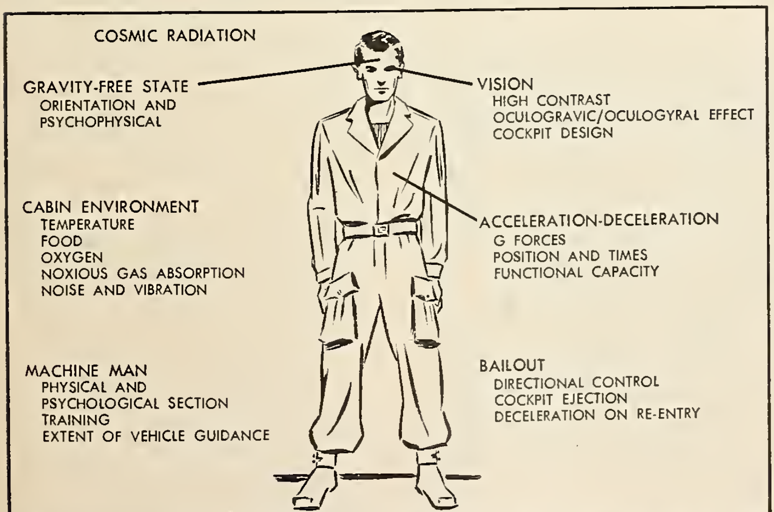
### Many Problems, Little Data

Further studies have indicated that not only are there many problems, but that very little data is available in many of the critical areas.

As an example, in the field of Geophysics and Astrophysics the problems of protecting man and his machine are relatively unanswered. Solar radiation will affect the structures and materials, the instrumentation, and the man himself. Cosmic radiation effects must be neutralized. Meteroids will cause damage to the machine by surface effect or direct collision. The chemical state of the atmosphere will affect structures, radio communications, aerodynamics, and will create problems due to the accumulation of charge on the machine. Winds and turbulence will raise problems in the guidance and the stability of the craft.

Each of these problems must be studied by actually measuring the effects in order to determine methods of preventing damage to both the machine and the occupant.

In the field of Aeromedicine similar problems must be studied. There are problems of living in a gravity-free state effecting orientation and those of the psychophysical condition of the man. Cabin environment must be studied in order to be able to maintain proper temperature, oxygen supply, noxious gas absorption, noise and vibration, and sufficient food for the crew. There must be




Some of the new environmental conditions to which man will have to adapt himself or from which he will need protection in space.

provision for control during emergencies, escape from damaged vehicles, and safe decleration on re-entry.

G-force position and time, as well as total capacity must be studied to answer the problems of acceleration and deceleration. Effect on vision due to high contrast, gravity and gyroscopic action must be understood in order for man to operate efficiently. The man-machine system must be studied to determine the physical and psychological requirements, the training requirements, and the extent of required control.

Here again in this field a means must be developed to obtain the information necessary to make man's existence in space possible. And not only in this field, but in Guidance and Control, Communications, Propulsion, Auxiliary Power, Structures and Materials, Aerodynamics, Re-entry, and Launching and Landing. In all of these fields, many tests and evaluations must be made before sufficient knowledge will be obtained to try manned flight into space.

As a matter of fact, present studies indicate that in the field of Guidance and Control, we know about 40 per cent of what we should know in order to send a manned ship into space. In Communication we know about 60 per cent of what we need. In Aeromedicine we have less than 10 per cent of the required knowledge and in Launching and Landing we know practically nothing. In other areas we are about as badly informed. This is not because we are not looking for answers, but because there has been no way to obtain the required knowledge.

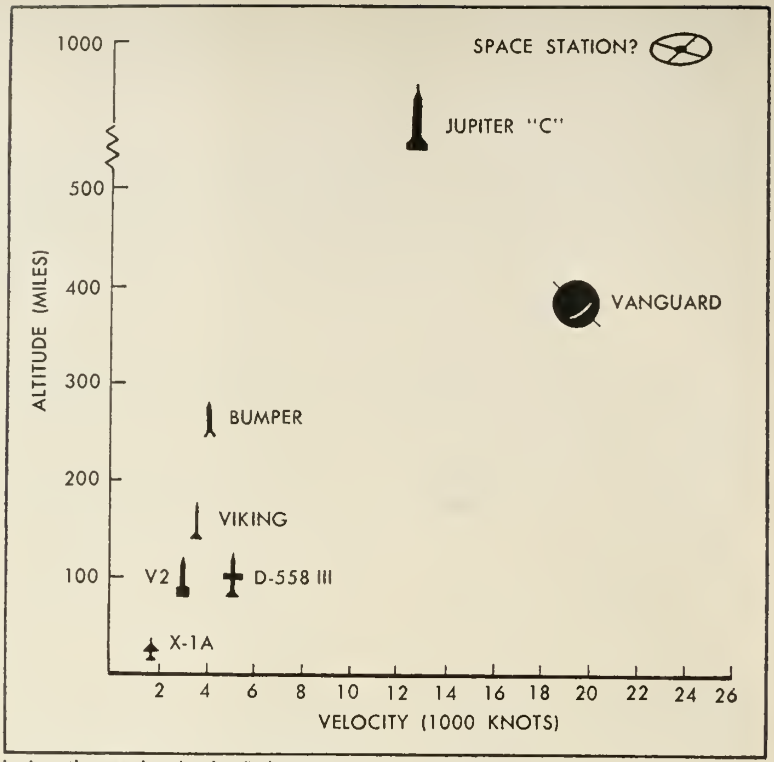
### New Research Tools Needed

Present methods of gathering research data are inadequate. Ordinary aircraft cannot fly high enough to measure the environment in which these aircraft of tomorrow will operate. Rocket powered test aircraft, although having the capability of achieving extremely high altitudes and speeds, can only gather data for seconds of time. This is due to the short duration powered flight.

Even high altitude rockets, capable of attaining extremely high altitudes can only provide minutes of data gathering, and then only for a few answers at a time. With the number of answers required, this becomes a rather expensive method of obtaining the necessary information. High altitude balloons, although capable of remaining aloft for hours at a time, can only reach the top fringes of the atmosphere, beyond which lies most of the unknowns.

In other words a means must be utilized which will give long periods of measurement time at extremely high altitudes at very high speeds.

New research tools must be developed which meet these requirements, and these research tools will be satellites.




In less than a decade the flight environment of man-made vehicles has progressed from subsonic and under 100,000 feet to Mach 19 and over 650 miles up.

Not just one, but a long series of satellites, each gathering more and more information, until all the answers are obtained. Actually the satellite is not an outgrowth of Science Fiction, but is just a logical step in a very normal research program, the results of which will be beneficial not only to our nation, but to the entire world. A satellite is the only space research tool capable of being developed at this time to permit man to learn more about himself, the world, and the planetary system in which he lives.

In addition to the basic scientific data which will be gained from the early satellites, more and more instrumentation will be included as the satellites are enlarged, and information will be gathered in order that man can learn how to penetrate space and return safely.

Studies of the launching techniques of the satellite missiles will give us necessary information as to the acceleration forces to which man will be subjected in his take-off from the earth.

The trajectories and paths of the satellites as they enter their orbits will tell us much about the control which will be necessary in order to place a manned ship in its orbit. Much will be learned about the problem of placing two vehicles in the same orbit, for rendezvous in space will be considerably different than in the atmosphere. In addition to these data, information can be obtained to determine the man's share in operating the equipment and the amount of full automation required.

Launching a series of satellites will tell us what we need to know about power requirements, not only for propulsion, but internal power as well.

The relay of information will test existing communication techniques as well as define the requirements for new methods. The use of digital techniques, data links, television, and methods of relay are only some of the many experiments which can be carried out.

Medical experiments will undoubtedly be of top interest in the early satellites. The effects on human beings can be extrapolated from telemetered data as well as from the recovery of animal subjects. Almost every part of the satellite and launching vehicle can be used in the aeromedical aspects of space flight. Later satellites will be returned to earth through the use of retro-rockets, drag techniques and parachute devices. These will give us the answers to the re-entry problems and the return and landing.

Man will fly into space just as the Wright brothers flew the first aircraft. The satellite will show us the way—first unmanned, then manned, and finally orbiting observatories and space stations.

[*Opinions expressed in this article are those of the author and are not to be construed as official or as reflecting the views of the Navy Dept.*]

# IAF AND UNESCO

Formal recognition of the International Astronautical Federation as a consultative Non-Governmental Organization (NGO) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) now seems virtually assured.

A two year delay in final action, however, appears to be unavoidable. Progress to date is due mainly to the efforts of Andrew G. Haley, General Council and a Director of the American Rocket Society and Chairman of the International Affairs Committee of the IAF.

Once space travel becomes a common thing, almost from the first of manned space flight in fact, a number of thorny international legal problems are bound to arise.

These include flight over sovereign territory—how high is up—problems of radio channel allocation throughout a wide range of frequencies; satellite navigational control; weather monitoring, etc.

It is obviously desirable that the machinery for sorting out these problems be in existence before they occur, rather than have to be jerry-rigged afterwards. It also seems desirable to set up this machinery in already-recognized, established international bodies.

For this reason, there has been a considerable effort during the past few years to link up the IAF with the UNESCO. Recently considerable progress has been made.

Elected at last September's Rome meeting of the IAF as that organization's official delegate to the 9th General Conference of UNESCO in New Delhi, Mr. Haley spent two weeks last November in India pushing for consultative status for the IAF.

IAF feels that with manned space flight now assured in the proximate future a proper grounding now for UNESCO will prevent a lot of headaches later. Mr. Haley's reputation is as one of the country's foremost authorities in the growing field of space law.

**UNESCO Status Voted IAF**

In New Delhi, NGO cooperating status for the IAF was motioned by Prof. Shemuel Sambursky, delegate from Israel and personal friend of Mr. Haley and Dr. Theodore von Karman. About a dozen organizations were proposed for membership in this category. All were approved in one vote by a small margin.

Mr. Haley reports that one of the biggest stumbling blocks has been UNESCO's inability so far to agree on the conditions of NGO status. It was for this reason that on the day following the vote for admission, this action was revoked. Mr. Haley, having departed India on the evening of the first vote, Prof. Sambursky carried on the fight. In a letter, he writes:

"In spite of this reversal, I took the question up in the program commission under the chapter, Cooperation with International Organizations of the Natural Science Department. I formally moved that UNESCO's Secretariat study the possibility of cooperation with the IAF, especially of consultation between UNESCO experts and the scientific committee of the IAF on all the problems of space flight and astronautics. Prof. Pierre Auger (Assistant UNESCO Director) was asked by the Chairman what his attitude was, and he replied in the affirmative, whereafter the matter was passed without opposition."

Preliminary negotiations are now under way for working out areas of cooperation between IAF and UNESCO. The former has agreed to bear the costs of these early studies, if necessary. It seems that by the expiration of the two year delay now required for any new admissions, most of the groundwork will have been completed.

In this connection Mr. Haley says: "The inauguration of the program in a peace and uncomplicated manner is a great achievement of scientists throughout the world."

On his way back to the United States, Mr. Haley stopped off in Athens, and there gave a lecture on the current problems of astronautics and showed movies of developments as the dinner guest of King Paul and Queen Fredericka of Greece.

The Queen, Mr. Haley reports, shows great interest in the field, along with her brother, Welf Heinrich, Prince of Hanover. The latter, like Mr. Haley, is an accomplished authority on space law. Other guests at the dinner included the Chiefs of Staff of the Greek Armed Service, the Minister of Defense, U.S. Ambassador George Allen and other embassy officials.

**Films Draw 700**

One showing of these films in Paris drew an audience of more than 700 people which, Mr. Haley suggests, is a good measure of the growing interest throughout the world in the field of astronautics.

The ARS director's films are currently being shown in other cities throughout France under the auspices of the French Astronautical Society, whose President, General P. Bergeron, plans to visit the U.S. during the latter part of January.

Internationalist Andrew G. Haley and Soviet space man Leonide Sedov at last September's Rome meeting of the International Astronautical Federation.

# EDUCATION . . .

# . . . for the Missile Age

## *How different the criteria?*

## *How different the curriculum?*

**By Kurt R. Stehling**
*Head of Propulsion,*
*Project Vanguard*
*Naval Research Laboratory*

IT IS OBVIOUS that education begins in the primary grades. It is perhaps not so obvious that the inspiration of the teachers and the quality of the subject matter taught in these early years are the mainsprings for the responsiveness and interest of a young person in the very important later high school and university years.

There is presently a great furor in this country about the lack of teachers, school physical plant, and money to pay the one or build the other. We have the paradox of a society composed of taxpayers who piously wish for these elements of education, but who are not willing to pay. Instead, they pour billions of dollars each year into vast amounts of "necessary" commodities, such as liquor and automobiles.

Educators and teachers are faced with the prospect of bringing up and educating the maladjusted offspring of those taxpayers who, in most cases, should be doing at home much of the upbringing left to the schools.

The great missile age is about to descend upon us. This will demand a generation of young people trained in the fundamentals of science and ancillary subjects. These very subjects are often bypassed in the frantic scramble to process every pupil as fast as possible through the school mill.

All this is enthusiastically endorsed by the parents who do not wish to see their progeny burdened with any intellectual exercises. Universities, especially those in the upper ranks of scholarship, often have difficulty in adapting their students to the rigorous curriculum which these good universities demand.

Those students who wish to enter the field of guided missile technology must be prepared to have a good grounding in physics, chemistry, and mathematics. They should not have their thought processes cluttered with too many generalities—liberally spread on by technical colleges who believe a student's education is directly proportional to the total number of technical subjects he has studied.

### Industry Must Share Burden

However, it must also be said that industry, particularly the guided missile industry, must share the burden of inspiring and training young people for this very complicated business. So far, industry has played only a meager part in this scheme, although many industrialists are the first to scream about the lack of engineers and physicists.

Yet, the aircraft, missile and component industry is partly responsible for this shortage of scientific workers:

1—Industry lets the schools do all the educating without much "on-the-job" training. The supervisory and managerial personnel, often haphazardly and sloppily trained in their functions, are busy empire building. They cannot, even if they wished, take a young person and lead him through the jungle of paper work complexities which cover the average engineering department.

2—Cost-plus contracts and empire building seem to favor the sucking in of "bodies" (a cynical generic term now widely used) without fitting these "bodies" into a proper niche and making the best use of them. Therefore, we often have three people doing the job of one. Meantime several other extras must undo the miasma of wasted effort introduced by this last useless group.

3—The same situation has the further effect of permitting industry to raid the staff of the very universities which supply the graduates industry needs so badly. The attitude is "Let's hire a few PhD.'s to build up our personnel roster on contract proposals." Many of the universities, therefore, have difficulty in maintaining their staffs, especially with the better people who have made names for themselves through publication and research. Those men who have been seduced from their campus positions by the lure of greatly increased salaries are often thrown into the wilderness of industrial operations without being especially fitted for this atmosphere.

### Conflict Tough To Solve

There is nothing wrong with the premise that our technical colleges and universities should serve industry and the community at large. And they must maintain their contacts with industry if they are to sustain a fresh viewpoint.

What is wrong, however, is the hiring of these research workers and scholars on a full-time basis, thus killing the goose that lays the golden egg. Again, this would not be so bad if these teachers found themselves in an amendable environment; but since many are first and foremost teachers, their best talents are not compatible with the fast-moving requirements of industry.

What then is the answer? Should the universities try to raise salaries to industrial levels? Should they permit more outside consultation by the faculty? Or should they encourage industry to build research centers on the campus to enable the faculty to work in two places at once?

In the case of the first question, it must be obvious that most universities in U.S. have neither the endowment nor wherewithal to pay industrial salaries. A few of the wealthier institutions could, perhaps, approach this by reducing the faculty and accepting more government or industry-sponsored research, and an increment above academic salaries.

Indeed, many technical institutions are so loaded down by outside contracts, usually government, that the scientific faculty in its eagerness to make a little more money spends as much time working on these sponsored contracts as on teaching. Yet teaching should surely be the prime objective of a university. Incidentally, a very undesirable by-product of research is the inequity which is produced in faculty salaries in an arts and science institution. After all, the professor of ancient history, arts, English, philosophy, etc., can hardly expect a research contract which will increase his regular salary, although an altruistic government agency will sometimes hand out such a small research contract.

Of course, the arts faculty ought to live with the ugly realization that it has no industrial salary scale to live up to since industry is not yet in the habit of hiring historians, philosophers, and students of English, although it ought to begin to do so.

The second question asked was "Should the faculty be allowed extra consulting time to implement their salaries?" This, of course, is widely done at present and is perhaps the least painful way to aid the industry and university through the feedback so obtained. However, the amount of consulting can easily become excessive and too often transcends into a full time job in industry.

The last question, i.e., whether universities should permit the building of engineering research laboratories on the campus, can be answered by pointing out that this is presently happening at such institutions as Massachusetts Institute of Technology, University of California and University of Chicago. There is no question that the campus atmosphere attracts many missile engineers who think fondly of their college days and often tire of industry's pace.

Several missile firms, such as Lockheed, have taken advantage of this recognized feeling by moving research labs close to a university campus. At the same time they have the advantage of the proximity of a scientific institution with all its resources of faculty, laboratories, and libraries.

### Missile Age Demands a New Man

The missile age will demand a new man. He must be educated not only in the superficialities of college curriculae, but he must be grounded in the fundamentals of physics and other branches of science and mathematics.

We tend to produce today an overtrained engineer who is only partly educated. The ability to write a clear and concise report, the ability to reach the fundamentals of a problem without a great crowd of redundant material is an important one. The growth towards specialization is becoming an obsession.

Many young engineers, and old ones too, are afraid to express themselves in a field other than their own narrow one. There is open jealous compartmentalization of the various enterprises on missile projects. The top missile engineer should be encouraged to cut across party lines and make contributions where he can—whether it be propulsion, guidance and control, structures, electrical and telemetering or dynamics.

Some of these fields, such as solid-state physics, metallurgy and cryogenics, are often neglected or underpopulated—both at the university level and beyond—because many students take the easier and more glamorous courses. Yet metallurgy, for example, is becoming a crucial factor in this age of super-jet engines and high pressure rocket engines and gas turbines.

Another interesting area with great potential is that of ceramics. Only two or three universities in this country have the study of ceramics as an undergraduate and graduate specialty. The missile age will demand trained and experienced men in such areas as ceramic rocket thrust chamber design, aerodynamic-heat resistant coating, "cermets" and ceramic coated turbine blades, acid resistant coatings, etc.

If a typical missile is divided into its major domains it is possible to point to either a major course of study required or to the kind of engineer who is doing such work or who should be.

It is not yet apparent whether the complete missile engineer of the future will be a finished product of some missile engineering curriculum or whether he will, as at present, "grow" into the job. Although some universities have missile engineering courses as part of an aeronautics curriculum, industry is presently fitting non-aeronautical engineers into many positions which may some day be filled only by recognized missile engineers.

The missile engineer of the future will need a thorough grounding in only the fundamentals of physics, mathematics and chemistry. He must have a sense of dedication and enthusiasm and an awareness of the mighty potential of missile technology—space flight. Then will he be an astronautical engineer. ✯

[*Opinions expressed in this article are those of the author and are not to be construed as official or as reflecting the views of the Navy Dept.*]

Seventeen-year-old rocketeer Jimmy Blackmon receives advice on propellant flow from some of the nation's top rocket engineers at the American Rocket Society annual meeting. Jimmy had just received the $1,000 Chrysler Corp. award for his basement-built rocket. "Now I can go to college," he said. Chrysler is to be congratulated for instituting this annual award, for if the shortage of engineers is critical in aviation, it's catastrophic in the missile industry.

# Versatile Regulus Now Operational

Factory checked, canned Chance-Vought Regulus leaves Dallas for parts unknown.


A big bird and quite conventional, this atomic missile is ready for war today.

Drag chute flares as chase planes guide test/training Regulus to safe landing.

At first glance, the Chance-Vought *Regulus* is a very ordinary unsensational missile. It's a nine year old program. So it's not new. It's an air-breather; is subsonic; and has a range of well under 1,000 miles. But there its plainness ends.

This undramatic approach to the very dramatic postwar business of guided missiles is paying dividends with interest compounded. For example:

—It is fully operational, can deliver an atomic warhead over 500 miles away under any weather conditions.

—It works as well on land, surface ship or submarine.

—There are even unconfirmed reports that it has been tried as an air-to-surface missile in tests from a B-52.

—In the fleet the on target success probability of each launch is 0.91, which must be some kind of record for a medium range missile.

—Guided Missile Group 11 at Chincoteague, Va., has completed over 100 launchings since it was formed in September, 1955.

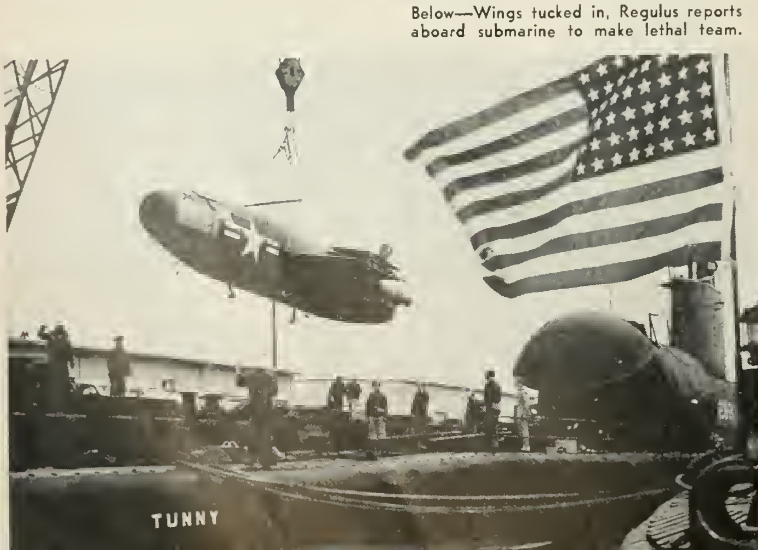
—And in most of these cases the bird flew home and landed to be studied and used again, because training and testing versions carry retractable wheels instead of an explosive payload. This compares, for example, to the $70,000 that's splashed every time a *Matador* is launched.

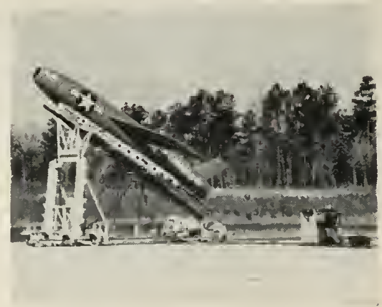
—Initially guided by a chase plane, *Regulus* can now also be ground directed to its target and will soon be equipped with self-homing equipment.

That's *Regulus I,* the Navy's fully operational medium-range surface-to-surface missile.

Now *Regulus II* is flying (see page 42 for artist's conception). Soon

Below—Wings tucked in, Regulus reports aboard submarine to make lethal team.



The Marine Corps should be happy that Navy's over 500-mile missile . . .

. . . works as well on land as it does at sea as this picture series of a . . .

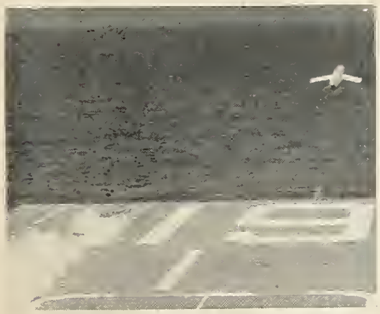
. . . JATO take-off at Navy's Chincoteague missile center show. Also . . .

. . . Regulus now needs no chase plane but can be ground guided from these trailers.

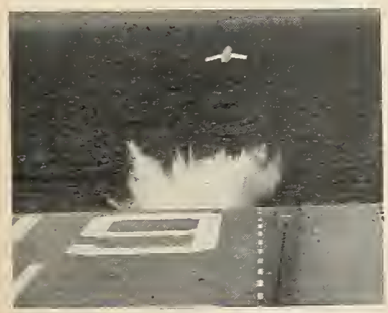

Like its manned cousins, this versatile bird doesn't need JATO . . .


One bird slides easily from twin cacoon on submarine's deck while second missile waits for it to clear before rolling down and around to the ready.

. . . to take off on its mission from any of the Navy's aircraft carriers but . . .



. . . uses conventional steam catapulting gear plus inexpensive disposable dolly . . .



. . . that splashes off carrier's bow as airborne Regulus streaks off to target.

to be operational, this improvement is supersonic and has greater range. It will require only slight modification to fit current *Regulus I* (submarine equipment and like its older brother, its got wheels for training and testing.

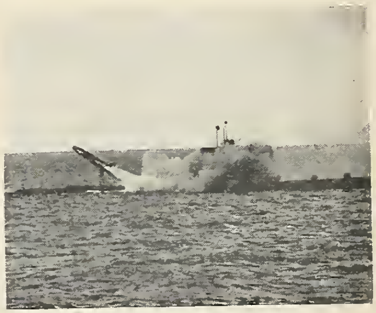
The secret of success of the *Regulus* program makes very interesting reading. Being a relatively simple conception in its original form, more time was available in the beginning to develop an operational missile system. Less had to be spent chasing down some of the more exotic bugs that infest our hypersonic and ballistic efforts. Once the system itself was perfected, improvements came naturally.

In all its life, *Regulus* has flown fewer than 300 hours, but they were hours well spent. For if something went wrong with a flight, in most cases is was possible to direct the missile back to base for a wheels-down landing. Then the recalcitrant circuit, the twisted mechanical linkage or the overheated tube could be chased down and studied in detail. How many Northrop and Air Force engineers would rather have a whole bird in the hand than a twisted wreck in the Brazilian bush?

Not only did this advantage of being able to recover the missile intact enable early perfection, but it also expedited improvements for the same reason. What's more, of course, it saved the American taxpayer a lot of hard-earned dollars.

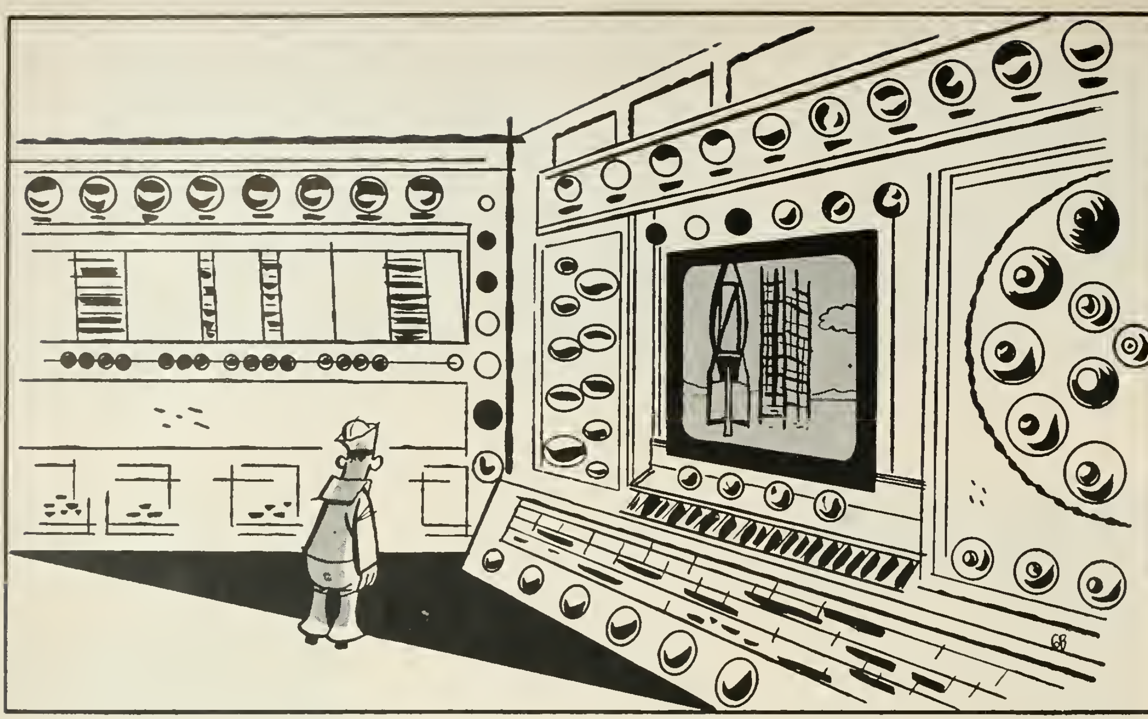
The Navy figures that even if the current *Regulus* amounts to little more than a highly successful unmanned Kamakazi, it has gained a good sound reliable missile system on which it can build effective future generations. For after the *Regulus II* will come the *Triton*—a "zip" fueled, ramjet powered bird with a 1500 mile range at speeds approaching Mach 4.0, a natural outgrowth of 100 per cent complete *Regulus* knowhow ✶

Cacoon door closed, Regulus is quickly mounted, elevated and ready to fire . . .



. . . and as JATO smoke and fire obscures conning tower, the Navy's pride . . .

. . . is airborne, the submarine having been on the surface for only a few minutes.



# Too Many Pushbuttons

**By Donald E. Mullen**
*Missile and Ordnance Systems Department, General Electric Company*

THE NAVY CHIEF entered the block house at the White Sands Proving Ground, New Mexico, to witness his first guided missile firing. Four hours and two aborted launching attempts later, he summarized his views —"I know why you can't make it work; too many pushbuttons!"

It was an obvious remark to make, but its true implication is of vital importance to the nation's defensive strength. In fact, the remark can be used as a very serviceable definition of the greatest remaining problem in the development of practical missile weapons—usability. Unless these complex weapons are simplified and made reliable, our arsenal will be stocked with impressive but useless machinery, totally beyond the comprehension of our men in the service.

To this end, industry and all the procuring services are placing top priorities on reliability, simplicity, safety and similar practical characteristics for guided missiles. While there is no pat answer to the problem of achieving reliability and simplicity in guided missiles, there are giant steps in philosophy that approach this goal.

Before defining these steps, the goal must be defined in meaningful terms. For instance, if a Task Force Commander is about to launch a close support missile over his own ships, how safe should he insist that it be? If he demanded that no more than one missile in 5000 would fail disastrously, this would not be unreasonable. Translate that kind of reliability to an automobile. Taking one trip a day, we could then expect almost fourteen years of untroubled driving.

Understanding the need for this kind of reliability is simple. Achieving it in the battle area is something else again! The classical methods fall into four categories.

Redundancy is one of these, but two of everything adds weight, cost and complexity. It means that a missile soon gets uneconomical, unwieldy and beyond the ability of a sailor to cope with the maintenance and operation of its complex circuitry. In some cases, however, this is the only practical way out.

The second approach is through "fail-safe" design. Reliability, as such, is not considered to be all important here. If a component fails, it does so in a manner designed to prevent catastrophic failure of the weapon system. Again, this is not the best answer, since it could result in substantial numbers of "duds"—as safe for the enemy as for our own troops. But in many instances, it is the only answer.

The most direct, and hardest approach to reliability is to simplify: simplification holds the greatest promise for the future of truly practical missile weapon systems. The fewer the parts, the fewer potential failures, and the fewer the parts, the easier the system is to cope with. The means for the creation of reliability, simplicity will become the guide lines for all missile men. There are any number of reasons why it is extremely difficult to simplify, but it is an old saying that the most worthy accomplishments entail the hardest work.

First problems of simplification are the limitations in the "state of the art."

In essence, this means that no one knows how to do it and/or no one has ever done it before. Assume, for example, that the problem at hand is to design an extremely accurate guidance system for the intercontinental missile. The first demonstration of feasibility in the laboratory might be the wildest dream of the scientist. He cannot and must not be bothered by the fact that his first breadboard circuit in the laboratory may not be simple or reliable. And no manager in his right mind would attempt to force such considerations on a truly creative mind. Developing increased simplicity and reliability in such a device is, in fact, another break-through in the state of the art.

Industry's answer here is to apply the ingredients of time, money and specialized talent to the simplification problem. The talent in this case, however, cannot be of the same type as the creative scientist. The simplification engineer must be dedicated to the reworking of others' creations so that the design will be compatible with the conditions of their ultimate use. Right now, these men are a rather rare breed, somewhat like operations research men and hypersonic aerophysicists. But as the need increases, the breed increases, yielding to the old law of supply and demand. It has been General Electric's experience that when we can't find them we have to make them.

The military service too has an obligation in the solution of this problem. It must conscientiously and regularly reappraise the military characteristics of each weapon in the light of the developer's progress and other new facts that have become known. It is also important that the Services differentiate between what would be nice to have and what they must have.

A typical example here might be the classic conflict of accuracy versus simplicity. The Army, for instance, has specified that a certain guided missile must be just so accurate. Should the nuclear efficiency of the warhead later be improved to yield a greater destructive force, it may mean that a relaxation of the missile accuracy requirement is possible.

### Simplified Assembly and Testing

Achieving simplicity in the original design is obviously the brute force method. Because it is a direct approach, it will undoubtedly be the most fruitful over the years. In the meantime, there are other constructive methods which can be employed to ease the problem.

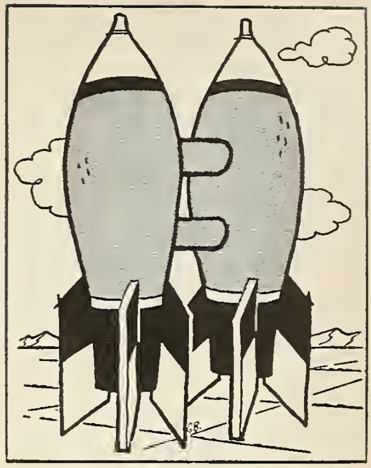
One such approach to the problem of simplicity is the *employment of advanced packaging and modular techniques.* In missiles, the added cost of this kind of assembly is not prohibitive. The initial design and manufacturing cost of any given part of a guided missile is completely lost in the cost of transporting, storing, maintaining and firing the weapon in the battle field. Further, the cost of the missile's atomic warhead is tremendous.

Add to these the true cost of a failure of a guided missile at a critical time in a battle, and it is quite apparent that it is truly economical to employ the most advanced and expensive modular techniques possible in the design of current missile weapons.

Very closely allied to the employment of advanced packaging techniques is the development of proper field test and maintenance equipment. The need, as always, is obvious, like the case of such important field equipment as a beer can opener at a picnic. In many ways, it is possible to substitute calibrated equipment for calibrated men. In military terms, this means that the average GI or sailor with the proper equipment can do the job of checking out a guided missile and then specifying the required maintenance.

All attempts to indoctrinate military personnel in the complexities of development-type testing procedures ended in abject failure. Weapons that were supposed to be in "hit and run" warfare suddenly required days instead of hours to set up, and still did not demonstrate a shred of the reliability that was originally required of them.

Getting the scientist responsible for missile development to stand still long enough to consider the testing problem is the toughest part of this approach. Second hardest is the convincing of the procuring service that high and early expenditures together with minor delays in the missile program are truly necessary to surround the field equipment problem. But in each instance of proper attention to test equipment, the post mortem analysis more than justifies the effort.

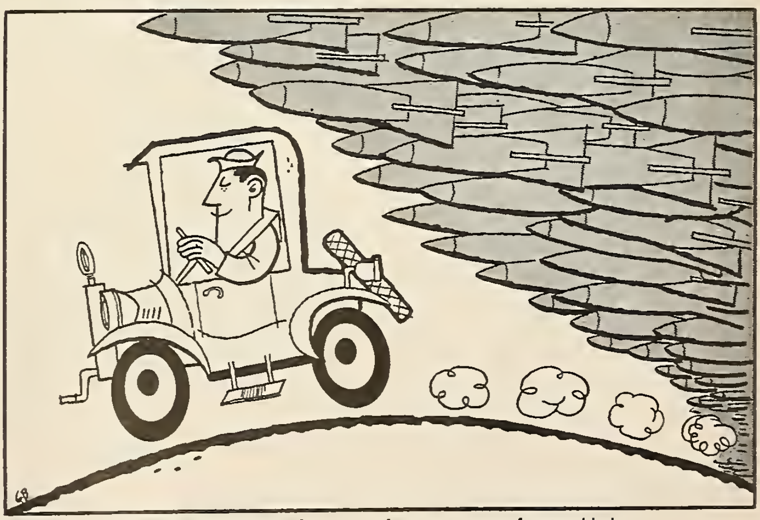


Redundancy . . .

When the latest in packaging techniques is coupled with truly tactical field test equipment, the problem of detecting and correcting malfunction in even the most complex equipment becomes a matter of observing either a red or a green light, followed by the replacement of a modular unit.

This utopian condition, however, is not particularly easy to achieve. First, a test method must be devised which is valid, sufficiently accurate, and repeatable. Further, the test equipment must be designed to standards similar to or even more exacting than those imposed on the guided missile. Lastly the tester shall be simple, reliable, easy to operate, and self-calibrating.

There can be no such things as



Missile reliability of 4999 out of 5000 = fourteen years of untroubled driving in the family car.

Fail-safe design . . .

testers to test the tester. It is significant, however, that tremendous advances have been made in the art of testing. Entire missile systems can now be tested remotely and automatically throughout a simulated flight procedure. The resultant go or no-go indication is then sufficient information for the operator to press the firing button or to call the maintenance man. Since the feasibility of this type of testing equipment has been demonstrated, it now remains for the military services to insist on test equipment considerations from their contractors from the outset of research and development on a missile weapon.

### "Horse Sense" Helps Too

In all the approaches thus far, the answer has appeared to be the result of time, money and manpower. There is another which required none of these.

Early in one missile program, for example, engineers were confronted with the need for a positive and reliable device to indicate that combustion had occurred in the rocket motor. The laboratory was soon filled with breadboards using thermocouples, pressure sensors and photo electric devices in various complex circuits.

One man looked at the problem a little differently. He advised the use of a piece of wood with a bare wire stapled to it. If this assembly were placed at the exit of the rocket motor, he was sure it would disintegrate when the motor was burning properly.

This device, called the "burp board," is now several years old and still in use. It represents the type of analysis that results in the simplest possible method to perform the required function. This is the type of thinking which can produce more practical weapons immediately. Like all the other solutions, however, it does have its drawbacks.

Engineers can be directed to be ingenious, but it's rather difficult to enforce this directive. As one engineer said when asked to use horse sense—"I didn't take that course at college."

Possibly the only other important simplification area remaining is best illustrated by the case of the old farmer who refused to buy a book on the scientific farming method because he "already knew twice as much about scientific farming as his actual procedures reflected." In other words, a lot can be gained just by making better use of current knowhow.

After the system has been designed, considering redundancy, fail-safe design, and simplification, there is yet another step to take—reevaluation. First, see that the system is properly balanced. No component should be unduly strong or weak. In the past, complex equipment has suffered from this ailment of unbalance. In World War II radar sets, for example, less than ten per cent of the components caused more than half of the failures.

The problem of balance also shows up in priorities or favors granted to engineers working on different parts of the missile. A structures man decides he needs an additional bulkhead for strength. It passes through an area previously reserved for the electronic guidance. The proper answer to the question, "Who gives?", must necessarily be the subject of a study in system balance.

Also a part of evaluation is the second look at the validity of the developed system as an answer to the military problem. Questions of weight, size and pay load can be satisfied by inspection. Where the reevaluation becomes complex is in the area of strength of materials and the true nature of the stresses caused by the environment all the way from the factory to the target. No matter how diligently a design has been pursued, if we don't know what it must withstand, we don't know that it will survive.

### Seven Points of Reliability

Using all these suggestions, a very worthwhile approach to the development of a guided missile weapon can be synthesized:

1—Military specifications—the system performance requirements—must be written so as to provide the maximum possibility of ending up with a truly practical weapon;

2—Specifications must be reevaluated and changed continuously, taking care that such changes will not destroy the continuity and effectiveness of the development program.

3—Industry must plan and man its projects so that proper attention is given to designing for simplicity.

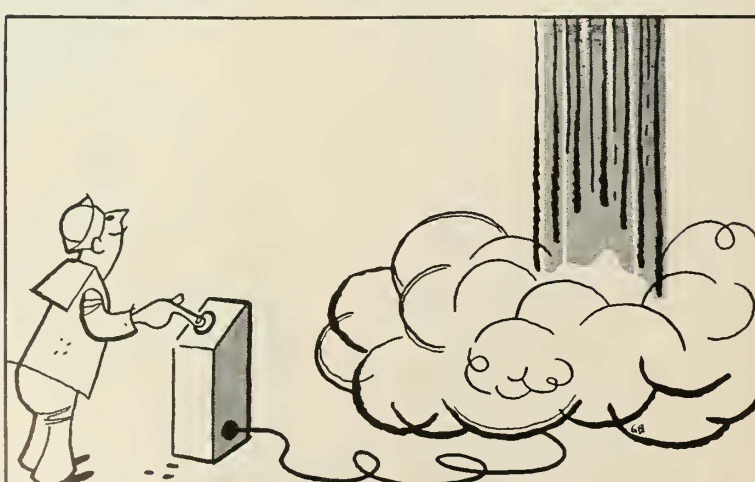
4—Principles of redundancy and fail-safe design must be included when necessary to assure appropriate reliability and safety.

5—Advanced packaging techniques, including modular design should be coupled with the latest in field test equipment to assure maintainability and constant weapon readiness.

6—True functional analysis should be applied to assure that the simplest possible method for performing the given function will be employed.

7—And in all the above things, both industry and the military should use their utmost capabilities in the creation of a practical missile.

If all these things are done, the guided missile system of the future will be worthy of all efforts and the dependence placed on it as the backbone of this nation's arsenal ★



Simplification . . .

# Simulators in Navy Missile Training

By LCDR John Huson, USNR, and Chief Keith K. Smell, TDC, USN

BECAUSE OF the lethal qualities of guided missiles they should and can be entrusted only to the care of highly skilled military personnel. Reasons for this high degree of skill and the means for obtaining it involve complex scientific and educational problems.

The rapidity with which the military research and development program is moving, particularly in guided missiles, demands new and more effective methods of training men in highly complex skills. In the beginning, technical military training followed the pattern of the guild system. Ships were built by craftsmen assisted by apprentices and laborers. Design of equipment was headed by the oldest member of a shipwright house and carried out by lesser members of the companies.

Use of equipment was taught by on-the-job methods; this was effective but slow and sometimes quite dangerous. Special groups would be trained and these men in turn would train other individuals. Even the most simple equipment was painstakingly taught in order to insure proper use.

No great strides were made in the field of military training until a dual crisis arose in World War II. The problem of training men in an incredibly short time with scarce and expensive operational equipment required immediate solving. A more subtle problem arose from the fact that research efforts were creating new knowledges and weapons faster than men could be trained to use them effectively. Steps had to be taken which would train men in larger numbers, faster, safer, and at a lower cost.

Today, much the same is true in the missile field. The dynamic progress of research and development necessitates accelerated training programs for military personnel who must operate and maintain the new equipment.

Yet the sources for obtaining necessary information are too widespread and diversified; there are no missile engineers graduating from colleges; and the weapon system team concept has not yet been fully enough developed.

In spite of these difficulties, men must be trained more thoroughly in a wider variety of skills than at any previous time in our military history. In the first place, the guided missile is a complex piece of equipment with equally complex testing and computer equipments. All of these must be maintained and operated intelligently within sharply defined time and accuracy limits. The margin for error is further reduced because once launched, the guided missile cannot be retrieved. It is too costly to permit trial and error launchings.

The variety and complexity of skills to be learned by guided missile personnel within pressing time limits, present a formidable training problem. But it can be substantially reduced by the use of properly designed and properly utilized training devices.

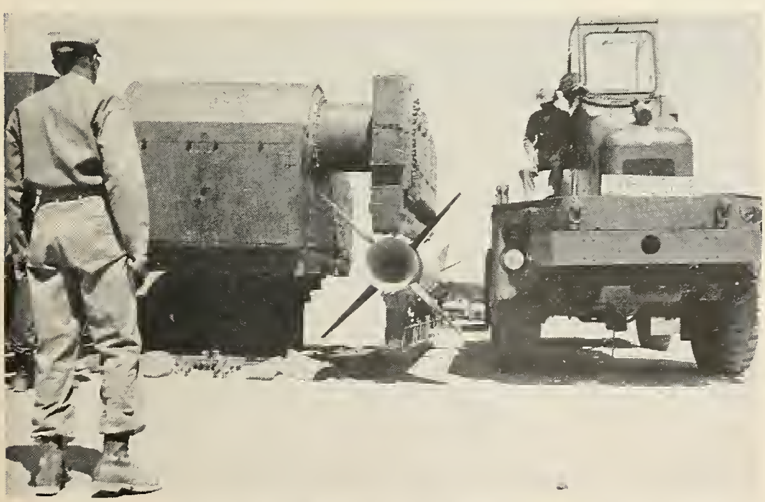
Such devices have proven their worth in many fields of military training. The use of a bomber flight trainer, for example, has been credited with saving the U.S. Air Force 119 lives and $28,850,000 in a period of one year. The Navy estimates the cost of training men in operational aircraft to be $560 per hour, as against $66 for equivalent training in a flight simulator which never leaves the ground.

The time required for training with simulators and other synthetic equipment is shortened because they can be operated day and night without regard for weather or other conditions which would affect the availability of the operational equipment. Synthetic training devices have been and are being developed for all the armed forces and for all aspects of modern warfare, whether it is airborne, surface, or sub-surface in nature. Over $135,000,000 worth of training devices are now used by the services.

In the guided missile field training devices have the following advantages:

1—Saving lives in hazardous situations.

2—Saving operational equipment for tactical use.



Navy's Training Device Center missile simulator package includes a complete store of spare parts for replacement when trainees make a mistake. Shown is the Marine Corp's mobile TERRIER launcher.

3—Increasing the number of students that can be trained.

4—Permitting accurate scoring of the student.

5—Enabling training to be stopped at any point for instructor guidance.

6—Enabling training to be carried on independent of weather conditions or availability of operational equipment.

7—Enabling round-the-clock 24 hour training to be conducted.

8—Lowering the cost of training.

9—Training men in less time.

10—Permitting standardization and improved team or crew training.

11—Sustaining the proficiency of personnel.

The U.S. Naval Training Device Center (Port Washington, Long Island, New York), under whose technical direction industry has provided more than 30,000 training devices to the military forces, has developed trainers specifically for the guided missile field. Particular effort has been directed toward designing low-cost trainers to reduce the effect of obsolescence resulting from the rapid progress and changes in missiles.

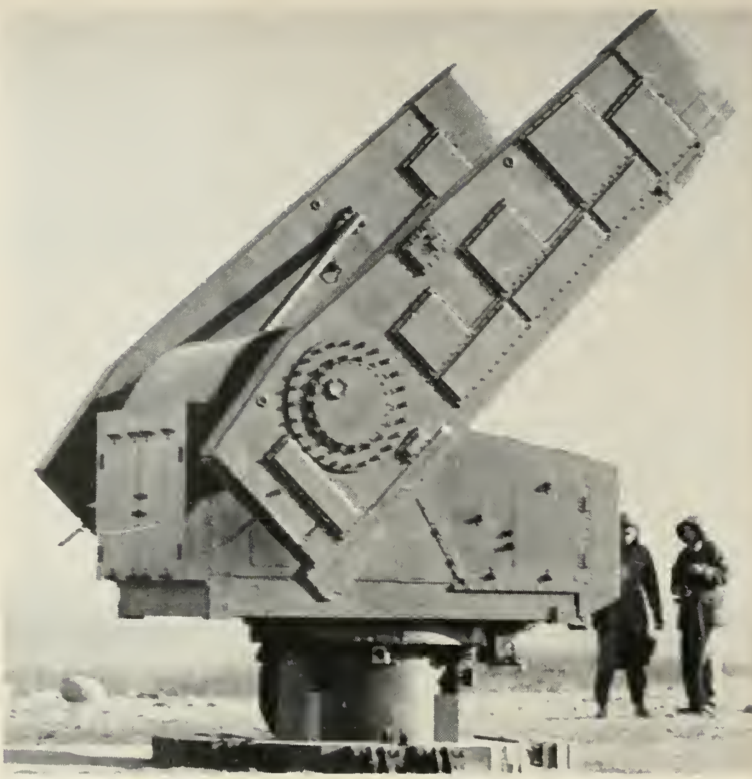
The development of adequate guided missile training devices involves many complex steps in analyzing the details of the training requirements. The type of training device is based on the multiple considerations of a set of variables such as environment, instructor qualification, student level of skill, level of skill to be attained, length of course, curriculum in use, subject material and hours of training.

In weighing these factors, the possible solutions are further subjected to close scrutiny to determine complexity, cost, lead time and useful life in the training program. Finally the most suitable synthetic training equipment is specified. The Naval Training Device Center follows this pattern of operation in the missile training equipment programs it has underway for the Army and Navy.

Industry, too, plays an important part in the development and production of guided missile training devices —by designing, developing, and manufacturing such devices under contract to NTDC.

At first it was necessary to train private enterprise in this new and specialized field. As a consequence many early devices were delayed while a contractor was being educated in the unusual training or simulation techniques involved. Industry needs information and equipment pertinent to the projects it is developing. This problem is caused by a general industrial reluctance to disseminate information and by the necessary security classication which impede the flow of information from one contractor to another.

It would be a great help if missile manufacturers would point out early in the game peculiarities of their missiles that might present serious problems in use, and therefore in training. Advance knowledge of this nature would enable training devices to be properly designed from the start. The dissemination of advanced missile design is of great importance in modifying current training device projects. Prompt relaying of technical information helps place devices in the service schools, the field, and the fleet at a time when they can be most effectively used.



Design of missile simulators calls for a lot more ingenuity than, say, did World War II Link trainers. The simulator for this TERRIER launcher, manufactured by W. L. Maxson Corp., is a full scale working mock-up, designed to fail like the real thing under mistreatment.

The weapon system analysis method for resolving the complex problems inherent in a new missile design has not been in operation long enough to determine its value as compared with other possible approaches.

However, there are additional considerations which should be included when the weapon system analysis is made. Technical consideration should be given *at that time* to development of the necessary supporting training devices.

A brief study of this problem indicates that the cost of training devices is very nearly directly proportional to the cost of operating equipment. Current figures range from 7 per cent to 12 per cent, the higher percentage being due in part to the fact that the training requirement was not recognized early enough, thereby resulting in a "crash program" which increased the cost of the training devices involved.

The ultimate goal of any military training device is to insure operational readiness. The devices developed to assist in the training of men cannot by themselves achieve this goal. They must be intelligently used by competent instructors in an environment for which they were specifically designed.

The success of our military men in the field has earned the admiration and respect of all nations. Prospective enemies are cautious in estimating the strength of the United States, a caution born of experience in operating with or against our land, sea, and air forces. This mark of prestige and efficiency has been largely made possible with the assistance of employing new methods and utilizing new training devices in training at all levels and skills.

The race between nations for technological and production supremacy in the guided missile field has been continuing for several years. It may well be that if the final count down is ever given, the superior training of men will become the determining factor. In fact, this marked superiority, made possible by diligent utilization of properly designed training devices, may be our best guarantee for a lasting peace ★

# New Fuel Flow Test Equipment

*By A. S. Kevorkian, Industrial Engineer Rocketdyne Division, North American Aviation, Inc.*

With the advent of large, liquid-propellant rocket engines such as those now being designed, developed and produced by Rocketdyne Division, North American Aviation, Inc., it has become necessary to develop whole new testing techniques.

The operation of a large, liquid-propellant rocket engine is essentially a precisely controlled, continuous explosion. Fuel is burned as rapidly as possible producing tremendous quantities of high-temperature gases which flow at supersonic velocities through an exhaust nozzle to produce the high thrusts needed to power today's missiles. In order to assure the proper function of these rocket engines, absolute control of the fuel flow rates must be maintained at all times. Testing components in rocket engines responsible for the control of these fuel flow rates such as valves, fuel lines, pumps, and thrusts chambers themselves, has resulted in the development of a unique testing device, the High Flow Bench.

Rocketdyne, which is now designing, developing, manufacturing and testing large rocket engines for the Army's Redstone missile, NAA's Navaho and the Air Force's Ballistic Missile Program, has also designed the Free World's largest High Flow Bench in operation.

This high flow test unit was built to obtain hydraulic data from rocket engine components. This data consists of accurate flow rates from approximately 100 to several thousand gallons per minute and pressures for various flow conditions ranging up to 1500 pounds per square inch.

The test medium used is clean water which is circulated through the components by large multi-stage centrifugal pumps. Since water and rocket engine fuel are practically identical in flow characteristics the flow rates and other data obtained with water are easily converted to the corresponding rates of the particular fuels being used in the rocket engines by simply correcting for the specific gravity.

The multi-stage centrifugal pumps are arranged so that the discharge can be piped into a main header with the pumps operating either in a series or in parallel. This enables the personnel testing the rocket engine components to set up the tests to be made with either maximum flow at a given discharge pressure, or maximum pressure at a given discharge flow. The flow rates are further regulated by remotely controlled throttle valves. By means of a bleed-of line or bypass line, any combination of flow rates and discharge pressures within given limits desired for the test, can be obtained. This system, designed and built by Rocketdyne, is a closed or completed circuit, enabling the clean water, after being pumped through the component being tested, to return to a water reservoir, ready for immediate reuse.

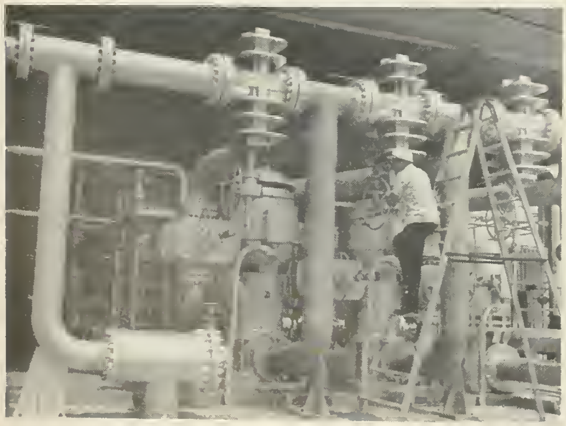
To further measure and control flow rates, a six thousand gallon water tank mounted on a scale system, as a part of the high flow unit, is used. Accurate flow rates are determined by means of time span versus pounds of water flow. Water is pumped into the scale tank and accurately measured to the nearest pound. Knowing accurately the amount of water being pumped through rocket engine component, and the length of time it takes to pump the water through the unit being tested, the recording and indicating instruments provide the actual flow data required for the test.

In order to accumulate the necessary data an elaborate system had to be designed and developed by Rocketdyne engineers for this high flow unit. The signals which are recorded or indicated are picked up by means of various instrumentation devices. Reluctance type transducers are used for pressure sensing and resistance type thermometers are used for temperature recordings which provide the necessary electrical signals for recording instruments.

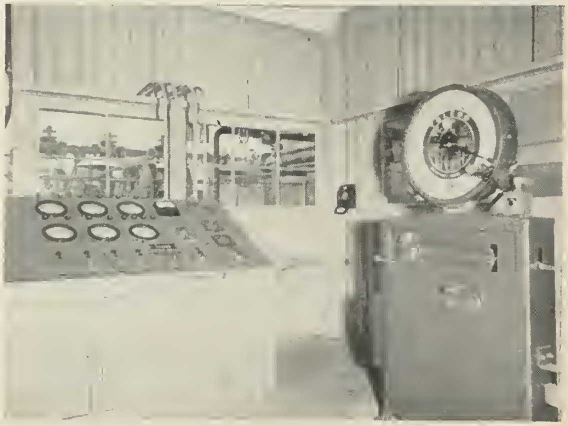
The flow rates are basically measured with the use of orifice plates, venturi tubes and turbine type flowmeters which produce a differential pressure that varies directly with the flow being measured.

This high flow bench, unique in the rocket engine industry, enables Rocketdyne to thoroughly test every rocket engine component used to handle fuel flow rates in perfect safety before the engine is assembled. Because the clean water is used over and over again, testing costs for these components can be kept relatively low without sacrificing the quality or the dependability of the engine.

Rocketdyne personnel operating this high flow bench can handle more than 30,000 gallons of water at a time



Main pipe lines from the three large multi-stage centrifugal pumps used on Rocketdyne's high flow rocket engine component testing unit. Mechanic Harold Hupp sets one of the tremendous valves on this piece of equipment, the largest of its kind in the free world.



Flow rates can be checked accurately by large scale at right. High flow bench operations are controled from console at left. Both units are a part of Rocketdyne's high flow testing unit used to check rocket engine thrust chambers at fuel control components.

and accurately measure it to the nearest quart. Any one of the three pumps used on the high flow bench is large enough to fill a large family swimming pool in the same length of time it takes to fill the average family bathtub.

Thus it is possible to obtain large amounts of accurate information on the hydraulic characteristics of a given rocket engine component from a proven rocket engine design or an experimental design at one central location at relatively low costs, and at the same time correct any malfunctioning parts before the engine is assembled and test fired.

This rocket engine testing facility is not only capable of testing components used in today's large liquid-propellant rocket engines, but is designed to handle upcoming rocket engines now under study which will be considerably larger than the ones Rocketdyne has in production today.

## Gas Generators Grow

Speaking before the Chicago Section of the American Rocket Society on December 12, 1956, Mr. Alfred J. Zaehringer, President of the American Rocket Company, Wyandotte, Michigan, presented an up-to-date view of the growing use of solid propellant gas generator. Related to the rocket, the solid propellant gas generator is being used in a wide variety of military, industrial, and commercial applications. They are used on a world-wide level and represent at $10-25 million per year business. In ten years, it is expected to hit $50 million, and in 15 years will be about $100 million.

Outstanding features of the solid propellant gas generator are low cost, high reliability, low complexity, high power-to-weight ratio, ability to operate under a wide variety of environmental conditions, and ease in design. Like the rocket, the solid propellant gas generator is completely self-contained and does not depend on air or oxygen for its operation.

The American Rocket Co. has devoted considerable attention in industrial systems and has pioneered in low-cost, low-pressure, and long-burning time units. It has developed and applied a low combustion temperature propellant that can be operated safely at *any* pressure from one atmosphere on up. With low-cost and high-performance, low pressures can be obtained *directly* without a bleed-down system. Thus, extreme simplicity and high reliability have been achieved. Mr. Zaehringer said that some units had been operated from times of a fraction of a second to over an hour.



# Problems and Promises of Liquid Ozone

Scientists and engineers attending the first International Ozone Conference held recently in Chicago were told "we have only scratched the surface of ozone research."

In a welcoming speech to 300 persons from all parts of the world who registered for the conference, Dr. Haldon A. Leedy, director Armour Research Foundation, deplored lack of research in the ozone field. This lack, he said, is rapidly depleting our residue of basic knowledge and is bound to reduce applied research later.

Although the conference covered, in the 65 papers delivered, many of the current techniques for producing and using low concentration ozone in the chemical industry and for municipal water purification, keenest interest was in the production and use of high concentration ozone and the determination of ozone's physical characteristics.

Use of liquid ozone as a "superoxidant" for rocket propulsion fuels would add a new order of magnitude to rocket motor thrust values possible with different fuels. However, questions on what percentage of ozone in an ozone oxygen mixture can be safely handled were refused answers. Speakers said this was "classified information."

Many researchers' reports emphasized liquid ozone's tendency to explode during laboratory experiments. Two reports, however, indicated some way to handle ozone safely may already have been found.

Dr. A. V. Grosse, The Research Institute of Temple University, revealed work being done there for the Office of Naval Research and AF's Office of Scientific Research. Despite reports of the violent instability of ozone when mixed with slight amounts of organic materials, Grosse reported success in premixing cyanogen and ozone. This was then burned to produce a temperature of 5200°K. Sometimes mixtures were left for 24 hours before burning.

Even more surprising to researchers was Grosse's prediction that "crystallization" of a cyanogen-liquid ozone mixture looks feasible. Expected temperature of combustion would be over 10,000°K, he said, and estimated pressure produced would be over "100,000 atmospheres."

Armour m/r learned, has a military contract for ozone research believed to be related to the missile field. ARF started ozone research 15 years ago, and first produced liquid ozone 10 years ago. The Foundation holds a basic patent on the hot copper catalyst method of desensitizing ozone.

It was learned also that ARF has developed a new material for liquid ozone storage containers. Portland cement is foamed to produce a "cement meringue" and is mixed with a Pearlite aggregate. Containers made this way weigh only 5 pounds per cubic foot of material volume.

The development of such containers may indicate current work in progress to apply liquid ozone to missile propulsion.

### Atmospheric Ozone

Many ozone study projects are scheduled during the International Geophysical Year. Information is needed on the exact concentration of ozone in various regions of the upper atmosphere, and on production mechanics.

Dr. A. B. Brewer, Oxford University, England, said that variations in ozone concentration at high latitudes are great during the winter season. However, he said, it is not so strong at low latitudes despite the fact that ozone is supposedly produced by photochemical action of sunlight. This occurs even though there is less light in the North during the winter season. This may be related to circulation of air masses.

Study of ozone with regard to high altitude flight are under way at the Air Force School of Aviation Medicine.

Dr. Hans-Georg Clammann, physiologist at the school told of tests during which he breathed a concentration of eight parts ozone per million of air for one hour. The safety level for humans has been set at 0.1 ppm.

Clammann was subjected to the near-lethal tests last July and found his breathing capacity greatly reduced with excessive lung irritation.

Ozone has been found even at stratospheric levels. Flights beyond this point would encounter larger amounts of ozone than can be breathed safely by humans.

# Evaluating Propellant Systems

By Joseph Irgon, *The Fulton-Irgon Corp.*

Determining the precise theoretical performance of a propellant system is tedious and time-consuming. It often takes several days for a hand-calculation on a relatively simple propellant, for example, one comprised only of carbon, hydrogen, oxygen and nitrogen. If lightweight metals or other high energy elements are also present, the calculation time may extend into weeks.

In the case of the more complex systems, the difficulties are compounded for two reasons.

The number of chemical species in the reaction products is appreciably increased, thus complicating determination of flame temperature equilibrium composition.

Temperature dependence of each of the many controlling chemical equilibria is far more critical at the elevated temperatures (5000°F) obtained with high energy systems.

A statistical method which provides a quick and accurate means of determining specific impulse has been developed and used with marked effectiveness by the author and his associates. Based on well-known mathematical techniques employed in the design and analysis of industrial experiments, this new approach is proving to be an invaluable aid also in the evaluation of other performance parameters.

These include such properties as characteristic exhaust velocity, hypergolicity, ignition delay, characteristic chamber length, scale factors and other propellant or engine design variables. As a generalized procedure, the method of response surfaces, as it is appropriately called, offers the most feasible means of optimizing the performance parameters under study, irrespective of their nature.

For these reasons, the various short-cut calculation methods that have been applied with moderate success to solid and liquid propellant systems in the low or even intermediate ranges of energy, have proved unreliable for determining the specific impulses of high energy systems (Isp 250 sec.). The approximate methods do not correct sufficiently for the dissociation of the product gases and for significant variations in the concentrations of the products over a small temperature range at high flame temperatures.

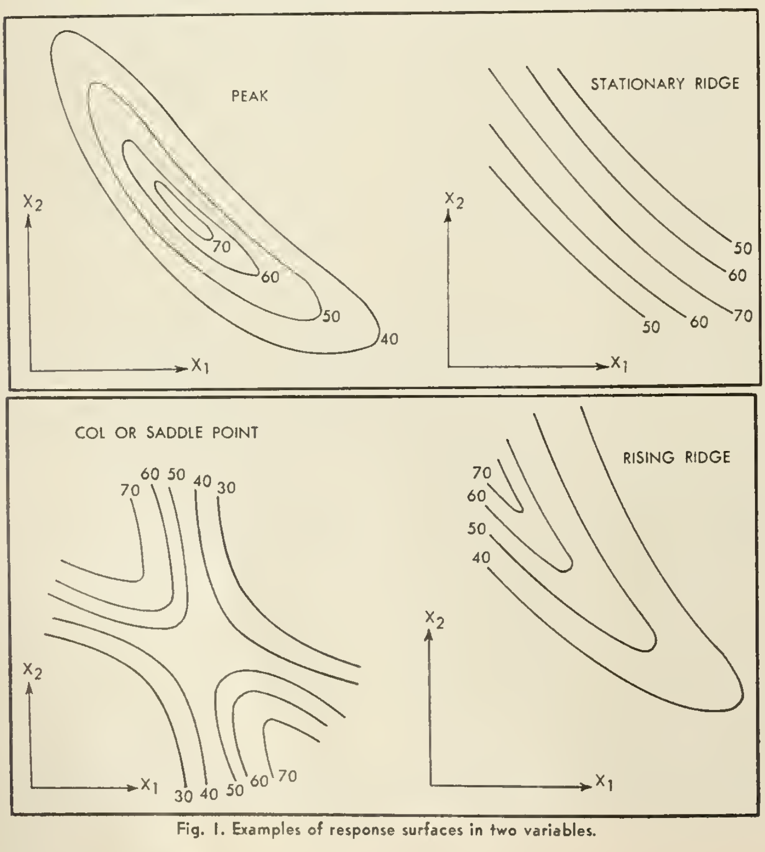



Fig. 1. Examples of response surfaces in two variables.

Machine computation methods are the most practical means of handling a large volume of propellant performance data. However, for a relatively small number of propellants the operational costs of electronic computer facilities seldom make the evaluation either economical or convenient.

The method of response surfaces provides, with the aid of sequential analysis, relatively simple quantitative models that correlate propellant or engine properties with the pertinent system variables, however complex the system. The models can be represented either geometrically or by mathematical formulae. They are readily deduced from a small fraction of the calculations or experiments required by usual evaluation methods.

Conservative estimates of savings by the new technique run upwards of 60% in the cost of development programs. This is made possible through the judicious selection of systems for study and a scientific evaluation of the data.

Examples of response surfaces in two variables are shown in the contour diagrams of Figure 1. The model is most conveniently represented mathematically, by a generalized polynomial equation that has been best-fitted to the available data by the method of least squares. It is of the form

(1) $Y = A_0 + A_1X_1 + A_2X_2 + A_{11}X_1^2 + A_{12}X_1X_2 + A_{22}X_2^2 + \ldots,$

where the A's are constants (multiple regression coefficients) associated with the various variables or combinations of variables $X_1$, $X_2$, $X_3$ . . ., and Y is the "response." Expression (1) is simply the Taylor's expansion of functions such as those representing the systems of ridges or peaks shown in the figures. The contour lines that represent constant values of the dependent variable Y, are referred to as the responses to the independent variables $X_1$, $X_2$, etc.

Illustrating the role of factor dependence, ridge systems of the type shown characterize most systems encountered in scientific and engineering work that involve two or more variables. The situation which can occur in many variables becomes progressively more complicated, as the three-variable contour diagram (Fig. 2) suggests. The latter arrangement can be regarded as being built up from two-dimensional contour diagrams.

In the absence of specialized knowledge, the method of response surfaces,

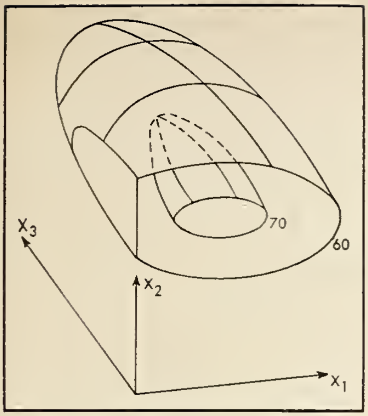



Fig. 2. A Three variable contour diagram.

which automatically takes into account the multi-factor problem. enables the optimum regions shown in the illustrations to be evaluated with considerable economy in effort and time. The conventional method would be to approach the optimum region on a hit-or-miss basis, which would require many more calculations or experiments to be performed than are actually needed.

With several factors to be varied, the possible combinations can number in the thousands. In such circumstances, it would be most difficult to determine the optimum region by the usual "one variable at a time" approach.

The investigator is apt to find himself figuratively stuck on a ridge, often without realizing it, having assumed some lower point of the ridge or peak to be the optimum. This cannot happen when employing the statistical approach, as it immediately provides the most pertinent details of the overall picture and minimizes the effort spent on unimportant features of the correlation.

Such an analysis of factor dependence in conjunction with theoretical knowledge often leads to a better understanding of the basic mechanisms governing the systems or processes under study.

It is apparent from the foregoing that the method of response surfaces is a powerful tool in analytical as well as experimental programs concerned with complex multi-factor problems and should, therefore. prove to be of increasing usefulness to the propulsion field.

*References:*

1. *Box, G. E. P., The Exploration and Exploitation of Response Surfaces, Biometrics 10, No. 1 (1954).*
2. *Box, G. E. P. and K. B. Wilson, On the Experimental Attainment of Optimum Conditions, Journal of Royal Statistical Society, Series B, 13, 1-45 (1951).*
3. *Fisher, R. A., The Design of Experiments, Oliver and Boyd, Ltd., Edinburgh, 1951.*

# Propulsion Notes

By Alfred J. Zaehringer

Look to Penn Salt to introduce a new fluorine propellant. A derivative of fluorine monoxide, the compound is said to avoid the difficult handling properties of liquid fluorine. Incidentally, one midwestern university supposedly has made small scale runs on liquid $F_2$ combinations. Early investigations have shown that even solid fluorine reacts hypergolically with hydrogen. Present difficulties with fluorine stem from the fact that reaction with water produces ozone which then bangs off.

Organic perchlorates appear to be heading for trials as liquid monopropellants. There have been attempts to use it as a burning rate accelerator for double-base propellants. Now, a downriver Detroit chemical manufacturer is looking into electrolytic production methods.

Cal Tech scientists claim that successful runs of Diver's Solution (ammonium nitrate dissolved in liquid ammonia) have not panned out. Troubles: difficult ignition and unstable combustion. A 75% solution has a calculated performance of 175 sec, is smokeless in operation, and is extremely cheap and easy to handle and store. However, the catch seems to be operating at temperatures above the boiling point of ammonia (about—25°F) and yet above the decomposition temperature of ammonium nitrate (about 338°F). The California group believes that success hinges on finding a powerful catalyst to promote smooth reaction between these "humps."

NACA has been running ammonia in regeneratively cooled rocket motors with heat transfer rates of 2.5 BTU/sq. in./sec. They used a novel light-weight engine fabricated from hydraulically formed sheet metal.

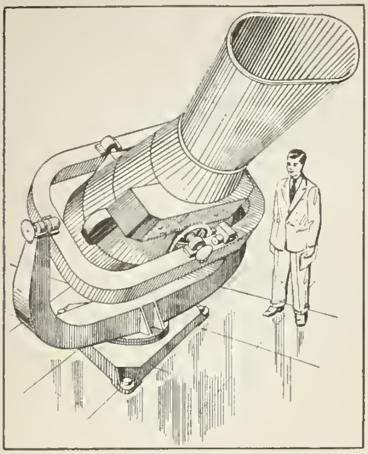
Ignition of solid propellants by detonating gases has not proved satisfactory for many combinations. Reason: low radiation intensities and absence of hot solid particles. For this reason, gunpowder continues to be a standard solid propellant igniter ingredient although the gasless or slag igniters offer promise.

Longest duration ever achieved by a large solid propellant rocket has been announced by Phillips Petroleum Co. It is claimed that a new design concept was used to accomplish this result. Operational solid propellant rockets have averaged 30 sec burning time, with lab reports of times up 5 minutes.

Phillips solid propellant materials cost is about 13¢/lb. This cost does not include materials handling and processing. Big limitation in the process is that extrusion rather than casting is used.

*Honest John* presumably could easily be launched from a sub today but its range (18-20 miles) will limit use to immediate coastal targets. The Soviet T-7A, also a solid propellant rocket, has only a slightly greater range (50 miles). It is assumed that our *Sergeant* solid rocket, now under development, will have a range comparable to the T-7A.

A nuclear test site is said to be in the works at the new Thiokol facility in Idaho. It is not known who will operate the facility. However it is certain that the program will pertain to nuclear rockets or the aircraft nuclear propulsion program.



# Vanguard Satellite Tracking Camera Developed

By Henry P. Steier

Key to whether the artificial earth satellites will tell us anything really new about the earth itself is the ease and accuracy with which they can be tracked.

Data on ambient conditions at orbital altitude can be telemetered to earth, but getting new facts about the earth depends upon observations of the satellites made from the earth.

Using an accurate computing system, the position of the satellite as checked by observing stations is expected to give information of previously unobtainable accuracy.

Determination of station location relative to the center of the earth and to each other is expected.

Out of a research program based on the observation positions of masses on the earth's surface, shape of the earth, distribution of mass within the earth and atmospheric density should be determined with new accuracy.

Smithsonian Astrophysical Observatory (SAO) has been assigned responsibility for obtaining the observation data and processing it. Twelve or more special satellite tracking cameras will be employed in a precision optical program designed to photograph the satellites as they pass over each station.

In addition, a visual observer organization will be set up under the direction of a National Committee of Visual Observers. They will use binoculars or monoculars and an accurate time source.

The visual observations organization will be headed by Dr. J. Allen Hyne of SAO and directed by Mr. Armand Spitz. During the final stages of the satellites' lives when they are rapidly spiraling to earth, the visual tracking work is expected to be very valuable.

Exact locations of all camera stations has not been revealed. Observation points for cameras are reportedly being considered for Alexandria, Egypt, Casablanca, Morroco, Hyderabad, India, and in the Union of South Africa and Australia. Best sky transparency and freedom from clouds is important.

### Camera Details

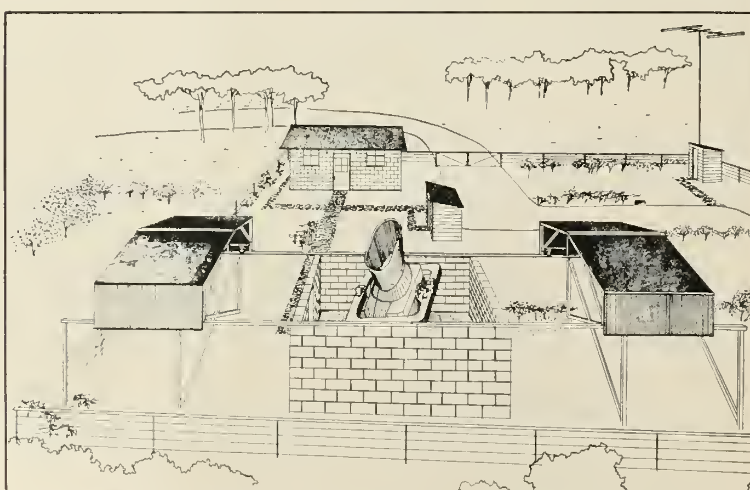
Goal of the tracking effort is to obtain positions oceupied by the satellites during each orbit to within seconds of an arc and a few thousandths of a second in time.

SAO has designed a special camera to fill the need for a photographic technique that can observe a satellite with an assumed perigee of 200 miles and apogee of 1500 miles.

Optics have been designed by Dr. James G. Baker of SAO, and the instrument by Joseph Dunn and Associates, Cambridge, Mass.

The Baker-Nunn camera, as it is known, uses a photographic Schmidt system with 20 inch aperature, 31 inch Schmidt mirror and focal length of 20 inches. Performance at the edge of the camera field is said to be better by 100 times than a classical f/1 Schmidt.

First of the cameras is nearing completion at SAO in Cambridge, Mass. Its



Artist's conception of a satellite tracking-camera station. Sliding roofs would cover camera during inclement weather. Antenna would be used for communication with Vanguard Computing Center in Washington, D.C. or other camera stations and visual observer stations.

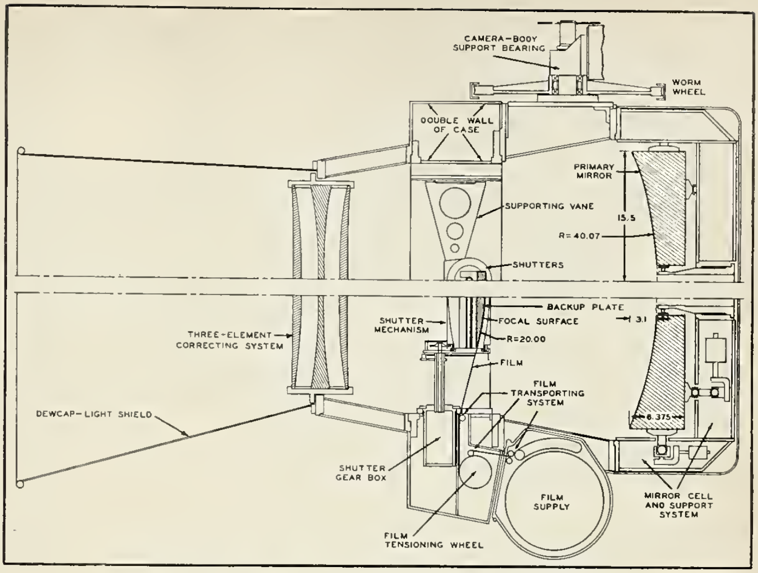
optics and film exposure mechanism was designed for taking both stills and moving pictures.

This will be done during evening and morning twilight hours when satellite visibility is at maximum. Depending upon whether bright or dark twilight conditions exist, and the satellite is far or near, different photographic techniques will be used.

A 20 inch sphere with an albedo (reflectivity) of 0.6 would have a photographic magnitude of 6.3 at 200 miles and a visual magnitude of 5.7. At 1500 miles visual magnitude would be 10.1.

Limit of vision with the eye is 5.7. Anything with a higher magnitude number would not be seen.

Angular velocity at 200 miles would be 87.8 minutes of an arc per second. At 1500 miles it would be 8.7 minutes of an arc per second. The apparent speed would be meteor-like at 200 miles and slower at 1500.




Section view of satellite-tracking camera showing film transport and shutter arrangements and Schmidt optics.

**High Optical Speed Needed**

The optical speed necessary to photograph the satellites under these conditions is difficult to achieve. To meet the problem of film fogging that would occur with exposures longer than ⅕ second, the camera will use continuous Kodak Tri-X film which can be transported in steps at different cyclic rates. These are determined by light conditions.

Two shutters will expose the film. A gross shutter will operate during a transport cycle and be open for 20 per cent of the cycle. In a one-second transport cycle the exposure would be 0.2 second. In the longest cycle of 5 seconds, exposure would be a full second.

During the gross shutter operating time a rotating barrel-type shutter with a period five per cent of the total transport time will interrupt the exposure for periods of 1/100 second.

This will give time marks spaced 100 microns (.0039 inch) in the satellite trail on the film. Synchronized with the rapid shutter will be a stroboscopic presentation of a crystal clock face photographed directly on the film strip. The clock accuracy will be 1/1000 second.

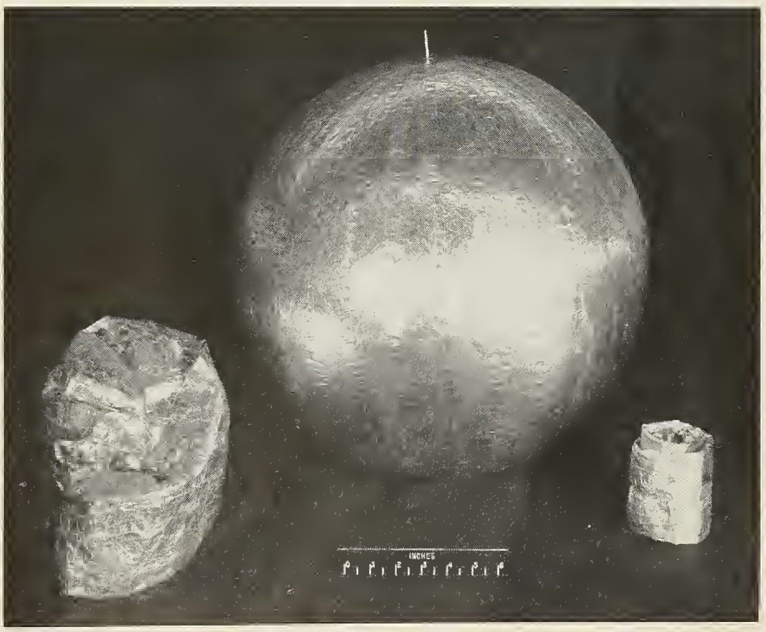
When the satellites are fainter than maximum, the fixed position will not be used. The camera will be moved in a partial motion rather than continuous.

This is because a star field will be photographed as a location reference for the satellite position. Continuous movement would show the brighter stars as long trails and faint stars would be lost altogether. The camera movement could be oscillatory or discontinuous.

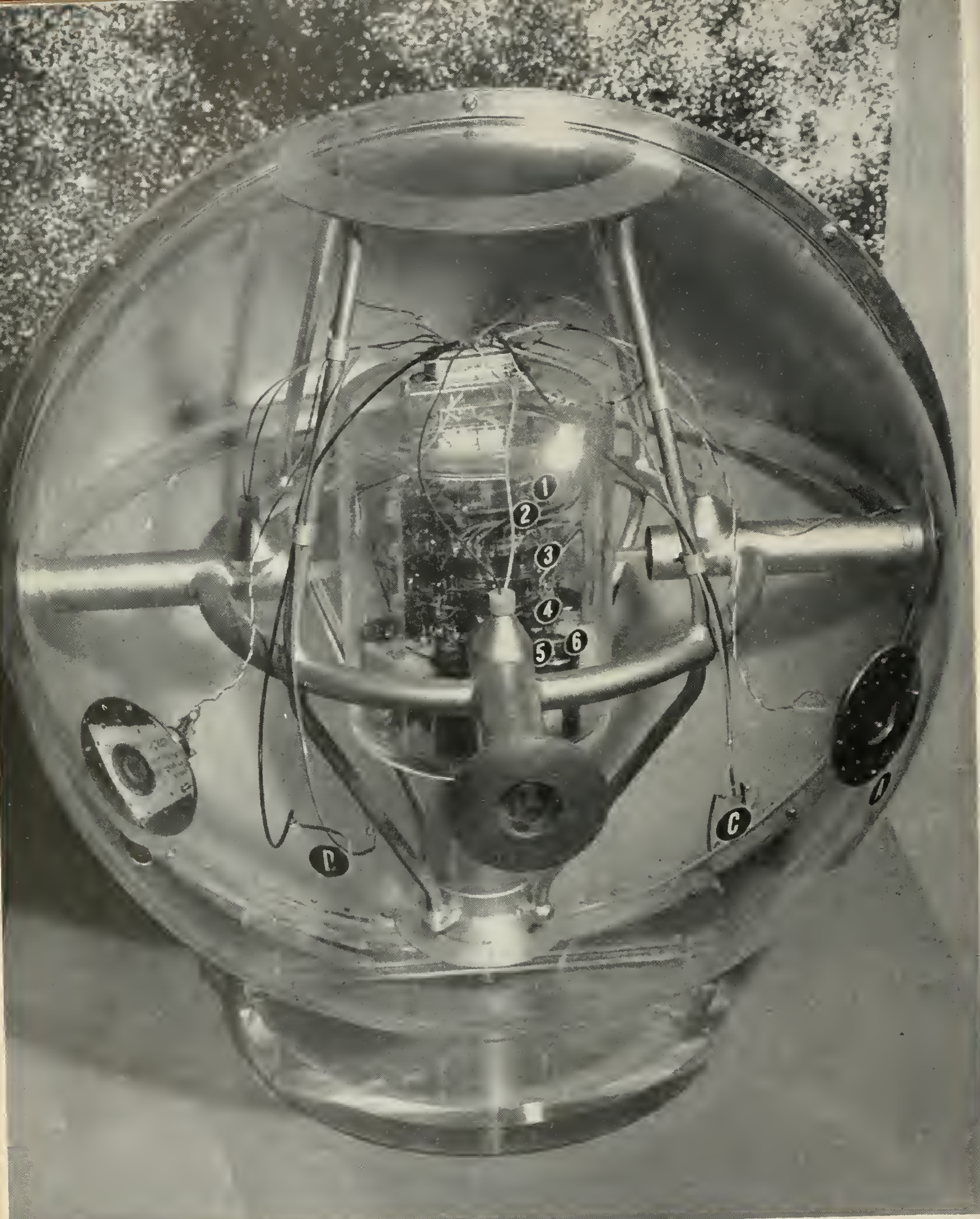
The optical axis of the camera will be allowed three motions: altitude, azimuth and tilt.

An orbit calculation and prediction center located at Cambridge will act as the nerve center for communications between the Vanguard Computer Center in Washington, D.C. and between different visual and camera observation points in the world. This collection and correlation of data is one of the most important parts of the IGY Program.

Data will be rapidly analyzed as soon after the photographic work as possible. This will aid planning for later satellites which may need alterations to get the most out of them.




The new camera will be especially useful in tracking these balloon-like sub-satellites that are scheduled to be released by earth satellites. The 20-inch diameter aluminum coated plastic bags, inflated after release at altitude, contain no radio equipment and will have to be tracked visually. NACA, who developed them, expects to gain valuable upper air drag and density data by following their movements.




Plastic mock-up of an advanced design IGY satellite with scientific instrumentation. Internal bracing will support four 1/4-wave antenna dipoles as well as a central housing for plug-in modularized telemetry and Minitrack transmitter circuitry (No's 1 to 6). Ports (A and B) will expose solar cells and Lyman-Alpha instruments for orientation and ionization measurements. "C" and "D" identify instruments on the skin for measuring meteoritic erosion and temperatures.

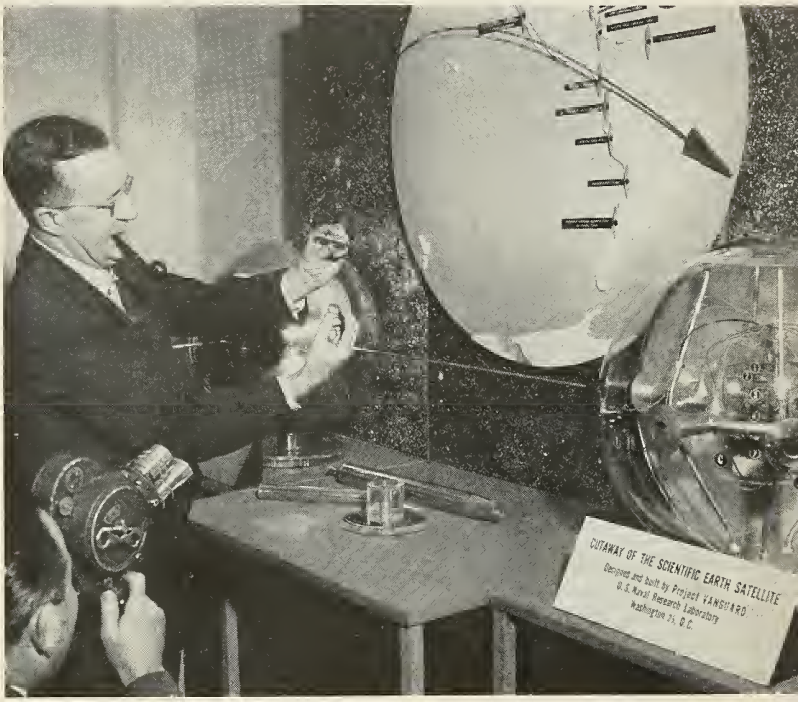
# Vanguard Instrumentation

Dr. JOHN P. HAGEN, director of Project Vanguard, demonstrates with a scale model the separation sequence of the satellite and third-stage rocket motor. Behind Hagen's hands is a full-scale satellite with antennas in erected position.

Cutaway of a satellite showing internal construction is at right foreground. Geographic diagram on wall shows location of Minitrack ground radio tracking stations and direction of a typical satellite orbit. All Minitrack stations will be located in the Western Hemisphere and will provide the Vanguard Computing Center located in Washington, D.C. with data on satellite locations.

Twenty minutes after meridian passage of the satellite over a Minitrack station two bits of angular data and time of measurement will be sent to the Center.

With these data an International Business Machines Corp. 704 computer will calculate times of arrival, zenith angle, angular velocity and location of a favorable acquisition direction for optical tracking stations located in many parts of the world.




ROBERT H. BAUMANN, Group Head, Satellite Engineering Consultant Staff, Naval Research Laboratory, plugs a modularized circuit into a satellite's gold-plated aluminum astrionics container.

Astrionics for telemetry coding and transmission is designed in circular layer modules. In this way various circuits needed for a variety of scientific measurements to be made with different satellites can easily be accommodated.

This satellite prototype is being readied for pressure, vibration, and shock testing. The assembly will also be centrifuged and thermocycled to determine the satellites' fitness for forecasted conditions in outer space.

Circular printed wiring boards that go into the satellites' astrionics housing have transistors and other components fastened directly to the boards. Pin contact boards fastened directly to the circular boards aid ease of interconnecting various circuit layers.

Light colored material at top of astrionics housing is Kel-f plastic. It is a low thermal conducting material for heat isolation and support of the housing.

"T" shaped Kel-f plastic pieces will fasten to internal bracing and aid centering support of the housing.

To the right—Back through the years, Naval research has been one of the most productive scientific investigative operations at the nation's disposal. Its latest project is The VANGUARD Satellite. The diagram on the next page shows its present-day organization.

→

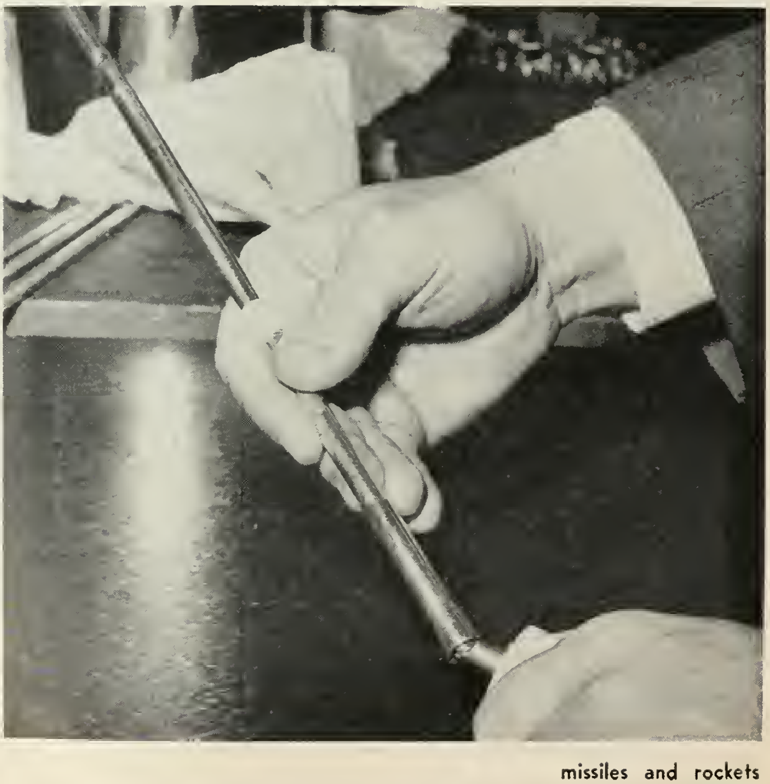
The four $\frac{1}{4}$-wave dipole antennas carried by the satellite will be folded during flight of the VANGUARD vehicle to orbital altitude.

After separation of the satellite from the third stage rocket motor, the dipoles will be erected. They will be activated by a spring-loaded hinge near the base of each dipole.

After the dipoles spring into place, funnel-shaped sleeves near the hinges slip down and lock the dipoles in straight-out position.

Antennas are located around the equator of the satellite and spaced 90 degrees apart. This configuration is expected to give circular polarization needed for best radio tracking.

Satellite orientation with respect to the sun, as detected by solar cells, and ionization as measured by Lyman-Alpha instruments should add wholly new knowledge of microwave refraction indices at satellite altitudes.



Rear Adm Rawson Bennett, USN

- **OFFICE OF NAVAL RESEARCH**
  - CHIEF OF NAVAL RESEARCH
  - DEPUTY & ASSISTANT CHIEF OF NAVAL RESEARCH
  - DEPUTY & CHIEF SCIENTIST
  - **POLICY COMMITTEES**
    - NAVAL RESEARCH ADVISORY COMMITTEE
    - NAVY RESEARCH FACILITIES REVIEW BOARD
    - INVENTIONS EVALUATION BOARD
  - **SPECIAL ASSISTANTS**
    - ADMINISTRATIVE AIDE
    - COUNSEL
    - SPECIAL ASST. FOR RESEARCH ADMIN.
    - SPECIAL ASST. FOR R&D LIAISON
    - SPECIAL ASST. FOR RESEARCH RESERVES
    - FACILITIES OFFICER
    - TECHNICAL INFORMATION OFFICER
    - SPECIAL DEVICES LIAISON OFFICER
  - **COMPTROLLER**
    - ASST. COMPTROLLER FOR BUDGETS & REPORTS
    - ASST. COMPTROLLER FOR ACCOUNTING & CONTROL
  - CONTRACT DIVISION
  - CIVILIAN PERSONNEL & SERVICES DIV.
  - MILITARY SERVICES DIVISION
  - **ASSISTANT CHIEF FOR RESEARCH**
    - SCIENCE DIRECTOR
    - DEPUTY SCIENCE DIRECTOR (RESEARCH)
    - DEPUTY SCIENCE DIRECTOR (COORDINATION)
      - EARTH SCIENCES DIV
      - MATERIAL SCIENCES DIV.
      - PHYSICAL SCIENCES DIV
      - MATHEMATICAL SCIENCES DIV.
      - BIOLOGICAL SCIENCES DIV.
      - PSYCHOLOGICAL SCIENCES DIV.
      - NAVAL SCIENCES DIV
  - OPERATIONS RESEARCH DIVISION
  - DEVELOPMENT COORDINATOR
  - **ASS'T. CHIEF FOR PATENTS AND PATENT COUNSEL FOR THE NAVY**
    - CIVILIAN PATENT COUNSEL
    - PATENT ADMINISTRATOR
      - PATENTS LEGAL DIV.
      - BUAER PATENTS DIV.
      - ONR PATENTS DIV.
      - BUORD PATENTS DIV.
      - BUSHIPS PATENTS DIV.
  - NAVAL RESEARCH LABORATORY
  - SPECIAL DEVICES CENTER
  - UNDERWATER SOUND REFERENCE LAB
  - NAVAL BIOLOGICAL LABORATORY
  - BRANCH OFFICE LONDON
  - BRANCH OFFICE NEW YORK
  - BRANCH OFFICE BOSTON
  - BRANCH OFFICE CHICAGO
  - BRANCH OFFICE SAN FRANCISCO
  - BRANCH OFFICE PASADENA

# Astrionics

**By Henry P. Steier**

Anti-missile missiles will compound to new proportions the reliability and life headaches of electron tubes. *Nike* battery Commanders are already wrestling with these problems. A typical *Nike* system uses 3,500 tubes. Each plays a vital role. Operating and maintenance costs vs. readiness factors must be considered. *Nike* stations do not stay "on the air" 100 per cent of the time. Defense planning takes into account warm-up time needed for readiness.

With the anti-ICBM missile, tube life-reliability considerations will grow drastically. Radar rf generators used for *Nike* now develop power in terms of 1,000's of watts. The *Nike Hercules,* reportedly the anti-ICBM design under development for the Army, will need rf of millions of watts to seek and destroy its target. *Nike Hercules* stations would probably stay on the air around the clock since readiness time is nil. Tube engineers will soon have to face the need for the ultimate in life and reliability (as well as the extremely high power), since there will be no down-time for checking tubes.

Astrionics information was cited recently as the weakest link in the body of information available for handling ICBM offense and defense. Dr. F. J. Tischner, Ohio State University and formerly with Redstone Arsenal's electronics laboratory, said although we have radar for detection, the all important determination of exact position and velocity is very difficult. Among the weakest links are wave propagation and antenna design information.

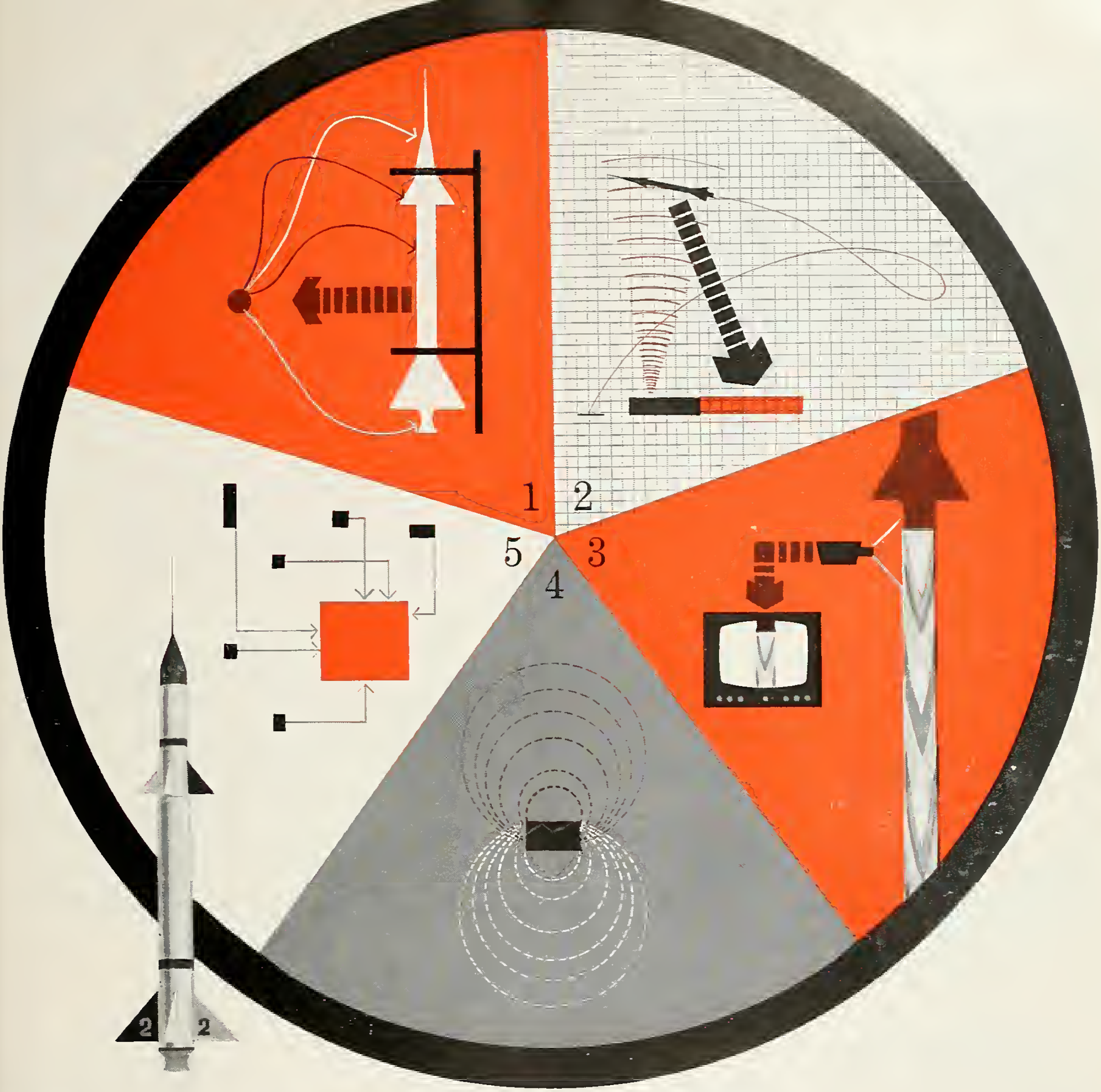
Usual approach to determination of wave propagation is through the index of refraction of the propagating medium. Microwave optics in hypersonic flight—above Mach 10—must cope with what Dr. L. M. Hartman, General Electric Co., Missile and Ordnance System Dept., calls a "monstrous lens" formed of dissociated gases in the stagnation region around the object. Electron density which regulates index of refraction begins to be considerable at Mach 10 and changes with altitude, so result would be a complex constantly changing electron lens. Besides finding a way to communicate with rockets through such a lens, the antenna would have to withstand 8,000°K.

•

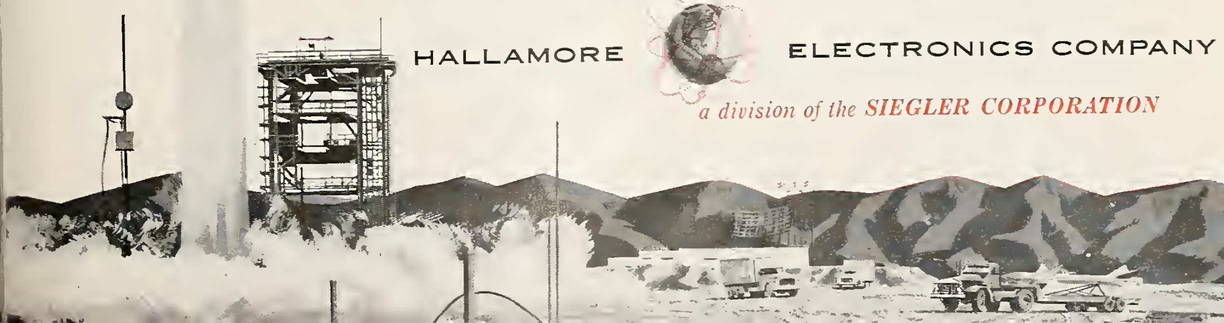
One member of scientific fraternity does not think much of using solar cells for getting astrionics power from the sun. Pointing out that only about 2 kw per square yard is available, and that solar cell efficiency is quite low, he reminded his listeners that "fast growing Iowa corn uses sun energy better than semi-conductor devices."

•

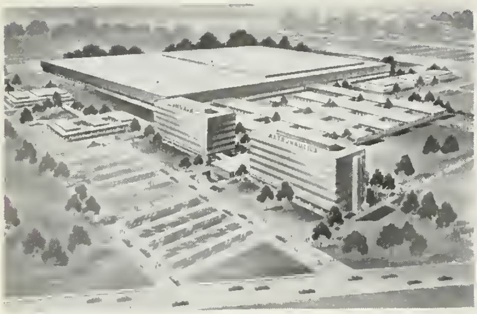
Optical tracking cameras for the IGY satellites are designed but none have been completed. The first is being constructed by the Astrophysical Observatory, Smithsonian Institute, with optics supplied by the Perkin-Elmer Corp. The 12 cameras to be built will photograph satellites as they pass "with meteor-like speed" in the words of Dr. K. Heinze of the Institute. Cameras will use Schmidt optics with a 30 inch field and Kodak Tri-X film. Both satellites and reference stars near them will be photographed.


1
2
3
4
5





## Here's the big "PLUS" for engineers...



*New $40,000,000 plant for Convair-Astronautics facility, soon to be completed.*

*New $300,000 Convair San Diego seaplane towing tank, first unit of complete hydrodynamics laboratory.*

*New $3,500,000 supersonic wind tunnel now under construction at Convair San Diego.*

*La Jolla Cove, one of many beauty spots within easy reach of San Diego.*

## the advanced projects and facilities, PLUS beautiful, year-round San Diego living

Tremendous projects at Convair San Diego include the F-102A Supersonic Interceptor, the Metropolitan 440 Airliner, the Convair 880 Jet-Liner, and a far-reaching study of nuclear aircraft. To aid engineers in these projects, big new facilities are being added to the already vast Convair San Diego plant. These include a huge installation for research, development, production and testing of the Atlas intercontinental ballistic missile, an elaborate new seaplane towing tank, and a new supersonic wind tunnel.

You'll find an ideal engineering "climate" at Convair San Diego – excellent salaries, comprehensive personal advantages, engineering policies to stimulate your professional growth, and a rewarding association with men who are outstanding in their engineering fields.

Add to all these the big "plus" of delightful living in sunny San Diego, where America's kindest all-year climate gives you and your family full enjoyment of beaches, mountains, desert resorts, Old Mexico, Hollywood, and many other fun possibilities. For the big "plus" in your future, send full resume to H. T. Brooks, Engineering Personnel, Dept. 2000

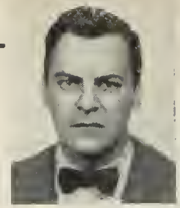
# C-V CONVAIR GD

A DIVISION OF GENERAL DYNAMICS CORPORATION

3302 PACIFIC HIGHWAY • SAN DIEGO, CALIFORNIA


New Plant for Callery Chemical Company for Producing High Energy Fuels
For the Military Today...
For Industry Tomorrow!
DESIGN and PROCUREMENT by
PARSONS
THE RALPH M. PARSONS COMPANY
NEW YORK
PASADENA
WASHINGTON
ENGINEERS • CONSTRUCTORS
LOS ANGELES
ANKARA
BAGHDAD
BEIRUT
JEDDAH
KARACHI
NEW DELHI
PARIS

# Aerophysics



**By Seabrook Hull**

The optimum solution to ICBM and IRBM reentry may lie in the use of plastics rather than exotic metals. NACA hypersonic test vehicle experiments have produced encouraging results. Of the two most promising organic groups being researched, epoxy resins have relatively high melting points, particularly with curing. Fluorinated plastics, already fully oxidized by fluorine, are chemically inert under the high temperature conditions of atmospheric reentry.

Both melt relatively slowly, due mainly to the fact that the thin fluid melt layer has a very slow heat transfer rate. Certain compounds in both groups sublime with profitably high specific heats. This not only facilitates reentry design but fits the concept of manned hypersonic vehicles entailing disposable parts. Laminating materials include tempered glass and quartz. Stainless steel, nickel-cobalt or molybdenum alloy screens might be used for structural backing.

The beauty of this approach to hyperthermantic flight is its dependence on well-known industrial techniques and readily available materials. And, importantly, it's cheap.

•

Time as an absolute standard is being challenged. Ephemerous time is based on there being 31,556,925.975 seconds in the year 1900; universal time, on there being 86,400 seconds in a day. The relationship of universal to ephemerous time is a standard that has never been seriously questioned, but on which all science is based. A 5-to-10 year experiment just now beginning, however, seeks to find if time as man has defined it is so standard after all. Like the solar system—corrected for Relativity, known variations, etc.—is consistant, so is the state of the atom. Both, reduced to absolute terms, bear an unchanging relationship—or so we have assumed these many years.

Current continuing measurements of the frequency of the cesium atom at Washington's Naval Observatory may, in a few years, prove this isn't so. If it does, Relativity limitations may become potentials; man's knowledge of his infinite environment may be grossly expanded and the rate of scientific progress accelerated exponentially.

If this seems remote, remember: It was Rutherford's work in the late 19th Century and Einstein's in 1905 that ultimately lead to man-made nuclear power during World War II.

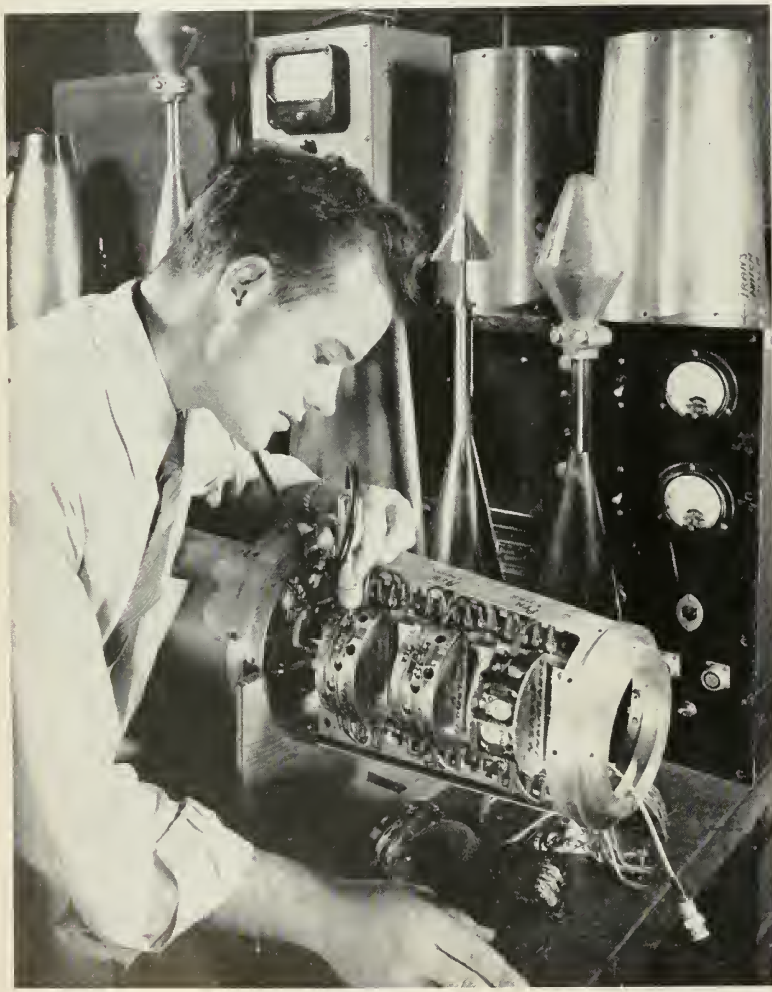
•

The practical nuclear rocket has been brought closer by a 12-man California University team under Prof. Luis W. Alvarez. Without the 100,000,000° temperatures now needed but with the same immense energy release, catalytic use of the negative mu meson "cold-fuses" heavy and light hydrogen into helium. Needed: A controllable production source of the scarce, short-lived mu meson. Outlook: Optimistic.

•

If anyone thinks ballistic missiles are "all-that-different" from military aircraft, the cost of research and development of "fool proof" guidance for long range missiles runs every bit as high as it does for the little black boxes in SAC bombers, interceptors, etc.

# SUBCONTRACTORS' GUIDE: Missile Electronics and Astrionics



**Like a doctor checking a patient,** this electronic specialist making careful adjustments to the telemetering brain of an NACA test missile symbolizes the critical importance of electronics and astrionics to the new age. In some major missile programs guidance development takes nearly two-thirds of the total project budget. The listing that starts to the right includes major U.S. companies doing missile work in the general fields of electronics and astrionics. Included are not only the names of the companies and their addresses but the names of their subcontracting officers as well. This is another *m/r* special service to its subscribers.

## CALIFORNIA

**Ampex Corporation**
Elton Bell, Purchasing Department
934 Charter Street
Redwood City, California

**Associated Missile Products Corporation**
Fred Henion, Manager, Procurement
2709 North Carey
Pomona, California

**Bendix Pacific Division**
Bendix Aviation Corporation
Robert N. Huntoon, Purchasing Department
11600 Sherman Way
North Hollywood, California

**Bill Jack Scientific Instrument Company**
Richard T. Johnson, Digitac, Inc.
420 S. Beverly Drive
Beverly Hills, California

**Coleman Engineering Company, Inc.**
E. J. Hannaman, Purchasing Department
6040 W. Jefferson Boulevard
Los Angeles 16, California

**Cubic Corporation**
2841 Canon Street
San Diego 6, California

**Donner Scientific Company**
L. T. Anderson, Purchasing Director
2829 Seventh Street
Berkeley 7, California

**Dynalysis Development Laboratory, Inc.**
Kenneth R. Jackson, President
11941 Wilshire Boulevard
Los Angeles 25, California

**Genisco, Incorporated**
G. F. Coyle, Purchasing Agent
2233 Federal Avenue
Los Angeles 64, California

**G. M. Giannini & Company, Inc.**
P. A. Coleson, Purchasing Department
918 E. Green Street
Pasadena, California

**Gilfillan Brothers**
1815 Venice Boulevard
Los Angeles, California

**Hallamore Electronics Company**
(Division of Siegler Corporation)
James E. Cravens, Purchasing Department
8352 Brookhurst Avenue
Anaheim, California

**Hoffman Laboratories Incorporated**
(Hoffman Electronics Corporation)
R. A. Gingrich, Purchasing Director
3761 S. Hill Street
Los Angeles 7, California

**Librascope Incorporated**
M. Cowan, Purchasing Agent
808 Western Avenue
Glendale, California

**North American Aviation, Inc.**
Rulon Nagely, Corporate Dir. of Material
International Airport
Los Angeles 45, California

**North American Aviation, Inc.**
Autonetics Division
S. D. Zemansky, Purchasing Agent
201 West Manville Street
Compton, California

**Pacific Scientific Company**
Pacific Scientific Aeroproducts
M. E. Hardigan, Purchasing Department
711 West Broadway
Glendale, California

**The Ramo-Wooldridge Corporation**
Mr. Fran Brown, Purchasing Agent
6245 West 98th Street
Los Angeles 45, California

**Raytheon Manufacturing Company**
Government Equipment Division
Robert T. Kiely, Purchasing Agent
Santa Barbara, California

Missile Systems Division
Fred H. Moore, Materials Manager
Pt. Mugu, Oxnard, California

**Ryan Aeronautical Company**
M. K. Smith, Outside Production
2701 Harbor Drive
San Diego 12, California

**Servomechanisms, Incorporated**
Western Division
Rezin H. Mathews, Purchasing Agent
12500 Aviation Boulevard
Hawthorne, California

Mechaponents Division
Oran J. Cunningham, Purchasing Agent
1000 El Segundo Boulevard
Hawthorne, California

**Summers Gyroscope Company**
A. A. Hartman, Purchasing Department
2328 Broadway
Santa Monica, California

**Dalmo Victor Company**
(Division of Textron Incorporated)
Ralph Brown, Purchasing Department
1515 Industrial Way
Belmont, California

**Telecomputing Corporation**
Vince Underwood, Purchasing Director
12838 Saticoy Street
North Hollywood, California

**Varian Associates**
H. Shutts, Purchasing Director
611 Hansen Way
Palo Alto, California

## CONNECTICUT

**Norden-Ketay Corporation**
Instrument and Systems Division
Joseph Payette, Purchasing Department
Wiley Street, Milford, Connecticut

**Perkin-Elmer Corporation**
W. Patrick O'Gorman, Purchasing Dept.
Main Avenue, Norwalk, Connecticut

## FLORIDA

**Radiation, Incorporated**
William Pierpont, Purchasing Director
P. O. Box 37, Melbourne, Florida

**Minneapolis-Honeywell Regulator Co.**
Aeronautical Division (Florida Plant)
Steven E. Puffer, Procurement Director
P. O. Box 760
Ulmerton Road and U. S. Highway 19
St. Petersburg, Florida

**Rich Electronics Incorporated**
G. F. Williams, Purchasing Department
212 N. W. 8th Avenue
Miami 36, Florida

## ILLINOIS

**Aero Electronics Company**
B. S. Maximoff, Purchasing Department
1512 N. Wells Street
Chicago 10, Illinois

**American Bosch Arma Corporation**
Chicago Division
E. B. Flood, Purchasing Manager
5555 Archer Avenue
Chicago 38, Illinois

**Cline Electric Manufacturing Company**
P. A. Benke, Purchasing Director
3405 W. 47th Street
Chicago, Illinois

**J. P. Seeburg, Corporation**
(Division of Fort Pitt Industries, Inc.)
Ernest M. Caswell, Contract Division
1010 Weed Street
Chicago 22, Illinois

## INDIANA

**Farnsworth Electronics Division**
(Division International T. & T. Corp.)
R. H. Hauser, Purchasing Director
3700 E. Pontiac Street
Fort Wayne, Indiana

## IOWA

**Collins Radio Company**
John Wagner, Purchasing Director
855 35th Street, N. E.
Cedar Rapids, Iowa

## MARYLAND

**Bendix Aviation Corporation**
Bendix Radio Division
E. A. White, Department 442
East Joppa Road
Towson 4, Maryland

**Hoover Electronics Company**
William H. Stiegler, Purchasing Agent
4003 Seven Mile Lane
Baltimore 7, Maryland

**Nems-Clarke, Incorporated**
O. E. Lanham, Purchasing Director
919 Jesup-Blair Drive
Silver Spring, Maryland

**Westinghouse Electric Corporation**
Electronics Division
D. R. Tashijian, Engineering Manager
2519 Wilkens Avenue
Baltimore 3, Maryland

## MASSACHUSETTS

**Baird-Atomic Incorporated**
Russell Mahan, Purchasing Director
33 University Road
Cambridge, Massachusetts

**CBS, Incorporated**
CBS-Hytron Division
100 Endicott Street
Danvers, Massachusetts

**Electronics Corporation of America**
H. F. McKenney, Vice President, Engrg.
1 Memorial Drive
Cambridge, Massachusetts

**Raytheon Manufacturing Company**
Paul B. Wilson, Director,
Planning & Procurement
Waltham 58, Massachusetts

Missile Systems Division
Bruce R. Brace, Purchasing Agent
Bedford, Massachusetts

Missile Systems Division
Thomas J. Flannery, Purchasing Agent
Lowell, Massachusetts

Government Equipment Division
George E. Larson, Purchasing Agent
Wayland, Massachusetts

Missile Systems Division
Francis H. Smith, Purchasing Agent
Lowell, Massachusetts

Government Equipment Division
Elmer G. Westlund, Purchasing Agent
Waltham, Massachusetts

**Sylvania Electric Products Incorporated**
Electronics Systems Division
J. H. Brewster, Director, Program Planning
100 First Avenue
Waltham, Massachusetts

**Ultrasonic Corporation**
W. Needre, Purchasing Director
640 Memorial Drive
Cambridge 39, Massachusetts

## MICHIGAN

**Abrams Instrument Corporation**
C. J. Arksey, Vice President, Sales
606 E. Shiawassee Street
Lansing 1, Michigan

**Burroughs Corporation**
Paul S. Mirabito, General Manager,
Defense Contracts Organization
6071 Second Avenue
Detroit 32, Michigan

## MINNESOTA

**General Mills, Incorporated**
Victor E. Benson, Supervisor,
Proposal & Contract Administration
Mechanical Division
2003 East Hennepin
Minneapolis 13, Minnesota

**Minneapolis-Honeywell Regulator Co.**
Aeronautical Division
W. Evert Welch, Procurement Director
2600 Ridgway
Minneapolis 13, Minnesota

**Remington Rand Univac**
(Division Sperry Rand Corporation)
C. J. Knorr, Vice President & Gen. Mgr.
1902 W. Minnehaha Avenue
St. Paul, W4, Minnesota

## NEW HAMPSHIRE

**Insuline Corporation of America**
H. Weston, Purchasing Agent
186 Granite Street
Manchester, New Hampshire

**Sanders Associates, Incorporated**
Chan Goldthwaite, Purchasing Department
95 Canal Street
Nashua, New Hampshire

## NEW JERSEY

**ACF Industries, Incorporated**
ACF Missiles Group
c/o Avion Division
W. W. Bingham, Purchasing Department
11 Park Place
Paramus, New Jersey

**Air Associates, Incorporated**
L. W. Willey, Purchasing Department
Teterboro Airport
Teterboro, New Jersey

**Bendix Aviation Corporation**
Eclipse-Pioneer Division
J. Quinn, Purchasing Department
Teterboro, New Jersey

**Allen B. du Mont Laboratories, Inc.**
C. P. Martin, Purchasing Director
760 Bloomfield Avenue
Clifton, New Jersey

**Kearfott Company, Incorporated**
C. F. Bartlam, Purchasing Director
Little Falls, New Jersey

**Radio Corporation of America**
Defense Electronic Products
W. F. Covert, Purchasing Agent
Building 8-9
Front and Cooper Streets
Camden 1, New Jersey

**Standard Electronic Corporation**
William Fillger, Purchasing Department
285 Emmet Street
Newark 5, New Jersey

**Stavid Engineering Company**
Route U. S. 22
Plainfield, New Jersey

## NEW YORK

**American Bosch Arma Corporation**
Arma Division
W. M. Maughan, Procurement Manager
Roosevelt Field
Garden City, New York

**Amperex Electronic Corporation**
Walter F. Sandberg, Purchasing Department
230 Duffy Avenue
Hicksville, L. I., New York

**Eastern Precision Resistor Corporation**
J. Bowdin, Purchasing Department
675 Barbey Street
Brooklyn 7, New York

**Ford Instrument Company**
(Division of Sperry Rand)
Charles Arcularius, Purchasing Department
31-10 Thomson Avenue
Long Island City 1, New York

**Fairchild Camera & Instrument Corp.**
Stephen Einig, Purchasing Department
Reconnaissance Systems Division
Robbins Lane, Syosset, L. I., New York

**General Electric Company**
Apparatus Sales Division
M. R. Johnson, Engineer Manager
1 River Road
Schenectady, New York

**General Electric Company**
Light Military Electronic Equipment Dept.
M. R. Johnson, Engineering Manager
French Road, Utica, New York

**General Precision Laboratory, Inc.**
W. P. Hilliard, Production Director
63 Bedford Road
Pleasantville, New York

**International Business Machines Corp.**
590 Madison Avenue
New York 22, New York

**Kollsman Instrument Corporation**
Herbert Mazarin, Manager, Subcontracting
80-08 45th Avenue
Elmhurst 73, New York

**The W. L. Maxson Corporation**
J. E. Caddle, Procurement Manager
475 Tenth Avenue
New York 18, New York

**The Narda Corporation**
E. H. Godfrey, Contract Manager
160 Herricks Road
Mineola, New York

**Polarad Electronics Corporation**
L. J. Lieberman, Purchasing Director
43-20 34th Street
Long Island City 1, New York

**Servo Corporation of America**
Robert O. Baxter, Purchasing Department
20-20 Jericho Turnpike
New Hyde Park, New York

**Servomechanisms, Incorporated**
Eastern Division
Garyn H. Hunter, Purchasing Agent
Post & Stewart Avenue
Westbury, L. I., New York

Mechatrol Division
Bernard N. Gordy, Purchasing Agent
625 Main Street
Westbury, L. I., New York

**Sperry Gyroscope Company**
(Division Sperry Rand)
Microwave Electronics Division
G. C. Hees, Chief Buyer
Great Neck, L. I., New York

**Telectro Industries Corporation**
Stanley Rosenberg, General Manager
35-16 37th Street
Long Island City 1, New York

## OHIO

**Aeronca Manufacturing Corporation**
H. C. Pettit, Director, Field Service Dept.
1712 Germantown Road
Middletown, Ohio

**Avco Manufacturing Corporation**
Crosley Division
Avco Defense & Industrial Products
Harold Brouse, Products Director
1329 Arlington Street
Cincinnati 25, Ohio

**Goodyear Aircraft Corporation**
(Goodyear Tire & Rubber Company)
H. A. Delaney, Purchasing Agent
1210 Massillon Road
Akron 15, Ohio

**Wacline, Incorporated**
R. G. Swanson, Purchasing Agent
35 S. St Clair Street
Dayton 2, Ohio

## PENNSYLVANIA

**Bliley Electric Company**
Union Station Building
Erie, Pennsylvania

**Clifton Precision Products Company, Inc.**
Sabine L. Baring-Gould, Liaison Engineer
Marple at Broadway
Clifton Heights, Pennsylvania

**General Electric Company**
Missile & Ordnance Systems Department
John P. Benzie, Purchasing Agent
Kenneth N. Thompson, Subcontractor
3198 Chestnut Street
Philadelphia 4, Pennsylvania

**Raymond & Rosen Engineering Products, Inc.**
Telemetering Division
32nd and Walnut Streets
Philadelphia, Pennsylvania

**Westinghouse Electric Corporation**
Defense Products Division
R. M. Wilson, Sales Manager
3 Gateway Center
P. O. Box 2278
Pittsburgh 30, Pa.

## TENNESSEE

**Raytheon Manufacturing Company**
Missile Systems Division
Theodore L. Sheldon, Purchasing Agent
Bristol, Tennessee

## WASHINGTON

**United Control Corporation**
Martin K. Lilheberg, Purchasing Director
4540 Union Bay Place
Seattle 5, Washington

## WEST VIRGINIA

**G. C. Wilson & Company**
G. C. Wilson, President
1915 8th Avenue
Huntington, West Virginia

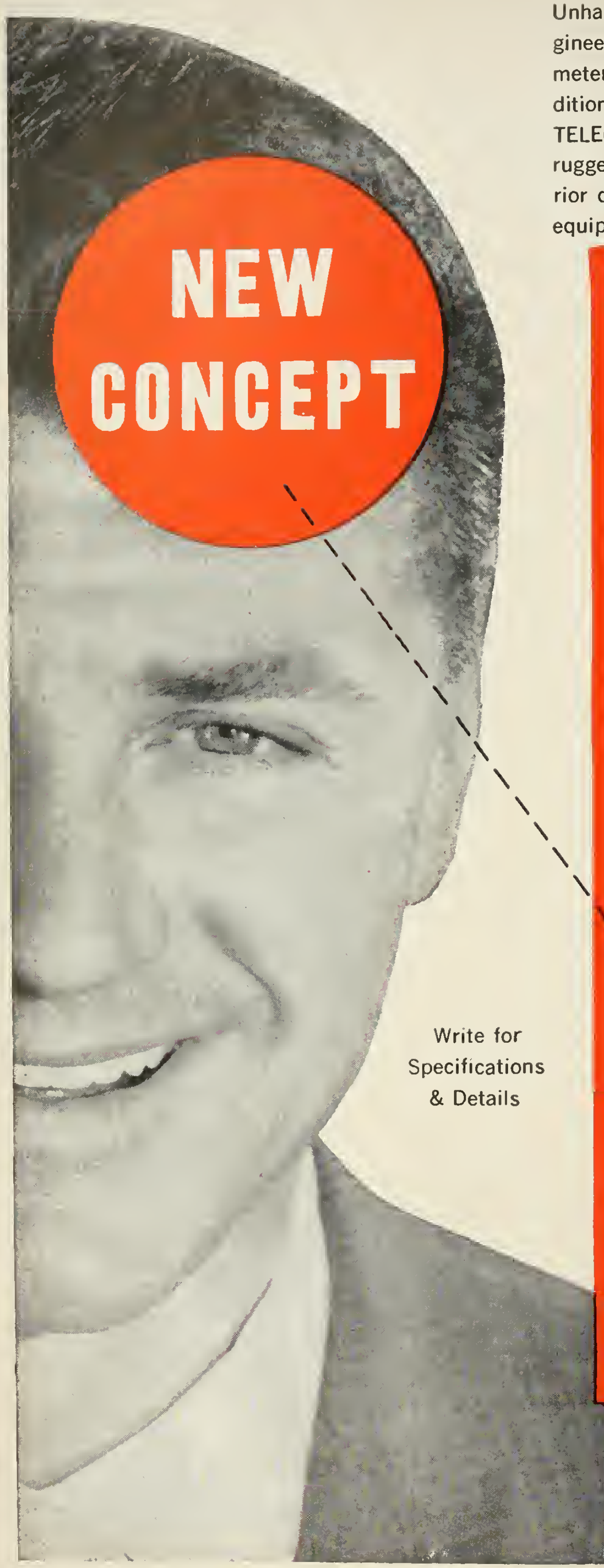
## WASHINGTON, D. C.

**James S. Spivey, Incorporated**
C. K. Vanderslice, Purchasing Department
4908 Hampden Lane
Washington 14, D. C.

## WISCONSIN

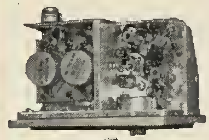
**John Oster Manufacturing Company**
Avionics Division
1 N. Main Street
Racine, Wisconsin

**In a future issue m/r will publish a subcontractors' guide to manufacturers of launching gear & other missile components**

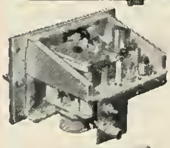



Unhampered by traditional thinking, TELECHROME engineers have developed an entirely new concept in telemetering equipment. Today's new environmental conditions and distances for missiles require new designs. TELECHROME units are unequalled in compactness, ruggedness* and dependability. Because of their superior qualities these highly efficient units are replacing equipment of other manufacture.

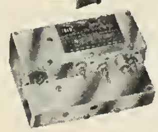
**Direct FM Transmitters Crystal controlled 215-235 megacycles. 125kc deviation.**



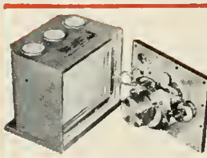
**Model 1462—6" x 4¼" x 3¾"**
**50 to 80 Watts**



**Model 1463—5 19/32" x 3 13/16" x 4"**
**15 to 30 Watts**



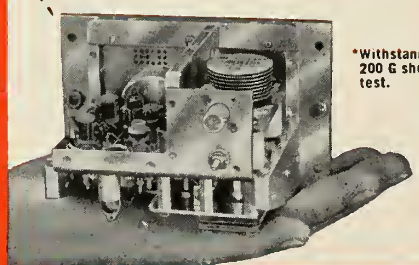
**Model 1472—4" x 1.5" x 2.7"**
**2 Watts**



**Model 1460—5" x 4⅝" x 3 15/16"**
**RF Amplifier**
**15 to 30 Watts**

**Model 800—4.5" x 1.3" x 1.4"**

**SUB-CARRIER OSCILLATOR.** Deviation stability ±1% of band width. Deviation linearity less than 1% of band width under all conditions measured from a straight line drawn between end points.



*Withstands 200 G shock test.

Write for Specifications & Details

## TELEMETERING TRANSMITTERS
## HIGH POWER IN SMALL PACKAGES

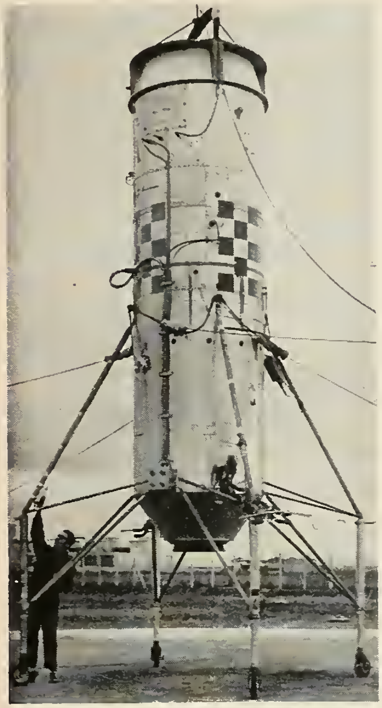
**TELECHROME** INCORPORATED

*The Nation's Leading Supplier of Color TV Equipment*

**28 RANICK DRIVE**
**AMITYVILLE, N. Y.**
**LIncoln 1-3600**

Circle No. 13 on Subscriber Service Card.

# French Coleopter Missiles Underway

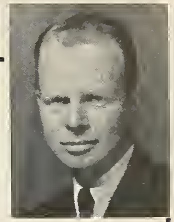


Missile derivations are planned for SNECMA's "Flying Atar" VTOL test vehicle. Shown above is the original P1 version of the French device. To date it has made some 200 takeoffs and landings. A piloted version, the P2, is ready for its test program while a more refined version, the P3, with a full cockpit with a rotating seat will be the next step.

From the P3 SNECMA will build an experimental aircraft with an annular wing, the C 450. This coleopter will be subsonic. It will make vertical takeoffs and landings but will fly like a conventional aircraft. Subsequently SNECMA will build a coleopter with a ramjet as well as an afterburner-equipped Atar turbojet. The ramjet will be installed in the space between the jet engine and the annular wing.

Eventually the "Flying Atar" will be developed into a Mach 3 vehicle, either in the form of a missile or a piloted aircraft. In five to ten years SNECMA can envisage civil applications of the formula. The most important use for the coleopter type of vehicle, however, is likely to be military in view of its small size and outstanding performance.

# World Astronautics



**By Frederick C. Durant III**

Outside of the U.S. only two countries have reported work on three-stage rocket vehicles. One of these was the Japanese *Kappa* rocket program, (m/r October 1955). The other rocket, a French one, is known as the *Monique*. The program has been under way for more than a year but little information has yet been released. Use of staged rockets introduces the designer to problems of clean separation and smooth ignition at space-equivalent conditions.

Japan's initial series of rocket tests in preparation for the IGY came to a successful conclusion in December with the launching of the seventh Kappa 128-JT at Michikawa. The test program is expected to be resumed in March when a double Kappa rocket will be launched.

•

British physicist Arthur C. Clarke is known equally well for his writings in science (EXPLORATION OF SPACE) and science-fiction (THE CITY AND THE STARS). Completing a five months' lecture tour of the U.S. he met with key individuals of Project *Vanguard* at the Naval Research Laboratory and Martin, Baltimore. In addition, he talked with those at The National Academy of Sciences and The National Science Foundation concerned with the overall U.S. program for IGY satellite vehicles. First hand impressions gained will end up in a forthcoming book on satellite vehicles to be published this fall by Harper and Brothers. The tentative title is THE MAKING OF A MOON.

•

On New Year's Day, Dr. J. Allen Hynek, Associate Director of the SAO, left for a month's tour of South America to follow up preparations for the official optical tracking program and to evaluate the interest in volunteer observing teams. First stop on his trip is Buenos Aires, where Hynek will meet with the Argentine IGY Committee Chairman and Professor T. M. Tabanera.

•

Einstein's Restricted Theory of Relativity (1905) contained one theorem entitled "The Behaviors of Measuring Rods and Clocks in Motion." Interpretation of this theorem has led to periodic controversy. The question is if a "clock" moving at near-light speeds would keep slower time than a "clock" which, relatively, is stationary. At the Seventh Congress of the International Astronautical Federation at Rome last September there was speculation on human aging rates under the same relative conditions. Kurt R. Stehling has a neat, witty summary of articles on the matter in the January issue of the ARS JET PROPULSION. Prominent scientists take contradictory stands. The ability to hurl sub-atomic particles at near-light speeds may provide data to settle this intriguing paradox once and for all—in any event, probably before any future generations have to test the time dilation effect in manned space vehicles.

•

Eighth Annual Congress of the International Astronautical Federation will be held at Barcelona, Spain, October 6-12, 1957. A focal point for technical papers and discussion on rocket and astronautical subjects, with representatives of twenty-one countries, the size of the Congresses has grown rapidly. More than 70 U.S. visitors and delegates were present at Rome. With the advent of the IGY and the anticipated *Vanguard* launchings this year, the Barcelona Congress is expected to be an outstanding event. A brochure describing the history and aims of the IAF is available upon request to: IAF, 35 Lowell Road, Concord, Mass.

# European Rocket Engineers in Argentine Astronautics

By Frederick C. Durant, III

SOUTH OF THE equator the world center of astronautical interest is in Buenos Aires, Argentina. There, the Asociacion Argentina Interplanetaria (AAI) has achieved national recognition for its many diverse activities.

Right now, the AAI is busy preparing for the optical tracking of the U.S. satellites. During the Seventh Congress of the IAF held at Rome last September (M/R October 1956) Professor Fred L. Whipple, director of the optical tracking program for the U.S. satellites outlined the need for volunteer tracking teams. The AAI was one of those IAF Members interested in the problem.

Founder and energetic President of the AAI is Prof. Teofilo M. Tabanera. In 1930, as a young mechanical engineer, Tabanera wrote his first article on the possibilities of space flight. Eventually, in 1948, he organized a study group including: Ing. Felipe Reca, Sr. Francisco von Proschek, Sr. Carlos Krotsch, Sr. Juan Lazlo, Ing. Jose Ovidio Martinez, Ing. Rodolfo Martinez de Vedia, Sr. Juan Landajo, Sra. Herminia Balado, and Sr. Arturo Loeffler.

Asociacion Argentina Interplanetaria President and astronautics pioneer PROFESSOR TEOFILO M. TABANERA., well-known IAF personality.

Austrian-born von Proschek has been an electrical engineering specialist with the Buenos Aires branch of the Siemens-Halske, AG, for twenty-five years. Krotsch and Lazlo are both of Austrian descent. They are electrical engineers each with more than 20 years experience with the Siemens organization. Martinez has a mechanical and electrical engineering background and is a consultant for the petroleum industry and is president of the South American Petroleum Institute. Martinez de Vedia has been a professor of mechanical engineering at La Plata University for nearly twenty years.

Also included in AAI membership are: Dr. Otto Waltz and Ing. Ricardo V. Dyrgalla. The latter, a current AAI director, who received his science degree from the University of Danzig before the war, served as an RAF fighter pilot and later as scientific officer at the RAE, finally emigrating to Argentina in 1947. In 1948 he designed and tested the first Argentina liquid propellant rocket motor. Dr. Otto Waltz, a former German, at one time designed V-2 fuel pumps for H. Walther at Kiel. Near the end of the war he developed rockets at the Schmidding works. He is now technical advisor to the D.G.N.F.M. (General Bureau of Military Production).

The Sociedad Argentina Interplanetaria was officially established in 1951, later changing to the present title.

Growth of the AAI passed the 600 membership mark in 1956. About one-third are professional people, university graduates; one-third, technicians and specialists; and one-third, university and technical students. It is interesting that the U.S. Earth Satellite Program has had little effect upon the rate of growth. The battle for acceptance of astronautics as a legitimate science had already been won in Argentina.

### German Scientists Help

Of no small help were the dozens of German scientists and engineers who emigrated to Argentina after World War II. Some of these men had played a part in World War II German rocket developments. Many are now employed by the Argentine aeronautical industry and the Institute of Scientific Research of the Armed Forces.

AAI activities during the past few years have been varied. In Argentina defense requirements rocket research are small. Interest in astronautics is, therefore, self-generated.

Papers have been presented on subjects ranging from "sounding rocket research," "electronics requirements of rockets," "interplanetary navigation" and "uses of plastics in astronautics" to "legal aspects of artificial satellites" and "space medical research." Dr. Aldo Armando Cocca, recently a delegate to the Legal Committee, ICAO meeting in Montreal, is one of the small group of lawyers who have in recent years given careful consideration to "space law."

The works of Drs. H. J. A. von Beckh and Heinz von Diringshofen of the National Institute of Aeronautical Medicine in Buenos Aires have been reported in the Journal of Aviation Medicine in the U.S. Papers by Cocca, von Beckh have been presented in behalf of the AAI at the annual congresses of the International Astronautical Federation in Europe.

The AAI has conducted two six-month astronautics courses, basic and advanced, for the past two years. Under the direction of Dr. Otto Waltz and Ing. Ricardo Dyrgalla a small group of younger members of the AAI have calculated, designed and constructed a liquid propellant micro-rocket motor.

In October 1955 the AAI held an exhibition which drew an attendance of more than 80,000 in its twenty days' run. Exhibits of models, photographs, charts explaining astronautics and the AAI micro-rocket set-up were displayed. Plans have now been made with the Argentine Government to set up an AAI-administered planetarium.

A 36-page review of activities and short articles is published quarterly. An astronautical library is maintained at secretarial headquarters. From time to time the AAI holds special meetings or social functions. An example of these was the overnight trip to the I.A.M.E. factory and the reaction motor proving grounds at Jose de la Quintana, Cordoba.

The AAI played a significant role in stimulating interest which resulted in the establishment of the Astronautics

This conception of an earth satellite was on display at the October 1955 AAI exhibition in Argentina which drew an attendance of 80,000. Note the arrangement of antennae.

# MISSILE METAL MACHINING

. . . a guided missile component being machined at Diversey Engineering. Another of the many missile hardware parts involving intricate and difficult machining techniques. Diversey Engineering makes these and many other missile and jet hardware parts. Some of these parts are midsections, accumulators, bulkheads, rings, cones, and nozzles.

Have your work done at Diversey Engineering by skilled machinists who use the finest and newest equipment, one of which is the very latest 48" Monarch Air Gage Tracer Lathe. Nowhere else can you get such extensive facilities and experienced machinists for contour machining of Titanium, Inconel, A-286, Haynes Stellite, and Zirconium.

Write or phone for information regarding your designs and blueprints.

LEADERS IN CONTOUR MACHINING

**Diversey ENGINEERING COMPANY**

10257 FRANKLIN AVENUE • GLADSTONE 5-4737
FRANKLIN PARK, ILLINOIS • *A Suburb of Chicago*

**FROM NOSE TO NOZZLE, FROM FIN TO FIN, CONTOUR TURNED PARTS—WITH PRECISION BUILT IN**



Circle No. 4 on Subscriber Service Card.

Center at the National University of Cuyo, Mendoza. Founded in 1953 by the Rector of the University, Dr. I. Fernando Cruz, in the Department of Scientific Research, it is believed that this was the first formal recognition of astronautics by a university. Directorship of the Astronautics Center was offered originally to Austrian-born Dr. Ing. Eugen Säenger and his wife Dr. Irene Säenger-Bredt.

The Säengers, widely known in rocket and astronautical circles, were at this time working for the French defense department near Paris. Säenger was formerly director of the German Luftwaffe rocket center at Trauen. Known especially for his technical works including *Raketenflugtechnik*, Säenger and his mathematician wife developed the preliminary design study for the globe-circling rocket bomber.

Unfortunately for the Institute, difficulties prevented the travel of the Säengers to Argentina. The first director was the well known Dr. Ing. Walter Georgii, a close friend of the Säengers.

When Dr. Georgii took over the directorship of the Astronautics Center there were five other Argentine academic institutions with astronautics research interests. They were: Institute of Nuclear Physics, Aerophysics Institute, Mathematics Center, Faculty of Medical Science Tomas Peron, all in Mendoza; and Astronomical Observatory Felix Aquilar, in San Juan.

Professor Georgii's efforts were directed towards a program of upper atmosphere research consisting of a sounding rocket program limited to a modest 60 km. The sudden death in 1954 of the founder, Dean Cruz, and the subsequent departure of Dr. Georgii from Argentina has resulted in the activities of the Astronautics Center virtually ceasing for the moment.

Further IGY activities of AAI include: translation of the MOONWATCH Bulletins for distribution to Spanish-speaking astronomers and IAF Member Societies. This assistance was welcomed. The MOONWATCH Bulletins are published by the Smithsonian Astrophysical Observatory, Cambridge, Mass., for the guidance of trackers.

Early in January Dr. J. Allen Hynek, Associate Director of the Smithsonian Observatory will meet with Tabanera in Buenos Aires to discuss progress. Professor Hynek, of the Ohio State University astronomy department, is on leave to aid Professor Whipple in the IGY optical tracking program.

The AAI is cooperating with the Asociacion Amigos de la Astronomia in organizing volunteer tracking teams. It is expected that at least three groups will be established in Argentina—in Buenos Aires, Rosario and Cordoba ★

# International Scene

By Anthony Vandyk

Low price was the prime reason why Japan ordered 200 *Airone* proximity-fused rockets from an Italian company, Polverifici Stacchini of Rome. The *Airone* uses solid fuel and is reported to have a range of 6,500 ft. The Japanese Air Force will test fire the *Airone* rockets from F-86F fighters. Polverifici Stacchini is working on a guided version of the *Airone* to be submitted to the Italian Air Force for evaluation.

•

Vickers-Armstrongs' air-to-air missile has been cancelled by the British government and, as a consequence, the British firm's Australian subsidiary has scheduled the closing down of its guided weapons division. The cancellation was decided because the missile was deemed too complicated and ambitious. Another company is to supply a cheaper and less complex weapon in place of the VA missile.

•

On the lonely rocky Mediterranean island of Sardinia Whitehead-Motofides has been testing its new *A.R.15* liquid-fuel auto-feed rocket. The Italian company, with its headquarters in Leghorn, is understood to have developed the *A.R.15* as an intermediate test vehicle as part of a program to develop a larger, fully guided ground-to-air missile.

•

"Fissile Missile" is the nickname used in the British press for the ICBM with H-bomb warhead under development by the British industry. Main headquarters for work on the British ICBM are at the Royal Aircraft Establishment. The work is under the direction of the Ministry of Supply's Ballistic Missile Division which is headed by 40-year-old Denis Lyons.

•

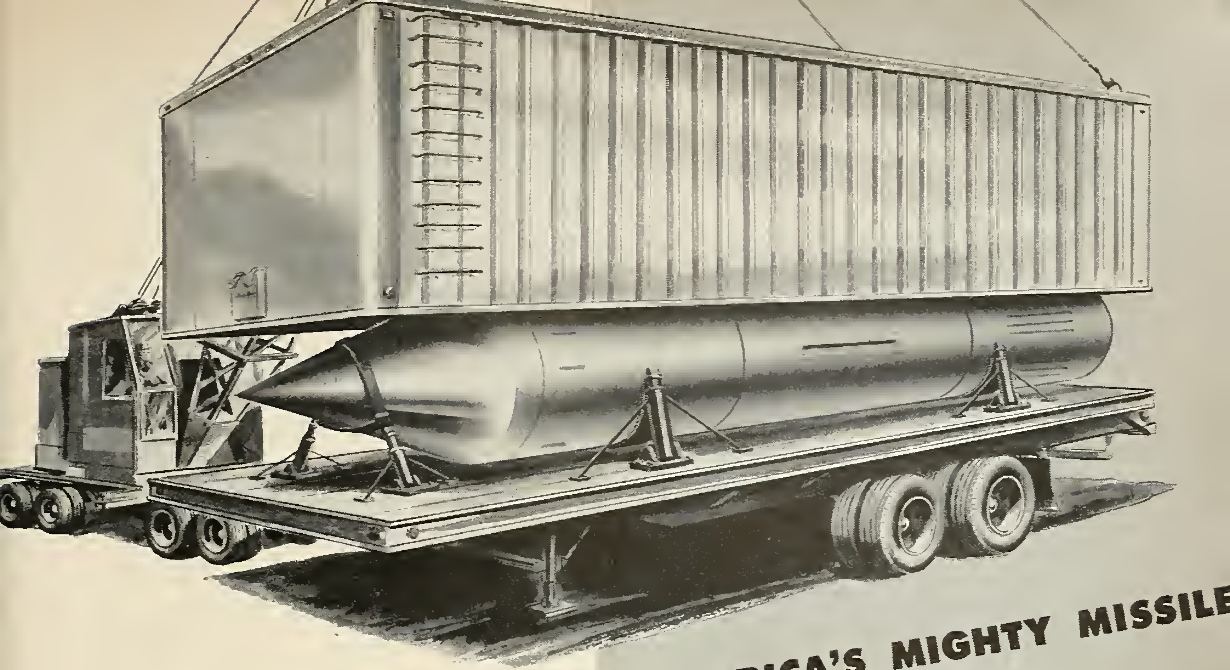
Many European companies are performing research work in the missile field under USAF contracts. One such contract has been awarded to Italy's Centro Italiano per la Propulsione a Reazione, located in Turin. It is understood that the Centro has been asked to develop a missile in the *Sidewinder* category with infra-red guidance.

•

It seems that it may be some long time before Fairey Aviation will be able to mention anything other than the air-to-air *Fireflash* in discussing its missile activities. Board Chairman Roland T. Oulton recently told stockholders that the new projects under way in the firm's Guided Weapons Division are "of long-term nature, due to their complexity." He reported that interest has been shown in the *Fireflash* by NATO countries.

•

The French Navy is becoming very missile conscious. Its 1957 budget provides for the conversion of the transport, Ile d'Oleron, into an experimental missile-launching ship. The 1958 budget will include a 5,000-ton missile-equipped cruiser as well as a 30,000-ton aircraft carrier. The French Navy is putting a lot of faith, and money, into the Breguet 1050 Dart-powered anti-submarine aircraft which is equipped with missiles. Fifty have been ordered under the 1956 budget, 25 in 1957 and a further 25 in 1958.



# INDUSTRY SPOTLIGHT

By Joseph S. Murphy

***NICKEL FORECAST:***

## Four More Years of Shortage

Recent decision by The International Nickel Co. of Canada to boost its annual nickel output by some 65,000 tons starting in 1960 should provc welcome news to aircraft, missile and rocket builders.

But before this new found supply becomes a reality, industry can look to a continuing shortage, possibly lasting through 1960, according to market consultant Henry D. Lytton.

Demands for nickel-bearing stainless steels and jet engine super-alloys continued unabated throughout 1956. Future needs for these same metals, plus those of K-Monel and nickel-cobalt alloys being developed to beat the heat problem in supersonic aircraft and missiles, have introduced an unknown quantity into the nickel supply picture.

According to the Lytton report, the true nickel shortage last year was larger than apparent in consumption trends. As a result, stainless steel scrap prices, particularly those of nickel-bearing 18-8 stainless, rode the crest of the shortage and soared as much as 45% between January and the year end.

If 1956 supplies had been adequate, the former government metals specialist adds, steel production alone could have used more than 77,000 tons of newly-mined nickel in meeting present demands and regaining all markets lost during the past 10 years of intermittent shortages. Another 88,000 tons usable by industry pegged the 1956 need at 165,000 tons, before allowances for any government stockpiling.

Against this need stood a late-year Commerce Dept. forecast of 150,000 tons supply in 1956 and 162,500 tons this year.

And just how influential aircraft and missile industry needs may be in shaping the future nickel supply situation is borne out in Lytton's analysis of 1965 demands.

Steel industry, he estimates, will require an additional 12,000 tons and non-steel nickel markets another 10,500 tons, placing minimum 1965 demands 22,500 tons above the 165,000 tons that could have been used in 1956.

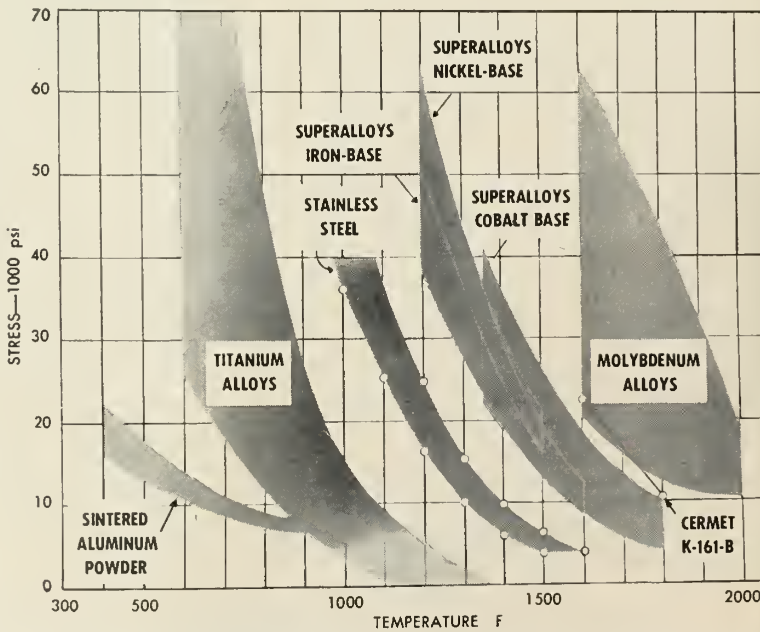
However, the analysis took into account present-day needs of some 12,000 tons of nickel in super-alloy stainless steels for jet engines, but made no provision for expanded civil and military jet needs or those for supersonic and hypersonic aircraft and missile.

Assuming that the first-half 1956 rate of jet engine super-alloy production were to increase four-fold in the next 10 years, says Lytton, total demand for nickel immediately would approximate Office of Defense Mobilization's 220,000-ton goal.

On the world-wide nickel production scene, according to Inco president Henry S. Wingate, the company's plan for increased production coupled with that of other industry sources should bring 1960 nickel output between 300,000 and 312,500 tons. This would represent a jump of about 82,500 to 100,000 tons over 1955's total output of 213,500.

Inco's expansion, involving two new mines in the Mystery-Moak Lakes area of Northern Manitoba, is a $175,000,000 project. When in operation, it will constitute the second largest nickel-producing operation in the world—the largest being the company's present operation in the Sudbury District of Ontario, Canada.

The Manitoba activity, plus programmed output from Sudbury, will raise Inco's 1955 nickel production about 50%, or by approximately 130,000,000 pounds to 385,000,000 pounds. Of this, some 24,000,000 pounds will be regular production to replace present temporary premium-priced production for the U.S. government stockpile, and




Key role of nickel in development of high speed aircraft and missile structures is evident in these 1,000-hr. stress vs. temperature curves. It extends from present use in nickel-bearing stainless, through the nickel cobalt group.

the balance of 106,000,000 will represent at net increase in total capacity for industry consumption.

The Lytton report, issued prior to the Inco decision, traces nickel consumption over the past 45 years and forecasts demands over the next ten years. Copies of the 81-page document along with a 20-page analysis of 1956 nickel demand are available from Henry D. Lytton, 1326 27th St., Washington 7, D.C., at $10.00.

## North American Aviation Surveys Midwest

North American Aviation's Rocketdyne division is making a detailed survey in midwestern states to determine new vendor sources for its Neosho, Mo. plant. H. H. Vaughn, superintendent of manufacturing; R. L. Radford, supervisor of purchasing, outside production, and N. G. Irvin, inspection, form a team currently visiting vendor sources checking capabilities of vendors to produce the intricate valves required at Neosho. Initial valve requirements have been placed with present Rocketdyne suppliers in California. Several other vendor surveys are just now being gotten under way.

## Renegotiation Decisions Hit Three Missile Firms

Douglas Aircraft Co. in December became the third major aircraft and missile producer to be judged on the receiving end of excess profits.

The Southern California regional Renegotiation Board recommended that profits of the *Nike* and *Honest John* producer be ruled excessive in the gross amount of $9 million for fiscal year 1953. If upheld by the Renegotiation Board in Washington, this would indicate a possible net refund to the government of $2,240,000.

Company president Donald W. Douglas said the company was not yet informed fully of the basis for the regional recommendation, but maintained that proper consideration of all facts would show its profits were not excessive.

In November, North American Aviation, Inc. was notified by a regional board that its 1953 profits were considered excessive in the amount of $6 million. Allowance for state and federal taxes for this amount would entail a refund of $1.3 million, if upheld.

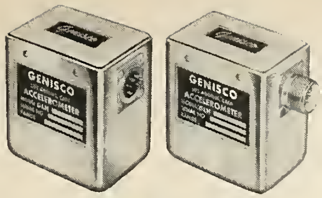
The third producer, Boeing Airplane Co., is still contesting a decision of the Renegotiation Board that its 1952 profits were $10 million in excess. Boeing comptroller Clyde Skeen, in a recent address, urged that Congress undertake a comprehensive review of current administration of the Renegotiation Act.

Skeen contended that the trend of present administration of the statutory Renegotiation Board, if it continues, will destroy industry incentive and result in less defense per dollar. He noted that if it is Congress' intent to arbitrarily restrict profits, this can be accomplished much more simply than by the complex, time-consuming and expensive process of renegotiation.

## Titanium Production Up Sharply This Year

Production of mill products by the titanium industry almost tripled its 1955 volume last year and will more than double its 1956 output this year, according to T. W. Lippert, Titanium Metals Corp. of America.

The TMC sales manager estimates output of finished mill shapes totaled 10.6 million lbs. in 1956 compared to




## Model GLH

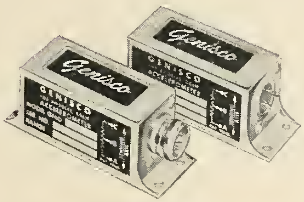
A rugged magnetically damped instrument with low natural frequencies for low range. High-quantity production assures good price and delivery schedules. Available in ranges from ±1 G to ±30 G.


## Model DDL

Magnetically damped low-range instrument available in ranges from ±1 G to ±30 G. Ultra-sensitive models supplied as low as ±0.1 G. Certified to MIL-E-5400 and MIL-E-5272A. Especially good in severe shock and vibration applications. An acceleration-sensitive switch version of the DDL is designated as the Model DDS.


## Model GAL

Incorporates a variable transformer a-c output with the magnetically damped sensory mechanism of the proven Models DDL and GLH. Superior reliability, life, resolution, and sensitivity. Available in ranges from ±1 G to ±30 G. Range as low as ±0.1 G also obtainable.

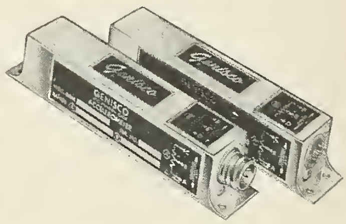



## Model GMO

A rugged, miniature, viscous-damped instrument with ranges from ±2 G to ±30 G. Unbalanced-range instruments also available. Medium high natural frequencies.


## Model GMT

Basically a Model GMO with internal thermostat-operated heater, assuring maximum environmental stability within the instrument. Damping remains constant with change in ambient temperature.



## Model GDM

Miniature double-potentiometer instrument capable of sensing lateral acceleration in two mutually perpendicular planes (e.g., pitch and yaw). Ideally suited for missile and high-speed aircraft flight control systems.

# NEW! GENISCO ACCELEROMETERS NOW GOLD PLATED FOR GREATER RELIABILITY

**CASES GOLD PLATED INSIDE AND OUT**—This new trend in instrument plating has two important advantages over tin plating or fusing. Being the least active metal, gold prevents the formation of crystalline "whiskers" inside the case which could reduce performance and even cause malfunction. Gold plating also assures positive protection against corrosion to the exterior of the case and, because of its excellent solderability, makes possible a more reliable hermetic seal. The new gold plating is available on *all* models at *no extra cost.*

*Descriptive data sheets available on all models.*
*Please send request on company letterhead.*

Genisco
INCORPORATED

2233 Federal Avenue
Los Angeles 64, California

Circle No. 18 on Subscriber Service Card.

3.8 million in 1955. This year the figure will rise to about 23 million pounds, he said.

Meanwhile, titanium sponge dropped in cost to $2.75 a pound from $3.45 a year ago and $5.00 in 1954.

## Convair Gets $29 Million Contract for *Terrier*

Navy has awarded Convair-Pomona division a $29 million contract to produce guidance and control units for *Terrier* missiles. The Navy also confirmed that Convair has entered production with a new version of the antiaircraft missile.

The improved *Terrier* entered production September 1, about two months before phase-out of the original version. The new *Terrier* is basically the same missile with revised engineering features to increase its producibility.

The Convair supersonic surface-to-air missile is now fitted on the cruisers *Canberra* and *Boston* as well as the destroyer *Gyatt*. According to Bureau of Ordnance chief RAdm. F. S. Withington, Navy plans its use on many other destroyer vessel types.

## Martin Sees $300 Million In Sales for 1956

Final sales figure at The Glenn L. Martin Co. for the year 1956 is expected to top $300 million, up more than 8% from $272 million in 1955, according to Martin secretary-treasurer W. L. Lucas.

The Baltimore firm, engaged in three major missile projects (*Matador, Lacrosse* and *Titan*) plus the *Vanguard* satellite, also experienced an increase over its backlog of $660 million a year ago.

Missile business at Martin is now almost equal its total volume in aircraft contracts, with the combined missile and aircraft orders representing about 90% of its backlog.

## AF to Spend $25 Million For ICBM Training Center

USAF plans to spend about $25 million this fiscal year to modernize and enlarge its first ballistic missile training center, according to Maj. Gen. B. A. Schriever, Western Development Division commander.

With top-level Defense Dept. approval, USAF has taken over Army's Camp Cooke at Lampoc, Calif. and expects the center to be fully operational in about six months.

Design contract to draw up plans has been awarded to Holmes and Narver, Los Angeles architects.

## Navy Reorders *Regulus*, Boosts Chance Vought Backlog by $26 Million

New Navy orders for *Regulus I* and *Regulus II* missiles amounting to $26 million have hiked total backlog for that service with Chance Vought Aircraft to more than $500 million.

It marked Navy's second order for *Regulus II, a* previous $12 million contract coming in July 1956. Navy also confirmed that the new *Regulus* is supersonic, although no further details were released.

*Regulus II* is fitted with Wright J65 on first eight pre-production models, but will use General Electric J79 in remainder. *Regulus I*, which is subsonic, is powered by Allison J33.

## *Bomarc* Mass Order Believed Near

An Air Force order for large quantity production of the supersonic ramjet-powered Boeing *Bomarc* missile is expected this month. The AF move is anticipated in the light of successful firings against B-17 drones at Patrick AFB Missile Test Center following several months of advanced testing.

Also pointing to an early order was the increased activity at Boeing in recent months to select a final site for *Bomarc* production. On November 7 the Seattle firm took option on the Ford Motor Co. plant at Richmond, Calif. and only a month later optioned additional land in San Ramon Valley near Parks AFB.

Although neither option has been exercised, Boeing plan is to establish the new facility as an integrated pilotless interceptor production and assembly plant should the site be selected.

## Aerojet Sales Increase 100% Over 1955

Total 1956 sales of Aerojet-General Corp., subsidiary of General Tire & Rubber Co., are expected to reach $140 million, up 100% over 1955, company officials estimate. However, net profit after taxes will rise only 50% over last year as the result of increased activity in cost-plus type development contracts.

Sharp increase in sales was credited to Defense awards to Aerojet's liquid rocket plant at Sacramento, Calif. An even sharper rise in sales is predicted for 1957 resulting from development of the AGN 201 nucleonic reactor by Aerojet's new subsidiary. Aerojet-General Nucleonics Corp.

# Industry Highlights

**By Fred S. Hunter**

Grand Central Rocket Co. is preparing to set up a new rocket engine test facility at a remote location about 15 miles from its Redlands plant. Grand Central picked this particular 1000-acre site because it is part of a large holding originally acquired under a Spanish land grant and still intact. The owners agreed to maintain a two mile buffer zone as a provision of the lease.

The new unit will supplement a six-stand test facility Grand Central now operates in the foothills back of the Redlands plant. Structurally, one of these stands can test rocket engines up to 1,000,000 pounds thrust and two others 500,000 pounds. But Grand Central's plans not to exceed the 100,000-pound thrust level in any firings at the factory site but to go to the country with bigger stuff. Grand Central is on good terms with the folk around Redlands and aims to stay that way.

•

Having phased out on production on the Sperry *Sparrow I*, Douglas now has the *Sparrow III*, on which it is the prime contractor, but this version of the Navy air-to-air missile has not been ordered into production. The Douglas contribution to the Raytheon *Sparrow II* was strictly R and D. It developed the missile airframe, but is not participating in its production. *Sparrow III* guidance is Bendix Pacific.

•

Dan Kimball, president of Aerojet-General Corp., would appreciate it if the government would establish a post office named Aerojet at the location of the company's growing rocket engine plant 15 miles east of Sacramento. There is nothing in the area except the Aerojet people now that the gold dredgers have gone their way, so why not a post office named Aerojet, Cailfornia? We wish Dan luck, but we dunno. Dan is an active Democrat and the post office department is in Republican hands right now.

•

If you can run a lathe or a typewriter, every employment office door in town will swing wide open for you. Next to engineers, most critical personnel shortage on the coast is machinists. Then secretaries. A sign of the times is to note how the proportion of help wanted advertising for missile people keeps growing in the classified columns of the Los Angeles papers. Another sign—one employment agency advertises it has openings paying up to $30,000 a year. And then there's North American Aviation's scheme to solve part of its problem with "week-end" jobs. Example—it hires key punch operators for Saturday work only.

•

Hughes Aircraft, a leader in this work, has 1500 physically handicapped employes at its Tucson plant . . . Everybody was happy to see Lockheed reward Herschel Brown with permanent appointment as assistant general manager of the Missile Systems division . . . The Douglas *Rockaire* sounding rocket is designed for launching from a fighter plane at altitude . . . North American's Rocketdyne division has four Ipsen heat treat furnaces capable of operating up to 2100° F . . . George P. Sutton, an engineering section chief at Rocketdyne and recently elected v.p. of the American Rocket Society, has published a second edition of his book, *Rocket Propulsion Elements*, including much new material.

•

We note that Mauna Loa on the island of Hawaii is one of the 12 official earth satellite tracking stations. Selection of this site, no doubt, was made because of the excellent visibility prevailing in the islands. And what a delightful way to make a lasting contribution to the progress of science, sitting under a palm tree, tracking a missile with one eye and a hula dancer with the other.

## Computer Conference Scheduled in New York

Conference on digital computing in the aircraft industry, including techniques used in structural analysis of aircraft and missiles, is being sponsored by New York University January 31 and February 1.

Entire program will be devoted to aircraft industry computer activities with some 25 papers slated for presentation. Write Dr. M. A. Woodbury, NYU College of Engineering, University Heights 53, N.Y. for arrangements.

## Link to Open West Coast Facility

Link Aviation, Inc. this month will begin operations in a new research facility at Palo Alto, Calif. intended to permit closer coordination with west coast missile producers.

New laboratory will be situated at 430 University Ave., Palo Alto, and is expected to have an initial staff of 75 employes. Negotiations are also underway for further expansion in Stanford University's Industrial Park.

Link's west coast activities will include work in advanced electronic computer systems, transistor circuits and missile test systems.

## NAA Pays $384,000 In C/L Adjustment

Employes of North American Aviation received a 3.2% cost-of-living pay increase effective December 17, adding an estimated $384,000 monthly to NAA's payroll.

Increase affects employes at five company facilities in Los Angeles, plus divisions at Fresno, Calif.; Columbus, Ohio; Neosho, Mo. and Cocoa, Fla.

## Douglas, NAA Receive Missile/Rocket Contracts

Air Materiel Command has awarded Douglas Aircraft Co., Santa Monica division a $3,650,622 contract for rockets, spare parts and data.

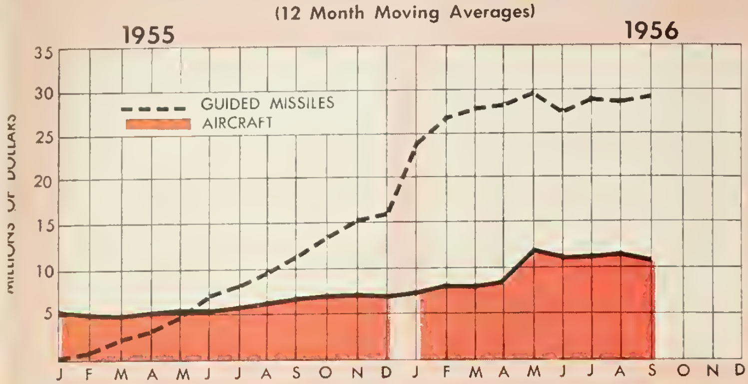
North American Aviation, Inc. received a $2,833,000 award covering new facilities for its guided missile (*Navaho*) program.

## Sperry Facility Underway

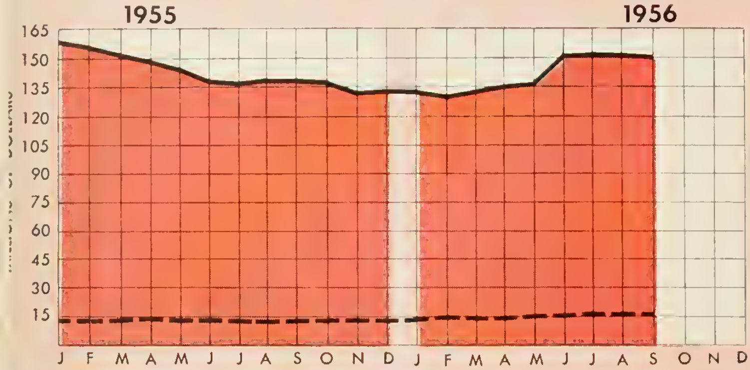
Newly formed Sperry Phoenix Co. has begun construction of a $3 million, 81,000 sq. ft. plant in Phoenix, Ariz. with target for completion set in August. Company expects to employ about 500 persons in new plant.

# INDUSTRY BAROMETER

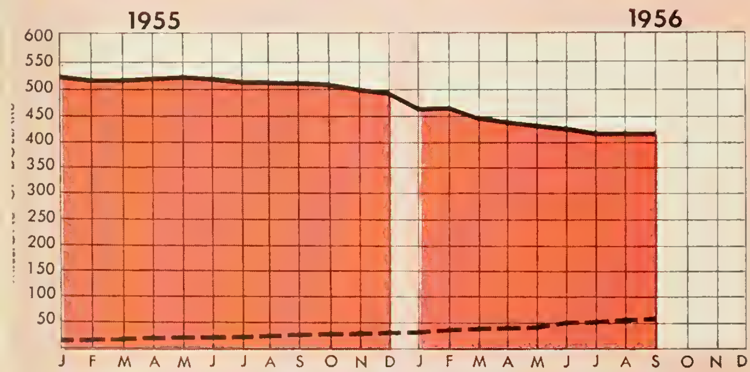
## MISSILE VS. AIRCRAFT EXPENDITURES
(12 Month Moving Averages)



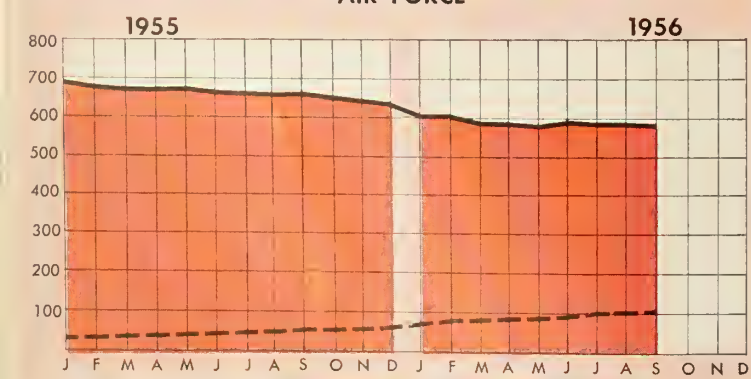

**ARMY**




**NAVY**




**AIR FORCE**




**THREE SERVICES TOTAL**

An examination of current Department of Defense expenditures for aircraft and guided missiles reveals that for every $5 spent on aircraft, the Government also disburses $1 on guided missiles and supporting equipment. A twelve-month moving average for the period ending September 30, 1956 shows DOD guided missile expenditures are now 19% of money spent for aircraft. As recently as January 1955 expenditures for missiles were only 5% of aircraft. The trend, shown in the accompanying charts, of spending a greater per cent of procurement money for missiles has been officially acknowledged by the Pentagon.

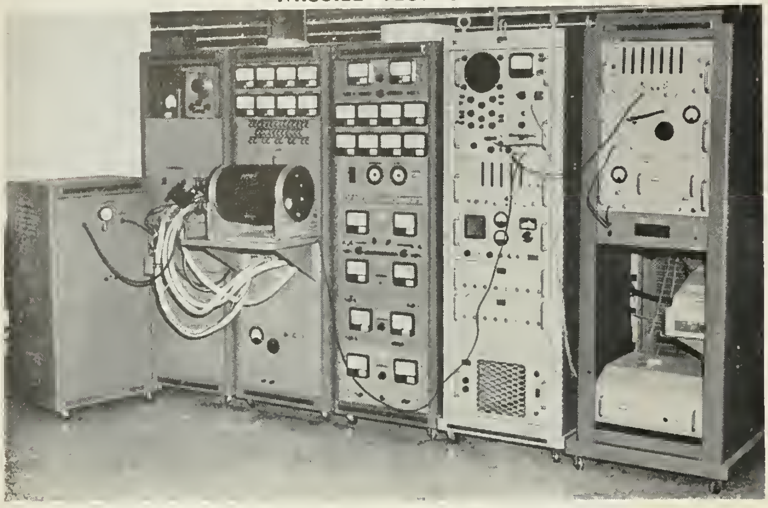
In September of 1956, Reuben Robertson, Jr., Deputy Defense Secretary, stated that the U.S. will spend well over $2.5 billion dollars on missile development and procurement in Fiscal 1957.

The position of the Air Force, as the largest missile procurer of the three services, is especially noteworthy. Col. W. A. Davis, Director, Procurement and Production, Deputy Chief of Staff, Materiel, made the following statement when he appeared before the House of Representatives Military Appropriations Subcommittee in March of '56.

". . . we are integrating missiles into our force structure as replacements for manned aircraft. The effect of these replacements will be minor at first but will grow progressively each year. In 1952, out of our total production money for aircraft and related equipment, only 4% was allocated for missiles. In our fiscal year 1955 buying program, we are applying 12% to missiles. By fiscal year 1959, we expect to use 35% of our production dollars for missiles."

While missile expenditures have increased tremendously in the past few years, the total spent for both aircraft and missiles has experienced relative stability. In January of 1955 a twelve month moving average showed the DOD spent approximately $729 millions for aircraft plus missiles. In June of 1955, the figure was $717 millions. Low point for the period January 1955 through September 1956 was March 1956, when $677 millions was spent. Since March 1956 expenditures have been on the rise. Based on latest Pentagon data (September 1956) aircraft and missile expenditures are at the $698 millions per month level. The year 1957 should find the DOD missile expenditures going well over $700 millions per month level.

## MISSILE TEST SET



A semi-automatic programmed test set for use in final testing of missile telemetering packages has been produced. Read-out is in digital form and the set is capable of programming about 200 different measurements.

According to the designers, the set electrically tests a 177-channel FM/FM missile telemetering system in less than an hour and can be operated by non-technical, semi-skilled personnel.

Only one operator is required to initiate the sequence of tests. Carrier frequency, power output, as well as frequency and amplitude of each sub-carrier channel are tested together with analysis of linearity sensitivity and frequency conversion.

A signal simulator rack provides simulated transducer signals. The read-out rack converts signals to digital form and this is printed on paper tape. Separate analysis of individual sub-carriers is permitted.

In addition to "Go No-Go" information, specific data is supplied. Bendix Pacific Division, 11600 Sherman Way, North Hollywood, Calif.

Circle No. 221 on Subscriber Service Card

## MINIATURE MOTORS

A series of new miniature d-c motors or generators measure only 1.625 in. long and 0.875 in. in diameter with a shaft diameter of 0.98 in.

Units feature self-aligning sleeve bearings with nylon retainers to assure quiet running. Shafts are hardened, ground and lapped and stators are Alnico TV ring type.

Motors include adjustable brush bracket for accurate speed of voltage output for clockwise or counter-clockwise rotation. Models with 1 in., 1.250 in. or 1.438 in. diameter are also available.

Heinz Mueller Engineering Co., 1906-08 N. Cicero Ave., Chicago 39, Ill.

Circle No. 205 on Subscriber Service Card

## SPRAY-ON CERAMIC

New Therm-O-Lab ceramic electrical heating elements developed for aircraft and missile use can be sprayed on surface to be coated and are rated to withstand Spec. MIL-E-5272A vibration tests.

The thin ceramic blanket is rated to perform dependably under operating temperatures up to 500°F. Therm-O-Lab Corp., 6940 Farmdale Ave., North Hollywood, Calif.

Circle No. 212 on Subscriber Service Card

## FLUID SYSTEM FILTERS

"Rigimesh," a rigidized wire mesh used in filter elements for aircraft or missile hydraulic, oxygen, nitrogen and helium systems is designed for operating temperatures from —65° to 900°F. Produced by furnace welding the wires of the mesh at all contact points, Rigimesh is said to have working features that permit fabrication by cutting, rolling, corrugating and welding without losing uniformity of mesh openings.

According to its producer, filter elements have been adapted to operating pressures from vacuum to 10,000 psi and with particle size retention ratings from two to 2,000 microns. In one application, a Rigimesh laminate is used to line combustion chambers and afterburners of turbine engines so they can be transpiration cooled.

Aircraft Porous Media, Inc., c/o Pall Filtration Companies, 30 Sea Cliff Ave., Glen Cove, N. Y.

Circle No. 213 on Subscriber Service Card

## MISSILE CABLE

Electronic cable with stable performance characteristics under temperature conditions ranging from —85° to 410°F has been announced. The manufacturer claims normal operation of the new cable under all present conditions of missile and rocket performance.

Teflon insulated conductors and a sheath of specially compounded silicone rubber have been used in a new design. Each conductor is free to move within certain limits and the entire cable core is allowed limited movement within the jacket.

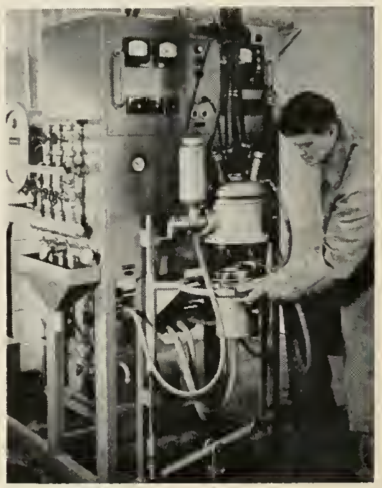
A continuing automatic adjustment of these movements is claimed to allow flexing far beyond the limits of any other cable type over the stated temperature range: Conductors can be supplied in many color combinations for identification.

Douglas Roesch Division, Hall-Scott Inc., 2850 Seventh St., Berkeley, Calif.

Circle No. 220 on Subscriber Service Card

## VACUUM ARC-MELTING FURNACE

A new laboratory arc-melting vacuum furnace that simulates conditions in a large production furnace is now available. The VA-L200C furnace is manufactured by W. C. Heraeus in West Germany and distributed in the U.S.



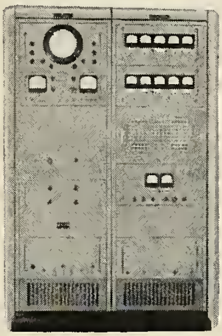
The furnace uses interchangeable consumable and non-consumable electrodes. It can handle high melting point metals such as nickel, iron copper and many metallic carbides and borides. Inert atmosphere or vacuum operation to 5 x 10 —4 mm hg is possible, and melts of a few ounces to several pounds can be handled.

The furnace has a water-cooled

# Pulse Width Data Systems

**THOMAS S. MEDEROS, JR., Sales Manager**
**Applied Science Corporation of Princeton**
**Princeton, New Jersey**

A PW data system is a grouping of equipment which uses the techniques of time division multiplexing and Pulse Width coding to put a number of voltages representing physical quantities, into a form which permits transmission over a single circuit or link, or recording on a single channel or track. The system also provides for the separation and identification of the previously multiplexed data channels and decoding back into voltages, which are used to provide visual display, graphic records, input to data processing equipment or control functions.



M SERIES PW GROUND STATION

**Separates and reduces all data channels in real time. Operates on signals from standard airborne set, FM/FM subcarrier, or magnetic tape recorder.**

In a PW system, the intelligence is conveyed by the pulse duration rather than amplitude, and therefore the transmission medium is not required to have amplitude linearity but only the ability to discriminate between two states which may be called "on" and "off" or "mark" and "space."

## Operation

The basic functional units required in any PW system are transducers, a commutator with suitable driving device, a keyer, an RF transmitter, and data reduction equipment for converting the PW data signals into usable form.

Since the PW data system requires that input signals should be in the form of voltages, suitable transducers capable of converting physical quantities into voltages are used. Present ASCOP PW multicoders operate from signals in the range of 0 to + 5 volts, and low-level equipment is now available with sufficient sensitivity to accommodate inputs in the low millivolt range.

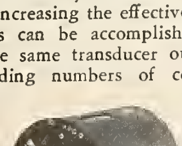
The time division multiplexing is accomplished by a motor-driven rotary sampling switch or commutator. Standard sampling rate is 900 samples per sec, and commutators are now available for operation at 30 RPS over 30 points, 20 RPS over 45 points, and 10 RPS over 90 points. Since two points of the commutator in any of the systems are left unconnected, to provide a gap in the pulse train for "frame" identification, the existing numbers of channels available for data and references are 28, 43, and 88, respectively.

F SERIES MISSILE SETS

**Samples up to 43 data sources. This rugged equipment is sealed and pressurized to withstand high altitudes, operation and temperature extremes.**

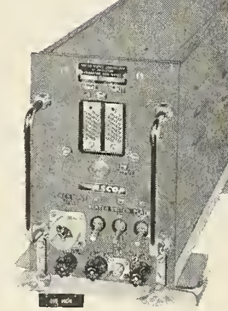
System linearity is determined by the transfer characteristic of the keyer, from volts to Pulse Width, and the linearity of the translator back into volts. A typical ASCOP Pulse Width data system does not deviate from linearity between the scale end points, by more than 0.5 per cent. The total system drift, from any cause, is less than ±0.5 per cent of full scale. Since system levels are maintained by an automatic electronic servo, this degree of stability is maintained over periods of days or weeks, and is accomplished without any warm-up time.

With the stairstep type of electrical output provided by the M Series ground station, it is generally conceded that 6 samples per cycle of the highest data frequency component present allow visual interpolation of output records to better than 1% accuracy. This means that any channel of a 30 × 30 system can reproduce 5 cps data. The frequency response of one or more data channels in the system can be increased by a factor of 2, 3, 4, or more by increasing the effective sampling rate. This can be accomplished by applying the same transducer output to a corresponding numbers of commutator contacts, and making similar provision during decommutation.



SPECIAL MISSILE SET

ASCOP-designed for a customer.



D SERIES PW MULTICODER

For aircraft, mobile or other applications where recovery or continued use is practical and where space and weight are not critical. Samples up to 43 data sources.

## Uses

At present, most PW data systems are used for recording experimental test data from missiles and aircraft, where hazard, space limitation, and volume of data to be gathered make the use of a human observer impossible. Measurements of such quantities as the temperature, pressure, strain, altitude, acceleration, flow rate and position are made at rates thousands of times faster and much more accurate than could be done by visual observation and manual recording.

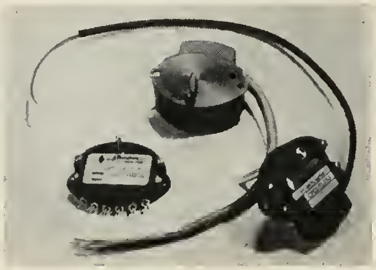
Additional application is also found in experimental test work where hazard and space are not limitations, but where the total volume of data require both high speed automatic measurement and recording. Engine test stands, reactors, and complex electronic equipment are typical devices whose testing requires the automatic measurement and recording of large numbers of physical properties.

PW data systems have been used where many measurements must be transmitted and displayed in easily interpreted form, as in the case where a pilot on the ground must rely on display instruments while he controls a drone aircraft, or in the case where the flight test engineers on the ground must observe conditions in a piloted aircraft in order to insure the safety of the pilot.

stainless-steel chamber with two windows for observing the crucible. A screw-type feeding device is provided. Height of the electrode head is adjustable electromechanically with push button operation. A Roots-type mechanical high vacuum pump with a speed of 950 cubic feet per minute, and which does not have an oil seal is used. Rochester Division, Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester, N.Y.

Circle No. 227 on Subscriber Service Card

## SECTOR POTENTIOMETERS



A new line of sector potentiometers especially engineered for missile and aircraft systems is available. Models are designed to measure angles from zero to a maximum of 90° shaft rotation. Accuracy is rated at 0.5 percent and resolution to 0.10°.

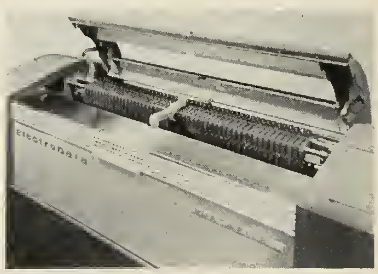
All-metal construction is used together with high temperature insulation for temperatures up to 300°F. The units feature resistance to severe environmental conditions of shock, vibration and temperature and meet explosion-proof requirements.

All three models are available with shaft extension from either side and with terminals or cables, singly or in ganged units. Humphrey, Inc., 2805 Canon St., San Diego 6, Calif.

Circle No. 216 on Subscriber Service Card

## ELECTRONIC FILING SYSTEM

An electronic filing device that uses short lengths of magnetic tape to provide storage and rapid access of records has been announced. The new DATAFILE segmentizes information by eliminating conventional tape reels.



According to the manufacturer, the new system supplies 10 times the maximum file capacity of any other data processing system equipment now available. Each unit stores 2-million characters, and up to 10 units can be integrated in one compute system.

Fifty 250-feet tapes are used and information is calibrated into addressable blocks of 200 characters each. The tapes move back and forth over guide rails at 60 inches per second.

Twin read-write heads are propelled beneath the tapes and stop at designated

# what is grey matter worth?

For the engineer or scientist who has enough to make him different, *grey matter* is worth a rewarding life of creative achievement in a working climate where ideas are King...and the benefits measure up to the man and his mind.

For 56 years Firestone has grown on *grey matter* — in Research, Development and Production. Now, simply, we need additional *grey matter* for such Firestone "firsts" as the "Corporal" surface-to-surface ballistic missile. Here are just a few of the Engineering activities in which Firestone needs more *grey matter:*

*Electronics Systems*
*Mechanical Systems*
*Propulsion Components*
*Flight Simulation*
*Mechanical Structures and Dynamics*
*Stress Analysis*
*Metallurgical Lab*

If you're the man with extra *grey matter* who wants the chance to really use it, write us today. We'll put you in touch with a Firestone man who has your kind of *grey matter*, too.

**Firestone**

**GUIDED MISSILE DIVISION**

RESEARCH • DEVELOPMENT • MANUFACTURE

*"Find your Future at Firestone" — Los Angeles • Monterey*

WRITE: SCIENTIFIC STAFF DIRECTOR, LOS ANGELES 54, CALIF.

positions to read or write 1 to 100 blocks of information at 46 milliseconds per block. Storage is in decimal form.

Electro Data, division of Burroughs, 460 Sierra Madre Villa, Pasadena, Calif.

**Circle No. 226 on Subscriber Service Card**

### SUBMINIATURE RELAY

New VG series of relays developed for aircraft and missile applications have a vibration rating at 15 g's from 55 to 2,000 cycles per second. Shock rating is 100 g's.

The VG relays, designed to meet Spec. MIL-R-57570 shock test II, are in the subminiature class. Relays measure less than ¾ cu. in. and weight is 1.3 oz. with a DPDT arrangement. Operating range is —65°C to 85°C and units with 125°C rating will be supplied on request.

Coil specifications call for standard operation at 24-29 volts d-c and maximum coil voltage is 38 volts d-c continuous with pull-in voltage rating at 18 volts maximum over the temperature range. Operating time is 6 milliseconds at 26.5 volts.

Life performance of VG series is said to be at least 100,000 operations at rated load. Elgin National Watch Co., Electronics Div., Elgin, Ill.

**Circle No. 206 on Subscriber Service Card**

### PULSE GENERATOR

A new pulse generator is available that is completely transistorized. Completely self-powered by a 22½ volt battery with a useful life of 450 hours, the generator provides a pulse length from 0.5 to 3 microseconds.


Positive and negative pulses are continuously variable from zero to full amplitude to a 20 volt peak into an 800 ohm load. Rise and decay time is rated at 0.1 microseconds or less; tilt and overshoot at less than ±2%.

Repetition rate on internal sync is from 50 to 5,000 pps, and on external sync from 0 to 5,000 pps. Model 502 generator is housed in a case measuring 8½ x 5 x 4½ inches. Cubic Corp., 5575 Kearny Villa Road, San Diego 11, Calif.

**Circle No. 222 on Subscriber Service Card**

### ROCKET ENGINE HEAT EXCHANGER

An all-aluminum heat exchanger developed for rocket engine propellant testing at Reaction Motors, Inc. has a design temperature range from +100° to —325°F.

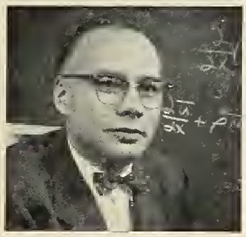
In the tests, liquid nitrogen will be vaporized in the shell side of the combination shell and tube unit at —320°F in order to cool liquid oxygen passing through the tubes at about —285°F.

# Wanted!

## *Engineers who will accept the challenge of the most urgent program in the free world today...*

# Long Range Guided Missiles

**Ten years ago there was only a handful of men in the country who said it could be done. Today, more and more engineers—their technological noses scenting the fact that engineering history is in the making—are picking up the gauntlet of the greatest engineering challenge American ingenuity has ever faced—the race against time and the phenomena of long range guided missiles.**



Dr. E. R. van DRIEST, Chief Scientist, is nationally recognized for his work in aerothermodynamics. He has a BS, Case Institute of Technology; MS, University of Iowa; Ph.D., Cal Tech; and Sc.D, Technisch Hochschule, Zurich, Switzerland. Around his home, in Whittier, he finds ideal opportunities for the pursuits he and his family like best—horseback-riding, archery and other outdoor activities—perfect complement to the absorbing mysteries of his work.

Research and development that would ordinarily take years is today—of necessity—being telescoped into months. Problems of aerodynamics, thermodynamics, high temperature materials, aeroelasticity—that a decade ago were only theory in textbooks are today being solved. What's more, the production techniques necessary to turn these solutions into hardware have been evolved.

### Major Missile Center

One of the major centers of this activity is North American Aviation's Missile Development Division. In 1945 North American started a program of research and development in this field. As far back as 1948, the first NATIV—North American Test Instrument Vehicle—streaked to trajectory altitude of 10 miles. One result of this type of pioneering was complete weapons system responsibility for the Air Force SM-64 Navaho Intercontinental Guided Missile—a gigantic task embracing almost every field of engineering.

JIM THOMPSON's career in missile engineering at North American began in 1951. Today, Jim is Group Leader of Flight Instrumentation at the Missile Test Facility, Patrick Air Force Base, Florida. The tropical climate there is ideal for his favorite sports—fishing and golf.

### Progress Grows Apace

We can't give details here, or describe facilities, solutions, flight tests. But we *can* tell you this: a new engineering chapter is being written. It is reaching its climactic phase. There will never be a better time for you to become a Missile Engineer.

### Are You This Kind of Man?

Can you break with tradition...leave conventional methods behind...and explore the unknown with the faith that in every obstacle lies the seeds of new successes?

MANUEL C. SANZ, Chief of Materials Research, found unique scope for his special talents at North American. This Chemical Engineer, with a Masters in Physics and Chemistry, is named as the inventor in a patent on the famous Chem-Mill Process. His son leads a Los Angeles school band—with a chem-milled baton!

### If You Join These Men, We Promise You

a management climate which stimulates personal growth—and rewards it with responsibility, professional recognition and material benefits limited only by your own abilities. Your own academic stature can be constantly enlarged with our Educational Refund Plan—and some of the nation's finest universities are close at hand.

Write today for full particulars. If you're the man we're seeking, we'll be glad to arrange a personal interview *where you are now residing.*

**Contact:** Mr. M. Brunetti, Engineering Personnel Dept. 91 MAR
Missile Development Division, 12214 Lakewood Blvd., Downey, California.

**NORTH AMERICAN AVIATION, INC.**

# NEW EEMCO MOTOR

## for new missile

. . . another example of the versatility of the nation's leading producer of motors and actuators for jet aircraft and missile systems.

**SPECIFICATIONS FOR TYPE D-855**

**Type:** DC motor with integral gear reduction
**Terminal voltage:** 24
**Horsepower:** 4.8 at 200 amps
**Output RPM:** 2600 minimum
**Duty Cycle:** 10 min. on, 30 min. off
**Ambient temperature range:** —65°F. to 250°F.
**Minimum starting torque:** 300% of running torque
**Mounting pad:** AND 20001
**Cooling:** Fan cooled with open thru ventilation
**Weight:** 17¾ pounds

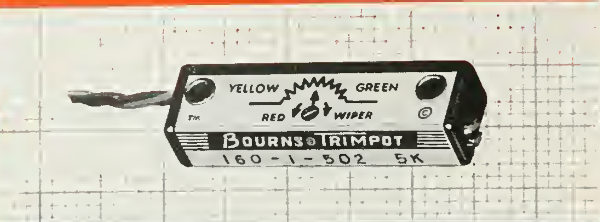
**EEMCO TYPE D-855,** a DC motor with integral gear reduction, was designed for use in missiles of the latest concept. Like all **EEMCO** motors, as well as **EEMCO**'s rotary and linear actuators, it packs maximum performance into minimum dimensions and weight. With a terminal voltage of 24, Type D-855 produces 4.8 HP at 200 amperes with a minimum RPM output of 2600. Duty cycle is 10 minutes on and 30 minutes off, with minimum starting torque at 300% of running torque. Ambient temperature range is —65° to 250° Fahrenheit. Type D-855 is fan cooled with open thru ventilation.

**EEMCO** has had many years experience in the exclusive design and manufacture of airborne motors and actuators. As a result, **EEMCO** is thoroughly skilled and equipped to produce these vital components that must operate unfailingly under the extreme environmental conditions encountered in today's supersonic aircraft and missiles. Thus **EEMCO**'s extensive specialization in this field is playing an important part in the reliability of the most modern air weapons now being produced for the nation's defense.

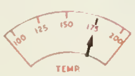
## Electrical Engineering and Manufacturing Corp.

4612 West Jefferson Boulevard
Los Angeles 16, California
Telephone REpublic 3-0151

Designers and Producers of Motors,
Linear and Rotary Actuators . . . Exclusively!









Shell has an inside diameter of 32 in. and the tubes are ⅜ in. diameter.

Aluminum was employed throughout the heat exchanger because of its high Charpy impact values at low temperatures. Plain or mill steel, at these temperatures, would be extremely brittle under impact. Design operating pressures are 50 psi on the shell side and 150 psi on the tube side.

The Griscom-Russell Co., Massillon, Ohio.

**Circle No. 214 an Subscriber Service Card**

## MINIATURE CLUTCH

New high performance miniature motor-gearhead clutch classed as Bureau of Ordnance Size 10 has a maximum length of 1¾ in. and weighs only 2.1 oz. Clutch is designed to operate directly from either 115 or a 26 volt line source with protection of gearing and loads supplied by an integral slip clutch.


Unit design includes motor and gearhead enclosed in a common aluminum housing. Its use as a control element gains in significance under conditions of high stall torques resulting from use of high gear ratios, the manufacturer says. Servomechanisms, Inc., Mechatrol Div., 625 Main St., Westbury, L. I., N. Y.

**Circle No. 212 an Subscriber Service Card**

## TELEMETERING POWER SUPPLY

A new 22.5 volt dc power supply for various telemetering and instrumentation applications has been announced. The MRP22-1 unit operates from a standard 400 cycle supply with an input voltage of 95-135.

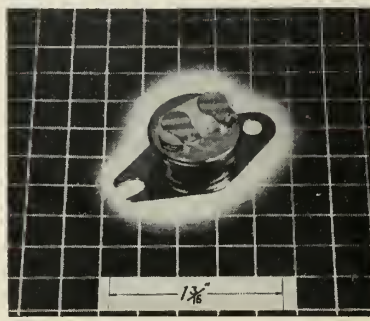

Said by the manufacturer to provide transient free, short circuit-proof performance, the units use dual magnetic regulation providing smooth output and high response speed and provide 0-100 milliamperes. The supplies are housed in hermetically sealed steel cases with thermosetting plastic impregnation and measure 3½" x 1½" x 2½". Connector

is a 4098 Triad octal plug. Magnetic Research Corp., 200 Center St., El Segundo, Calif.

**Circle No. 225 on Subscriber Service Card**

### PRECISION THERMOSTAT

Hermetically sealed, snap-acting thermostats developed for aircraft and missile installation can be preset at factory over range from —65° to 400°F and are then non-adjustable. Electrical ratings extend up to 7 amps resistive, 30 volts a-c/d-c; 6 amps resistive, 125 volts a-c; 3 amps resistive, 250 volts a-c depending on life expectancy.




Thermostat weight is 4 grams and design conforms to Spec. MIL-E-5272A. Insulation resistance is 1,250 volts a-c, 60 cycles for one minute. Overall height of a right-angle terminal model is 0.50 in. maximum including bracket, although flattened or pierced terminal types are also available.

Metals & Controls Corp., Spencer Thermostat Div., Attleboro, Mass.

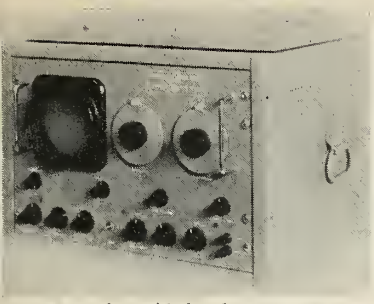
**Circle No. 207 on Subscriber Service Card**

### SPACE SUIT

New full-pressure space suit developed for Navy Bureau of Aeronautics is said to be the lightest yet produced and substitutes specially designed shoulder and upper-arm bellows for metal bearings used previously. Although most details are classified, the new high-altitude garment is said to permit pilots to sit, stand and walk freely. Arrowhead Rubber Co., 2350 Curry St., Long Beach, Calif.

**Circle No. 202 on Subscriber Service Card**

## SPECTRUM ANALYZER



0-100 kc wide-band spectrum analyzer is available that will give an instantaneous fuorier analysis of noise, vibration and harmonics in applications of telemetering, aircraft tests and for the filter, acoustic and medical fields.

Special features are automatic optimum resolution, bandpass input filter, continuously variable center frequency and sweep width controls. A flat 5-inch cathode ray tube is used with a camera mount bezel.

Input range is 500 microvolt to 500 volts full scale. Probescope Co., 44-05 30th Ave., Long Island City, N. Y.

Circle No. 218 on Subscriber Service Card

## VARIABLE FREQUENCY FILTER

A variable filter designed for use with vibration analyzers made by the same firm provides for measurement of amplitude and phase of vibration frequencies. The Model 1065 Variable filter permits tuning or scanning of the vibration spectrum over frequencies up to 30,000 cpm with a rated accuracy of 5%, and within 10% from 30,000 to 300,000 cpm.

The unit operates from 110 volts, 60 cycles, single-phase power. Bandwidth is ±5% of the nominal frequency to the 3 db-down points. The Model 1065 filter is inserted between an IRD velocity pickup and the vibration analyzer which is being used. International Research and Development Corp., Columbus, Ohio.


Circle No. 224 on Subscriber Service Card

## HIGH TEMPERATURE RIVET

New stainless steel rivet for aircraft and missile structures requiring high strength at high temperatures has an 85,000 psi shear strength at 800°F. Room temperature shear strength is more than 100,000 psi.

Designated the Cherry "600," the new rivet uses a stem and sleeve of A-286 stainless steel, heat-treated and aged for optimum strength and corrosion resistance.

Write: Townsend Co., Dept. M/R, Box 2157-Z, Santa Ana, Calif.

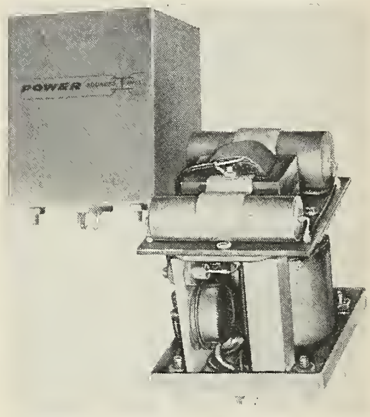
Circle No. 204 on Subscriber Service Card

## MISSILE POWER SUPPLIES

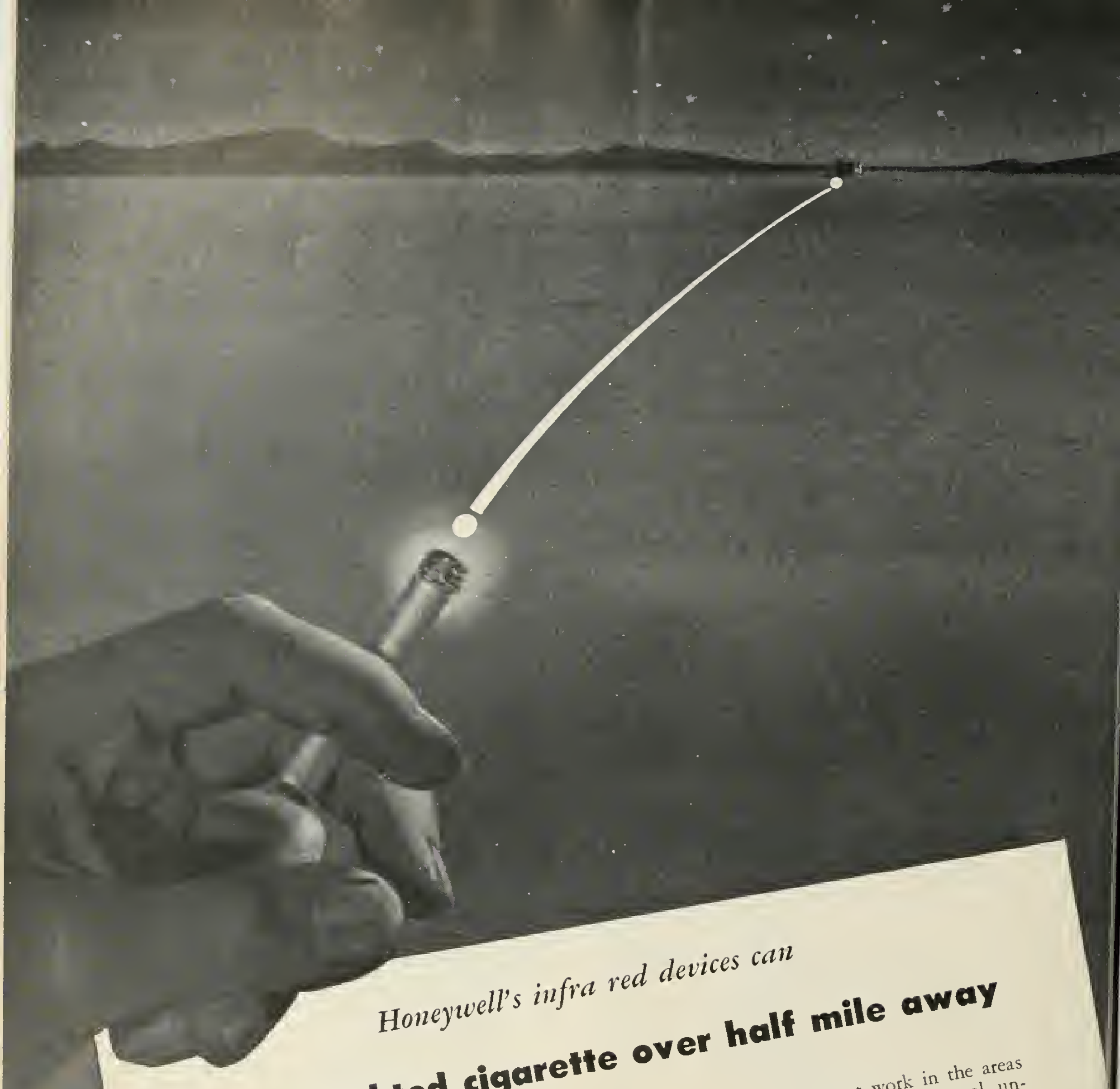
Four new all semiconductor dc-dc converters have been announced for use as missile beacon power supplies and other mobile applications. Units are available with inputs of 12 and 28 volts dc and filtered dc outputs of 325 volts at both 100 and 200 milliamperes.

Units are supplied in hermetically sealed packages measuring 3 1/16 x 3 3/16 x 2 5/8 inches. The supplies use two power transistors in an oscillator to interrupt the dc input.

Silicon power diodes and special capacitors are used in the rectifier circuit. Regulation is rated as 20% on standard units, and 0.5% regulation with special input-output voltages can be provided on a custom basis. Power Sources, Inc., 6 Schouler Court, Arlington, Mass.




Circle No. 219 on Subscriber Service Card



## missile literature

HIGH CURRENT RECTIFIERS. An 11-page brochure, No. ECG-148A, of application notes and graphical data on General Electric's 4JA60 series of small high current silicon rectifiers is available. The new units handle up to 10 kilowatts in a three phase circuit. Write: General Electric Co., Dept. M/R, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

MAGNETIC SHIELDING. A 33-page brochure entitled Data Sheets 101 (1957), describes construction features, performance characteristics and typical applications of non-shock sensitive, non-retentive Fernetic and Co-Netic magnetic shielding material. There are 14 pages of illustrations and 5 pages of graphical data. Write: Magnetic Shield Division, Perfection Mica Co., Dept. M/R, 20 N. Wacker Drive, Chicago 6, Ill.

TAPE RECORDER. A 24-page bulletin No. 1561B describes complete characteristics of a new magnetic tape recording and playback system for handling stress, pressure, temperature and vibration data. Detailed photographs of different parts of the Consolidated DataTape system are also provided. Write: Consolidated Electrodynamics Corp., Dept. M/R, 300 North Sierra Madre Villa, Pasadena, Calif.

ELECTRONIC COMPONENTS. A 15-page catalog of AN connectors, RF connectors, Rack and Panel connectors and RG-/U coaxial cables stocked by Amphenol distributors for same-day delivery. Catalog IEC-2. Write: Amphenol Electronics Corp., Dept. M/R, 1830 South 54th Ave., Chicago 50, Ill.

### TECHNICAL LITERATURE

TUBE MANUAL. A new edition of the Radio Corp. of America receiving tube manual, RC-18, has been announced. Technical data on 575 receiving tubes and cathode ray tubes is included. (Price $.75). Write: Commercial Engineering, Tube Division, Radio Corp. of America, Dept. M/R, Harrison, N. J.

TEST EQUIPMENT DATA. A comprehensive compilation of descriptive data on more than 1300 electronic test equipments has been published to fill a need in the electronics industry for a handy time-saving reference file of information in this field. Information comes in five volumes of hard cover binders. Periodic additions and revisions will be published. The complete set, including revisions costs $170.00. Write: Carl L. Frederick & Associates, Dept. M/R, 4630 Montgomery Ave., Bethesda 14, Md.

STORAGE BATTERIES. Yardney Electric Corporation, 40-50 Leonard St., N.Y. 13, N.Y. announces publication of a new brochure on its line of SILVERCEL* (silver-zinc) and SILCAD* (silver-cadmium) rechargeable storage batteries. The outstanding features of Yardney cells are outlined in an attractive three-color folder. These advantages include light weight, small size, flat voltage characteristics and high current output. Copies of the new brochure will be mailed free on request by the Yardney Electric Corp. Ask for "Compact Power by Yardney."

RECORDING CAMERAS. Multiple-purpose precision data recording cameras are the subject of an eight page, illustrated brochure offered by Flight Research, Inc., Richmond, Va. Small and lightweight, the MULTIDATA cameras permit automatic, synchronized motion picture or single frame operation. Full operating specifications and details of construction are given for both the MOD III 16mm and MOD IV-C 35mm MULTIDATA cameras. Complete information is contained in the bulletin. Write for a copy to Flight Research, Inc., Post Office Box 1-F, Richmond, 1, Va.

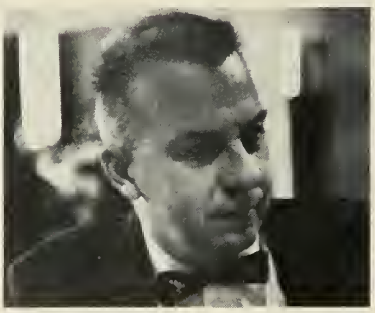
MINIATURIZED GEAR BOXES. A revised four-page, two-color illustrated brochure, number SW-1, describes and illustrates Southwestern's miniaturized gear boxes, miniaturized vibration-resistant pressure switches, and light-weight, compact screwjack actuators. Southwestern Industries gear boxes are designed for electronic and instrument applications, servo mechanisms, computers, small actuators and electronic components. Write: Southwestern Industries Inc., 5880 Centinela Ave., Los Angeles, Calif.

SERVO CONTROL VALVES. Cook Research Laboratories Division of Cook Electric Company, Chicago 14, Ill., has released Volume 3, No. 2 of the Cook Technical Review. This issue of 28 pages deals with electrohydraulic servo valves. Part I presents basic information relative to the types and characteristics of high response servo control valves. The subsequent part describes the various types of valves which are commercially available and discusses the selection of electrohydraulic servo valves and their system application. Bernard A. Johnson, Project Engineer; Lee D. Schmid, Senior Engineer; and Jay Warshawsky, Technical Director, Automatic Control Systems Section, all of Cook Research Laboratories, are the authors of this issue of The Cook Technical Review. The price of this issue of the Cook Technical Review is $1.00 per copy in U.S. and Canada ($1.25 in other countries).

## people

Well-known general buries a smile as world's top ballistic missile expert says: "I read in LIFE magazine that we are supposed to have fired a missile 3,000 miles . . ." Some of those at the head table for the Honors Night dinner at the recent annual meeting of the American Rocket Society in New York included (left to right): REAR ADM. JAMES S. RUSSELL, Chief, Bureau of Aeronautics; MRS. JAMES H. WYLD, retiring ARS President, NOAH DAVIS; ABMA Development Director, WERNHER VON BRAUN; ABMA Chief, MAJ. GEN. JOHN B. MEDARIS; CMDR. ROBERT M. TRUAX, USN, AF WDD; MRS. ROBERT H. GODDARD.

Maybe it was the hour, or maybe it was Defense Secretary Wilson's November memorandum that joined well-known science writer WILLY LEY and Boeing engineer NORMAN BAKER in deep contemplation.



Eager beaver KURT R. STEHLING, propulsion chief, NRL's Project Vanguard, listened.

DR. S. FRED SINGER, Professor, Maryland University Physics Department, had a point.

The points, in fact, that were made were many and ranged far into the early morning hours.

Rocket pioneer and former ARS President G. EDWARD PENDRAY describes a fundamental principle.

From Peenemunde to Redstone—Former German professor HERMANN OBERTH, father of space flight, now special consultant to VON BRAUN at ABMA.

Making the round of hospitality suites was a tough circuit; playing host was tougher.

Curtiss-Wright's G. S. WING seems to have doubts as to where it all will end.

And two just couldn't take it any longer.

# people

**Peder W. Larsen**, formerly Senior Military Officer at the Royal Aircraft Establishment at Farnborough, England, where he was responsible for the development program of Army guided missiles, has been appointed manager of government projects of PSC Applied Research Ltd.

Bell Aircraft Corporation's new Aircraft Division announces four appointments: **John W. Rane, Jr.**, director of engineering and sales; **George D. Ray**, chief engineer; **Stanley W. Smith**, chief project engineer; **John J. Weisbeck, Jr.**, contracts manager.

**Eduard Baruch**, president of Heli-Coil Corporation, a subsidiary of Topp Industries, Inc., has been elected a vice president and director of the parent firm.

**H. C. Riggs** has been named coordinator of missile applications engineering by the Exide Industrial Division of The Electric Storage Battery Co., Philadelphia.

KING

**Dr. Donald D. King**, formerly director of the Radiation Laboratory at Johns Hopkins University, was elected vice president-research for Electronics Communications, Inc., a subsidiary of Air Associates, Inc.

**Alden R. Ludlow, Jr.**, has been appointed director of sales for U.S. Industrial Chemicals Co., Division of National Distillers Products Corp.

**Roy S. Fisher** was elected vice president and named director of sales for National Vulcanized Fibre Co.

**John S. Anderson**, president of Aeronautical Radio, Inc., has been reelected to a two-year term as vice chairman of the Radio Technical Commission for Aeronautics.

**C. Charles Miesse**, a specialist in liquid propellant engines, formerly with Aerojet-General Corp., has been named supervisor of the newly created combustion section at Armour Research Foundation of Illinois Institute of Technology, Chicago, supervising activities in area of combustion, jet engines, liquid rocket engines and gas turbines.

**David D. Stone** has been appointed vice president in charge of sales and customer relations for Wyle Laboratories, El Segundo, Calif.

**Robert L. Clark** has been appointed to head Ryan Aeronautical Co.'s Manufacturing Division.

**Charles E. Miller** has been named head of engineering services for the Pacific Division, Bendix Aviation Corp. **William H. Chester** and **Charles W. Thomas** have been appointed asst. supervisors of the telemetry engineering section of the division.

**Dr. William B. McLean**, technical director of the Naval Ordnance Test Station, has received a $25,000 cash award for his role in the development of the Navy's *Sidewinder* air-to-air missile. Decorations and citations were awarded the following men, who developed the first guided missile, the TDR-1, launched in wartime against the enemy: **Commodore Oscar Smith** (Ret.), **Capt. Robert Jones** (Ret.), **RADM D. S. Fahrney** (Ret.), **LCDR Fred Wallace, Lt. William Bowlin, LCDR John Burrell, LCDR William Bailey, Capt. S. E. Jones,** and **Capt. G. E. Merrill.**

**John N. Kerr**, former chief of associated projects at Northrop Aircraft, Inc., has been appointed vice president of Horkey Associates.

BAILEY

**John T. Bailey** has been named quality control director for Bell Aircraft Corp.'s Weapon Systems Division; **Raymond C. Sears** was named director of quality control for Aircraft Division. New assignments in the Rockets Division, a unit of the Weapons Systems Division, are **Floyd H. Walters**, director of manufacturing; **R. Dewey Rinehart**, director of engineering; **Harry A. Ferullo**, director of programs; **Stephen D. Krull**, director of tests; **Joseph R. Piselli**, manager of customer relations and sales; **Melvin J. Blessing**, manager of contract administration.

**Phillip Movitz**, staff asst. to the division general manager, Grand Rapids Division of Lear, Inc., has been promoted to quality control manager. **J. C. Owen** has been named manager of the advanced engineering department of the division.

**R. J. Sullivan** has been named director of quality control and **Conrad Hohmann**, asst. chief engineer-special airborne devices, for Vickers Inc. **Mr. Sullivan** will be responsible for coordination of quality control at Detroit, Omaha, Joplin (Mo.) and Jackson (Miss.) divisions.

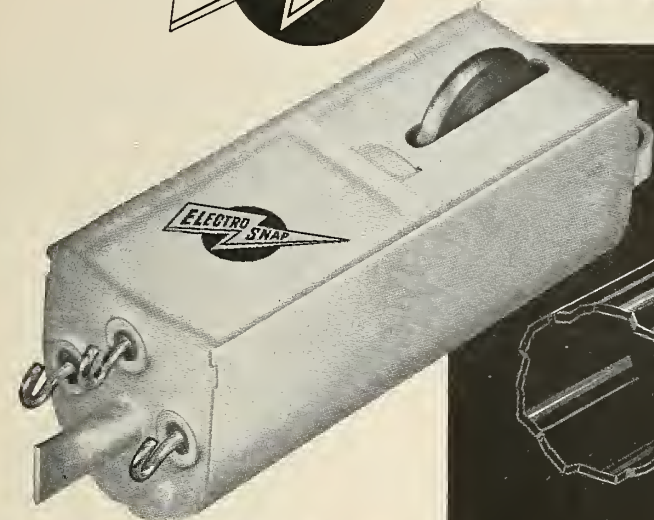
SHAW

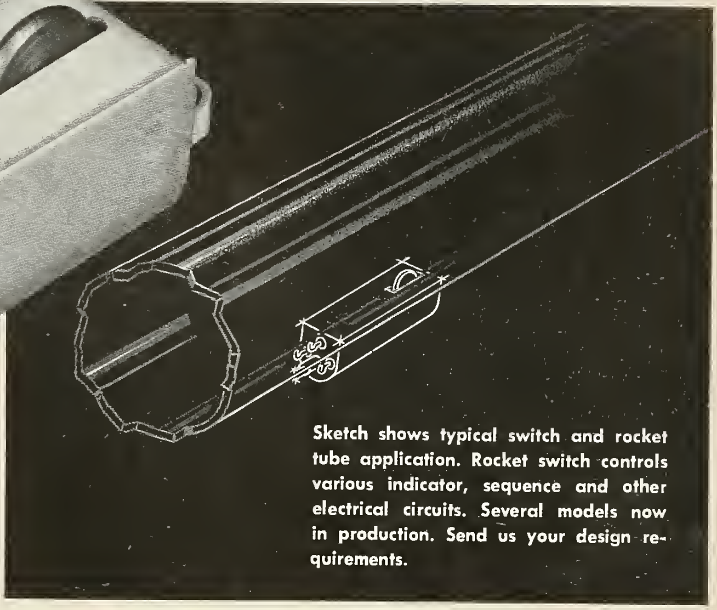
**George B. Shaw**, vice president-procurement for The Martin Co., has been named president of Martin International, a new subsidiary company which will develop world markets for nuclear powered electrical generating systems.

**Dr. Adolph K. Thiel** has been appointed assistant program director for the *Thor* intermediate range ballistic missile program.

**new**

# ROCKET SAFETY SWITCH

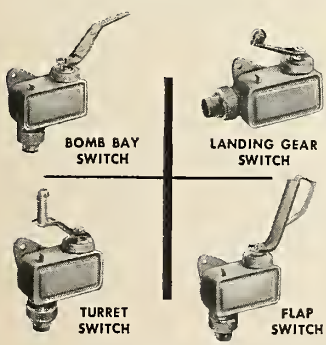




Sketch shows typical switch and rocket tube application. Rocket switch controls various indicator, sequence and other electrical circuits. Several models now in production. Send us your design requirements.

**...from the makers of the leading line**

## of HERMETICALLY SEALED LIMIT SWITCHES




Electro-Snap has developed a complete line of hermetically sealed limit switches to bring the ultimate in environment-free switching to aircraft control circuits. With a record of dependability totaling millions of hours, Electro-Snap Hermetically-Sealed Switches have been used as original equipment by major aircraft producers—on standard and experimental aircraft for both commercial and military use. They are also being widely used for retro-fitting, to modernize existing control circuits for the more exacting demands imposed on today's aircraft. If aircraft switching is your responsibility, you should know about this modern line of switches for modern aircraft. Write for specifications.

To meet modern aircraft requirements, Electro-Snap has developed and perfected this, the first truly hermetically sealed rocket switch. Because both the basic switch and the operating mechanism are sealed in an inert gas, the switch is unaffected by extreme heat, or cold, humidity, water, oil or temperature cycling. Tipping action of the actuator prevents jamming by ice. Completely environment-free, the dependability of the switch and its operating action have been thoroughly proved on today's newest fighter aircraft.

### IMPORTANT CHARACTERISTICS

Contact Arrangement................SPDT, 1 circuit

Capacity........4 amps. resistive, 2.5 amps. inductive at 30v DC.

Electrical and Mechanical Life................150,000 operations min.

Vibration and shock resistance........................................Excellent

Full information is available on request. Write for Data Sheet RY-1.

**ELECTRO-SNAP SWITCH & MFG. CO.**

4252 West Lake Street, Chicago 24, Illinois

*We will meet your design requirements—send us your prints* employment briefs

## Labor Dept. Finds Training Lack

The aircraft and missile industry is neglecting apprentice training in a large majority of its major plants and is generally falling short of its goal of meeting skilled manpower needs, according to the Dept. of Labor.

Results of a recent Labor survey show that apprenticeship training is being neglected entirely in 99 out of 143 plants employing more than 400,000 persons each. Only about one-third of the facilities surveyed were found to have some kind of junior training projects under way.

Labor's Bureau of Apprenticeship found that aircraft and missile firms not participating in apprentice programs are relying on short-term training, upgrading, recruitment from other plants, and other haphazard methods for skilled workers. It noted that a few plants are doing excellent work in training skilled craftsmen, but that they are too few to carry the training responsibility for the industry.

The Labor report states further that the chronic skilled-manpower shortages in the industry over the past few years point up the need for developing adequate training programs in many plants not presently training workers to meet their skilled manpower needs.

Full text of the Labor study, entitled *Training in the Aircraft Industry*, is available free from the Publications Branch, Bureau of Training and Apprenticeship, Dept. of Labor, Washington 25.

## Douglas Employes Get Pay Raise

More than 7,000 salaried employes at the five divisions of Douglas Aircraft Co. were scheduled to receive a pay increase ranging from 4% to 7% effective January 7. Average rate of increase was placed at more than 5%.

The new wage hike effects all salaried employes except those represented by the Southern California Professional Engineering Assn. Similar upward adjustments are scheduled by the company for some 3,400 represented by SCPEA upon approval of the pay formula by the union membership.

## No Seniority Loss In Missile Move

Transfer of employes in Lockheed Aircraft's Missile Systems Div. from Van Nuys to the San Francisco Bay area will involve no loss in seniority. Company has signed a new wage agreement with Local 508, International Assn. of Machinists.

## Republic Launches Engineering Training

Republic Aviation Corp. this month will inaugurate a non-credit, college-level training program to be conducted on company time for its engineering personnel. A series of 15-week courses taught by Republic engineers will extend from drafting room mathematics to stress analysis. The company expects enrollment eventually will reach 1,500.

The new program is designed to ease the shortage of trained technicians by upgrading the qualifications of personnel now employed, according to Republic president Mundy I. Peale. Classes begin on January 7.

## Two Missile Firms Plan Denver Plants

Two missile accessory firms, both subcontractors to The Martin Co. in its *Titan* ICBM project, are planning to open new facilities near Martin in Denver. One is Associated Missile Products Corp. located at Pomona, Calif. and the other Hallamore Electronics Co. of Anaheim, Calif. Latter is a division of Siegler Corp. of Chicago, Illinois.

Associated Missiles will locate a field office at 3550 So. Inca St. and

expects to maintain about 60 to 65 engineers at the new facility. It will be headed by William Entrickin, former general manager of AMF's Micro-Pak Division in Colorado Springs.

Hallamore plans to open its Denver office at 1301 W. Third Ave. later this month and expects to expand by late 1957 to a staff of between 500 and 600 employes and payroll of about $300,000.

Pentagon has clamped a top secret cloak on the activities of both companies in the *Titan* project, a positive indication they are both key producers in the vital missile program.

## Aircraft, Missiles Top $3 Billion

Air Force and Navy contract awards in October 1956 for aircraft, missiles and drones and related equipment totaled $387 million raising their total obligations for the first quarter of fiscal 1957 to $3,235,000,000.

Of this amount, AF obligated $181 million in October and $2.19 billion for the four months. Navy placed $206 million in orders in October and $1,045,000,000 for the four month period since July first.

Air Force spending, meanwhile, totaled $613 million in October and $2,117,000,000 from July through October whereas Navy figures were $169,000,000 and $580,000,000 respectively. Total spending for both services for the Fiscal 1957 first quarter in aircraft and missile categories amounted to $2,697,000,000.

## Aviation Industry No. 1 Employer

The nation's aircraft industry, including an ever-increasing activity in guided missile development and production, became the nation's largest commercial employer in 1956, according to Aircraft Industries Assn.

AIA's year end report placed average industry employment at 800,000, an estimated 50,000 above the automobile industry in second place. It also noted that aircraft and missile workers increased their hourly earnings from an average $2.17 in 1955 to $2.31 by September 1956 with the trend still on the increase at the year end.

AIA also predicted a substantial change in the proportioning of Defense aircraft and missile orders in the future. By 1958, it said, military aircraft and related equipment procurement probably will assume a ratio of 65-to-35 in favor of manned aircraft over missile.

By as early as 1961, however, AIA viewed the possibility this ratio may become 50-50.

**TO ALL ENGINEERS** (ELECTRICAL, MECHANICAL, AERONAUTICAL, CHEMICAL)
**METALLURGISTS, CHEMISTS, MATHEMATICIANS, PHYSICISTS.**

# How did you do in '56?

*Engineers and Scientists from Many Fields Urgently Needed for Rocket Work at Reaction Motors*

This is the time to consider all the advantages and disadvantages of your present position and decide whether you should make a change in '57. Once you've taken stock of '56 and your prospects for '57, you will find it well worth your while to consider these unsurpassed career positions.

Reaction Motors offers high-calibre positions to professional men with or without rocket experience—no faster growing industry or company in America—earn top salaries and benefits in a field known for its big rewards—enjoy advantages of both military and industrial applications. If you have worked in any one of a large number of diverse fields, RMI can turn you into a successful rocket man—FAST.

**Now's the time to take inventory. Do as businessmen do; it's smart to take stock of your progress and compare—**

- ☐ Opportunity to work with leading technical authorities in the field.
- ☐ Work assignments that demand your best skills, give you full scope.
- ☐ Important responsibility without excessive supervision.
- ☐ Opportunities to advance your education in fine graduate schools.
- ☐ Maximum training with assignments necessary to your self-development in a series of brand new fields.
- ☐ Tremendous growth opportunities where your security is assured in a field marked for great strides.
- ☐ Top scale salaries at all levels, in full recognition of your skills.
- ☐ Frequent professional advancements.
- ☐ Good, pleasant suburban communities—minutes from work.
- ☐ Entertainment and cultural facilities of New York City just 50 minutes away.
- ☐ A year-round mountain lake resort in your backyard.

## LOOK OVER THE BROAD RANGE OF EXPANSION-CREATED ASSIGNMENTS IN OUR MAIN PROJECT AREAS:

Missiles—Piloted aircraft—Launching devices—Ground support equipment—Liquid and solid propellant chemistry—Nuclear rockets

| | |
|---|---|
| Engine design | Combustion phenomena |
| Project engineering | Applications engineering |
| Test | Fluid flow |
| Analog simulation | Thermostress and vibration |
| Chemical kinetics | Servo mechanisms |
| Instrumentation | High temperature alloys |
| Aerodynamics | Nuclear applications |
| Data reduction | Technical planning (advanced design) |
| Controls (hydraulic, pneumatic, electrical) | Proposals |

*To find out just where YOUR present skills fit in with the growing RMI picture, drop us a note or card. (Include address and phone number.) For immediate action, ask for an application form, or send complete resume to* ***Supervisor of Technical Personnel***

*Power for Progress*

**REACTION MOTORS, INC.** — A MEMBER OF THE OMAR TEAM

50 FORD ROAD, DENVILLE, N. J.

# West Coast Stresses Engineer Shortage

Los Angeles Council of Engineering Societies, acting jointly with the Technical Societies Council and Consulting Engineers Assn. have set aside February 18-22 as Engineering Week in Los Angeles. Its dual purpose will be to focus public attention on the growing shortage of engineers and their importance to the well-being and security of the nation.

General chairman of the activity will be J. Calvin Brown, a past national president of the American Society of Mechanical Engineers. Guest speaker at a banquet February 21 at the Statler Hotel will be Donald W. Douglas, president of Douglas Aircraft Co. Douglas also will be presented an award in recognition of his contributions to engineering and the Southern California aircraft industry.

# Aerojet to Expand Plastics Activity

Aerojet-General Corp. has announced plans for major expansion of its structural plastics group within its Solid Engine Division. The program calls for new buildings and equipment to facilitate plastics research, development and manufacturing.

Main areas of activity for the group, headed by E. L. Rucks, will be in the fields of pressure vessels, thermal insulation and missile/rocket components.

# Minn-Honeywell Forms New Division

Minneapolis-Honeywell Regulator Co. is combining the operations of its Doelcam Division and Transistor Division into a single organization identified as the Boston Division.

The new M-H unit will have two sections—semiconductor products and instruments—under division v.p. and general mgr. George J. Schwartz.

# Employment Up in San Diego Area

Employment by San Diego's four major aircraft and missile manufacturers or subcontractors totaled 50,898 on December 15 marking an increase of 1,550 over November 20.

Convair reported 35,022; Rohr Aircraft Co. 7,148; Ryan Aeronautical 5,928 and Solar Aircraft 2,800. Convair employment increased 1,356 in the preceding two-week period.

ENGINEERS · SCIENTISTS

# RECENT BREAKTHROUGHS IN SUPERSONIC AND HYPERSONIC KNOWLEDGE AND TECHNOLOGY— BASIS OF MAJOR RESEARCH AND DEVELOPMENT ACCELERATION AT REPUBLIC AVIATION

*Alexander Kartveli, Vice President in Charge of Research and Development, Invites the Inquiries of High Calibre Engineers and Scientists*

Recent discoveries justify a large scale, long range integrated attack on all the complex, interrelated aspects of passage through the upper atmosphere, in the opinion of Alexander Kartveli, creator of Republic's famous family of Thunder-Craft.*

Republic's R & D activities are now being materially augmented and accelerated to speed the exploration of this new knowledge and technology. The broad areas under study are:

- **Hypersonic and Satellite Weapons Systems.**
- **Advanced Propulsion Systems.**
- **Nuclear Energy Applications to Aircraft.**
- **Capabilities of Materials in Hypersonic and Nuclear Environments.**
- **Electronic systems development to exploit the full potential of the most radical concepts of flight.**

The quality of the opportunities for creatively unhampered professional men with specialized experience in many fields is evident. Republic welcomes your inquiries regarding positions in any one of the areas outlined:

*Positions Open At All Levels*

NUCLEONICS
ELECTRONICS
SERVOMECHANISMS
PROPULSION
STRUCTURES
FLUTTER & VIBRATION
DYNAMICS
AERODYNAMICS
THERMODYNAMICS
FIRE CONTROL SYSTEMS
FLIGHT CONTROL SYSTEMS
INERTIAL NAVIGATION
INFRA-RED
OPERATIONAL ANALYSIS OF WEAPONS SYSTEMS
AIRFRAME AND SYSTEMS DESIGN
MATERIALS

*Each Thunder-Craft in turn has represented a significant advance in aircraft design. Latest member of this famous family is the incredible F-105 Thunderchief, most advanced USAF fighter-bomber — supersonic and nuclear-weapons carrying.

*Please forward comprehensive resume in confidence to David G. Reid, Engineering Personnel Mgr.*

**REPUBLIC AVIATION**

FARMINGDALE, LONG ISLAND, NEW YORK

# Advertisers Index

# TAKE ADVANTAGE OF MISSILES AND ROCKETS NEW SUBSCRIBER SERVICE

## DO YOU WANT MORE INFORMATION ABOUT NEW MISSILE AND ROCKET PRODUCTS?

All you do is circle the number on the card to the left that corresponds to the number following the items mentioned inside this magazine.

## DO YOU WANT MORE DETAILS ABOUT THE ADVERTISED PRODUCTS OR SERVICES IN MISSILES AND ROCKETS?

This data are yours for the asking. Just circle off the proper number indicated below or next to the particular advertisement you want to know more about. Your request for information will be forwarded promptly to the companies concerned.

**MAIL YOUR SUBSCRIBER SERVICE CARD**

*Today*

MISSILES AND ROCKETS
JANUARY, 1957
Expires 30 Days After Above Date

NAME ____________
TITLE/POSITION ____________
COMPANY ____________
ADDRESS ____________
CITY ________ ZONE ______ STATE ______

*Card cannot be processed unless all information is given.*

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• • **Advertisements**

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

• • **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

For Other Information Give Page Numbers: ____________

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY ADDRESSEE

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

**AMERICAN AVIATION PUBLICATIONS**
17 EAST 48TH STREET,
NEW YORK 17, N. Y.

SUBSCRIBER SERVICE DEPT.

# MISSILES AND ROCKETS INTRODUCES A NEW AND SPECIAL SUBSCRIBER SERVICE

Do you want detailed data about the latest in missile and rocket or satellite components and related equipment? Want to know more about the advertised products in this and future copies of Missiles and Rockets?

All this information is yours for the asking, through Missiles and Rockets' new and special Subscriber Service. All you do is circle off in pen or pencil the number that corresponds to the particular item you want to know more about. Then fill out the reply card, tear out and mail it to us. (If you live outside the U.S.A., please add proper postage to this reply card).

The Editors of Missiles and Rockets hope you will benefit from this new service. Write and give us your comments and suggestions for any further improvements you'd like in Missiles and Rockets.

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

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

POSTAGE WILL BE PAID BY ADDRESSEE

AMERICAN AVIATION PUBLICATIONS
17 EAST 48TH STREET,
NEW YORK 17, N. Y.

SUBSCRIBER SERVICE DEPT.

NAME ______
TITLE/POSITION ______
COMPANY ______
ADDRESS ______
CITY ______ ZONE ______ STATE ______

*Card cannot be processed unless all information is given.*

MISSILES AND ROCKETS
JANUARY, 1957
Expires 30 Days After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• • Advertisements

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

• • 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

For Other Information Give Page Numbers: ______