April 25, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

Astronaut Fights to Leave *Mercury* Capsule

AN AMERICAN AVIATION PUBLICATION

COMPONENT KNOW-HOW
THE KEY TO SYSTEMS CAPABILITY

In systems development there is no substitute for experience in component and subsystem design. For more than five years, Daystrom's Pacific Division has been providing gyroscopes, transducers and other basic building blocks for major airborne and missile systems. The development of equally reliable airborne instrument systems has further enhanced the Pacific Division's overall capability.

Backed by its parent organization, Daystrom, Incorporated, the division has expanded its airborne instrument and subsystem work to include systems development programs that require the competency of an outstanding technical team... the thinking and abilities of an advanced planning group.

If you are responsible for the development of a major systems program, you will be interested in the experience and systems capability of Daystrom, Incorporated, Pacific Division. Write for our engineering brochure—File No. MR-876-1.

Openings exist for qualified engineers.

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PACIFIC DIVISION
9320 Lincoln Boulevard, Los Angeles 45, Calif.

potentiometers / gyro instruments / airborne systems

Circle No. 1 on Subscriber Service Card.

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

MARMAN

Leads in Joint and Coupling Engineering

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

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

CONOSEAL is an Aeroquip Trademark

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MARMAN DIVISION

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

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

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

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

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

CONOSEAL Joints provide zero-leakage connection of tubing and piping over temperature range of —300° F. to +2000° F., pressures to 20,000 psig.

Wide range of products on display at Design Engineering Show, May 23-26, New York—Booths 1809 and 1908.

The only operational cartridge starter...

SPECIFICATIONS:

Output shaft speed	3000 rpm (max)
Dry weight (not including cartridge)	60.0 lbs (approx)
CARTRIDGE STARTING	
Operating temp.	—65° to 160°F
Chamber pressure normal operation	850 psi
Safety plug diaphragm burst pressure	2000 psig (nominal)
Operating voltage	15 to 32 volts
PNEUMATIC STARTING	
Operating air pressure and temp.	50 psia and 350°F (nominal)
Operating air flow	100 lbs per min (approx)

AIRESEARCH'S CARTRIDGE/PNEUMATIC STARTER *has completed more than 20,000 successful cartridge starts for the F-100, F-105 and Hound Dog missile applications.*

Completely fail-safe, this lightweight package is the only cartridge starter capable of full containment of a wheel hub burst.

The AiResearch starter is extremely flexible and compact, making it easily adapted to any jet engine envelope. For example, the same starter now used on the Hound Dog missile can be delivered immediately for use on the B-52 itself.

This self-contained, aircraft-installed starting system provides quick, dependable starts in any climate or location by means of high temperature cartridge gases *or* low pressure air such as supplied by an AiResearch gas turbine serving as an onboard pneumatic power source or conventional ground support unit.

The starter consists, basically, of an air turbine starter and a removable solid propellant cartridge chamber. Combustion of the cartridge directs high pressure gas against the turbine wheel, turning the output shaft. Overspeed is controlled by aerodynamic braking action of air compressed by radial blades on the other side of the turbine wheel.

This simple system consists of proven components with many thousands of hours of successful operating history. The pioneer and leading manufacturer of air turbine starters of all types for both military and commercial application, AiResearch has more than four years of cartridge experience and 12 years' experience in pneumatic starters.

Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems and Components for: AIRCRAFT, MISSILE, SPACECRAFT, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

THE MISSILE / SPACE WEEKLY

missiles and rockets

April 25, 1960 Volume 6 No. 17

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An American Aviation Publication

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THE COVER

Project Mercury *astronaut struggles to leave his capsule during training off Pensacola. All seven astronauts have found maneuver very tough. See pictures, p. 20.*

APRIL 25 HEADLINES

ADVANCED MATERIALS

PROPULSION ENGINEERING

ASW ENGINEERING

ELECTRONICS

INTERNATIONAL

DEPARTMENTS

30,700 copies this issue

Cover Pros and Cons

To the Editor:

Congratulations on your new cover! The new format, added to your already thorough coverage of the missile/space industry, makes MISSILES AND ROCKETS even more inviting to read. Our best wishes for your continued success.

Ralph W. Sheehy
Specialist—Product Information
Defense Electronics Division
General Electric Co.
Utica, N.Y.

To the Editor:

We hope the M/R signature remains at the top of the cover. As you mentioned, its former location was hidden by the magazine rack and other means of display. We finally attached a card at the top for identification.

MISSILES AND ROCKETS seems to be a favorite with our Design and Engineering Departments and we look forward to each new issue.

So . . . we hope it stays with its new cover format.

Marjorie S. Sellstrom
Librarian
Missile Systems Division
Raytheon Company
Bristol, Tenn.

To the Editor:

With due respect to the artist involved and your expense, the new cover for M/R is just *too* ordinary for a magazine of this type. Your original cover was much more in keeping with its contents. More specifically, *keep* the signature on the lower portion of the page.

The inside changes are noticeably good, especially the idea to edit subject matter into departments.

As the mother of two small children, I find that M/R affords an excellent opportunity for me to keep abreast of the rapidly changing Space Age and thereby, intelligently discuss it with my husband and others.

Living this close to the Cape, and having a husband with Martin-Orlando, I crave all of the knowledge I can readily absorb . . .

Sorry I didn't go for the cover! Keep up to your standards.

(Mrs.) Grace H. Barnhart
Orlando, Fla.

ASW Section Greeted

To the Editor:

Your new ASW department makes a very significant contribution in assisting our planning of ASW activities. This is certainly a worthwhile addition to your already informative magazine.

William S. Wheeler
Vice President & General Manager
Military Electronics Division
Motorola Inc.
Scottsdale, Ariz.

anphier Progress Report

) the Editor:

Just saw a copy of your April 4 issue, which you gave my Press Club effort ch handsome coverage. For which, thank ou very much.

Thanks also for the thorough and ılid account you did in your magazine ı my appearance before the Space and ience Committee. As a result of report-ıg such as yours, I am having the satis-ıction, at last, of finding my point of ew clearly recorded for the considera-on of the sort of readers I appreciate aving an understanding of it.

I also note, from the public print ıese days, that the Administration is at ast and at last beginning to shift its osition to some degree toward a more ppropriate direction—if not in an appro-riate order of magnitude.

Thomas G. Lanphier, Jr.
San Diego

Reaction's Affiliation

To the Editor:

In an article on the *X-15* in a recent ssue of M/R, the writer credited develop-nent of the engine to "Reaction Motors nc." As you know, Reaction Motors has been a Division of Thiokol Chemical Cor-oration for about two years.

Because Reaction Motors was so long he only name identified with the engine's levelopment, we understand how easily a writer can forget to identify the new ffiliation.

On the other hand, the Corporation expects us to continually remind publica-ions that the name Reaction Motors should be used only when identified as a Division of Thiokol Chemical Corpora-ion. If the full credit is not possible, hen the name "Thiokol Chemical Cor-poration" or "(RMD) Thiokol Chemical Corporation" is sufficient.

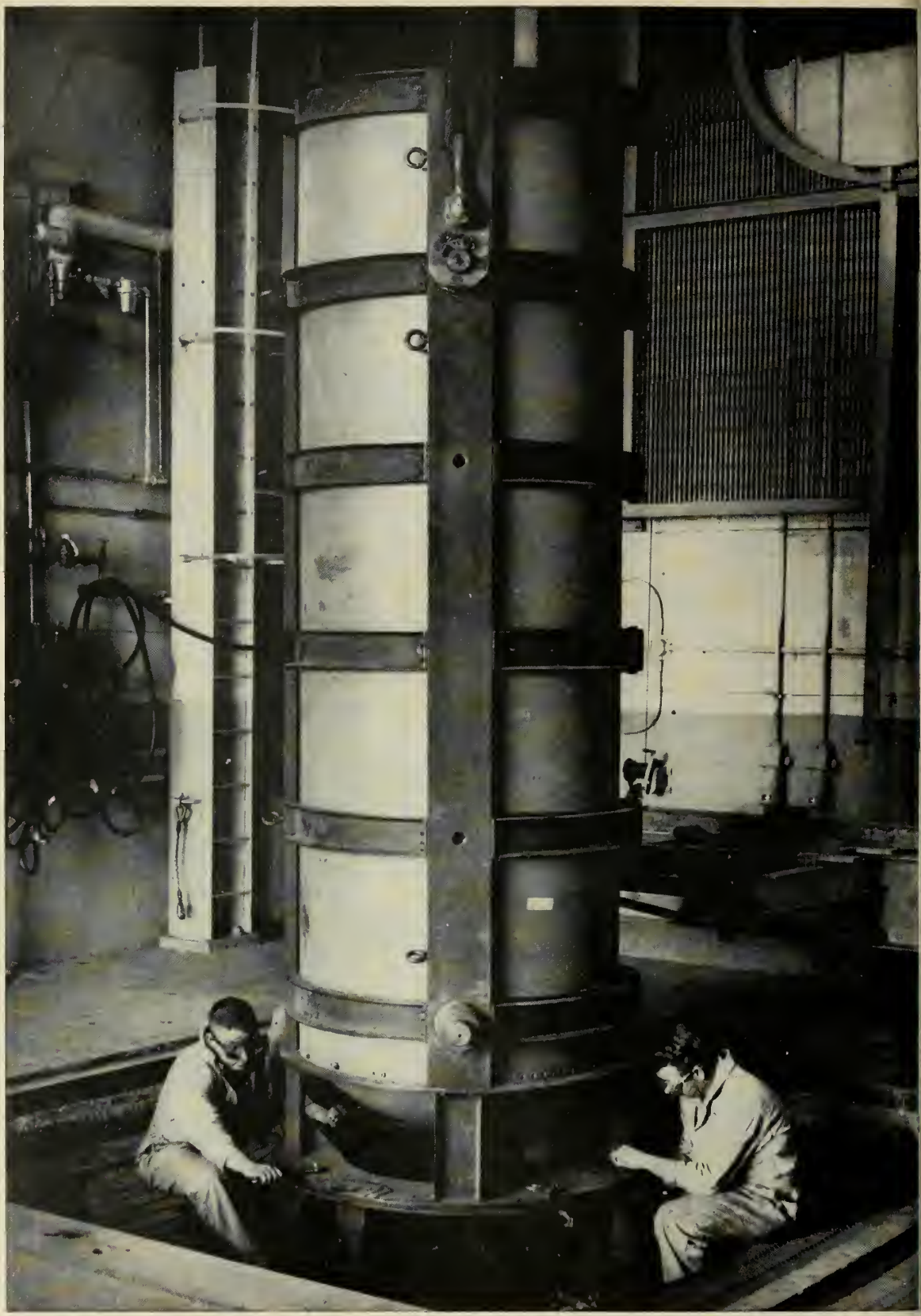
Tom Johnston
Brown & Butcher, Inc.,
Advertising
New York, N. Y.
for Thiokol Chemical Corp.

Cubic's *Mercury* System

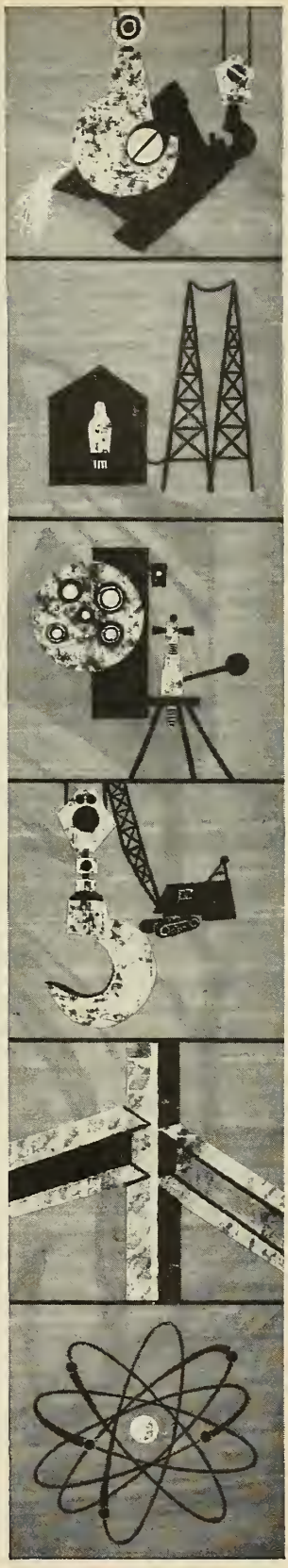
To the Editor:

In the Feb. 22 M/R you published a story regarding the Underwood-Canoga contract for antennas for Project *Mercury* ground-based telemetry, communications and command control. Actually, Underwood-Canoga, in supplying antennas for the program, is a subcontractor to Cubic Corporation, which is furnishing its AGAVE tracking system for the around-the-world task of radar acquisition and communication link with the space capsule. Our department did a general release at the time the contract was received (from Bendix), but we neglected to do a proper follow-up.

Bill Sunday
Public Relations Director
Cubic Corporation
San Diego



THIOKOL's Utah Division is fully staffed and equipped to produce solid rocket motors of unprecedented size . . . of ICBM and even satellite proportions.



Why THIOKOL subcontracts to Industry, U.S.A. in the production of rocket powerplants of unprecedented reliability.

In development of advanced powerplants for missiles like Minuteman, Nike-Zeus, Subroc, and for research vehicles like Little Joe and X-17 . . . THIOKOL draws on its own vast propulsion know-how plus the advanced technological background of scores of industrial organizations.

The Allison Division of General Motors, Scaife Company, Goodyear, General Electric, Heintz Mfg. Co., Curtiss-Wright, RCA, Solar Aircraft, Borg-Warner Corp. . . . these are but a few of the many companies, large and small, to whom THIOKOL has subcontracted in producing dependable propulsion systems.

We have called upon the pressure vessel industry to whom metals for strength are second nature to get rocket casings combining light weight and high tensile strength.

We have called upon the electronics industry whose art is instrumentation for the delicate devices required for precise testing and production controls.

We have turned to the transportation and construction industries for development of specialized equipment such as monorail systems and movable cranes needed to process giant rocket motors with unfailing precision on an assembly line basis.

Many industrial technologies are met in a rocket propulsion system. Recognizing this, THIOKOL calls on specialists to achieve highest reliability, to meet the critical rocket power requirements of national defense and space research.

Thiokol® Chemical Corporation

BRISTOL, PENNA.

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GCRE GOES CRITICAL
NEW REACTOR DEVELOPED
by AEROJET
Attainment of criticality by the Gas-Cooled Reactor Experiment in Idaho is a step forward towards compact, transportable nuclear power plants. This facility to test advanced concepts for mobile power reactors was designed and developed by Aerojet-General Nucleonics, San Ramon, California, and the Aetron Division of Aerojet-General Corporation, for the U. S. Atomic Energy Commission. As systems contractor for the Army Gas-Cooled Reactor Systems Program, Aerojet is designing the world's first mobile power plant.
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CORPORATION
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Engineers, scientists—investigate outstanding opportunities at Aerojet.

The Countdown

WASHINGTON

ubroc May be Scrapped for *Aster*

Serious development problems reportedly have hit *Subroc*, the Navy's 25-50-mile-range underwater or surface-to-underwater missile. The trouble lies mostly in conversion to surface launch. COUNTDOWN has learned the Navy is seeking a replacement by marrying the *Asroc* torpedo to the *Terrier* antiaircraft missile. Applied Physics Lab, Vitro and Ford Instrument are working on the new missile—called *Aster* (not to be confused with Westinghouse's *Astor* rocket torpedo). *Aster* would have 30-35 mile range, with the torpedo dropping away from *Terrier* carrier rocket over the target.

Hottest Issue: *Polaris* Subs

Insiders are saying the Mahon House Military Appropriations Subcommittee is getting ready to vote more construction money for *Polaris* submarines—at least six instead of the three in the Eisenhower budget. The decision will come late this month. Though the Administration said it would up funds for long leadtime items from three to nine subs, the feeling in Congress is that three more subs in hand are worth nine in the bush.

Sea Launcher for *Minuteman*

The Air Force is believed to be getting ready to spring a new type of submersible launcher for *Minuteman* on the Navy in the continuing fight over fixed and mobile sites. A proposal is being advanced. COUNTDOWN is told, to put the missiles in platforms similar to Texas Towers. The platforms would be able to move beneath the surface of the ocean—or maybe lakes. At the time of launch legs would be lowered to the ocean floor and the platform would rise to surface to fire the birds from tubes.

First Capsule Abort Shot

First of two NASA shots coming next month will attempt the first abort of an operational *Mercury* capsule (unmanned) at Wallops Island on May 4. It will be a pad abort triggered by the escape rockets. On May 5, the first attempt to orbit a 100-ft. *Echo* passive communications satellite will be made with a *Thor-Delta* at Cape Canaveral, if all goes according to schedule.

INDUSTRY

Vitro Drops $200,000 on Proposal

Latest victim of the high cost of military contract proposals is Vitro Laboratories. The company is reported to have spent $200,000 in an unsuccessful bid for the Fort Huachuca, Ariz., electronic range. Pan American won the contract, expected to run to $40 million.

Boeing, Westinghouse Boost ASW

Major drive for ASW business is quietly under way at Boeing Aircraft, which is said to have spent about $750,000 building in-house capability . . . In a move to strengthen its ASW effort, Westinghouse has appointed Adm. L. J. Down (USN-Ret.) as staff assistant for ASW Activities, a new position in the company's Defense Products Group. Down has been with the company since 1957.

Excuse for the Arsenal?

The Army is quietly boasting that its Rock Island, Ill., arsenal is bringing in the *Davy Crockett* bazooka-type nuclear-warhead missile with just three years leadtime. The first operational type *Crocketts* are already available for demonstration firings. Some Army R&D men are contending industry couldn't have done the job this fast.

AF Halves Propulsion Dollar

Liquid fuels are far from dead in the Air Force research book, though solids are gaining. Of $23.6 million for rocket R&D in the 1961 budget, the AF is asking $11.4 million for liquids and $12.2 million for solid-rocket technology.

Titan Base-Building Pushed

Sites for only four more *Titan* squadrons remain to be selected. The Air Force has named Davis-Monthan AFB, Tucson, Ariz., and McConnell AFB, Wichita, Kan., as locations for two squadrons each. This brings to ten the number of squadrons—all underground—either ready or being built. Cost of the last two facilities will be $80 million apiece.

INTERNATIONAL

Soviet 50-60 Pad ICBM Base

Reports seeping under the Iron Curtain have the Russians constructing one of their largest ICBM bases at Semipalatinsk, at the western edge of the Kazakh Uplands. Many of the 50 to 60 pads are complete, so the reports go. and all of them are "soft" above-ground launchers.

Red Chinese Satellite Shot

Round-about word reaching Washington, and thought to be reliable, says Red China is preparing for a satellite launching within 10 months.

French Eye *Polaris*

The French are reported considering cancellation of their land-based IRBM, which is still in the development stage, if they can procure *Polaris* missiles. Like the British, the French favor deployment of long-range missiles on mobile platforms, either submarines or barges.

For Technical Countdown, See Page 29

TO REACH THE MOON... MEN AT WORK

These men are ARMA researchers. They are putting to use a three-dimensional Trajectory Analyzer, designed and produced by them to provide simple, visual understanding of the complexities involved in guiding missiles to interplanetary bodies.

Today they use it in their studies of trajectory kinematics and missile guidance in lunar orbits. Sometime soon they will employ it to study travel to other bodies.

The Trajectory Analyzer—with which the trajectory of any computer-simulated or real missile can quickly be plotted *in grease pencil*—demonstrates the ingenuity and analytical ability of ARMA's imaginative research staff, creators of the Atlas ICBM inertial guidance system. Their experience and performance are unequalled in the broad field of space navigation.

ARMA, because of its *people*, will find many of the answers in astronautics. ARMA, Garden City, N.Y., a division of American Bosch Arma Corporation . . . the future is our business.

7403

AMERICAN BOSCH ARMA CORPORATION

Twelve-foot diameter dish of WSR-57 "Stormfinder" radar. System operates at S band, has 250-mile range, 500 Kw output.

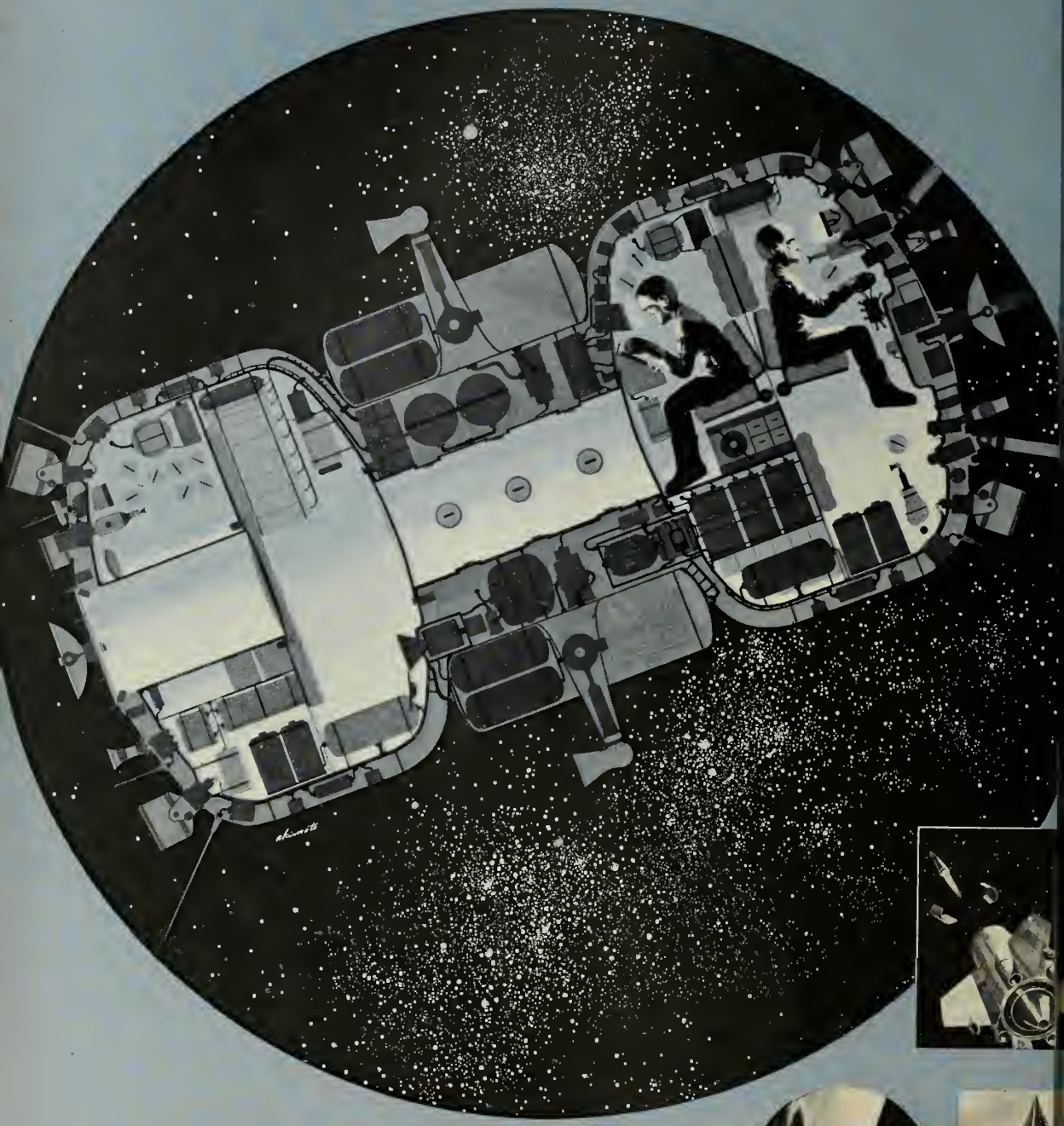
Now being delivered to the U. S. Weather Bureau are WSR-57 weather detection radars. Each unit covers 200,000 square miles, tracks storms, identifies rain, snow and fog. This equipment is designed and produced by Raytheon.

RAYTHEON COMPANY, WALTHAM, MASS.

RAYTHEON

EXCELLENCE IN ELECTRONICS

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY



THE

STROTUG

Tugboat for Space: Spaceborne scientific laboratories and platforms for further exploration into space are an accepted concept based on established engineering techniques. Components would be fired as individual units into space, on precalculated orbits, and there assembled. To solve the major problems of how men are to live and work in space during the assembly process, Lockheed has prepared a detailed engineering design of an astrotug—a manned vehicle housing a crew of two or three. Missile-launched, the astrotug will be capable of supporting its crew for a number of days in an environment of suitable atmosphere, artificial gravity, and with provisions for exercise, relaxation, bathing facilities, medical care, illumination and adequate food and water.

The Lockheed astrotug is a completely independent working vehicle. Personnel need not leave it in space suits in order to work on the project of assembling the space station components. As shown in the diagram, the tug consists of two double-walled pressure vessels approximately 20 feet long overall and 9 feet in inside diameter. Swivelling rocket nozzles are arranged for maneuvering. On the forward end, extending out are four mechanical manipulator arms with interchangeable "hands" for such specialized functions as gripping, welding, hammering, cutting, running screws, etc. "Hands" can be changed by remote control from inside. Viewing ports provide uninterrupted observation. Radar antennas, searchlights, and other equipment necessary to the tug's work are mounted externally. Main controls and instruments including radar, radio, infrared, computers and navigation consoles are duplicated in each of the two major compartments as a safety measure.

Men working in single units afloat in space suits would have little applicable force and could work for very limited periods of time. With the Lockheed astrotug, personnel could carry on the work in relative safety and comfort with maximum efficiency. A special reentry vehicle, separate from the astrotug, has been conceived for ferrying to and from earth. Tugs themselves would remain floating in orbit indefinitely, being reprovisioned and refurbished as fresh crews arrive in relief.

Space vehicle development is typical of Lockheed Missiles and Space Division's broad diversification. The Division possesses complete capability in more than 40 areas of science and technology—from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetohydrodynamics; man in space; materials and processes; applied mathematics; oceanography; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sonics; space communications; space medicine; space navigation; and space physics.

Engineers and Scientists: Such programs reach far into the future and deal with unknown and stimulating environments. It is a rewarding future with a company that has an outstanding record of progress and achievement. If you are experienced in any of the above areas, or in related work, we invite your inquiry. Please write: Research and Development Staff, Dept. D-29B, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense clearance required.

Lockheed

MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; the Air Force AGENA Satellite in the DISCOVERER Program and the MIDAS and SAMOS Satellites; Air Force X-7; and Army KINGFISHER

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CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII

Circle No. 6 on Subscriber Service Card.

CAREER OPPORTUNITIES AT ATLANTIC MISSILE RANGE AND FORT HUACHUCA

Service to scientific exploration has been performed by the Guided Missiles Range Division of Pan American World Airways since 1953.

Pan American has prime responsibility for the engineering, operation and maintenance of the Air Force Missile Test Center's 5,000 mile Atlantic Missile Range beginning at Cape Canaveral.

Now, having been awarded a prime contract by the Army Signal Corps, Pan Am has the new responsibility for engineering and operating an Electronic Environmental Test Facility near Fort Huachuca, Arizona. Fort Huachuca will be the brain center of the Test Facility, where information gathered in the field will be analyzed in the Army's automatic data processing facilities, among the most modern and complete in the world.

Additionally, Pan Am will engineer, install, operate and maintain facilities for a test range for Army drone aircraft, with drone flights to be monitored by radars, telemetry, and optical equipments.

Openings for:

ENGINEERS
- Telemetry
- Optics
- Communications
  - Command Control
  - Microwave
  - UHF
  - VHF
- Civil
- Electrical

PHYSICISTS

MATHEMATICIANS

TECHNICIANS
- Radar Operators
  - SCR 584
  - MPQ 12
  - FPS 16
- Telemetry
- Communications
- Optics

To investigate career opportunities with Pan Am at the Atlantic Missile Range, contact J. B. Appledorn, Dept. B-18, Guided Missiles Range Division, Patrick AFB, Florida; or at Fort Huachuca, contact C. A. Hodgins, Dept. B-18, 1535 East Broadway, Tucson, Arizona.

PAN AM

GUIDED MISSILES RANGE DIVISION

PATRICK AIR FORCE BASE, FLORIDA

3M Materials Memo

News of materiel for the aerospace industry—from the 27,000 products of the 3M Company

■ GOT A DIRTY BIRD?

You needn't have. Missile "raincoats" made from 3M's new 4222 coated fabric protect against not only the ravages of the weather, but the attack of solvents and fuels, as well. This new polyester coating, available on nylon, Dacron, glass cloth, or other types of fabrics, is by no means a fair weather friend. It takes the punishment of wind and salt spray, has abrasion resistance greater than all other commonly used coatings, and offers excellent resistance to mildew. It's no slouch either when skies are blue. It has superior sunlight and ozone resistance. At temperatures as low as −80°F, it retains its flexibility and it's still in there pitching at 375°F. What's more, this low temperature flexibility is permanent. There are no plasticizers to bleed out upon aging.

The fuel and solvent resistance of this versatile fabric is a story in itself. It's quite at home with aromatics, aliphatics, ketones, and esters, as well as jet fuels, synthetic ester oils and hydraulic fluids. These characteristics have literally revolutionized the thinking in storage of fuels. For example, by today's standards, do you know the difference between a fuel tank and a hole in the ground? The answer is 4222 fabric of course! Spread out as a fuel resistant layer over the surface of an excavation, the hole becomes a cheap, safe storage well for jet fuels, diesel fuels, or oils. The finishing touch is another layer of 4222 to provide a cover.

Armed with these remarkable properties and your imagination, even the sky's no limit for you and 4222. For more information, either check below or see your ELECTRICAL PRODUCTS representative.

■ A BRIGHT IDEA!

Ever think of getting your illumination by the gallon? As farfetched as it may seem — such a thing is possible now, thanks to 3M's "CODIT" reflective liquid. Night handling and launch operations need no longer hold any qualms for you, if you take advantage of "CODIT's" unique retro-reflective properties.

"CODIT" has been "showing up" on the electrical connectors in many of today's missile systems. A quick glance with a portable light shows you in an instant whether these vital connections have been properly made. Even the security people are praising the virtues of "CODIT" in its ability to quickly show whether enclosures are open or closed, fences have been cut, or a piece of equipment has been moved or taken from a storage area.

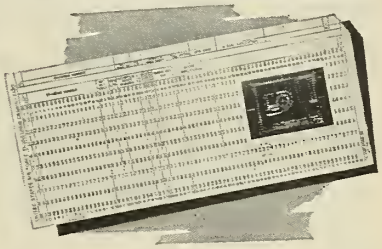
"CODIT's" suspension of special reflective elements in a solvent dispersed vehicle returns light directly back to its source about 60 times as bright as any white paint could. Furthermore, it reflects at all angles, too. You still get reflectance when your viewing angle is almost 90° with respect to the normal of the coated surface. This is particularly important on rounded or complex shapes.

"CODIT" can be applied by spraying, brushing, hand rolling, or silk screen printing to most clean, dry surfaces. It even takes concrete, rough metal, and wood in its stride. Having a durability comparable to a high grade of exterior enamel, it can be used for exterior applications provided the surface is weatherproof or suitably treated. There is more information to be had from your REFLECTIVE PRODUCTS representative or clip the coupon below.

■ THE HOLE STORY

Want to know what's in a missile? Chances are you can find out from a "Filmsort" Aperture Card, a product of THE FILMSORT COMPANY, one of the divisions of 3M. The engineering drawings for the components of a missile go into these "Filmsort" Aperture Cards. It's no trick to put an engineering drawing as big as 34 x 44" into a standard punch card. All you do is microfilm the 34 x 44" drawing first. The "Filmsort" Aperture Card is simply the winning combination of microfilm and punch cards.

What does The Filmsort Company do? It produces the aperture cards that make microfilm standard, simple and practical.



Several agencies and their prime contractors for missile systems use these "Filmsort" Aperture Cards to keep up with the pace of the space age. These cards have something to do with time — not the time in space, but the time in our everyday world. Seems that in less than 90 seconds, you can put your hands on any one of these cards out of thousands in a file. Then, simply take the "Filmsort" Aperture Card to the *Thermo-Fax* "Filmac 200" Reader-Printer. Now, you can take a look . . . or, take more than a look, take a copy. That's all it takes to get a print these days.

If you'd like to learn more about these "Filmsort" Aperture Cards and expect to be in New York April 19-21, see a demonstration at the National Microfilm Convention in the Statler-Hilton Hotel. If you're chained to the desk then The Filmsort Company will be glad to send you the hole story if you'll so indicate below.

■ ABOUT "MIL"

3M's Missile Industry Liaison is a service staffed by technical personnel experienced in rocket propulsion and other phases of space technology. Their job is to translate problems of the aerospace industry to those 3M specialists best qualified to solve them. If you have questions on any of the items mentioned here, or would like to know what else 3M makes—or could make —for your needs, mail coupon.

3M Company, Missile Industry Liaison — VAB-40
St. Paul 6, Minn.

Please send more information on ☐ 4222 Coated Fabric
☐ 3M "CODIT" Reflective Liquid ☐ "Filmsort" Aperture Cards

NAME_____

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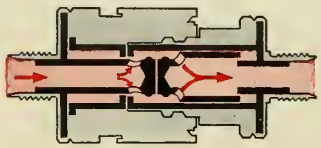
CITY_____ ZONE_____

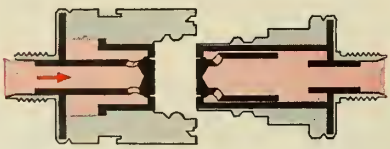
STATE_____

. . . it's a no-spill valved coupling by Snap-Tite!"

To use Snap-Tite Valved Coupling:



CONNECT—Full flow instantly



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The 15 Series valved coupling automatically snaps off the flow of the most volatile fluids when disconnected—with no leakage.

Snap-Tite's 15 Series valved coupling contains valves in both sections. Thus, the only fluid lost is that which clings to the outer metal surfaces. This coupling meets military specifications and can be used with fuels and other fluids to 3000 psi working pressure and 400°F. Sizes: 1/4", 1/2", 3/4", 1" in 6061T6 aluminum anodized; 3/8" in steel (electroless nickel plated), and 6061T6 aluminum.

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ST-59-03

House Fights Over DOD-in-Space

by James Baar

Members of the House Space Committee have plunged into a backstage fight over whether the military should be given a bigger role in space at the expense of the expanding National Aeronautics and Space Administration.

The principal target of some members: President Eisenhower's repeated insistence that the military has no business in space beyond a few hundred miles.

The Committee scheduled a series of closed-door meetings this week to act on a series of Eisenhower-proposed amendments to the National Space Act.

Committee members are sharply divided over whether the amendments go far enough in clarifying the Pentagon's space role. Some contend that the present division of space activities between the Pentagon and NASA needs only the minor adjustments included in the amendments. Others contend that much greater changes are needed or the nation's defenses will suffer in the coming decade.

• **Watch McCormack**—House Majority Leader John W. McCormack (D-Mass.), a top-ranking Democrat on the committee, looms as a principal factor in which way the committee vote will go.

The shrewd, white-haired Democratic leader is known to have been concerned for months about the growing operations of NASA in space as opposed to the shrinking activities of the military services. His influence could easily swing enough votes to insert a tough military clause in the Space Act.

The key part of the proposed amendments is Section 309. It says:

"Nothing in this act shall preclude the Department of Defense from undertaking such activities involving the utilization of space as may be necessary for the defense of the United States, including the developing of weapons systems utilizing space vehicles and the conduct of supporting research connected therewith.

"In order to accomplish the most efficient utilization of resources, responsibility for the development of each new launch vehicle whether intended for use by (NASA) or the Department of Defense or both, shall be assigned by the President to either (NASA) or the Department of Defense."

Critics charge that the Section 309 in plain English means that the Pentagon can expand its activities in space if the Administration gives it permission to do it. And, they add, the Administration has no intention of doing it.

• **WW II approach?**—Rep. B. F. Sisk (D-Calif.), another high-ranking member of the Space Committee, says "it is imperative that the Defense Department not be hamstrung" in developing space weapons.

"The President is still living back in World War II," Sisk said. "This is not a partisan matter. Everyone who is living with this situation day by day, all of the top military research men coming before our committee, disagree with the President.

"The Space Act should be amended to upgrade the Defense Department's space role."

• **Ike defended**—However, Rep. James G. Fulton (R-Pa.), another high-ranking committee member, contends the best thing that can be done for the Space Act is "to make it less rigid."

"The President's amendments are good because they allow room for more give and take," he said. "Both NASA and the Pentagon have important roles in space and if they overlap that's all to the good."

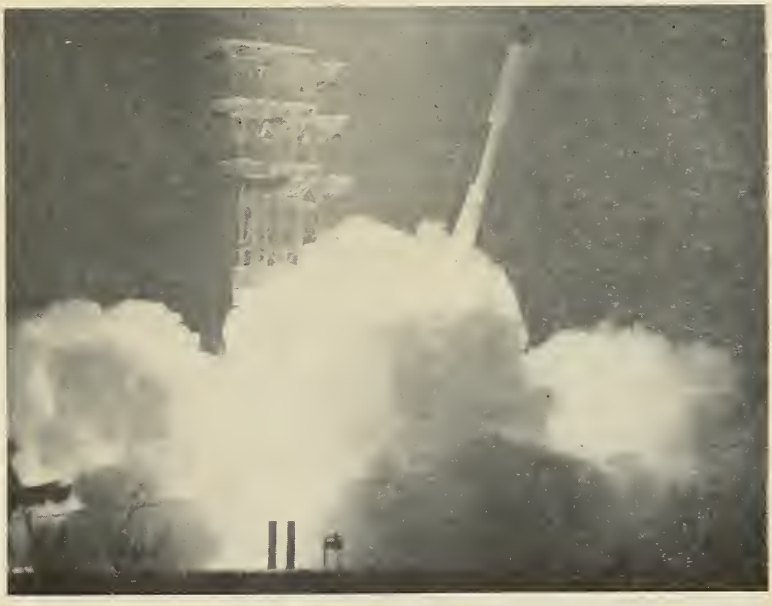
He disagreed that the amendments would shortchange the military, even if NASA developed all of the nation's big boosters.

"That's strictly a matter of procurement," he said.

Military officials violently disagree. They contend that forcing them to go to NASA for boosters cripples military space programs. They say that such an arrangement results in not getting the kind of boosters they want or the number they want when they want them.

This is the heart of the dilemma before the Space Committee.

First Scout Gets Off—Fails



NASA launched the first test model of the solid-propellant *Scout* four-stage satellite launching vehicle from Wallops Island, Va., April 18, with mixed results.

Only the Aerojet 100,000-lb.-thrust *Algol* first stage and the Hercules 10,000-lb.-thrust *Antares* third stage were tested. The *Algol* functioned successfully, lifting the vehicle to an altitude of 30 miles and about 80 miles out over the Atlantic. The *Antares* motor failed to ignite.

The second-stage *Castor* engine by Thiokol and the fourth-stage X-248 *Altair* engine were not used because they already have been flown.

Aerojet said the *Algol*, which burned about 40 seconds, was the largest solid rocket ever flown. It is a modified *Polaris* test vehicle, with a single nozzle instead of four.

production delay . . .

Mobile *Polaris* for Britain Will Take 15-Month Minimum

Even if it acts quickly, Britain faces a wait of at least 15 months in obtaining mobile-based *Polaris* missiles to replace its cancelled *Blue Streak* IRBM, M/R has learned.

The time lapse will be even longer —four years—for the *Skybolt* air-launched ballistic missile, which is still under development.

There is likelihood that there will be a delay of several months before any extra production of *Polaris* is authorized. The United States, rather than sell *Polaris* directly to Britain, wants the British to procure it through NATO.

There was speculation that France also may want to buy *Polaris*. This could further complicate the funding and build in more delay in stepping up production.

Authoritative sources gave this timetable for producing operational *Polaris* missiles (assuming sufficient funding) for allies:

- On land-based fixed-site launchers—minimum of 11 months.
- On barges, railroad flatcars, or trucks—minimum of 15 months.
- Aboard submarines—minimum of 46 months (nuclear power reactors for subs have a leadtime of more than 40 months).

The British probably would build their own type of fleet ballistic missile submarines. But they could be expected to equip them with many U.S. systems integral with the missile, i.e. launchers, fire control and inertial navigation.

British Defense Minister Harold Watkinson, who ordered cancellation of the fixed-base *Blue Streak*, is due in the United States late next month or in June. He is understood to be under pressure from the Royal Air Force to buy the Douglas *Skybolt*.

However, *Polaris* will be operational with the U.S. Navy this year and its earlier availability undoubtedly will influence the British decision.

Blue Streak Out

Industry Will Suffer; *Bloodhound* May Follow

by G. V. E. Thompson

LONDON—Heavy layoffs in the British missile industry are expected to follow the Macmillan government's decision to cancel the 2500-mile *Blue Streak* missile. Dropping of the *Bloodhound* Mark III antiaircraft missile appear imminent.

Companies immediately affected are de Havilland Propellers, the main contractor; Sperry Gyroscope, the guidance package; and Rolls Royce, which is making the motor under license from Rocketdyne.

Extent of the layoffs may be made known this week when Parliament begins debate on a Labour Party motion to censure the government for not cancelling the program sooner.

The government has spent $180 million to date on the *Blue Streak*. But when contract commitments have been settled the figure will amount to $280 million. The project had been expected to cost between $1.4 billion and $1.7 billion.

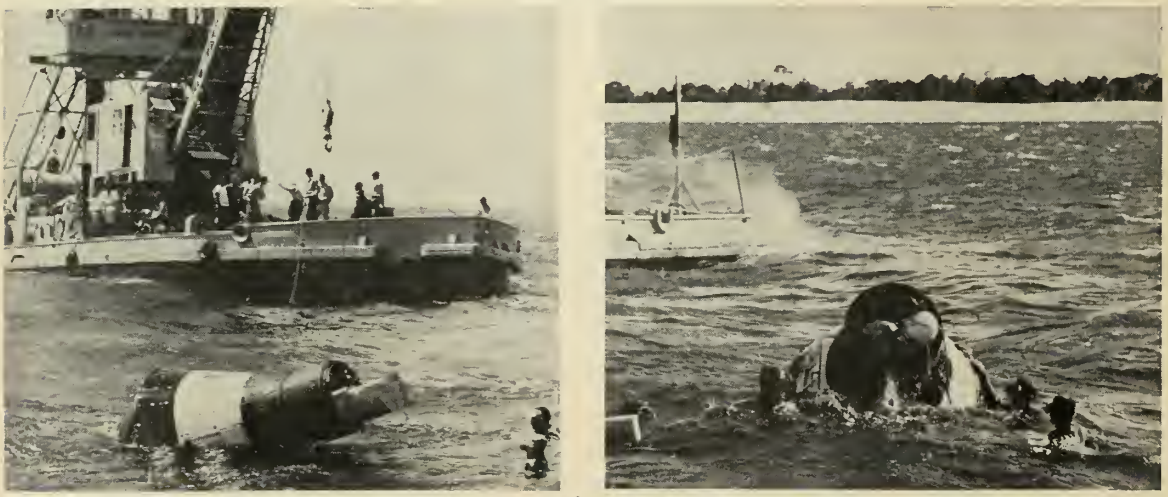
A slight hope remained that the Government may decide to use the *Blue Streak* for space research. But this would require only about $56 million in funding.

And even this sum may be considered too high. The whole question has been referred to Lord Hailsham, Minister for Science, who is not a scientist. The Committee which advises him has already indicated it is not favorably inclined toward space research.

- **Emigration**—Accordingly, a number of design engineers, lacking opportunities in their field, may decide to leave Britain for some other country—possibly the United States—where they can remain in rocketry. Some American companies were understood to be actively recruiting top missile engineers in the affected plants.

The cancellation created further repercussions in Australia, where the Australian Government has spent $200 million on the Woomera rocket range, including many special facilities for the *Blue Streak*.

Astronaut's Escape at Sea—Capsule Squeeze Play



RISK OF DROWNING will be high for the *Mercury* astronaut who attempts to leave his capsule at sea. Series of photos taken during training at Pensacola, Fla., show the problem in wriggling out of the small container. After removing his restraining belt, unshackling his oxygen hose and removing the pins from the instrument panel to push it aside, the astronaut then can open the pressure

Democrats Undercut Own Space Issue

For the second straight year, a Congress controlled by Democrats has started to undercut one of the party's major campaign issues by chopping the nation's space budget.

Though many Democratic Congressional leaders—including Senate Majority Leader Lyndon Johnson—have criticized the nation's space program as being underfunded, the House Independent Offices Appropriations Committee, chaired by Rep. Albert Thomas (D-Tex.), again recommended that NASA's budget be cut.

Last week, the full House approved the cuts without changes.

Last year, when Democrats were screaming about the inadequate space program, Thomas and his associates lopped $45.5 million off NASA's supplemental '59 and FY '60 money requests. (See M/R, July 13, '59, p. 11). Congress approved most of the cuts.

• **Senate crossed**—This year, with the space program looming as a major campaign issue, Thomas's subcommittee recommended that the House slash NASA's '61 authorization request by $38,985,000. The move came at a time when Democrats on the Senate Space Committee are recommending that NASA's budget be increased $30 million.

The Thomas Committee bill (H.R. 11776) cuts NASA's FY '61 research and development budget by $19,213,000, the construction and equipment budget by $15,512,000, and the salaries and equipment budget by $4,260,000.

Programs cut in the NASA R&D budget included in-house R&D support, research grants and contracts, sounding rockets, scientific satellites, meteorological and communications satellites, Project *Mercury*, vehicle systems technology, and tracking and data acquisition.

Major R&D cuts were $5 million from research grants, a "token cut" of $2.75 million from Project *Mercury*, $3.1 million from the scientific, meteorological and communications satellite program, and $1.5 million from the tracking and data acquisition program, most of which would have gone for the *Mercury* world-wide tracking fence.

• **Standing pat**—Major cut in the construction and equipment budget was $6,563,000 for construction of new facilities, at NASA's newly acquired George C. Marshall Research Center at Huntsville. The money, which would have been used to build a central laboratory and office facility, complete the guidance and control building, and add a new wing to the fabrication laboratory, was not considered "essential . . . to the fine plant that is now operating satisfactorily."

The salaries and equipment budget was cut by a reduction of 373 positions in the number of new personnel NASA wanted to hire. The new personnel would have been employed at Huntsville, the new Goddard Center, Wallops, and at NASA's Washington headquarters.

Heading Off Aerojet?

Two competitors for the Air Force's Project 3059 big solid-fueled booster reportedly submitted a last-minute joint bid in an attempt to head off award of the contract to Aerojet-General. Air Force Undersecretary Joseph Charyk will make a facilities inspection trip to the West Coast this week, prior to announcing the winner.

Bendix Gets $21 Million For More Work on *Eagle*

Bendix Aviation, Detroit, last week was awarded a $21-million Navy contract for continued development and evaluation of the *Eagle* air-to-air long-range missile. The new contract is in addition to the research and development contract previously given Bendix.

Douglas Chooses Burton As New Engineering Chief

Douglas Aircraft Company has tapped Edward F. Burton to succeed retiring Arthur E. Raymond as senior vice president-engineering.

Burton, with Douglas for 35 years, had been vice president-Engineering.

Moving into new positions as Burton's assistants are Elmer P. Wheaton, who will be responsible for technical affairs, and R. L. Hoskinson, who will assist in administrative matters.

hatch at the top of the capsule. Procedure calls for first ejecting the empty parachute can (far left) and then pulling himself upward through the bobbing 16-by-32-in. opening. All of the seven astronauts have found the feat extremely difficult—even with the help of frogmen. *Mercury* project officers decided that the first one to return from space into the sea should try to leave only in emergency.

Horner Defends Present Space Setup

Outgoing NASA Assistant Administrator Feels Civilian Space Program Has Secure Future

by Paul Means

Richard E. Horner, who will leave his position as Assistant Administrator of NASA for a position in industry this summer, outlined for M/R last week his appraisal of the U.S. space program —how it got that way and where it is going.

(Horner has not yet made a public announcement of his plans to resign, which were reported exclusively by M/R April 11.)

Giving the type of studied, comprehensive answers to questions that made him a favorite witness before Congressional committees, Horner:

- Defended the present U.S. space organizational setup, even though admitting the reasons for a civilian space agency may have been illusory at the time NASA was set up.
- Criticized those who would "turn back the clock" and put the entire space program under the Department of Defense, stating that such action would waste a lot of time and money.
- Reported that liaison between the civilian and military space programs is good, and will get better as NASA becomes more organized and moves into its permanent headquarters.
- Felt that too much time is wasted by top NASA personnel testifying before Congress, and suggested that Congress might consider the formation of a joint space committee similar to the Joint Committee on Atomic Energy.
- Predicted that the U.S.'s comprehensive space program will produce more real results than the Soviet program in the not-too-distant future.
- Believed that the most important product of the space program during the next ten years will be technological advancement and its application to all phases of U.S. industry.

Horner came to his NASA post almost 11 months ago after two decades as an Air Force officer and administrator. A decorated pilot in World War II, Horner has been technical director of the AF Flight Test Center at Edwards AFB, Calif., deputy for requirements to the Assistant Secretary of the Air Force for R&D, and Assistant Secretary of the Air Force for R&D.

- **No return**—In answer to the question whether NASA should have been created in the first place and whether the civilian agency should have all of the projects now under its direction, Horner reminded that "you can never turn the book back . . . it is one thing to ask what you would do today, and another about how one would have done it yesterday."

NASA was set up, according to Horner, for the "rather sketchy abstract reason that it was the nation's intent to have a peaceful program for peaceful purposes benefitting mankind, and therefore we had to have a civilian agency."

He pointed out that the Department of Defense had carried out peaceful space programs before NASA was formed, and that "present NASA projects have military applications and present DOD projects have civilian applications . . . it is difficult to explain to everybody's satisfaction the difference between civilian and military space programs."

RICHARD E. HORNER, who will leave NASA for a post in industry this summer.

- **DOD snafu**—The underlying reason NASA was set up, Horner thinks, is that the American people have an "aversion to handing something over to the military" during a time of peace, and because of "malorganization in DOD during that period."

Horner believes that "if DOD had been organized as well in 1957 as it is now, there might not have been a NASA."

He added that the present organization can work and will work with proper liaison, and that it would be much better for the nation to go ahead under the present organizational set-up than to tear it down and start all over again.

Horner is satisfied that NASA and DOD have found the right technique to correlate their efforts. This technique, according to Horner, calls for "lateral exchanges of information liaison at all levels."

The Holaday Military-Civilian Liaison Committee did not work, according to Horner, because it had "no responsibility and no authority."

In order for such a liaison committee to operate effectively, Horner believes, it "must incorporate the management authority of both organizations."

This creates, Horner thinks, a difficult problem: "how do the Secretary of Defense and the Administrator of NASA share their authority and responsibility with a third party?"

- **Lateral liaison**—Lateral liaison at all levels, Horner predicts, will become more effective when "more confidence is demonstrated in the space program personnel—that they are doing the right thing—by all of their associates in government," and when "NASA begins to give a better display of their ideas to the military, Congress and industry."

The first problem is being minimized, Horner believes, with each new successful launch. "The therapeutic effect of each successful launch is the enthusiasm of important people in government who now see space is useful."

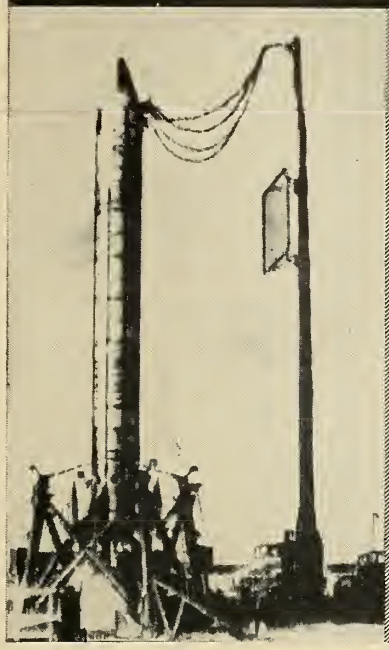
The second problem has been somewhat neglected by NASA, Horner admits, because "we have been too busy organizing." It will be eased with the completion of NASA's program management control center on which Horner presently is hard at work.

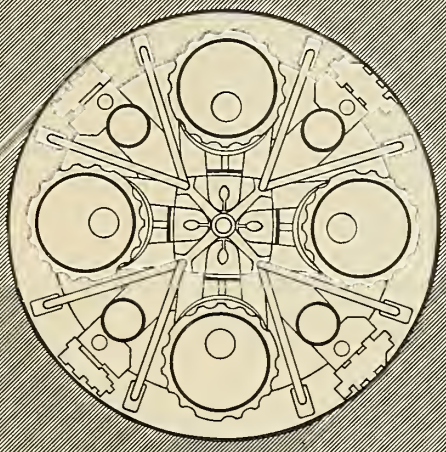
- **Control center**—The center, which will be similar to the General Services Administration's program management center and the Navy's *Polaris* program control center, "will help NASA give focus to its problems both in money and in time."

A makeshift center will be in operation soon, Horner stated, but the more mechanized center cannot be built until NASA moves into its new headquarters next year.

With such a center, Horner predicts, NASA can give better program briefings to DOD, Congress, industry, and

Gamma rocket engine proves its unique reliability in British space probe...





End view showing combustion chambers which can be inclined for vehicle guidance.

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One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce the Gamma. A liquid propellent rocket engine, the Gamma delivers 16,400-lb thrust (7,438 kg) at sea level rising to 19,000 lb (8,618 kg) outside the earth's atmosphere for a total engine bay weight of under 700 lb.

The Bristol Siddeley Gamma has four gimbal-mounted combustion chambers which are hydraulically actuated for vehicle guidance. Each combustion chamber is fed with propellents by its own turbopump unit and the four units are joined at the centre by a common manifold. The Gamma burns hydrogen peroxide (HTP) with kerosene and uses silver-plated nickel gauze as a catalyst to decompose the HTP into oxygen and superheated steam.

Gamma powers Black Knight. The Bristol Siddeley Gamma powers the Saunders-Roe Black Knight, Britain's highly successful space research vehicle. The Gamma has proved itself to be exceptionally reliable. In fact, in all firings to date Black Knight has never failed to start, and has reached a height of over 500 miles above the Woomera rocket range in Australia.

Since Bristol Siddeley's rocket division began work in 1946 it has developed a wide range of rocket components. By combining these components in single or multi-chamber layouts, thrust requirements from 500 lb up to 100,000 lb. can be met. *For further information please write to Bristol Aero-Industries Limited, 200 International Aviation Building, Montreal 3, Canada. Tel: University 6-5471.*

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other organizations participating in the space program, and will produce a "real working liaison, which depends on a common understanding of the facts."

Horner also predicts that NASA's liaison with all groups in the future will be complete, since as a civilian agency "NASA has little to hide."

Horner believes that NASA's relations with Congress also will be smoother with the establishment of the center, which could dispatch requested information, displays, and provide for briefings more adequately and faster than is the case presently.

• **Wasted time**—Though he didn't "feel too strongly about the issue," Horner believed that NASA personnel were presently being asked to spend too much time briefing Congressional Committees.

Horner said he did not dispute Congress' "right to know," but that the same briefings and information sometimes had to be given to as many as four different committees.

One solution that Congress might investigate, according to Horner, is combining the House and Senate Space Committees into a Joint Space Committee similar to the present Joint Committee on Atomic Energy. This way, Horner believes, Congress would get all of the information—and NASA would have to give its authorization requests and briefings only once.

Horner defended NASA's present policy of gearing the U.S. space program to conduct broad research programs rather than concentrating on a few spectacular shots as the Russians have done.

"The nation is understandably fascinated by our 'lift competition' with the USSR, and does not yet recognize the growing problems of making efficient use of our launching capacity."

"It is going to become terribly apparent during the next few years that just being able to lift heavy loads into space will not be enough," he predicted.

• **Future trend**—Horner believes that the tremendous research and development effort in the future will swing away from propulsion and launch vehicles to payloads and spacecraft. "The tremendous research and development effort in that end of the spectrum will make vehicle development seem relatively unimportant."

Space vehicle payloads, he pointed out, are already becoming more complex than military aircraft because of space limitations, environment, difficulty in testing, and expense.

Although vehicles will not change from launch to launch, payloads will. Horner admits that there will be a "generic relationship between payloads—but something like the difference between

the F-86 and the F-100."

For the next few decades in space, Horner foresees no booster shortage, but he does see many advances that must be made in instrumentation before "talking about landing on the moon in ten years becomes believable."

After his experience with the space program both in the Air Force and at NASA, Horner states that he "can't help but be impressed at the useful work going into the space program"—useful, that is, to other phases of American industry.

He is "convinced that the real product of the space program is U.S. technological advancement." One of many examples, Horner believes, is the fact that much of the work done for the space program has miniaturized components, a by-product which is changing the appearance of our radios, TV sets, ice boxes, and industrial automation.

• **Useful post**—Asked about the need for his position in the NASA organization, Horner said he "had worked harder at NASA" than he had in any of his previous jobs.

He described his position as resembling a corporation vice president in charge of operations. Such a position in NASA, Horner believes, is necessary because the "rather diverse internal operation which consists of research laboratories such as Lewis, development operations such as the Marshall Laboratories at Huntsville, contract development operations such as are conducted with JPL, and pure contract operations with industry."

NASA's greatest task, according to Horner, has been to develop a "coherent and energetic operation organization capable of conducting and performing the nation's space aims, and with a strong motivation for meeting schedules which are so important in a hardware development operation."

This has involved, according to Horner, the welding together of the individual activities referred to above into one operational organization. The problem was more difficult, Horner believes, because at the time NASA was reorganizing its inherited NACA organizations such as Langley, Lewis and Ames, it was continually acquiring new organizations such as NRL, JPL and Huntsville.

Horner recognizes that "it has taken considerable time to weld together an organization capable of conducting the U.S. space program." With Congressional and public support, Horner believes, the organization formed—NASA—is not only capable of overtaking the Russians, and providing new technology for industry, but can also effectively aid the DOD military space operation.

Bell Bows Out of Defense Industry

Bell Aircraft Corp. stockholders early in June are expected to approve a $30-million offer from Textron, Inc., for Bell's defense and aircraft business. Equity Corp. of New York, an investment company which holds 51% of Bell's stock, has indicated that it favors sale.

Divisions affected would be Bell's Niagara Frontier division, the Bell Helicopter Corp. of Fort Worth, Tex., and Hydraulic Co. of Burbank, Calif. Bell's aircraft business is estimated to have made profits in excess of $6 million a year before taxes the last five years. Textron, which last year aggregated $308 million with profits of $16.6 million, hopes to add $100 million a year in sales with the purchase.

The divisions would be operated by Textron as an autonomous, wholly-owned subsidiary under the name Bell Aerospace Corp. No immediate change in management is expected in the corporate setup. Bell Chairman Leston Faneuf and President Harvey Gaylord would retain their positions in the new company, with Dr. Walter Dornberger staying on as director of engineering.

The commercial divisions remaining in the Bell Aircraft Corp. would presumably have new corporate management. Divisions are: the Wheelabrator Corp. of Mishawaka, Ind., the W. J. Schoenberger Co. of Cleveland, the Birma Manufacturing Co. and the Lake Erie Machinery Corp. of Buffalo, and Lord Chemical Corp. of York, Pa.

Should the Bell stockholders approve the sale, it will mark Textron's seventh acquisition within 15 months and its 24th since 1955. Textron owns several large electronics companies, and military sales accounted for 13% of its revenue in 1959.

mergers and expansions

Emerson Shifts Defense Work Into New Subsidiary—Emertron

Emerson Radio & Phonograph Corp. has formed a subsidiary, Emertron, Inc., to handle its government and industrial electronics business.

Taking over a $20-million backlog of orders from the parent company, Emertron will develop and produce altimeters, countermeasures devices, missile fuses, flight data recorders and other electronics equipment. Adm. John D. Small, USN (Ret.) will be chairman of the new company, with headquarters in Silver Spring, Md.

THOMPSON RAMO WOOLDRIDGE International Division has been organized to coordinate the company's foreign activities. Subsidiaries already are operating in Brazil and Mexico, and joint ventures are upcoming in Argentina and France. George W. Fenimore, former assistant vice president, will be general manager.

BRUSH BERYLLIUM is doubling the capacity of its principal plant at Elmore, Ohio, to produce vacuum-cast beryllium billets and beryllium hydroxide.

HOFFMAN ELECTRONICS CORP. has started construction of a new Science Center in Santa Barbara, for applied research in industrial electronics and in satellite and anti-submarine warfare systems.

SPACE SYSTEMS LABORATORIES, Burbank, Calif., has been created to provide research, analysis and development services on physical, biological and engineering aspects of space technology. Dr. Morton Alperin, previously Director of Advanced Studies and Aeronautical Sciences for the Air Force Office of Scientific Research, is technical director of the new company.

US STEEL BROKE ground at its Gary Steel Works recently for a new rolling mill expected to produce the widest steel plates in the world. Plates weighing as much as 60,000 lbs. will be available for use in submarines, atomic energy installations and missiles and support equipment.

GARRETT INTERNATIONAL has teamed with German industrialist Hans Liebherr to form Interaero GmbH to manufacture and maintain Garrett product lines in West Germany.

ELGIN NATIONAL WATCH CO. will build a research and engineering plant for Elgin Micronics Division near Palatine, Ill. . . . Acoustica Associates, Inc. is expanding plant space in Los Angeles and Garfield, N.J. . . . Filtron Co., Inc. of Flushing, N.Y., and Culver City, Calif., has established a Palo Alto, Calif., field engineering facility for radio-frequency interference engineering services.

BELOCK'S ASTRO-SPACE LABORATORIES, CORP. has leased an 18,000-sq.-ft. building in Huntsville . . . Wyle Corp. has acquired Burgoyne Testing Laboratories, Inc. in Westbury, N.Y., specializing in environmental simulation . . . Hazeltine Corp., radar-electronics firm, is opening a Washington office . . . Waldorf Electronics and Fluid Systems division of Huyck Corp. changes name to Huyck Systems Co.

Capsule Recovery Foiled When It Fails to Re-enter

The Air Force failed again last week to recover a capsule from an orbiting *Discoverer* satellite. However, a Navy *Transit* transmitter carried for the first time in the satellite itself functioned successfully.

A *Thor* booster placed *Discoverer XI* in a polar 380-109-mile orbit on April 15. The *Agena* second stage ejected the capsule, but it remained in orbit rather than re-enter the atmosphere. The *Transit* transmitter was carried as a backup to the navigation satellite program.

U.S. Contracts to be Topic Of GW Law School Institute

The seventh annual Government Contracts Institute will be held by the George Washington University Law School in Washington, D.C., April 28-29.

The Institute will discuss landmark cases in government contract law during the past year, the recently revised ASPR Section XV and application of its cost principles, proprietary and technical data, and standards of proprietary conduct in dealing with or for the government.

At 00h00m01s GMT, April 1, 1960, Martin logged its 490,932,000th mile of space flight

Lacrosse, U.S. Army's most accurate surface-to-surface missile
– developed and produced by Martin

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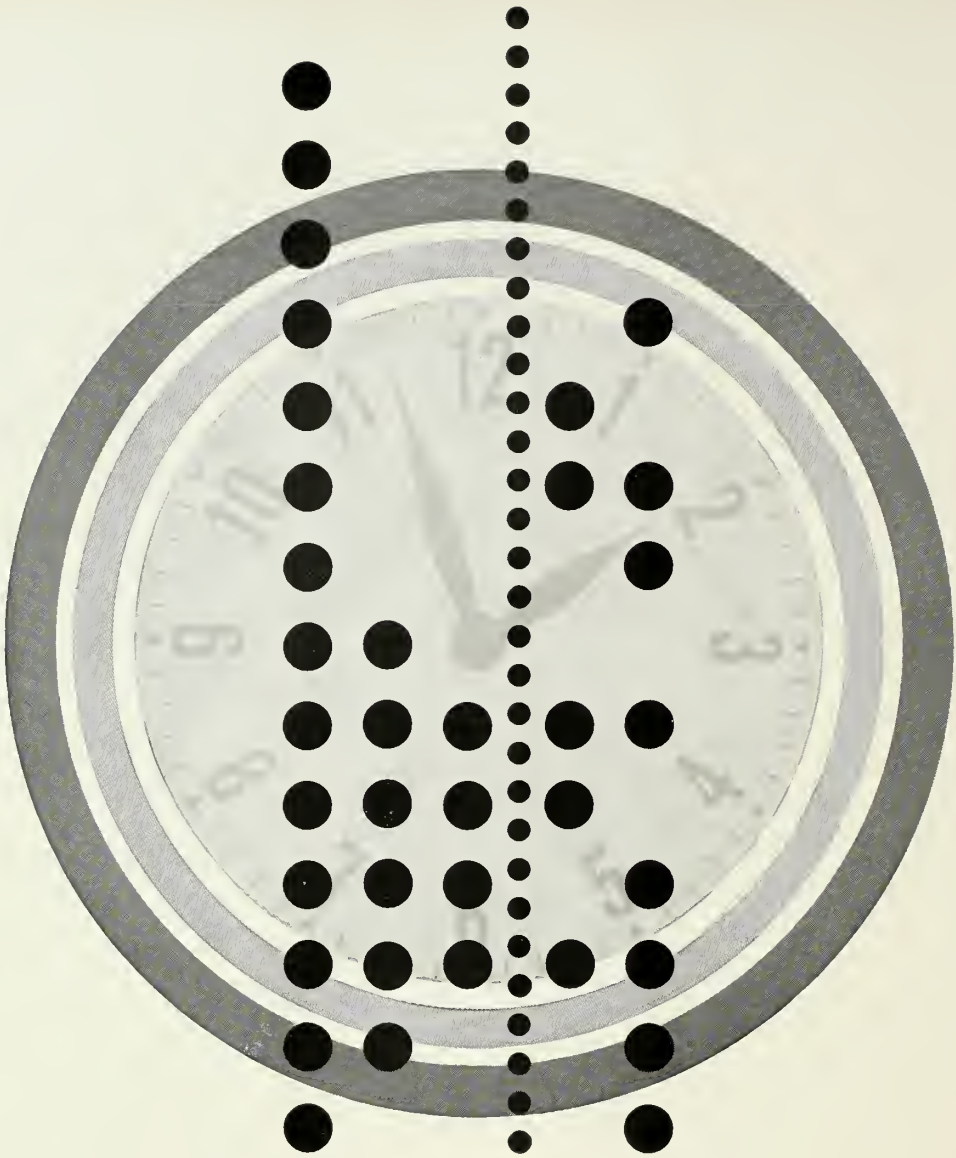


TAPE AND MICROSECONDS

are essential to missile development. Instruments must record every function against time... in fractions often finer than one ten-thousandth of a second. Reams of electronic and optical data must be collected, reduced and evaluated before any missile can become operational. Vitro designed, built and helped instrument the Air Force missile test center at Eglin Air Force Base, Florida. Today it operates the center's test ranges and tracking stations throughout the Southeast. At Eglin, Vitro and the Air Force, working as a team since 1952, are responsible for checkout of missiles, rockets, weapon systems, countermeasures, space probe vehicles and bombing techniques. Beyond this Florida site, other Vitro capabilities: underwater (torpedo) and electronic environmental ranges.

SCIENTISTS AND ENGINEERS: JOIN THIS TEAM.

Vitro LABORATORIES

A DIVISION OF VITRO CORPORATION OF AMERICA

SILVER SPRING, MD. • WEST ORANGE, N. J. • EGLIN AFB, FLA.

Technical Countdown

ADVANCED MATERIALS

Orbital Environment Lab

Next big selling program in space for major systems contractors should be a manned environmental lab for testing materials, equipment and human engineering. Martin last week jumped on the bandwagon with a proposal at an IAS meeting that such a project is a "technically feasible second-generation space vehicle"—beyond *Mercury* and *Dyna-Soar*—and can be accomplished by 1965. Some specs: 16-ton lab using three-stage *Saturn* for boost into 400-mile orbit; 4-6 man capacity; double shell (beryllium, outer, 5456 aluminum alloy, inner); three compartments separated by aluminum alloy honeycomb bulkheads with airlocks; LOX and nitrogen for atmosphere.

Camouflage for *Atlas* Warhead

Convair has designed an explosive charge which will fragment the final stage of *Atlas*. With pieces spread over several thousand square miles in space, detection by radar of real warhead will be almost impossible.

HF Acid Production Boosted

With national consumption of hydrofluoric acid expected to be 170,000 tons annually by 1965, and a substantial amount going for missilery and space, Dixon Chemical Industries, Inc. is gearing for a big cut of the market. The company is building $3.5 million facility at Paulsboro, N.J., for completion next year with annual 11,000-ton capacity.

Thermionics Spurt Tellurium Market

Tellurium market—small only because it is geared to supply existing markets—is growing because of interest in thermoelectric energy convertors and possibilities of its value as strategic material. U.S. and Canadian producers say production can be raised from 500,000 to 750,000 lbs. annually through existing facilities.

More About Inflation

Dumb-bell-shaped inflatable satellites are being proposed for manned space stations by Martin-Baltimore engineers. They say the station will expand in two directions from the metal canister in which it is launched. The canister will then serve as a rigid center section joining the satellite's two space cabins. The satellite would be erected using the sun as a heat source to expand liquified gas within the vehicle.

ASW ENGINEERING

More Market for Buoys

Dr. John Knauss of Scripps Institute of Oceanography predicts "a vast number" of deep-sea buoys—instrumented for observing water temperature, salinity, density, current velocity, etc.—will be planted in the oceans within a few years. Aim: to provide a better understanding of weather and its prediction through study of heat transfer and circulation of large water masses.

Douglas' JADA

Douglas is developing under a $1.5-million BuWeaps contract an airborne computer system for attack and fighter aircraft. Used by aircraft not normally carrying ASW search and localization equipment, it will be an adjunct to *Julie* sonobuoys.

ELECTRONICS

Mercury Radar Delivered

Cubic Corp. last week delivered the first horizon-to-horizon radar tracking and acquisition unit for *Mercury*. Some 13 AGAVE (automatic gimballed-antenna vectoring equipment) systems will provide surveillance for the vehicles.

PROPULSION

Hercules to Win *Minuteman* Contract

Minuteman third-stage contract will be awarded soon to Hercules Powder Co. Air Force evaluators are reported to be convinced that Hercules double-base propellant, in a fiberglass and plastic case, is not too big a technological step. Aerojet-General, the other competitor, is taking a more conventional approach with a polyurethane-base propellant in a metal case.

Linde Lifts LOX Output

Linde Co. is increasing its oxygen-producing capacity by 4000 tons a day in a $50-million expansion of plant facilities over the next year. Expansion amounts to more than 20% of the total presently installed U.S. production capacity for oxygen. While much of the new facilities will primarily serve steel and chemical industries, Linde is building plants with total daily capacity of 450 tons of liquid oxygen or nitrogen at Huntsville, Ala., Neosho, Mo., and Fontana, Calif., for missile/space requirements.

Polaris Has Stage Limitation

Regardless of possible short-range mission, both *Polaris* stages must ignite. Thrust termination is on second stage only, since forward bulkhead of first stage has no blowout ports to cut thrust component to zero.

$400,000 for Plug Nozzle

The General Electric plug-nozzle engine will receive about $400,000 of NASA's advanced engine design money in FY '61, about the same as this year. Other projects will share the $4.3 million of advanced design money although testimony of Deputy Administrator Hugh L. Dryden before House Appropriations Subcommittee was interpreted as meaning plug-nozzle would get all.

Liquid H_2 to cost 25¢/lb.

Liquid hydrogen will cost about 25 cents per lb. when delivered in large quantity for testing high-energy *Saturn* upper stages, Dr. Abe Silverstein, NASA Space Flight Programs Director, estimated before the House Appropriations Subcommittee.

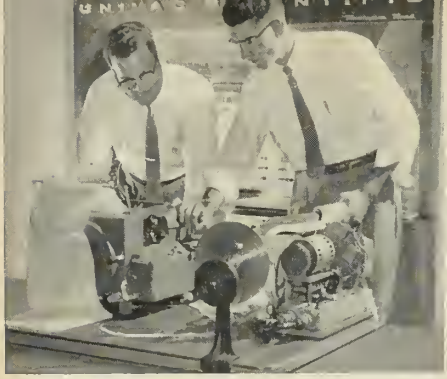
Polaris Gamma Tested

High-energy gamma rays, from a Cobalt 60 source, are being used to check *Polaris* motors for cracks, bubbles and fissures in the fuel and for imperfect bonding of propellant to the case. Rucker Co., Oakland, Calif., installed the test system at Aerojet-General's Sacramento solid rocket plant.

SPACE MEDICINE

Look, Ma, No Cavities!

AF's announced plans to spend $30,000 in FY '61 to study reaction of astronauts' dental fillings to space flight stresses, brought a quip from Rep. George Mahon (D-Tex.) last week that the money could be more effectively used for ASW work.



The Univac Scientific computer is used to simulate and prove the projected design of new systems. This concept of mechanized design, which may be described as the use of one computer to build another, eliminates prototype building and attains a degree of reliability once regarded as only theoretically possible.

A technician follows the wiring diagram produced by the Univac Scientific. This application of mechanized design greatly facilitates the production of reliable automatic data processing equipment.

A significant achievement of mechanized design is the BOGART computer, produced by Remington Rand Univac, for the U.S. Navy. Intensive preliminary testing of the projected system made it possible to reduce the size of the computer while materially increasing its reliability through the use of transistors and printed circuitry.

From the **REMINGTON RAND UNIVAC**

Military Division

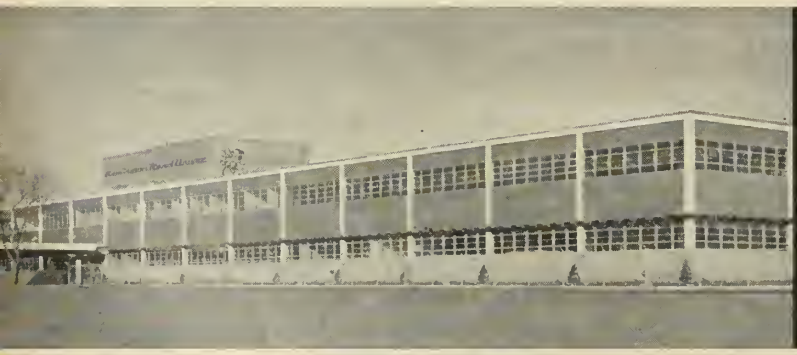
Mechanized Design Dramatically Speeds Development and Increases the Reliability of New Data Processing Systems

Remington Rand Univac was the first to apply the concept of mechanized design to computer development. By using the Univac Scientific computer, the design of a projected system can be fully simulated and proved—thus avoiding the expensive, time-consuming process of prototype building.

This important technique has already made indispensable contributions to the development of such systems as the Univac LARC and Athena and the Univac Advanced Navy computer. Mechanized design has significantly aided Univac scientists and engineers in attaining the farthest limits of reliability, even under the most demanding environmental conditions.

The Military Division's tradition of excellence is firmly established by a distinguished series of defense systems. Mechanized design is another example of the outstanding capabilities which Remington Rand Univac can bring to bear on the development and production of complex computer equipment for military applications.

UNIVAC®



Remington Rand

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DIVISION OF SPERRY RAND CORPORATION

Univac Park, St. Paul 16, Minnesota

Control and data systems developed by the Remington Rand Univac Military Division include:

ATHENA, the Ground Guidance Computer for the U.S. Air Force ICBM TITAN.

TACS AN/TSQ-13 (Tactical Air Control System for the U. S. Air Force)

BOMARC Computer for the U. S. Air Force Target Intercept Program

SEA SURVEILLANCE SYSTEM FOR THE U. S. NAVY

AN/USQ-20 (Advanced Computer for the U. S. Navy)

Additional information describing capabilities and experience or career opportunities may be obtained by writing to Remington Rand Univac at the above address.

Autolite Enters Missile/Space Field

Old-line automotive firm wants to diversify and reap advantages of present R&D in hydraulics, ceramics

by William Beller

An M/R Management Engineering Feature

TOLEDO—Another old-line industrial company is entering the lists for missile-type contracts. This is The Electric Autolite Company, world's largest independent manufacturer of automotive electrical equipment. Its experience related to the missile field is in ceramics, hydraulics, acoustics, pneumatics and plastics.

To diversify and also get the advantage of the research and development work it has been doing in connection with its automotive line, Autolite late last month set up a Special Products and Research and Development Division (SPARD). Heading it is the company's director of research, George E. Spaulding, with Autolite since 1948.

Spaulding says that his Division will begin pilot production of subminiature hydraulic and electro-hydraulic devices for the missile and rocket field. Development work will be going on in electrical, electronics, and mechanical controls as well as in semiconductors and fuel cells.

• **How change came**—During the half century the company has been in business it has, except during wartimes, been devoted exclusively to the automotive industry. This was the way the late president, Royce G. Martin, wanted it, the way the company had prospered until the highly competitive fifties, and a way the company would have to change unless it wished to go full cycle back to its unobtrusive beginnings.

After Martin's death in 1954, patent attorney and industrial consultant James P. Falvey was named president. He brought New York financier Gurdon Wattles into the picture in late 1956, and by 1957 Wattles was chairman of the board.

This was the signal Falvey needed to chop down the archaic vertical managerial set-up and replace it with autonomous units headed by vice presidents, in several instances brought in from the outside.

Then, early last year, Robert H. Davies, industrialist and former vice president of Clarke Equipment Company, was elected president. Falvey was raised to chairman of the board, although he is now on leave to serve as Deputy Assistant Secretary of Defense for Supply and Logistics. Davies is eager to give Autolite a wider market and modern frame.

• **Hydraulic miniature**—G. W. Lewis, manager of mechanical engineering research, paints a fascinating picture of the miniaturization work Autolite is doing in the electro-hydraulic field. He expands his thesis by saying, "Hydraulics is today in its infancy in sophistication. There are areas of the field still untapped: for example, we are today in a 'direct flow' hydraulics which is analagous to DC electricity. Work that should be done is in 'pulse' hydraulics, analagous to AC."

He explains that by electronic means he can send out slugs of oil that pulse at a certain frequency and with certain phase relationships. "Thus, high energy can be transmitted over great distances with only small losses of energy. The analogy between AC and DC is obvious."

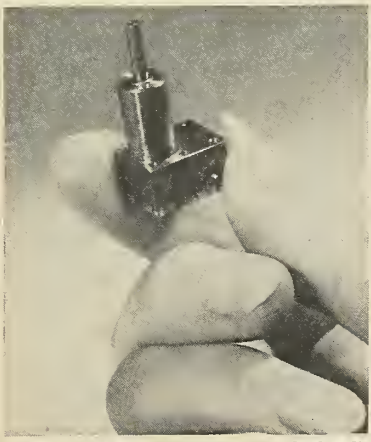
These techniques lead to great miniaturization, savings in power and money. Also, with pulse hydraulics it is possible to have a system with one hydraulic line instead of two. There would be rectifiers, transformers, subsystems and other devices peculiar to AC electricity.

Lewis adds that, "Relationships between electricity and hydraulics would become so close as to enter an area that might be termed 'fluid electronics.' It's conceivable that electronic control of fluid flow would be done without any moving mechanical elements."

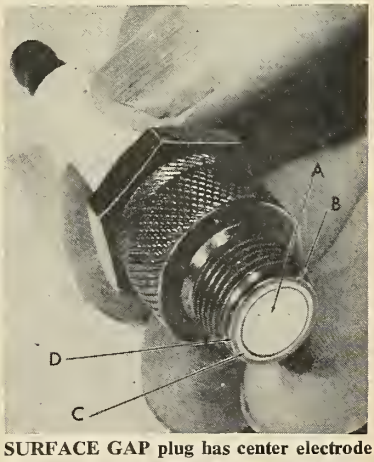
The practical results would be tremendous amplifications of tiny energies, high-speed control of machinery, and great precision in such control. Thus, pulse hydraulics would have a profound effect on the whole field of controls, computers, communications equip-

Autolite's Space Age Products

SUBMINIATURE electro-hydraulic valve cycles in a few thousandths of a second and can he actuated hy an electromagnet.



AUTOLITE'S subminiature hydraulic pump is expected to find use in missile servo-control circuits.



SURFACE GAP plug has center electrode (A), semi-conductor gap (B), ground electrode (C) and shell (D).

ment, and on any other field where pulse work or energy conversion is involved.

Here are details on the two Autolite advanced products, an electro-hydraulic valve, and a low-voltage surface-gap plug.

• **Electro-hydraulic valve**—This is a "pilot" valve in which a very small valve is actuated directly by an electromagnet; this in turn produces a hydraulic imbalance which opens the main valve member.

The action of the valve is very rapid in its response to "on" and "off" energization of the electromagnet. Open and close cycles of about 0.006 seconds are being obtained and even faster cycles are possible.

Taking advantage of their fast response, the valves may be used in digital or numerical control systems for precise positioning or precise modulation of process valves. Operating the devices by magnetic tapes or punched cards is being studied by Autolite.

While the valves are tiny by present standards, the flow capacity is 35 cubic inches/minute. At 1500 psi hydraulic pressure, this is more than one-eighth horsepower.

The valve is designed to be incorporated into the device that it controls or it may be arranged as an assembly in a valve block for various applications of electro-hydraulic controls.

The company is also developing subminiature pumps of size and capacity to service the miniature valves described. Incidentally, during World War II the company made hydraulic devices for autopilots and supercharger controls, and hydraulic pumps for armament. Autolite's hydraulic experience also stems from work it has done in making hydraulic units for power steering, power brakes and all the accouterments that hydraulics could power in a modern car.

• **Surface-gap spark plug**—This unique plug is unaffected by either liquid or solid deposits upon the firing surface. Thus it has considerable value as a liquid-rocket ignitor. This is borne out by the company's several years' experience with this plug in the ignition of fuels with low-atomization when compared with liquid-rocket fuels.

The spark plug consists of a center electrode and ground electrode separated by either a dialectric or semiconductor material. The gap between the electrodes is on the order of 0.003 to 0.008 inches.

A high-power, high-frequency condenser of 5000 volts or less ionizes the surface of the gap material and makes a conduction path for the spark to travel from center electrode to ground electrode. This mechanism is known as "surface gap discharge."

Since the spark is not required to fire through air and since the gap is relatively small, this type of spark plug needs less voltage to initiate the spark and is, inherently, less sensitive to ambient atmospheric pressure variations than conventional air-gap spark plugs.

• **Insulator & wire**—In connection with its spark plug work, the company has done much research in the ceramics field. Out of this work they have devised an insulator body that, though weighing only 10 pounds per cubic foot, can withstand 3000°F. If higher temperatures and strength are desired, a 50-pound-per-cubic-foot composition can be made. It will withstand upwards of 5000°F and severe thermal shock.

Perhaps what is not widely known is that Autolite has for the past several decades been the country's largest supplier of high-temperature wire to the airframe manufacturers and lately to missile manufacturers. This work is a natural extension of the job Autolite has been doing in supplying wire to the automotive industry. The company is now developing high-temperature insulated wire able to operate in 1800°F and over environments.

A Missile Engineering Exclusive . . .

Design Details of Nord *5103*

by Jean-Marie Riche

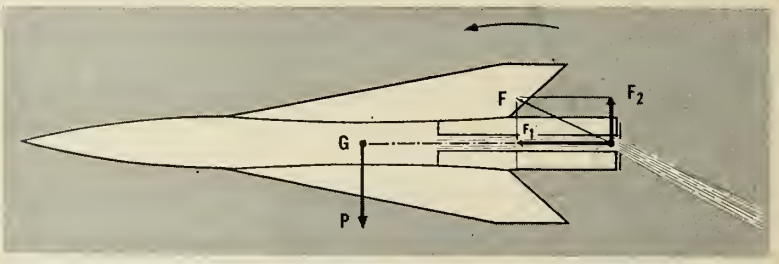
PARIS—Specifications and performance data on France's air to air radio-controlled *5103* missile have just been released by the manufacturer, Nord-Aviation.

Currently in production, the missile is standard equipment or is being adapted to aircraft such as Dassault's Mystere IV A, Super Mystere SMB 2, Etendard IV M, Mirage III, Sud-Aviation's Vautour, Aquilon and the Fiat G. 91.

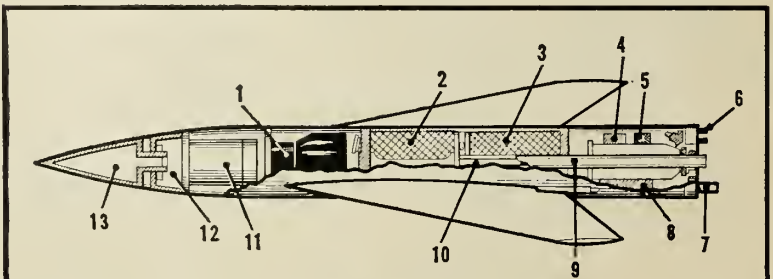
Designated the AA. *5103* Type M 2 RT missile, it is 8 ft. 6 in. long, 2 ft. 7.5 in. overall span with a body diameter of 9.84 in. and weighs 293±6.6 lbs.

The missile is supersonic, but its flight speed and range depend upon launching speed and altitude of the firing aircraft. Command guidance is by visual alignment. The missile is directed by the pilot using a control stick installed in the aircraft's cockpit.

• **Criteria**—In gaging the missile's performance, several factors must be considered. The three main ones are the speed increment at the end of the



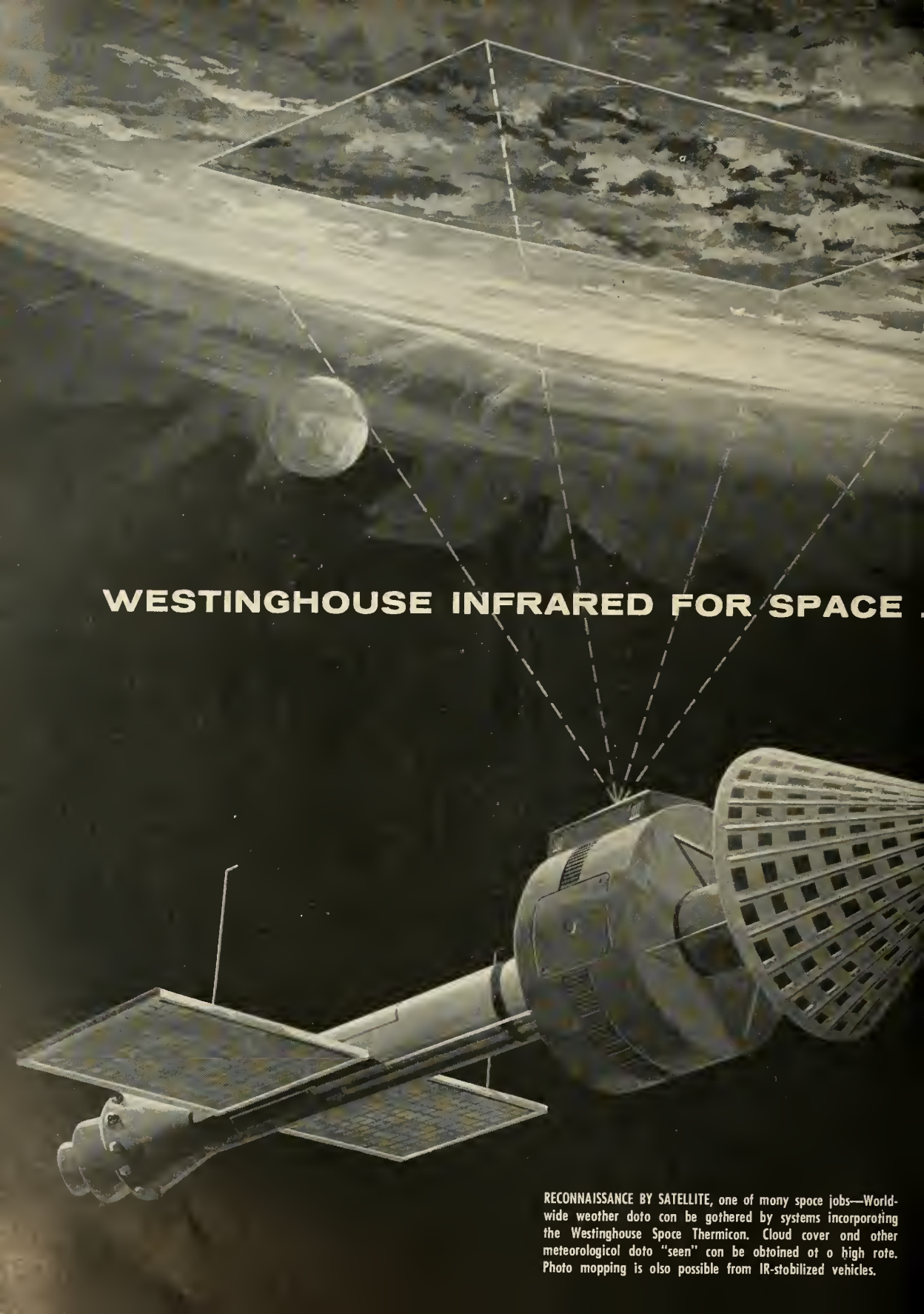
MISSILE IS CONTROLLED in flight through jet spoilers. The reaction force "F" may be broken down into a propulsion component "F1" and a sideways-acting component "F2" applied to the rear of the *5103*.



CROSS-SECTIONAL view of the *5103*. 1—warhead; 2—sustainer; 3—booster; 4—gyro; 5—relay; 6—quick release connector; 7—tracer; 8—command guidance link; 9—booster nozzle; 10—sustainer nozzle; 11—power pack; 12—proximity fuse; 13—nose.

The U.S. Air Force's
Atlas, produced by
Convair-Astronautics,
is the free world's
first ICBM and is now
operational with the U.S.A.F.
Strategic Air Command.

CONVAIR
A DIVISION OF GENERAL DYNAMICS CORPORATION



RECONNAISSANCE BY SATELLITE, one of many space jobs—World-wide weather data can be gathered by systems incorporating the Westinghouse Space Thermicon. Cloud cover and other meteorological data "seen" can be obtained at a high rate. Photo mapping is also possible from IR-stabilized vehicles.

1. SATELLITE STABILIZATION—Satellites must keep fixed positions in orbit if they are to perform the vital jobs foreseen for them. A key element designed for such systems is the Space Thermicon, an IR development at Westinghouse. This lightweight, static, electronically scanned "heat-seeing" device operates day or night, guiding the satellite by detecting and responding to Earth's infrared radiation.

2. DETECTING OBJECTS IN SPACE — Fire control systems in stabilized satellites can be designed around advanced Westinghouse infrared equipment. Here static, electronically scanned sensors with a wide field of view can detect and track objects, providing data at a high rate with high accuracy and top reliability.

3. IR COMMUNICATIONS — Westinghouse developments will permit use of active infrared radiations to carry voices or other signals on a narrow microwave beam. Such a system would be almost impossible to detect or jam. It uses low power and requires little weight, and yet is useful for most communication requirements. Its "security" makes it particularly valuable in military applications.

HERE ARE A FEW OF ITS IMPORTANT APPLICATIONS

4. AIRBORNE DEFENSE — Westinghouse-developed infrared devices, techniques, and systems, to detect and track enemy missiles or aircraft, offer vital advantages in both bomber defense and interceptor fire control systems. Such systems operate in daylight as well as darkness. Effective differentiation between targets and background is obtained.

5. TANK FIRE CONTROL — Infrared systems developed by Westinghouse offer special advantages such as 24-hour fire control capability. They are rugged, compact and cannot be detected by an enemy. Electronically scanned sensors eliminate problems of complex optical or mechanical linkage.

6. UNDERSEA DEFENSE — A broad program incorporating Westinghouse developments in scanning systems, sensors, and special circuitry make possible detection of submarines in a tactical environment.

Engineers at the Air Arm Division of Westinghouse Electric Corporation are developing a variety of advanced infrared systems for the Army, Navy and Air Force . . . another demonstration of *Westinghouse Capabilities for Defense.*

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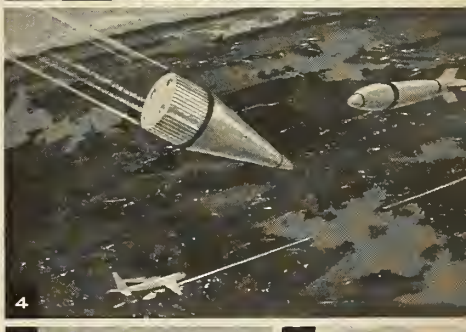


acceleration phase—the difference between the missile's speed and the aircraft's, absolute maximum range and maximum range ahead of the firing craft.

Specifically, if the *5103* is [illegible] from a jet at an altitude of 33,000 ft. and traveling at Mach 1.2, the missile's speed increment will be 820 ft./sec. Its maximum absolute range will be 36,000 ft. and the maximum range ahead of the firing aircraft will be 14,400 ft. The speed of the *5103* along its own trajectory can vary with the firing conditions.

• **Hardware**—The main structural element is the case surrounding the motor. To this is attached the cruciform wings—slightly canted to induce spin, the warhead with tapered nose and the rear section.

A two-stage solid rocket motor makes up the powerplant. The booster, which operates for two seconds, is designed to provide thrust sufficient to leave the firing aircraft and attain enough speed to catch its target. The booster discharges through two diametrically opposed lateral nozzles.

The sustainer fires about one second after booster burnout and maintains thrust for about 20 seconds. Within the single axisymmetric nozzle of the sustainer, there are four jet spoilers which serve to deflect the gas efflux for the purpose of guiding the missile.

The spoilers are four knife edges which pivot about axis perpendicular to the plane of the nozzle orifice and which are designed to protrude into, or withdraw from, the exhaust jet. Each spoiler is actuated by an individual electromagnet. The distance between each pair of spoilers remains constant since diametrically opposite edges function in parallel.

• **Guidance method**—The missile spins about its roll axis. This means that, in order to change direction in a given plane, each successive diametrically opposed pair of spoilers must be energized the instant they lie in that plane.

In effect, successive pairs of coupled spoilers must act at each quarter spin of the missile. This command system is embodied in a powder-energized gyro, the outer gimbal of which pivots about an axis parallel to the missile's roll axis. A four-collector-ring, four-sector commutator integral with this gimbal ensures the correct distribution of the commands to the spoilers.

This gyro is started just prior to ignition of the booster and retains a fixed attitude throughout the flight of the missile.

The gyro, its command receiver, the command link receiver, and the relays are housed in the missile's rear section

together with the tubes connecting the nozzles with their respective firing chambers.

The tapered nose cone houses a group of instantaneous, self-activating [illegible] batteries which supply 27 volts to power the spoiler electromagnets and 7 volts to operate filament heaters for the command-link receiver and proximity fuse. A high voltage static inverter supplies the receiver and the fuse.

The intermediate space between the motor and the nose is occupied by a pre-fragmentation charge weighing about 50 lbs. The explosive itself weighs 11 lbs. and its half hexogene-half tolite. Detonation of this warhead is accomplished either by the proximity fuse or by a self-destruction device after sustainer burnout. The detonator is fired by an electric initiator through an orifice normally masked by a protective flap.

• **Safety**—Three safety features prevent the warhead from being detonated while the missile is at rest or while too close to the firing aircraft. Self-destruction is automatic if the proximity fuse does not function at its appointed time.

The link between the aircraft and the missile is through a two-component system—the modulator and the pressurized transmitter. The transmitter is linked to the control stick through a co-ordinate transformer. This permits the missile to be guided independently of the firing plane's maneuvering. A free gyro aboard the plans is uncaged simultaneously with the missile gyro. The pilot then has a constant indication of the missile's reference system. The coordinate transformer translates into the missile's reference system the commands the pilot transmits in his own reference system.

The entire firing system must be energized two minutes prior to firing. In practice, this is actually done upon take-off. All switches and warning lights are laid out in the cockpit.

Substitution of a contact fuse and a 73 lb. warhead provides the *5103* with air to ground capability.

A three-point attachment is used to sling the missile from a special launcher which provides either ventral or underwing storage. Pyrotechnic stops lock the *5103* in place during flight but in an emergency the lower portion of the launcher, together with the missile, can be jettisoned.

advanced materials

Explosive Forming: No Panacea Seen

By John Judge

Explosive forming is no longer being heralded as the panacea for the metalworking industries. As with many other aspects of this missile/space business, limitations within high-energy rate forming process have proven more difficult than first anticipated.

E. W. Feddersen, chief of Manufacturing Research and Development at Convair, Fort Worth, told the Society of Automotive Engineers at their National Aeronautic Meeting in New York recently that the practical approach is being emphasized now in thinking about this versatile new form of energy.

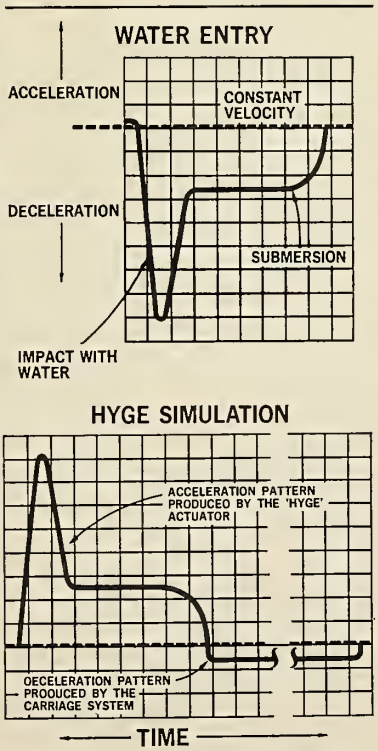
Feddersen said that other means of applying high-energy rates to the deformation of materials that do not employ explosive charges have been developed to a fairly reliable degree.

The Convair manufacturing expert split the field into three categories:

• Explosive forming—The shaping of materials by the exertion of sudden pressure from the explosion of a chemical charge.

• Hydro-Electric—The sudden triggering of electrical energy stored in capacitors, applied through a water or like medium, results in the deformation of materials.

• Pneumatic-Mechanical—Applying the high-energy rate by the sudden release of compressed gases. Current applications in each of the three systems range from laboratory to full-scale production.



CONVAIR'S HYGE simulation curve is an exact mirror image of the actual deceleration pattern experienced by a high speed body impacting in water. The G-loads are equal, but opposite in direction. **(See p. 39)**

Each has the same general advantages over conventional forming means —the ability to produce large, complex sections and the elimination of extremely large mechanical machinery.

But each in turn has advantages over the others when compared among themselves, especially in specific applications. Explosive forming does not lend itself to large-volume production and requires extreme safety measures. The hydro-electric method is accurate, repeatable and can be used within an inhabited factory because of the complete controlability. The pneumatic-mechanical method is semiconventional, using simple punches and complicated dies in some instances.

• **Participation**—Those mainly interested in explosive forming and its allied methods have been predominantly the airframe, missile and engine accessory manufacturers, Feddersen says. Relatively small quantities of parts, frequent configuration changes and a constant effort to stretch the defense dollar account for this.

Besides Convair, Ryan Aeronautical Co., Aerojet-General Corp., North American Aviation, Inc., Lockheed Aircraft Corp. and Boeing Airplane Co. have vigorous programs in this area. Talco Engineering Co. and E. I. DuPont de Nemours are among the metal fabricators interested.

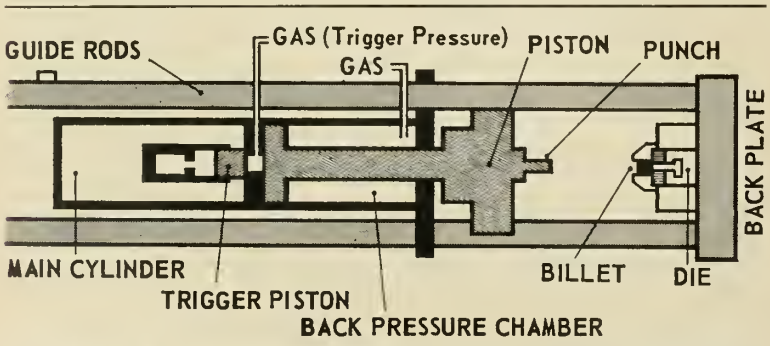
According to Feddersen, Convair, like the others, followed the path of least resistance and involved itself initially in the expansion of preformed

America's biggest, most versatile satellites

hollow bodies. All of these used explosive methods. Within the last year says Feddersen, Convair, along with Chrysler Corp. and Republic Aviation Corp., substituted electricity for dynamite and moved into the hydro-electric aspect of the process.

Early work involved high voltages from 14,000 to 22,000 volts and from 30 to 60 microfarads. Subsequent power increases were realized by reducing the voltage to 4000 and the capacity increased to 1200 microfarads. When the unit is fired, an initiating wire connecting the electrodes is transformed into a cylinder of metallic vapor. This vapor expands against the medium (water), the inertia of which causes a pressure build up from 15,000 to 20,000 atmospheres.

Feddersen said that the variable wave front was discovered and applied here. Various shapes of the initiating wire resulted in sharp-nosed, spherical and plainer wave fronts. Each of these fronts can be put to a specific job of forming.



PNEUMATIC-MECHANICAL Dynapak. The main cylinder is charged with compressed gas to the desired firing pressure. Trigger pressure is applied to the small space between the trigger piston and the main piston. This forces the trigger piston back and the main body of compressed gas acts upon the large piston, driving the punch toward the die at high velocity. The die housing is moving toward the punch at the same time, keeping all of the stresses created within the device. Hydraulic oil forces the piston back to its cocked position and pushes the gas back out of the main cylinder.

• **Big savings**—The high-energy spark method was applied to the same ends as explosive forming—expanding and sizing hollow bodies. Feddersen said that when it comes to forgings, impact and straight extrusions, the third general method, pneumatic-mechanical, answers the need. The device is marketed under the trade name "Dynapak" and consists basically of a compressed gas driven piston. The machine can be used in forging, forming, extruding, compacting, shearing and blanking. Feddersen said the most common current uses are in forging and closed cavity extrusion molding.

In the fabrication of one particular part, a gas-tight corner, the Dynapak method resulted in a considerable cost saving. The Precision Forge Co., one of the two forging firms in the Los Angeles area who decided to try the method, produced the corner for Convair at a total cost involvement of $3,670.75. If conventional forging and machining had been used, the total cost would have been $9,984.04. The saving was effected through elimination of the machining steps.

Feddersen concluded by pointing out that each method of high-energy rate applications has its own area of economical use. Right now they should be used only if the job cannot be done any other way, the finished product is better physically or when it is definitely the most economical approach.

Additional uses—The latest development in the Dynapak concept is simulation of the impact that occurs when a missile nose cone, or any other object, hits the ocean at supersonic speeds.

About six "water-entry" test facilities are in operation at Convair's Dynapak section—all involving the Hyge principle and the high-energy-rate forming machine.

The principle depends on the fact that g-forces are identical, regardless of their source. The abrupt deceleration of a body upon contact with the water creates huge g-forces within the body. Past simulation attempts centered around the use of resilient or semiresilient materials against which the test object was hurled. Even with acceptance of partial destruction of the facility with each test, Convair's engineers have been limited in the size and speed of test objects because the entire force created had to be absorbed by the testing facility.

• **Stresses reduced**—The Hyge water-entry simulator creates a shock load that exactly simulates the desired environment by pouring energy into the test object, in a controlled manner, rather than removing the energy. Since the test takes place during acceleration, deceleration can be stretched over a safe distance, thereby reducing the forces on the test equipment.

The heart of the Hyge system is the Dynapak device. A simple metering pin controls the air flow that pushes the piston. By changing the shape and length of the pin, a wide variety of shock patterns can be obtained on the same machine.

When testing for water-entry, the test object is located a short distance away from the piston. On firing, the piston builds up a tremendous velocity and transmits this to the specimen upon impact. The sudden energy input creates up to 5000-g acceleration in the carriage assembly. This shock is relatively shortlived, lasting only until the kinetic energy of the piston has been absorbed. Then the piston and the specimen move down a track together, accelerated by the compressed gas.

In effect, this technique reverses the water-entry conditions, the velocity achieved by the specimen at the end of the test approximating the speed of the object as it hits the water. A number of mechanical methods are used to slow the carriage down—the only requirement being that the deceleration g-forces remain low, avoiding any additional damage to the test specimen.

The tests are exactly reproducible since no damage occurs to the instruments. This has the effect of reducing cost of such tests and increasing reliability of components destined for such operating conditions.

Curved Honeycomb Panels Announced by Allied R&E

A new process at the Allied Research & Engineering Division of the Allied Record Mfg. Co. results in all-metal contoured honeycombs with any number or shape of curves, and in almost any size.

Material is presently available in high-purity nickel—with heat-resistant properties limited only by the melting point of nickel, 2651°F.

Skin and cell walls can be as thin as 0.0005 in., with skin and cell thicknesses having no bearing on each other. Cell size can be varied within the same structure or from one piece to another. It can be manufactured with load bearing inserts.

West Coast Gets Measuring Facility

High temps, vacuum, fluid flow, cryogenics and acceleration will be fields for Metrolonics, Inc.

COMPARATOR AND monochromatic light room at Metrolonics. For calibration purposes the latitude, longitude, elevation and gravity values have been exactly calculated for this particular room.

BURBANK, CALIF.—With the opening this month of Metrolonics, Inc., a new traceable calibration service now is available to the missile industry on the West Coast.

The company was established after 60th Air Force and Aerospace Industries Association surveys indicated the need for additional measuring facilities in the West.

Some 49 of 67 major contractors reported to AIA they were having difficulties in obtaining calibration services as quickly as needed. Certified accuracy of measuring devices after transportation from the East Coast was questioned.

In the Air Force survey, contractors also noted excessive times required and commented on frequent lack of traceability to the National Bureau of Standards.

Need for improved accuracies particularly was noted in these areas:

- Cryogenic temperatures.
- Acceleration.
- High temperature ranges associated with rocket engines.
- Vacuum.
- Fluid flow.

With a number of missile failures directly traceable to faulty calibration, the military now is beginning to enforce more rigidly the calibration standards required by MIL-Q-9858.

It is in anticipation of growing calibration demands from the missile industry that Metrolonics has been established, at an initial investment of almost $250,000.

"The services Metrolonics, Inc., will supply to industry have been generated by the new demands for Space Age precision," a company spokesman says. "Under recently revised regulations of the Department of Defense, all prime contractors and their subcontractors must demonstrate that their precision measuring instruments have been compared to and referenced to the primary standards in the National Bureau of Standards. Metrolonics' function is to provide the necessary link between the National Bureau of Standards and the multitude of manufacturers who must use precision measuring instruments."

A Metrolonics survey indicates there are some 2500 subcontractors who do not maintain their own calibration laboratories, although the military requires that all instruments used for precision measurements in such fields as optics, physical dimensions, electronics, micro-wave and infrared must be compared at specific times—usually annually—with "reference" standards which in turn are regularly compared with those at NBS.

• **The setup**—Preparations for the Metrolonics opening have been under way for more than a year. The metrology lab, devoted to physical measurements of length, time and mass now is complete.

Among the more than 50 types of measuring equipment it contains are the automated electronic interferometer for measuring gage blocks to 1/10-millionth of an inch by absolute measurement and the interference microscopes for measuring surfaces to less than one-tenth of a millionth of an inch; optical universal measuring equipment where components can be evaluated for size, roundness, and shape without removing the part from its position; and comparative optical instruments that can measure angularity to one-tenth of one second of an arc.

Under further expansion planned by Metrolonics, the electronics, microwave, optics and infrared laboratories will be established next, in that order.

Directing the technical and scientific activities of the company will be John A. Harrington, vice president-technical operations. Company president and treasurer is Donald S. Bibbero, with Donald G. Michealsen, Santa Barbara industrialist, as chairman of the board. Other officers include Alexander Glass, Jr., vice president and secretary; and Thomas G. Utley, vice president-administration.

Address of the new firm is 2201 N. Hollywood Way, Burbank, Calif.

LMSD Developing Inorganics

SANTA BARBARA, CALIF.—Lockheed Missiles and Space Division is developing inorganic coatings and semi-inorganic paints that combine the advantages or organic paints with better stability in space.

This was revealed at the recent American Rocket Society meeting here on structural design of space vehicles. The Lockheed work is part of a major program to study the stability of temperature control surfaces under combined vacuum, temperature and ultraviolet radiation and under rapid ascent heating.

Final result of the program is expected to be a set of stable surface finishes with predictable and desirable thermal radiation characteristics.

"For each structural material which may be used, such as aluminum and magnesium, a surface finish will be available in each of the four standard exterior surfaces plus any special sur-

Somewhere at sea, crews of U.S. military patrol aircraft are intent on preventing a surprise attack by enemy bombers. Critical to the success of this patrol network is continuous knowledge of position and attitude.

For all missions of long flight times, Autonetics has developed and produced stellar-monitored inertial navigation systems of maximum accuracy and reliability. These systems make use of periodic starlight information... day or night... to correct for the gyro drift inherent in all pure inertial systems.

Autonetics stellar-inertial subsystems now in test meet requirements for ASW, AEW and reconnaissance.

Stellar-Inertial navigation by Autonetics

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INERTIAL NAVIGATION / ARMAMENT AND FLIGHT CONTROL / COMPUTERS AND DATA SYSTEMS

faces which may have been developed for interior use," the Lockheed report said.

Information on all such surfaces will be compiled in a design handbook, the Lockheed researchers said. This will include not only characteristics but also manufacturing instructions, methods of application and control, and any special handling instructions such as the necessity for the use of a specific strippable paint. The book will be cross-indexed and will be in considerable detail.

"With the proposed design handbook," it was stated, "it will be possible for a designer, with little or no experimental verification, to select successful thermal control surface coatings for any given application."

Details of the program were given in a paper by Morris Steinberg, J. J. Fox and Bruno Augenstein. The researchers pointed out that a requirement of effective and flexible space vehicle thermal control is the development of four types of coatings that will not degrade appreciably over the projected useful life of the vehicle:

- A flat reflector—a surface having a low emissivity at all wave lengths.
- A flat absorber—a surface having a high emissivity at all wave lengths.
- A solar reflector—a surface having a low emissivity in the solar region (below about four microns wavelength) and a high emissivity in the infrared region.
- A solar absorber—a surface having a high emissivity in the solar region and a low emissivity in the infrared region.

Flat absorbers include some black paints such as the Dow 9 surface on magnesium-thorium alloy and black chromium electroplate, the Lockheed paper said. It reported that commercially available silicon-based black paints with carbon black or graphite pigmentation appear to be promising, possessing good resistance to ascent heating conditions. The development of soluble silicate, titanium ester, and silicone ester paint vehicles with suitable black pigments also is said to be a promising possibility.

- **Help from metals**—Some polished metals and even lightly oxidized metals act as solar absorbers, the paper noted. Aluminum with normal atmospheric oxidization is one such surface; metal-plated surfaces are another. It was noted that vacuum and electrodeposited surfaces on magnesium are generally of a poor quality with some manufacturing development work probably required.

A surface used in the *X-17* project, sulfamate of nickel is a promising plating material, the Lockheed researchers said, together with silver, "crack-free" rhodium, and crack-free platinum.

Now on Atlas, Titan & Centaur Missiles

LEONARD PILOT OPERATED RELIEF VALVES

with operating temperature range of −320°F to +200°F

These two Pilot Operated Relief Valves, currently in production at Leonard, have zero leakage over a temperature range of −320°F to +200°F, and withstand the extremes of shock and vibration. Featuring a unique pilot operated circuit, the units are small in size, and but 14 ounces in weight. Their reliability and accuracy has gained for them wide recognition as ideal missile components, as well as for many ground and static applications. The two valves shown are typical of the many relief valves that have been produced by Leonard which cover wide ranges of pressures, medias and flow conditions. Note the detailed specifications.

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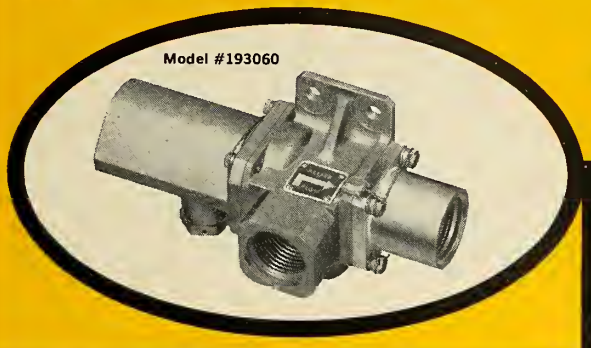

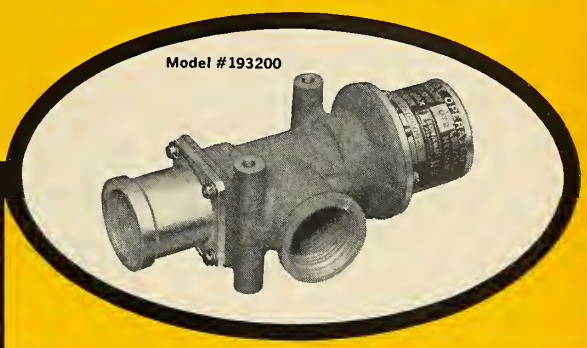

SPECIFICATIONS • MODEL #193060

Media	Helium
Cracking Pressure	385 psig max.
Reseat Pressure	370 min.
Flow	.15 lbs/sec.
Leakage	55 cc/min @−320°F
Operating Temperature	−320°F to +200°F
Vibration	30 G 10 to 2000 cps
Acceleration	20 G's
Weight	14 oz.
Overall Length	5.40 in.
Response Time	5 ms. to full open

SPECIFICATIONS • MODEL #193200

Media	Helium
Cracking Pressure	32 psig max.
Reseat Pressure	29 min.
Flow	.032 lbs/sec.
Leakage	5 cc/min @−320°F
Operating Temperature	−320°F to +200°F
Vibration	MIL-E-5272, Proc. 1
Acceleration	20 G's
Weight	14 oz.
Overall Length	6.00 in.
Response Time	5 ms. to full open

DESIGN PARAMETERS • MODEL #193060

Maximum Flow	.36 lbs/sec.
Cracking Pressure	250 to 1000 psig.
Media	GOX, Hydrogen, Nitrogen, and other gases

DESIGN PARAMETERS • MODEL #193200

Maximum Flow	.2 lbs/sec.
Cracking Pressure	30 to 250 psig.
Media	GOX, Hydrogen, Nitrogen, and other gases

The relief valves featured are typical of the more than 200 precision pneumatic and hydraulic pressure control devices which have been developed during the past 10 years at Wallace O. Leonard, Inc., and are now standard equipment on all ICBM's. Leonard product classifications cover: **Regulators • Valves • Switches • Flow Restrictors • Primary Pressure Source • Servo Transducers—Flight Test Systems, Pressure Ratio Computers, Lox and Fuel Tank Level Computers • Systems—Tanking Computers, Primary Pressure Standards.**

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Able-Star Makes Technological First

by Jay Holmes

The Aerojet-General *Able-Star* scored a major technological first April 13 when it became America's first rocket to start and restart in space. So far, there has been no indication that the Soviets have done it.

Able-Star is an advanced model of the reliable *Able,* which, prior to the *Transit 1B* navigation satellite launching, had a record of 13 consecutive successes. Aerojet spokesmen said the two firings made the record 15 for 14 —a batting average of 1.070.

Despite the success of the new rocket, only a few are on order. The military will use *Able-Star* as an upper stage on the Army's Project *Courier* communication satellites, as well as the Navy's *Transit.* Both the military and the National Aeronautics and Space Administration are committed to the Lockheed-Bell *Agena B* for fulfilling much of their needs in restartable upper stages.

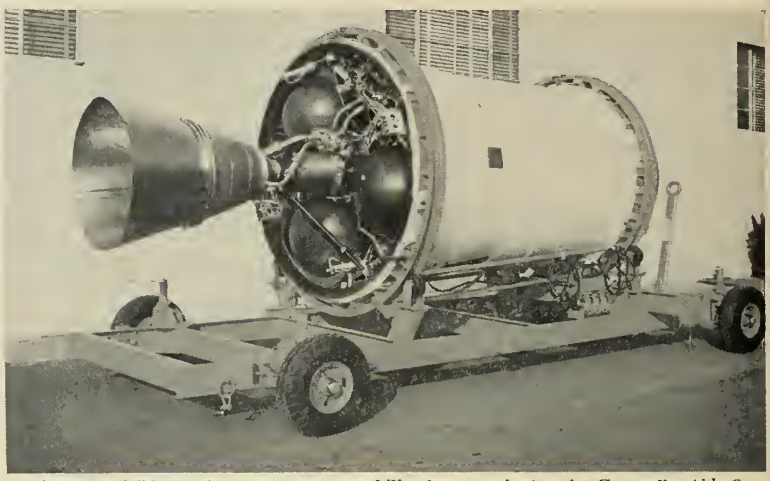
Agena B, a larger and somewhat more complex rocket, is in late stages of development. It is scheduled to be used in the Air Force's *Midas* and *Samos* early warning and reconnaissance satellites and for more than 60 NASA firings in the next 10 years. The first NASA *Agena B* is scheduled to be fired in the first quarter of calendar 1961. The first *Midas* firing is expected this year.

Able-Star generates about 8000 lbs. thrust for 300 seconds, a total impulse of 2.4 million pound-seconds. *Agena B* is expected to generate 15,000 lbs. thrust for about 240 seconds, a total impulse of about 3.6 million pound-seconds—about 50% greater than *Able-Star.*

• **Same combination**—Both rockets use the same hypergolic propellant combination—inhibited red fuming nitric acid and unsymmetrical dimethyl hydrazine (UDMH), which has a theoretical vacuum specific impulse of 276 seconds (1000 psia chamber pressure).

The major difference between the two is in the propellant feed system. *Able-Star* has a simple pressure feed, powered by three helium filled spheres. *Agena* uses turbopumps.

Thus the restart of *Able-Star* is accomplished simply by opening valves. In the *Agena B,* a solid-propellant charge is used to start the turbine pump.



FIRST ROCKET to gain start-restart capability in space is Aerojet-General's *Able-Star,* used on *Transit* navigation satellite.

A small kick also is necessary to force the propellant to the rear in a zero-gravity environment. In the *Able-Star,* this is provided from a container of cold nitrogen, which also supplies pitch, yaw and roll control while the vehicle is coasting. In *Agena B,* solid propellant will provide the propellant gravity and compressed air will be used for attitude control.

• **Virtue of simplicity**—Aerojet spokesmen said the simplicity of the *Able-Star* makes for greater reliability and lower cost. They said *Able-Star* development was begun by the Air Force last fall as a backup for *Agena B.* The simplicity resulted in faster development, they said.

Aerojet spokesmen said the cost of *Able-Star* is about half as much as *Agena B* per vehicle. Air Force spokesmen said the cost figures are classified.

Propulsion Side Effects May Endanger Man in Space

by Frank G. McGuire

Los Angeles—Side effects of certain propulsion systems may be dangerous to the crew of a space vehicle, the national meeting of the Institute of Environmental Sciences was told here.

Side effects, mainly strong magnetic fields, have been under study for some time; recently they have been getting more attention because of the approaching era of ion accelerators, fusion reactors, photon motors, and other "teratogenic devices" for space.

Dr. Harold S. Alexander, a psychologist at the Missile Division of North American Aviation, presented a paper on "Bio-Magnetics" to the meeting, citing experimental effects of magnetic fields on mice and calling the danger to the attention of propulsion system designers. The systems noted above involve the potential use of strong magnetic fields.

Dr. Alexander strongly emphasized, however, that "no extrapolation, based on the state of the art, from mice to men is presently possible."

Many of the propulsion devices now being developed for space feature strong magnetic fields which will undoubtedly affect the crews of vehicles —for better or for worse. One of the advantages promised by magnetic effects is suggested by the increased life

span of mice as well as their increased activity despite lower food consumption. All these phenomena would be beneficial to astronauts.

• **Dynamic testing**—In a paper entitled "Vertical Wind Tunnel and Six Degrees of Freedom—Dynamic Test Stand for Complete Missile Systems," T. C. Helvey of Radiation, Inc., proposes a method for saving hardware, time and expense of test firings.

Pointing out faults in current testing practice, Helvey notes that rigorous testing of components under single or even double environmental conditions causes a systematic error in complete testing because data cannot be extrapolated to multiple environment and dynamic stress conditions.

Noting that "The larger missile systems, according to the present and past experience, show structural integrity and operational reliability not higher than 15 to 20% . . ." Helvey suggests a vertical wind tunnel which would increase this figure significantly.

In the test stand suggested by Helvey, the missile would be placed in a heavily instrumented silo, in which it could rise a few feet. The missile would be placed in normal launching position, and in fact, each stage of a multistage vehicle could be tested individually.

The chamber would be wide enough to allow for a few degrees of drift from the desired vertical axis, much as in actual flight, until guidance corrections take effect. At the top of the silo, a jet engine—or a number of jet engines—would direct a high-temperature, high-speed airstream downward. This airstream would partially counteract the thrust of the missile's operating rocket engine.

This method would make it possible to test the same missile repeatedly in dynamic conditions, and to test modifications before flight tests prove them necessary, at the expense of a failure.

• **Hyper-environments**—"It is unfortunate that designers and environmental engineers are still influenced by the requirements of low-altitude piloted aircraft and are projecting from that base into the hyper environments. In fact, many of the old specifications are still being used with extrapolations."

Thus one of the basic problems in current environmental engineering is spelled out by M. H. Simpson of Frankford Arsenal. Analyzing the hyperenvironments and their effects on military hardware in the interior of a space vehicle, Simpson says there may be unexpectedly easy solutions to some problems.

Path resistance, attenuation, reflection, filtering, decay and other phenomena may possibly reduce the se-

verity of problems affecting hardware inside space vehicles. Extrapolating data from old specifications sometimes results in extreme rigor in some cases, and not enough rigor in others.

"The various parts (of a missile) must be unfailingly reliable, but only long enough to do the job required," Simpson points out, taking a slap at the school of thought that electronics equipment, for example, must operate for extended durations on the ground as well as in the air.

Bomarc-B Ramjet Tech Problems Appear Overcome

The ill-starred *Bomarc B* completed its test series at Cape Canaveral without a completely successful firing last week—but the first shot from Eglin AFB fulfilled expectations.

In the final shot at the Cape April 15, the solid-propellant booster and the ramjet sustainer ignited and performed well. But a malfunction in the experimental flight control changed the missile's attitude so much that the supersonic wind blew out the flame a few miles beyond the sight of observers.

The April 15 shot was the eighth at the Cape and the ninth altogether. In the first five, the booster fired but the ramjet did not, the Air Force said. Defense Secretary Thomas S. Gates has said the problem in the ramjet was pinpointed as one of valve functioning.

• **Problems solved**—Marquardt Corp., which manufactures the air-breathing kerosene-burning ramjet, said that although *Bomarc B* represents a substantial step forward in performance requirements, the technical problems encountered in the ramjet seemed to be solved. Boeing Airplane Co., prime contractor on *Bomarc*, said that although both powerplants operated satisfactorily, on the sixth test a random failure in the guidance system prevented complete success.

The seventh test was scrubbed when an accident caused a fire a short time before the countdown was to begin. The eighth was the successful shot at Eglin April 13, in which the missile traveled more than 170 miles.

Thiokol Chemical Corp., manufacturer of the solid-propellant booster, noted that the booster had a perfect record in flight tests.

AEC Approves NASA's Test Reactor Design

An Atomic Energy Commission committee last week approved the design of a test reactor built by the National Aeronautics and Space Administration at Sandusky, Ohio.

The AEC's Advisory Committee on Reactor Safeguards found that the 60 thermal megawatt device, called the Plum Brook Reactor, "should be capable of being operated without undue hazard to the health and safety of the public."

NASA plans to use the Plum Brook Reactor in testing the properties of materials irradiated at liquid hydrogen temperature (–423°F). The tests are necessary in the development of components for the Project *Rover* nuclear rocket.

The AEC committee did not comment on the operating procedures or the design of experiments using the Plum Brook reactor. In 1957, the committee concurred in the need of controlled holdup storage of radioactive gaseous and liquid products, because of the nearness to Sandusky. For the same reason, the committee said, "proposed experiments will have to be carefully reviewed and appropriate limitation may be necessary at this site."

Avco-GE Get Study Award On Plasma Propulsion

Avco Corp. and the General Electric Co. were chosen last week to make one-year competing studies of the feasibility of pulsed plasma propulsion.

The National Aeronautics and Space Administration will award the two companies contracts totaling about $250,000 each to build and operate nonflying breadboard engines drawing 30 kilowatts of power and generating about ½ lb. thrust. Power in space would be supplied by a *SNAP-8* nuclear reactor, which is expected to be flyable in about five years.

NASA said it will decide at the end of the Avco and GE studies whether to go ahead and authorize development of a flyable plasma unit. Administrator T. Keith Glennan said their proposals offer "promising and different approaches to the problems this system presents."

The plasma jet's chief mission is expected to be the lifting of satellites and space vehicles from low earth orbits to the vicinity of the moon, in cases where the trip by ion propulsion would be too slow.

NASA said a major problem is the development of electrodes capable of operating reliably for two months or more.

Avco and GE were chosen over seven other competitors, Westinghouse, Rocketdyne, Republic, Aerojet-General, Plasmadyne, and Marquardt. One of the basic differences between their proposals is in the engine-cooling arrangement.

Shield Test Reactor Goes Critical at Oak Ridge

The Atomic Energy Commission has put in operation a high-powered nuclear reactor that will be suspended from 324-ft. towers to test the safety of operating nuclear-powered aircraft. The results will be applicable to nuclear rockets and ramjets.

The reactor at Oak Ridge National Laboratory, Oak Ridge, Tenn., is designed to operate at power levels up to 5000 thermal kilowatts for studying atmospheric scattering of radiation and for experiments in connection with the shielding of materials. It is designated Test Shielding Reactor 2.

Test Shielding Reactor 1, used in nuclear experiments that required suspension as high as 190 ft., was shut down in December, 1958, because it could not emit a uniform intensity of neutrons in all directions.

TSR-2 cost $1,090,000. It achieved criticality March 26.

Space Plastic, Lubricant Reported at ACS Meeting

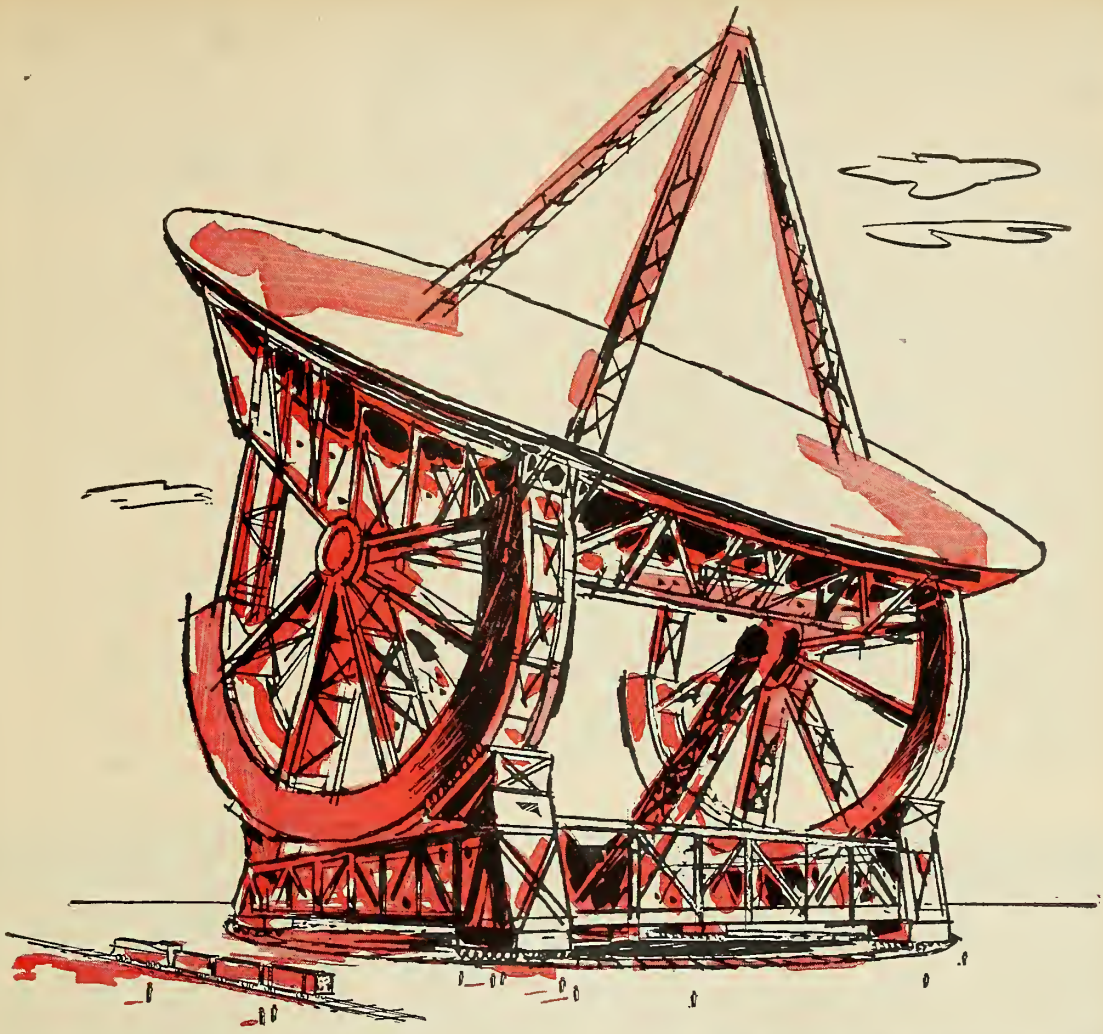
A gamma radiation-resistant, flexible polyurethane material has been developed by B. F. Goodrich out of what once was a laboratory curiosity.

The elastomer, Estane (5740x1) can stand strong radiation doses before being rendered useless because its constituent molecules are not tied together by actual chemical means. This reduces the action of radiation which induces brittleness in elastomers by excessively binding polymeric chains together.

Dr. Charles S. Schollenburger, of Goodrich's Research Center, Brecksville, Ohio, told the American Chemical Society in Cleveland that the material's radiation-resistant qualities should find use in shielding personnel, on earth and in space, and in manufacture of gaskets, tubing, pads and binders for radiation applications in reactors, nuclear propulsion and other nuclear installations.

In another paper delivered before the Society, three Battelle Memorial Institute scientists reported the development of a new high-temperature lubricant.

Dr. H. H. Krause, Dr. S. L. Cosgrove and Dr. C. M. Allen said that the lubricant, metal-free phthalocyanine, will function effectively up to 1350°F. Lubrication over a wide temperature range in the absence of oxygen and water vapor is possible with the phthalocyanines. Lack of water vapor destroys the lubricating efficiency of graphite, one of the current high-temperature lubricants. The phthalocyanines are more familiarly known as dyes in coloring metals.



Huge radio telescope for celestial exploration and space communication. Note how freight train is dwarfed by it.

Loewy plays vital role in design and construction of world's largest radio telescope

Loewy-Hydropress, well established in the design and construction of testing and launching installations for missiles and rockets, has extended its activities into the field of radio telescopes and allied equipment. Loewy is currently making a major contribution to the world's largest telescope (now under construction for the U.S. Navy) by designing and building the huge bearings, drives, supports and other mechanical elements which motivate altitude and azimuth position and control the fine balance of the structure.

In addition to the Navy project, Loewy engineers have been working on another enormous telescope, one with a reflector diameter of approximately 300 ft. And they have also been instrumental in the development of the complex mechanisms and structures for large radar tracking antennas.

For information that could be helpful in your structural and mechanical problems concerning radio telescopes and radar antennas for scientific and ordnance requirements, write Dept. S-4.

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Industry Tells Navy How to Push ASW

If money and encouragement are given to industry working in the ASW field, then significant improvements in ASW techniques will probably follow, according to a report released this week by the National Security Industrial Association's ASW Committee. The Committee soberly warned that, "A major technological breakthrough should not be expected . . . in the ASW field."

NSIA is a nonprofit, nonlobbying organization of top industrial experts who combine their experience in technical committees to advise the Defense Department and other military departments on matters that affect the security of the United States.

Ninety-seven industrial organizations are represented on NSIA's ASW Committees, which have 318 members. They were honored for their work on April 13, when the Chief of Naval Operations awarded the Committee the Navy Certificate of Merit.

Last week the Committee's three-volume report of ASW data and recommendations was submitted to the Chief of Naval Operations. This is the Committee's first report on its findings except for a January verbal briefing given to Admiral Arleigh A. Burke.

• **Recommendations**—The Committee calls for the Navy to use in its Task Groups the most modern ASW equipment, even if it has not yet been formally accepted. In this way, evaluations could proceed parallel to paper work and much time saved.

The Committee wants those men in fleet and research ASW assignments to stay in their assignments for increased lengths of time so that professional-type ASW personnel can be developed.

Test ranges for evaluating torpedoes and other ASW missiles must key in with submarine developments. Hence the Committee is endorsing the Navy's endeavor to establish deeper and longer-range facilities.

The submarine is called the "best mobile sonar platform for ASW work." With this in mind, the Committee says, it wants a program for providing "adequate numbers of special-purpose, mobile, manned, sonar, underwater vehicles which would also contain data processing and communication equipment." The Committee also says that it hopes "the Navy will look favorably on the problem of industry acquiring and operating its own target submarines."

A flexible contract that allows a company to change its R&D emphasis, after military approval, if technical evidence calls for this change is recommended. Type contract asked for is Cost Plus Fixed Fee.

• **And further**—Here are some other recommendations:

The Navy should continue its policy of employing the use of service and

maintenance contracts with industry.

Navy and industry should strive to find a way to make proprietary information generally available.

More contracts should be written for feasibility studies in the ASW field and more money be made available for preliminary experimentation before specifications are written.

The Navy must increase its acceptance of the Fixed Ammunition concept to include major elements of weapon systems and perhaps complete weapon systems. For example, "there is no present technical reason why the Navy should continue to burden itself with shipboard overhaul and maintenance of its torpedoes. New design should feature a completely sealed torpedo with no possibility of test and adjustment."

There is a vital need for establishing an ASW Information Center. Some bibliographies have been made by the Committee, industry and the Library of Congress, but "a centralized information source with modern library facilities would be of immeasurable help."

• **Approvals**—The Committee unanimously endorsed the need for far greater activity in oceanography. It called out the following studies as ones where work is critically wanted: (1) opacity of sea water to various wavelengths of light, heat or other electromagnetic energy; (2) salinity versus depth and location; (3) temperature versus depth for various locations; (4) depth contours of the ocean; (5) ocean currents and current changes; (6) ocean tides and wave motion; (7) ocean bottom conditions; (8) gravity anomalies for the ocean; (9) magnetic charts and anomalies for the ocean; (10) biological studies as they relate to ASW; and (11) characteristics of submarine wakes in the ocean.

The Committee approved the creation of the ASW Readiness Executive Office of the Chief of Naval Operations. This office, it was said, has already given industry a feeling of confidence that worthwhile proposals will receive top rank attention.

Also endorsed was the establishment of the Office of Deputy Chief of Naval Operations (Development). This office has already initiated an Underseas Warfare Research & Development Planning Council, consisting of commanding officers and technical directors of eight Navy laboratories and directors of five nonprofit contractor laboratories.

Industry approval was given to the formalizing of the Navy ASW Committee, with the Secretary of the Navy as chairman. Members of NSIA's ASW Committee said they would cooperate freely and fully in any area in which they might be able to give help.

Radar Needed for Satellite Forecasts

SAN FRANCISCO—Radar stands as the only means by which precipitation detection can be achieved from a satellite for weather prediction, said two RCA meteorologists in a paper presented at the Eighth Weather Radar Conference here.

Lack of knowledge, they said, of actual occurrence and distribution of precipitation is a major deficiency of the observations being made by *Explorer VII* and the more recent *Tiros* weather satellite. (These vehicles employ IR horizon scanners for stability, radiation detectors and television cameras for surveillance.)

In their paper "Weather Radar Observations from Earth Satellites," J. E. Keigler and L. Krawitz of RCA's Astro-Electronic Products Div. describe a workable satellite-borne radar system having minimal design characteristics.

A nonscanning antenna beam, requiring no moving parts or sophisticated circuitry, could be employed in a system using today's state of the art, they said. Based on the application and extension of more conventional radar techniques, it could still use electronic scanning with suitable correlation techniques and precipitation-ground discrimination methods.

The power requirement would be well within the capability of contemporary solar power supplies, while the weight and size of the system, including the antenna, would be within the capacity of existing launching vehicles.

"Feasibility of this sounding radar already has been investigated thoroughly; it could be fabricated and placed in orbit now," Keigler-Krawitz said.

However, it also was noted that a radar satellite yielding full global coverage of precipitation at several levels would not be available in the immediate future.

• **Characteristics**—Characteristics of a minimal orbital radar system include a frequency of 10,000 mc, 80-kw peak power, 5-μsec pulse width, and an average power of 36 watts. It would have a duty cycle of 10^{-6} and a receiver noise figure of 10 db. Detectable radar cross-section would be 2×10^5 ft.^{2} at 800 miles. A system could be developed, they believe, weighing about 50 pounds and using a 4-ft paraboloidal antenna with a 1.75° beam width.

To avoid the high power required to oscillate an antenna transmitting over an appreciable angle at this rate (sweep frequency of 1/sec. for a beamwidth of 1° from an altitude of 300 nautical miles), the authors suggest that a continuously rotating antenna array might be employed.

For the receiving antenna they suggest one proposed by Dr. R. Wilmotte of RCA's Advanced Military Systems group: one that would revolve around a satellite at the end of a cable about 40 feet long, with the transmitting antenna fixed at the center of this circle.

The authors assume that the simplest and most accurately maintained

motion for the receiving antenna is one in which the plane of rotation remains substantially unchanged in space. This means that it changes position in relation to the earth such that objects on earth will have a motion relative to the antenna which will appear as a Doppler frequency in the echo signal reaching the antenna. Since the unique Doppler frequency is known for each point being surveyed, it is possible to resolve adjacent points.

To differentiate between ground return and precipitation, the authors explain that precipitation particle size, relative to a wavelength, causes its back-scattering cross-section to be a function of radar frequency. The heterogeneous ground return would be independent of frequency, hence simultaneous observation of a given elemental volume at two frequencies would indicate precipitation in volume proportional to the difference in returned signals at the two frequencies.

Since the precipitation has a vertical velocity relative to the ground, return from it possesses a Doppler frequency shift. A Doppler radar could double as the sensor unit for satellite stabilization to the local vertical, Keigler-Krawitz conclude.

Transit Success

Another Navigation Satellite Slated Soon

Successful orbiting April 13 of the ARPA-Navy *Transit 1B* satellite is expected to be followed within 60 days by another more "advanced" type which should eventually provide the world with a more truly accurate shipping and submarine navigation system.

First stage of the 265-lb. 36-in. spheroid was an Air Force-modified *Thor* IRBM; second stage was an Aerojet-General *Able-Star* rocket employing for the first time a new restart ignition

Thor-Able-Star Vital Statistics

First stage: modified Air Force *Thor* IRBM
- Weight—100,000 lbs. plus
- Thrust—150,000 lbs.
- Operating time—160 secs. after launch
- No guidance, but roll- and pitch-programmed control

Second stage: Aerojet General *Able-Star* engine
- Weight—1000 lbs. plus
- Thrust—7890 lbs.
- Operating time—300 secs. (258 sec. initial)
- Length—14'10"
- Dia.—4'7"
- Fuel and oxidizer—inhibited red fuming nitric acid, UDMH

Launch vehicle, both stages
- Weight—105,000 lbs. plus
- Length—79.3'

unit. Shutdown and restart capability was needed to kick the satellite into a circular orbit as it approached orbital altitude. This was the first try at restarting a rocket engine in space.

Restart attempt was successful but instead of achieving the desired 575-mile near-circular path, an elliptical orbit was attained: 479-mile apogee; 233-mile perigee. Its 96-minute period carries the satellite roughly from 51°N latitude to 51°S latitude.

Life span of *Transit* has been reduced from the anticipated 50 years to about 16 months.

• *Able-Star* **system**—For its first space launch, the *Able-Star* rocket engine was combined with a *Thor*. The Air Force was responsible for the launch vehicle and payload marriage, launch, flight and orbital control.

Initiated by ARPA, propulsion for the system was built by Aerojet-General; attitude and guidance subsystems were built by Space Technology Laboratories. STL also built and integrated all the other instrumentation.

Restart ignition was actuated by ground radio command from the AF Ballistic Missile Div.-STL mobile tracking station at Erding, Germany.

Developed by the Navy's Bureau of Weapons, *Transit 1B* is identical to its predecessor, which failed to reach orbit during a Sept. 17, 1959, attempt.

Eventually, four 50-lb. operational satellites will be employed for a near permanent world navigational system.

Transit 1B, powered by chemical batteries and recharged with cells, contains two ultrastable oscillators. Each transmits on two frequencies at 1-minute intervals: 54, 324, 162, and 216 mc.

Six ground tracking stations, with headquarters at Johns Hopkins University Applied Physics Laboratory in Maryland, are the principal data receiving centers.

• **Significance**—The immediate importance of such a system will be for military application, particularly for the *Polaris*-carrying nuclear submarines.

In using the system, analysis of Doppler shift will be employed to fix the position of a ship. To do this, precise knowledge of the time and satellite's position at that time is necessary. (This is simply the reverse of the method used to plot satellite orbits.)

Dr. Richard B. Kershner of Johns Hopkins APL, technical director for the program, estimated that future satellites designed for a 5-year working life will cost $1 million each to launch. A four-satellite operational system will cost roughly $3 million a year.

Target date for an operational system is tentatively set at 1962. Developmental costs over next two years will be $50 million, DOD officials say.

Japanese Steadily Prepare For Domestic Missile Making

by Kazuo Takita

TOKYO—Aircraft and electronics industries have started full-scale preparations in anticipation of a nod from the Japanese Defense Agency to start production of Japan's first home-grown missiles. Three models, a surface-to-air, an air-to-air and an antitank missile, are in the R&D stage under a $1.2 million appropriation this fiscal year (April 1, 1960, to March 31, 1961) and production on at least one will begin in 1961.

Under a new five-year plan for defense beginning FY 1961, all three services of the Japanese defense forces will be armed with guided missiles. In addition to its own models, however, some $3 million has been allocated for purchase of *Tartar* missiles for the Japanese Maritime Force and *Sidewinders* for the Air Force.

• **Industry leads**—The first move toward revamping facilities for missile production in Japan has been the trip by 14 top industry executives and engineers to the United States, Britain and Europe to study rocket production techniques. Headed by Yoshinaga Sake, president of the Mitsubishi Electric Co., the team is now on tour throughout Britain, West Germany, the Netherlands, France, Switzerland and Italy.

The Guided Missile Agency, a private organization with government support, has been a propelling force in orienting Japanese industry to missile production. In addition to organizing the current tour, it plans to sponsor construction of a supersonic wind tunnel and rocket testing facility.

The Japanese Defense Agency's Technical Research Institute has begun test production of a surface-to-air missile called the *TSAM-1*, expected to be very similar in configuration to the *Nike-Ajax*. It will have an ambidextrous propulsion system, capable of using both solid or liquid fuels, although Defense Agency plans call for a liquid-propelled version for *TSAM-1*, with a solid-fuel booster.

Speed of the missile will be Mach 2 with thrust capability of 2000 lbs., with booster thrust of 80,000 lbs.

• **Japan's missile schedule:**

• Domestic production will be started in 1962 of either *Nike-Hercules* or *Hawk* class (surface-to-air) missiles.

• Production will begin in 1965 of *Bomarc* class.

• Production of *Sidewinders* class will start in 1961. Eventual annual output will be 1500 to 2000.

• Experimental production of antitank missiles under study will be continued and full-dress production started in 1961. Annual production target will be set at between 300 and 400.

• Production of *Little John* class missile will begin in 1964.

The ratio of domestic production of these missiles is set at 20% for the initial years, but will eventually be raised to 70% for air-to-air and 90% for surface-to-surface missiles.

The antitank missile production will be wholly domestic throughout the program.

soviet affairs

By DR. ALBERT PARRY

Part of Russia's man-in-space research . . .
is being done in Czechoslovakia. This is evident from two items in recent issues of *Prague News Letter*. On Feb. 20 the Czech publication revealed the creation of a Commission on Cosmic Medicine in the Physiology Section of the J. E. Purkyne Medical Association in Prague, with 140 members. The first conference of these Czech space-medicine experts is announced for the second half of April, with "the technology of rockets and astronautics" as its main topic.

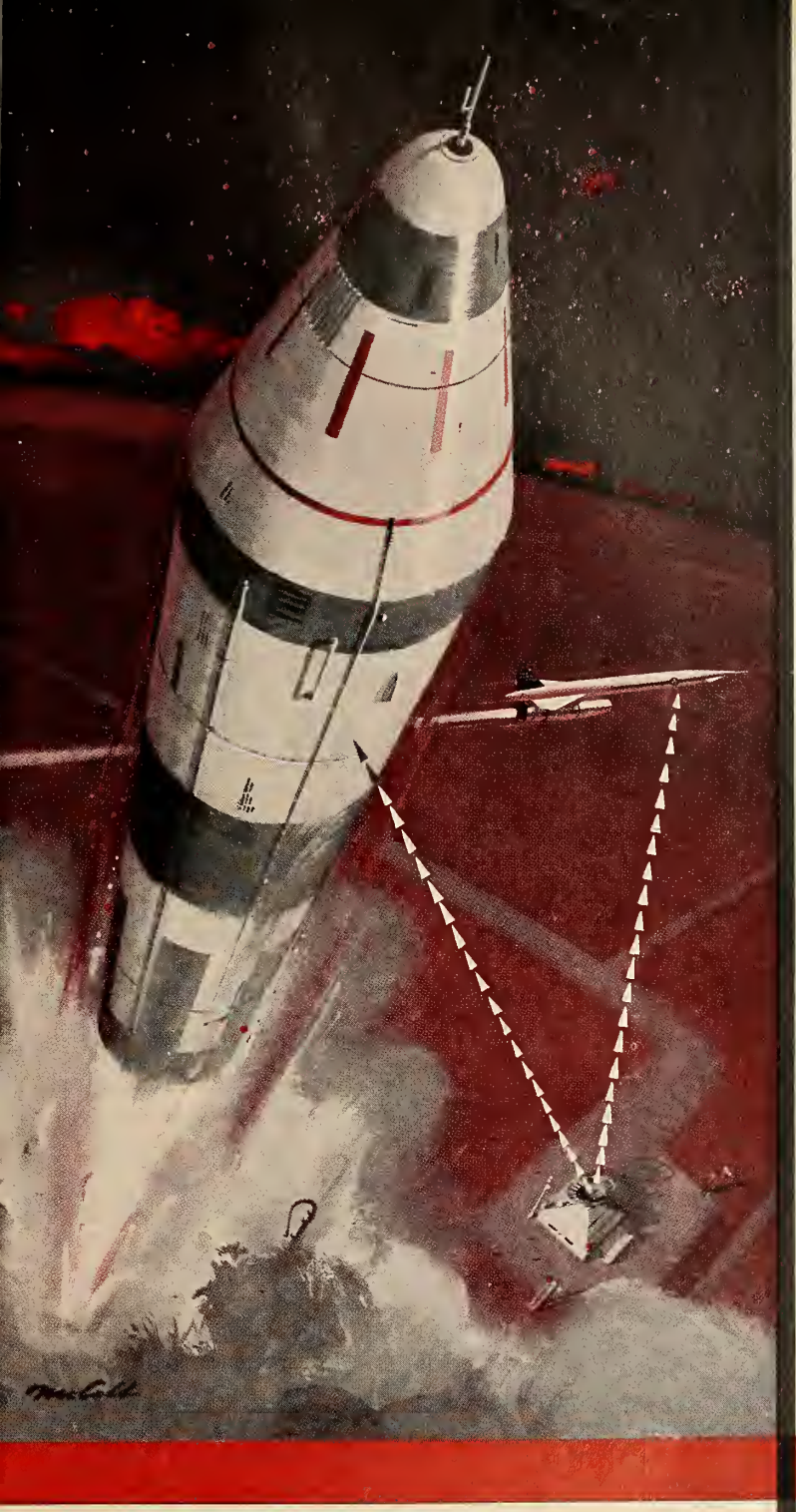
A film on space medicine . . .
has been made in Czechoslovakia and will soon be released for public showing. This we learn from the April 2 *Prague News Letter*, which prints an account entitled "Preparing for Cosmic Flight; Space Doctors Filmed at Work." The movie, one hour long and called "Before Man Steps Into Space," was produced in color by the Prague Popular Scientific Film Studio under the direction of Kurt Goldberger, whose previous films on medical subjects have won international prizes.

A giant centrifuge . . .
was used by the film's makers to reproduce the latest Czech researches on weightlessness. In it, prospective astronauts were whirled around in a cabin suspended on the end of a 30-foot rotating arm. The Czech article states: "The resulting centrifugal force acts like the accelerating and decelerating forces in a rocket. The tormented body of the human space guinea experiences only some of the arduous conditions awaiting the first space travelers. . . . We also see the strange behavior of liquids in a weightless state." This sequence was filmed by the Czechs in a large transport plane, converted into a movie studio, with lamps, cameras, and other objects carefully bolted down.

A large steel vacuum chamber . . .
was used for that part of the film where man's resistance to low air pressure and lack of oxygen was watched by the Czech doctors. Here altitudes up to 80,000 feet were simulated. At 24,000 feet a man was tested for his resistance to low atmospheric pressures. In one test, the subject (himself a doctor, who may or may not be an astronaut in training) was told to write consecutive numbers from 500 down. The log of his experiences tells us: "After five minutes his writing gets slower, his hand is heavy, and then he begins his losing struggle against suffocation." In the seventh minute he becomes unconscious. At low atmospheric pressure the subject's blood starts to boil at normal temperatures and gas blisters appear under the skin.

Solitary confinement . . .
to duplicate a two weeks' flight in a rocket was simulated for the film. These tests were conducted in a very narrow space within a steel cylinder resembling a rocket's cabin. The Czech description informs us: "The astronaut cannot even rise from his seat, suffers from limited sanitary conditions, and is subject to somewhat decreased atmospheric pressure." This solitary confinement in an air-tight, sound-proof cabin, completely isolated from the outside world, is supposed to last 336 hours. The man's nervous tension reaches its climax on the 12th day; he has hallucinations, and loses power to concentrate on his job. All this time, the Czech space doctors watch him intently on closed-circuit TV. Cardiographs, tensometers, encephalographs, and other instruments record every movement of his body, every action of his brain.

"Break-off complex" . . .
or a kind of mental depression, caused by a feeling of being cut from earth and fellow men, is an important target of Czech research and is dealt with quite dramatically in the film.



New from Crosley...

miniaturized

Command Receivers for missiles and drones

To meet the critical need for high-density packaging in missiles, Avco's Crosley Division has developed new miniaturized Command Destruct Receivers that weigh only three pounds.

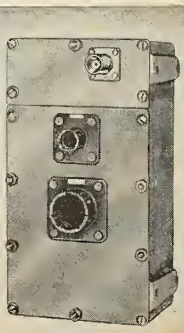
Their task: To receive and act upon instruction from the ground to destroy a missile that has gone out of control.

In the Command Destruct configuration for range safety and similar applications, the miniaturized Command Receiver has four channels incorporating a decoder, to provide a secure link between the ground station and missile.

For high-performance drones and decoys, there are similar miniaturized Command Receivers that employ a 12-channel network. These receivers will actuate control surfaces, direct engine operation, and open a recovery parachute—all by radio-conveyed ground instruction.

Today Avco/Crosley Command Receivers are standard equipment on most of the nation's missiles. And by meeting the most severe environmental and operational requirements they have proved themselves for the future.

For more information, write to Vice-President, Marketing-Defense Products, Dept. M-CR, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio



New Crosley Command Receiver is about the size of a kitchen match box.

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO/CROSLEY TODAY.

Avco / Crosley

Circle No. 3 on Subscriber Service Card.

names in the news

Dr. Milo P. Hnilicka: With the firm since 1952, promoted to the new post of scientific assistant to the vice president and director of research for National Research Corp. He will continue to serve as a consultant in various aspects of space technology, particularly the simulation of the environment of outer space.

HNILICKA

Rear Adm. Sir Matthew Slattery and **Peter G. Masefield** have resigned from Bristol's board and from their respective appointments as chairman and managing director. **Sir Reginald Verdon Smith,** chairman and joint managing director of the Bristol Aeroplane Co., appointed chairman of Bristol Aircraft and **Dr. A. E. Russell,** former chief engineer' technical director. **J. F. Harper,** former assistant managing director of Bristol appointed director and general manager. **D. J. Farrar,** formerly chief designer, guided weapons, promoted to chief engineer, guided weapons.

E. Paul Jackson: Appointed marketing director, Eastern region, for Rocket Power-Talco division of The Gabriel Co. Prior to joining the firm was manager of special projects for Fairchild Engine and Airplane Co.

JACKSON

John A. Moreno: Appointed executive assistant in charge of engineering administration at the Pomona Division of The Marquardt Corp.

Frederick Stevens, Thomas H. Quayle and **William A. Jones:** Promoted to newly created positions as vice presidents of Northrop Corp.'s Nortronics Division. Stevens is in charge of the electronic systems and equipment department at Hawthorne; Quayle directs the systems support department at Anaheim, and Jones heads the precision products department in Norwood, Mass.

Maxwell White: Named manager of the newly formed advanced systems research dept. of the Military Systems-Stavid Div. of Lockheed Electronics Co. Earlier served as a project manager and project engineer at the Martin Co.-Baltimore in connection with the *Minuteman, Matador* and *Mace* programs.

WHITE

Dr. James King, Jr.: Joins the technical staff of Electro-Optical Systems, Inc., as a senior scientist in the energy research division. Was previously a senior research engineer at Atomics International in the solid state physics group, where he researched measurement of thermal properties of solid materials at high temperatures.

L. J. Braun: Appointed director of corporate contracts for American Bosch Arma Corp. Was previously president and director of sales for Tele-Dynamics, Inc., acquired by American Bosch Arma Corp. in February, 1960; now a division of the corporation.

BRAUN

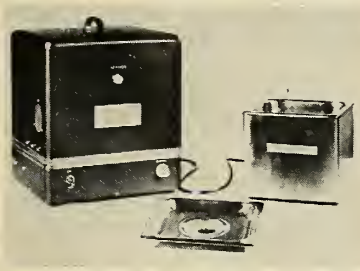
William R. Carlson: Formerly with Raytheon's Semiconductor Division, joins the Semiconductor Division of General Instrument Corp. as planning and controls manager.

Edward J. Rhoad: Appointed a senior scientist at Hughes Aircraft Co.'s ground systems group. Was formerly project manager of Frescanar, an advanced radar development for the U.S. Army.

Ultrasonic Cleaner

McKenna Laboratories has developed an ultrasonic cleaner featuring several simultaneous ultrasonic frequencies.

In addition to the "Poly-Sonic" feature, the V-100 provides thorough



cleaning because it produces uniform concentration of ultrasonic power throughout the cleaning chamber. Completely uniform cleaning results are obtained throughout the volume of the container even in a parts basket. Another feature of the "Poly-Sonic" units is the more effective cleaning through the use of heated solutions.

The V-100 runs at 400 KC with overtones of other frequencies ranging down to 20 KC. 400 KC removes dirt particles down to 1 micron in size and penetrates into small crevices and recesses. The lower frequencies provide cleaning action required for larger dirt particles and provide cleaning on areas that are not accessible to high frequency because of shadowing.

Circle No. 225 on Subscriber Service Card.

Standard Missile 'Clock'

A 400 cps-frequency standard—featuring extremely high stability under rugged environmental conditions and varying input voltages—has been designed and developed for use in missiles by the Electronics Division of Bulova Watch Company, Inc.

The unit's most important application is said to be as a "master clock" type of frequency standard to assure generation of precise and stable frequencies for missile guidance and fire control systems.

Bulova designates the frequency standard as its Model MB400.

Input requirements are 28 volts D.C. (25-29vdc), 1 Vrms ripple. Maximum power required for the unit's oven and oscillator circuitry is 11 watts. The output of 400 cps (plus-or-minus 10 ppm) is a square wave 2 volts peak-to-peak minimum into a 1 kilohm load.

The 400 cps (± 10 ppm) frequency is maintained throughout temperature ranges of −20 +71 degrees C at vibration levels of 5 to 2000 cps at 15g and up to 100g shock in all directions. An additional tolerance of ±10 ppm is necessary when the MB400 is operated at temperatures ranging from −55 to +85°C. The unit can be stored at −55 to +120°C.

Circle No. 226 on Subscriber Service Card.

Novel Air Flow Meter

The first air-flow measuring device with direct "deadbeat" readings has been developed by the Highland Engineering Co.

Designed for the Air Force MB-1,

presently being built by Highland, this unique flow meter has a revolving drum-type dial 25 inches in circumference permitting direct read-out of all flows from 20 to 200 CFM at any pressure from 2 to 12.5 PSIG. The circular dial's long calibration range of 25 inches, plus dampening by paddles turning in oil in the drum reservoir, provide direct deadbeat readings at any point throughout the circumference of the dial, a degree of accuracy previously unobtainable in airflow measuring equipment.

The dial is actuated by a turbine wheel attached to a spring wire stretched within a vertical duct. As airflow velocity rotates the turbine wheel, the torque created is opposed by the spring of the wire, thus registering the rate of flow on the circular calibrated dial.

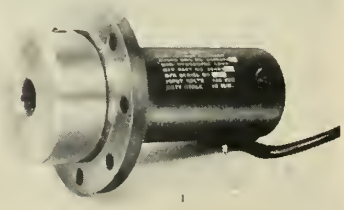
Pressure drop through the device is less than 1/10th pound and it has passed 8g acceleration tests. The design is suitable for air or liquids, can be constructed from nearly any metal—also glass, fiberglass or plastic—to handle practically any conditions of temperature or corrosion.

For extremely wide ranges of flow velocity, it is necessary to use more than one unit, a range of 5 to 1 being accurate to 1%.

Circle No. 227 on Subscriber Service Card.

Small Impeller Pump

Hydrodyne Corp., engineers and manufacturers of gas and liquid controls, have announced production of a small centrifugal impeller pump for heavy duty work in areas requiring subminiature equipment. Designed



originally for Naval Ordnance, this unit delivers up to 8 gpm at 150 psi. It's designed to handle salt water and certain other corrosive fluids. Normal temperature limits are −60° to 350°F. Duty limit is 10 minutes. It's sealed at the shaft with the Skinner Rotary Face Seal, a product manufactured by Hydrodyne's Skinner Seal Division, which withstands pressures to 600 psi. Principal materials used in this pump include aluminum housing and bronze impeller. Power source is direct current electrical pump.

Circle No. 228 on Subscriber Service Card.

new literature

HEATING ELEMENT. A complete 16-page catalog describing Electrofilm's new "wire mesh" heating element is now available from Electrofilm, Inc., of North Hollywood, California. In addition to detailing the exceptional "reliability" features of this new wire mesh type heating element, the catalog also gives complete technical data as to its versatility, physical properties and thermal characteristics, as well as a visual description of the varied components now being used in the aircraft, missile and space age fields.

Circle No. 200 on Subscriber Service Card.

HIGH TEMPERATURE ALLOY—A booklet, "W-545 Vacuum Melted High Temperature Alloy," is available from the Westinghouse Electric Corp. This 12-page technical data booklet is complete with photomicrographs showing structures of the material and many tables and graphs illustrating the material's properties. In addition to general information on applications, other sections of technical data booklet 52-263 deal with metallurgical characteristics, physical properties, mechanical properties, creep and creep-rupture properties, availability, and material processing of W-545 alloy. W-545 alloy is an austenitic iron-base alloy containing nickel, chromium and relatively small portions of molybdenum, titanium, boron, silicon and manganese. This alloy is precipitation hardened and was developed primarily to meet the need for improved gas turbine discs, one of the most critical components of jet engines. It has exceptionally high creep strength combined with good ductility and excellent oxidation in the temperature range of 1000 to 1350°F—the range in which gas turbine discs operate.

Circle No. 201 on Subscriber Service Card.

BROCHURE—The Pennsalt Chemicals Corp. has published a brochure titled, "The Cleaning Of Processing And Handling Equipment For Liquified Gas Producers And Users." The brochure treats each separate liquified gas problem individually, and elaborates on some of the detailed procedures used in cleaning.

Circle No. 202 on Subscriber Service Card.

CHART. Ronan & Kunzl Inc. has available an 8½ in. by 11 in. wall chart showing the gaseous equivalents of one through 5000 gallons of liquid oxygen, nitrogen and argon. The chart shows the cubic feet of gas available when the liquid is converted into gas, and the approximate number of high-pressure cylinders is also shown.

Circle No. 203 on Subscriber Service Card.

contracts

NAVY

Radar Relay, Inc., Santa Monica, Calif., for electronic control display units for *Polaris* checkout system. (performed under $200,000 in contracts to **Nortronics Div., Northrop Corp.**).

$20,000,000—**Sperry Gyroscope Co.,** Great Neck, N.Y., for navigation systems and field engineering for the *Polaris* submarine fleet. ($8,817,022 for design and manufacture of navigational systems; $10,868,269 for field engineering.)

$2,000,000—**Chance Vought, Range Systems Div.,** for instrumentation of the S. S. Skidmore Victory for use on the Pacific Missile Range.

NASA

$114,000—**National Research Corp.,** Cambridge, Mass., for development of special satellite instrumentation and related testing equipment.

$48,000—**Fischer Research Laboratory, Inc.,** Palo Alto, for indicating millivolt potentiometers for general use in tunnel tests.

$27,230—**Task Corp.,** Anaheim, Calif., for internal strain gage balance, for use with low-life type vehicles in the 8 x 7 supersonic wind tunnel.

$26,820—**Precision Instrument Co.,** San Carlos, Calif., for one 14-channel recorder-reproducer for tests in 12 ft. wind tunnel.

AIR FORCE

$12,000,000—**The Hallicrafters Co.,** Chicago, for production of electronic countermeasure equipment designed to disrupt hostile radar and missile guidance systems.

$2,600,000—**Westinghouse Electric Corp.,** for tactical scatter communications equipment.

$1,272,00—**Motorola, Inc., Semiconductor Products Div.,** Phoenix, for reliability improvement of semiconductors for the *Minuteman*. Sub-contract from **Autonetics Div., North American Aviation, Inc.**

$1,091,483—**Research, Inc.,** Eden Prairie, Minn., for building temperature sensing and recording devices used in research on missiles.

$600,000—**Boeing Airplane Co.,** Seattle, for *IM99A* mobile inspection equipment.

$384,910—**Boeing Airplane Co., Pilotless Aircraft Div.,** Seattle, for copy suitable for photographic reproduction and photolithographic negatives applicable to the *IM99A* missile. (5 contracts)

$225,000—**Space Electronics Corp.,** Glendale, Calif., for further research and development on a terminal guidance system for the *Titan*. Sub-contract from **Avco Corp., Research and Advanced Development Div.**

$134,125—**Barnes Engineering Co.,** Stamford, Conn., for infrared tracking systems and ancillary equipment.

$47,740—**Ryan Aeronautical Co.,** San Diego, for radar components.

$42,765—**General Electric Co., Defense Electronics Div.,** for design study of a satellite ionospheric sounder.

$40,800—**Consolidated Electrodynamics Corp.,** Albuquerque, for recorder/reproducers.

$33,730—**Consolidated Electrodynamics Corp.,** Albuquerque, for recorder to be used in support of Project *WS-133A*.

ARMY

$10,500,000—**Thiokol Chemical Corp.,** Bristol, Pa., for production of rocket motors and plant maintenance at the Longhorn Ordnance Works, Marshall, Tex.

$4,800,000—**Chrysler Corp.,** for the *Jupiter* ($2,796,382 for modification of ground equipment; $2,018,983 for missile components).

$3,457,070—**Radioplane Div., Northrop Corp.,** for 400 target missiles.

$2,184,000—**Temco Aircraft Corp.,** for manufacture of components for the *Hawk* missile.

$227,650—**Raytheon Co.,** Waltham, Mass., for concurrent repair parts for *Hawk* missile.

$167,140—**IMSCO,** El Paso, Tex., for *Nike-Hercules* Battalion headquarters facility Walker AFB.

$162,509—**Robert L. Scott,** San Antonio, for construction of guided missile field maintenance shop.

MISCELLANEOUS

$2,600,000—**Raytheon Co.,** Santa Barbara, for continued work on a fire control system for the *Shillelagh*. Subcontract from **Aeronutronics Div., Ford Motor Co.**

$1,000,000—**Lear, Inc.,** for manufacture of universal component test stands for rocket engines. Subcontract from **Rocketdyne Div., North American Aviation.**

reviews

SHORT TIME HUMAN TOLERANCE TO SINUSOIDAL VIBRATIONS, G. H. Ziegenruecker and E. B. Magid, WADC. Order PB 161083 from OTS, U.S. Dept of Commerce Washington 25, D.C. $.50.

The experiment tested the voluntary endurance limit to which healthy men could tolerate sinusoidal virbrations. These vibrations appear to be a vital environmental element in rocket propelled, manned space vehicles during launching and re-entry operations. The vibratory flight environment was simulated by an instrument monitored, mechanical shake table.

During tests, the frequency of vibrations ranged from 1 to 15 cps. Observations showed that tolerance limits were the result of one or more of seven specific sensations.

Test subjects reported dull pains, short breath and malaise increasing in intensity with time and vibratory rate.

SURFACE EFFECTS ON SPACECRAFT MATERIALS, Edited by Francis J. Clauss. Transactions of the Symposium Co-sponsored by the Missiles and Space Division of Lockheed Aircraft Corp. and the Air Research and Development Command, U.S. Air Force, Palo Alto, California, May 12 and 13, 1959. John Wiley & Sons, New York, 404 pp., $11.50.

The temperature control problem in space is initially treated with methods of calculating the required radiation characteristics of surfaces, experience to date with space probes and satellites in this area and methods of measuring the radiation characteristics.

The effects of environmental conditions in space on the surface and structrual properties of materials, ultraviolet radiation, the myriad effects of high vacuum on mechanical properties, interplanetary dust distribution and its erosive qualities are among the subjects handled in the rest of the papers in the collection.

—when and where—

APRIL

The Combustion Institute, Western States Section, Spring Meeting, sponsored by Lockheed Aircraft Corp., Palo Alto, Calif., April 25-26.

ASME Maintenance and Plant Engineering Conference, Chase-Park Plaza Hotel, St. Louis, April 25-26.

American Welding Society, 41st Annual Meeting and Welding Exposition, Los Angeles, April 25-29.

2nd Southwestern Metal Exposition and Congress, State Fair Park, Automobile Bldg., Dallas, April 25-29.

National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton-Gibson Hotel, Cincinnati, April 27-28.

British Interplanetary Society, High Altitude Chambers and Pressure Suits, Church House, London, April 28.

MAY

Society of Aerospace Materials and Process Engineers (SAMPE) Eastern Division, Spring Meeting, Massachusetts Institute of Technology, Cambridge, May 3.

National Association of Relay Manufacturers, Eighth Annual Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, May 3-5.

Materials Handling Exhibition and Convention, Mechanical Handling, sponsored by Associated Iliffe Press, Dorset House, Stamford St., London, May 3-13.

Properties and Application of Materials in Aerospace Vehicle Design, sponsored by The Martin Co.-Denver, Park Lane Hotel, Denver, May 4-6.

National Machine Tool Builders Association, 58th Spring Meeting, The Roosevelt Hotel, New York City, May 5-6.

Radiation Research Society, Annual Meeting, San Francisco, May 8-12.

Aerospace Medical Association, 31st Annual Scientific Meeting, Miami Beach, May 9-11.

1960 Symposium of the Institute of Radio Engineers' Professional Group, on Microwave Theory and Techniques, Hotel del Coronado, San Diego, May 9-11.

Instrument Society of America, Instrument-Automation Conference and Exhibit for San Francisco, Brooks Hall, San Francisco, May 9-13.

Second Southwestern Metal Congress and Exposition, American Society for Metals, Sheraton Dallas Hotel and State Fair Park, Dallas, May 9-13.

1960 Electronics Components Conference, sponsored by Institute of Radio Engineers Professional Group on Component Parts, American Institute of Electrical Engineers, Electronic Industries Association, Hotel Washington, Washington, D.C., May 10-12.

New York University, Conference on "The Critical Million—How to Talk to the Nation's Scientists and Engineers . . . Industry's Most Vital Audience," New York City, May 17.

Second *Polaris* Underwater Launch Test Is Successful

SAN CLEMENTE ISLAND, CALIF.—The Navy passed another milestone in its fleet ballistic missile crash program here when the Lockheed *Polaris* successfully achieved ignition after an underwater launch. All phases of the test worked perfectly and the missile roared to approximately 1800 feet with its cut-grain propellant charge.

Four days later another *Polaris* test vehicle ripped from the Observation Island surface test ship off Cape Canaveral. The launching was successful, but the missile fell short of its scheduled 900-mile flight because of premature trailing off of the second-stage motor. There was no immediate indication as to the seriousness of the problem.

But success of the underwater test indicates the Navy will succeed in its drive to have two FBM submarines —George Washington and Patrick Henry—on station by the end of this year. The George Washington has already fired "a number of sets of complete salvoes" from her tubes. The missiles used were the *Dolphin* operational configuration.

The April 14 test of the ignition system was the 67th launch from the Navy's San Clemente sea test range, and the first in which ignition was achieved—from either surface or submerged tubes. The first attempt at ignition was made on March 27, resulting in failure "when a pair of relays closed in the wrong sequence." This circuit was modified to prevent a recurrence on the second attempt.

After the initial "Fire" signal at approximately 2:19 p.m., the sequence of events was quite rapid. The missile left its submerged launcher, broke the ocean surface within two seconds, achieved ignition instantaneously, and roared off to the northeast without losing momentum.

• **Faster than expected**—The rapidity with which the *Polaris* ignited after clearing the surface startled many observers, who expected a second or two delay while internal events had time to occur. The tail of the missile appeared to be within 18 inches of the surface when flames sprouted from the nozzles.

A simplified guidance system quickly pitched the vehicle over into a ballistic trajectory, and the propellant charge carried it to less than 2000 feet before burning out and allowing the missile to fall. The remainder of the rocket casing was filled with an inert propellant to bring the weight of the vehicle up to fifteen tons. Powered flight lasted five seconds.

A three-link telemetry system was used for flight test data.

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editorial . . .

Only Industry Can Insure Reliability

Recently we published a story describing successes in the battle to improve parts reliability in electronics (M/R, March 28, 1960). The two companies reported on are representative members of an industrial community trying vigorously to solve a never-ending problem—man's inability to reach perfection.

In the field of missiles and space vehicles, equipment must meet requirements for operation throughout astronomical lengths of time and distance, in an unknown environment, with exquisite accuracy. It can be allowed only infinitesimal failure probabilities.

In this realm, success is not only a noble objective—it is an absolute necessity.

And yet in this boldest of struggles to conquer space, we find our progress retarded by incompetency, delay, unhealthy competition and even plain greed.

Time after time incompetent vendors are awarded subcontracts solely on the basis of shaved prices and fast delivery promises.

The huge and costly engineering systems built to conquer space rarely fail because of failure in the design concept. They fail because of malfunction or nonfunction of some minor part which costs an infinitesimal part of the whole—a valve or tiny electrical connection.

And because of these tiny failures million-dollar missiles collapse and burn on the launching pads.

The Procurement Act of 1948 requires formal advertising for all general procurement (10 U.S. Code, Section 2304) with award to the lowest responsible bidder.

Under the act is a list of exceptions for negotiated contracts; government interpretation of these has generally worked well for the major contracts to the big primes. The Services, for instance, use what is known as the "two-step advertising system." A no-price bid is requested to establish competency, then price bids are requested from a selected few.

Procurement by the primes and large subcontractors is a different story. Specifications—which may run into thousands for MIL-type parts as passed from government to prime contractor—may lack as much as 12 months of being current. They may even be subtly incomplete because the original makers (around whose products they were written) were trying, understandably, to protect their proprietary rights.

The government has passed the ball to the primes and main subs to buy the thousands of component parts on the specifications.

If the company is conscientious, it makes certain that its engineers update MIL-spec requirements and that its buyers purchase only from vendors who can prove reliability and competency. It demands—by instituted policy—that buyers consider workmanship and performance ahead of price and delivery date.

If the company is other than conscientious, or if its purchasing agents are incompetent or ignorant—or if they are allowed to operate under a policy of expediency—then the buying will frequently be at the expense of reliability.

We have a great belief in U.S. industry, in its competency and its integrity—in its great pride of product. Most of it is conscientious, and most of it has set up rules and procedures to buy the best and the most reliable product.

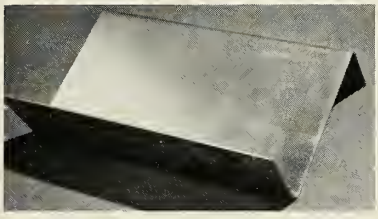
But there are those who have put the fast buck ahead of integrity, the slick deal ahead of reliability. They are the companies which must be weeded out of the missile/space industry. And they can be weeded out—by government regulation, by industry boycott and by exposure to public opinion.

Clarke Newlon

DOW | *Now in magnesium and aluminum*

FOUR MAGNESIUM DEVELOPMENTS ANSWER DESIGNERS' PROBLEMS

New Dow developments in magnesium provide solutions to critical problems for aircraft, missile and electronics designers. Among them are: a special bend sheet; new close sheet tolerances; precision extrusions; elevated temperature alloys.



Heated dies are not necessary with Special Bend sheet.

NEW SPECIAL BEND SHEET bends easily on standard bending equipment at room temperature. This AZ31B-O Special Bend sheet can be cold-bent without cracking through an angle of 90 degrees around a mandrel radius equal to the bend factor times the nominal sheet thickness . . . bend factor for .040″ to .100″ sheet thickness is 2.0! And tensile yield strength meets the requirements of Federal Specification QQ-M-44.

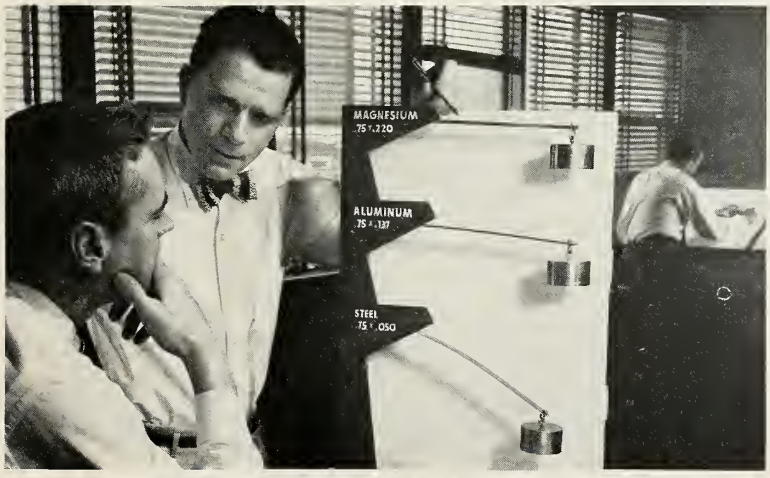
NEW CLOSE SHEET TOLERANCES can now be obtained on standard gauges when required. For example, on .090″ gauge, 48-inch-wide sheet, tolerances can now be held as close as plus or minus .002″. Standard tolerances run plus or minus .004″. These closer tolerances help to cut down on weight penalty, so important in missile and aircraft design.

PRECISION MAGNESIUM EXTRUSIONS from Dow give you exact-tolerance parts without costly multiple machining operations. Sharp V's, deep notches, thin slots, accurate serrations . . . all can be economically produced in Dow's Madison, Illinois, extrusion plant.

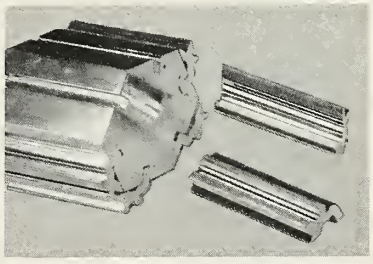
LARGE EXTRUSIONS. A huge 13,200-ton press easily handles large sections, stepped extrusions, combined extrusion forgings and single unit extrusions to replace fabrications. This giant can handle sections of up to a 30-inch circumscribed circle!

ELEVATED TEMPERATURE ALLOYS are available from Dow for extruded and rolled products. These alloys have excellent static and creep properties, some up to or above 700°F. Because of magnesium's high specific heat, it's an excellent heat sink for instruments and components!

Compared pound for pound with other metals, magnesium permits the use of heavier-gauge, more rigid sections for extra structural strength . . . and substantial weight savings!



Mognesium gives greoter rigidity for equol weight than other metols.



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For more information on these products, and on Dow's fabrication facilities for magnesium and aluminum, contact the nearest Dow sales office, or write THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Department 1002CL4-25.

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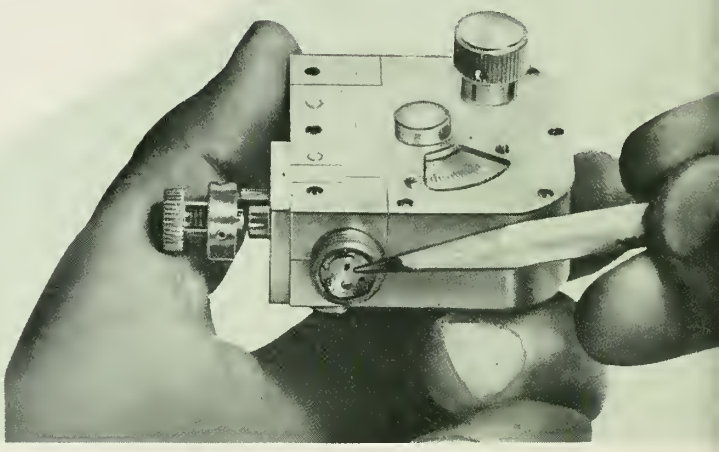
Other components shown below.

Slotted section, shown here, actual size.



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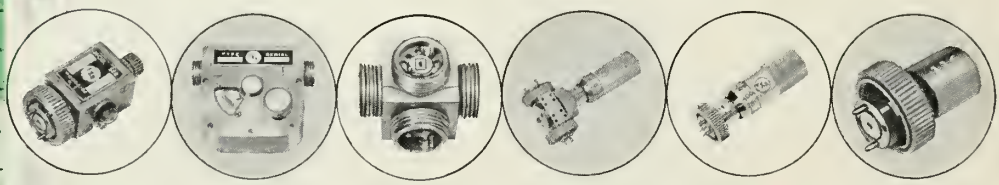

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