FEBRUARY 2, 1959

AX–1 POLARIS LAUNCH

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

NEXT TIME...LOOK TO LEACH/INET FOR PRECISE GROUND POWER

This INET 400-cycle ground power unit was tailor-made for the Atlas. The unit operates in parallel with the missile's power system and provides remote control regulation. Frequency regulation is $\pm 0.2\%$. With shock load equal to a third of rated output, frequency recovers to $\pm 0.2\%$ in 0.15 seconds. Voltage regulation is $\pm 0.5\%$ with recovery time at 0.30 seconds.

LOOK TO LEACH

INET DIVISION
LEACH CORPORATION

18435 SUSANA ROAD, COMPTON, CALIFORNIA

DISTRICT OFFICES AND FIELD REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA • EXPORT: LEACH CORPORATION, INTERNATIONAL DIVISION

CLAY PIGEONS

low-cost, supersonic target drones

Clay pigeons that fly faster than sound—that's a nutshell description of the new low-cost target drones developed by Bendix Systems Division.

Program-controlled (with radio override, if desired) they will provide the answer to our need for airborne target drones which can be built in quantity and at a moderate cost. They are ideal vehicles for testing the effectiveness of our new aerial weapon systems, as well as the skill and training of the men who fly or launch them.

The basic design, developed over a two-year period (at no cost to the American taxpayer), is relatively small and light, which accounts in part for its low cost, and carries radar and infrared augmentation equipment which enables it to realistically simulate a much larger target if desired. It can operate at all required altitudes, speeds and ranges.

Bendix target drones realize small diameter, and hence low cost, by means of the Bendix Lens, a small plastic sphere for enhanced bistatic, as well as monostatic radar reflection. Also included are Bendix electronic scoring devices for a miss distance indication. Components and airframe tests are continuing in conjunction with the Armed Services.

Bendix Systems Division, working with six other Bendix Divisions and major aircraft and propulsion organizations, directed all phases of development work up to and including prototype construction and testing.

Bendix Systems Division welcomes inquiries and is prepared to provide full information to the Armed Forces.

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

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

ASSOCIATE EDITORS:

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

ASSISTANT EDITORS:

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

CONTRIBUTING EDITORS:

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

EDITORIAL ADVISORY BOARD:

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

REGIONAL EDITORS:

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

PRODUCTION:

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

WAYNE W. PARRISH
President & Publisher

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

missiles and rockets Vol. 5, No. 5, Feb. 2, 1959

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

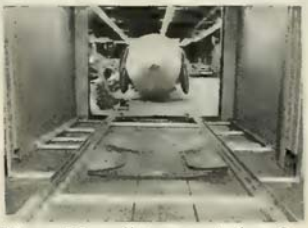
Subscription rates: U.S., Canada and Postal Union Nations—1 year, $8.00; 2 years, $12.00; 3 years, $14.00. Foreign—1 year, $20.00; 2 years, $30.00; 3 years, $40.00. Single copy rate—$.75. Subscriptions are solicited only from persons with identifiable commercial or professional interests in missiles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

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Cover: *Polaris* launch from Canaveral. Lockheed's approach to systems management told on p. 16.

FEBRUARY 2 HEADLINES



Now it's rail transportation for large missiles as NYC tests transport feasibility. (p. 19)

ASTRONAUTICS ENGINEERING

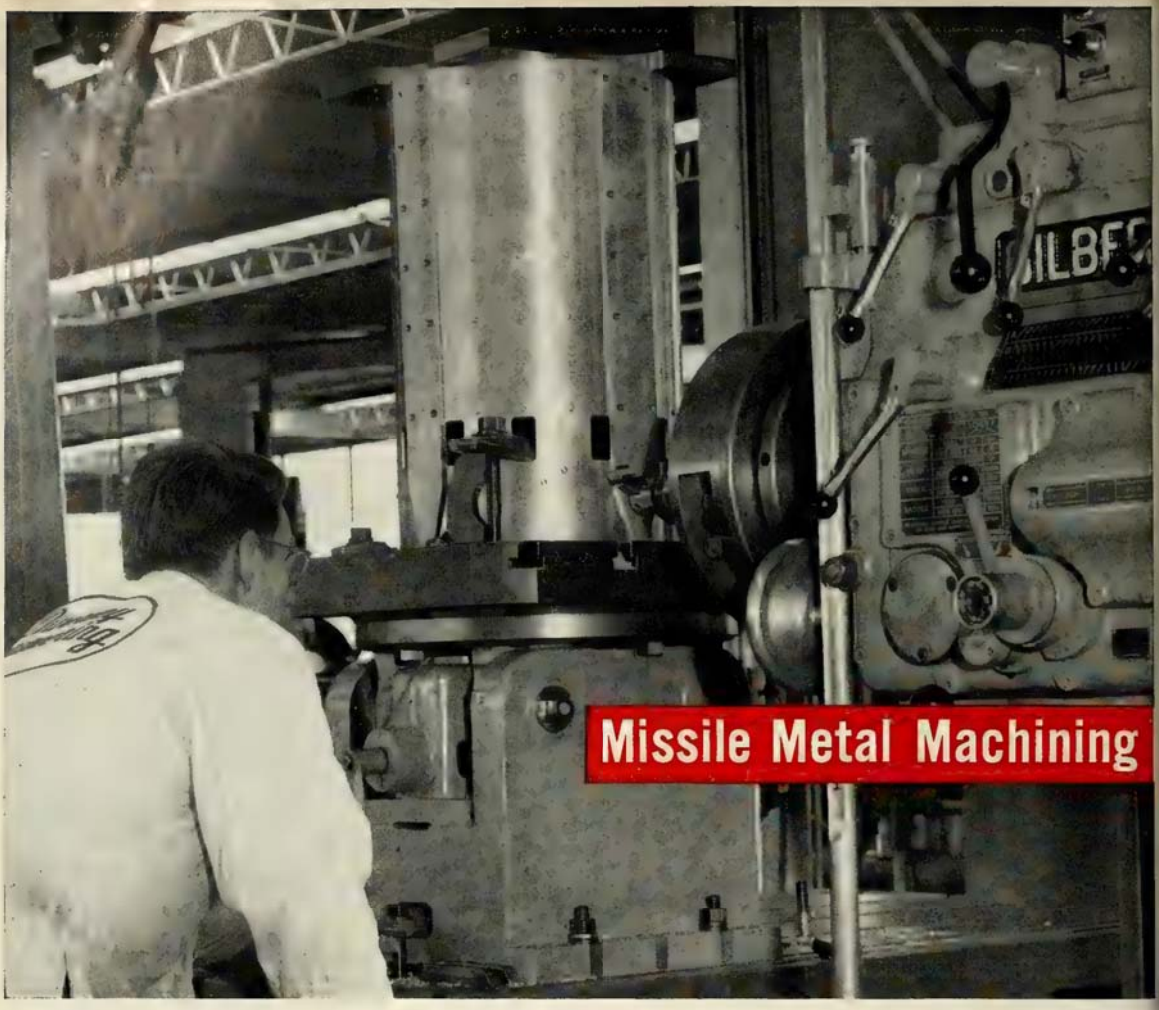
Perkin-Elmer has developed new azimuth alignment theodolite for *Jupiter*. (p. 30)

MISSILE ELECTRONICS

Orbiting scientific laboratory like this Rocketdyne conception is goal of U.S. astronautics research. (p. 12)

DEPARTMENTS

Army's tracking ship may have long-range radar for anti-missile detection. (p. 32)



Another Tough Job

Above you see an extremely complex body section of a missile being finish machined on a horizontal boring mill. You are looking at another intricate example of Diversey skill and craftsmanship. A visit to our plants would show you many comparable jobs that would astonish you.

At Diversey you have the LARGEST FACILITIES exclusively devoted to your missile metal machining problems. You work with fast, precise, and progressive technical people who know what works and what won't. Bring your tough jobs to Diversey.

HYDROSPINNING NOW AVAILABLE

A new Hydrospinning Division has been formed at Diversey which uses the latest and largest equipment to produce intricate missile parts.

SEND FOR FREE BOOKLET

Diversey

LEADERS IN CONTOUR MACHINING

ENGINEERING COMPANY

10550 WEST ANDERSON PLACE
FRANKLIN PARK, ILLINOIS • *A Suburb of Chicago*

FROM NOSE TO NOZZLE, FROM FIN TO FIN, CONTOUR TURNED PARTS—WITH PRECISION BUILT IN

In My Opinion . . .

. . . it has become clear in the last couple of years that the Army's chances of staying in the space business are diminishing constantly simply because of poor public relations and lack of guts on behalf of the Army's top planners.

To be sure, almost every man and woman in this country is familiar with the Army's missile and space capabilities. But the Army's failure to push ahead for tomorrow's ventures and challenges is known to but few.

The reason for the inadequacy starts at the top, where Army leaders have been less than forceful in selling the service's achievements, capabilities and needs. Too often the selling—at least in public—has been left to Maj. Gen. John B. Medaris and Dr. Wernher von Braun, at times when they could ill afford to be away from their missile business in Huntsville.

A few weeks ago we asked Dr. von Braun how the Army's manned ballistic rocket carrier program was coming along, and he said: "Well, right now I think the Army has difficulties establishing a requirement for the program."

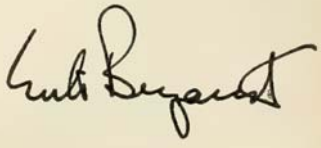
Why is it so difficult for the Army to establish requirements? We refuse to believe that the many excellent Army leaders have any difficulties recognizing requirements—if this is what it takes.

Let us keep in mind that the Russians have said they are aiming to establish bases on the moon. Also, remember what Brig. Gen. Homer Boushey, AF research chief, has said about the moon: The moon is high ground—the nation that controls the moon will control the earth. Perhaps, this may be somewhat of an over-enthusiastic statement. But—indeed, it doesn't take much to figure out how the moon can be used to house observation posts, communications centers, reconnaissance stations and even automatic launching sites.

If there is the slightest possibility that this is what the Russians might do—then we must beat them to it. This—furthermore—would be a logical job for the Army. No other service has a Corps of Engineers capable of building the moon sites and of managing the construction of parts and components on earth before they are ferried to the moon. No other service has a Signal Corps capable of handling the complex task of setting up all the communications and tracking gear required. No other service has the capability to produce the rocket hardware that is currently manufactured by industry and the Army at Huntsville—to successfully complete this nation's effort to establish a base on the moon for military reasons.

Yet, we know of no Army effort along these lines. In fact, we've just learned that ARDC's Wright Field already has invited industry to bid on recoverable lunar capsules and vehicles—designed for landing on the moon and take-off for return to earth, the first step in establishing manned lunar operations. Obviously, the Air Force is looking ahead in its planning—which is what they must and should do. We wonder if the Air Force is hamstrung because of lack of requirements . . .

We recall the days when Army Secretary Brucker was known as a fighter, and as a man devoted to the advancement of military sciences, to the Army, and to its requirements. This country certainly needs the Army's missile capabilities, Mr. Brucker. It is up to you to push for the requirements that it will take to keep the Army in the business. And don't forget it will take as much public and government relations as that produced by the Air Force at all times.

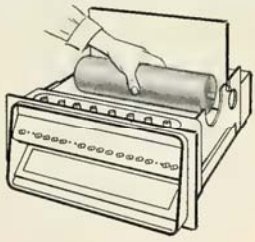


These features of

new Brush ultralinear recording systems...

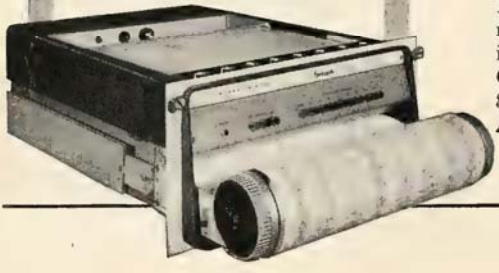
. . . give you more application versatility!

Simplified Chart Re-loading.



Interchangeable, plug-in signal conditioners.

Positive Chart Take-up Drive.



In the fields of telemetry, ground support systems, analog computing and laboratory testing, Brush recording systems have incorporated features which have consistently kept ahead of engineering requirements. Here are a few that show why—

INTERCHANGEABLE PLUG-IN SIGNAL CONDITIONERS. You get your *choice of sensitivities*—you get high input impedance—zero suppression.

SIMPLIFIED FAST CHART RE-LOADING. Loaded from the top—features automatic alignment and tracking.

ACCURATE, EASILY REPRODUCIBLE RECORDINGS. Your choice of rectilinear or curvilinear charts—rugged "throw-proof" pens.

Illustrated above is a Brush RD-1684 rectilinear, 8 channel recording system. Sensitivity of 10 millivolts per chart line—input impedance, 10 megs balanced or 5 megs grounded. Complete system includes mobile cabinet, oscillograph and 8 signal conditioners. No additional preamplifiers required. Available from stock.

brush INSTRUMENTS

DIVISION OF

37th & PERKINS — CLEVITE CORPORATION — CLEVELAND 14, OHIO

washington countdown

"Busiest" People in Washington . . . today are the Pentagon's legislative liaison personnel, who number 302. Army has 71; Navy, 70; Air Force, 147; and DOD, 14.

The man in NASA's space capsule . . . will be an AF officer on active duty who has graduated from one of the two AF test pilot schools. He will be screened out of 110 candidates who have these requirements and also are college graduates with degrees in the physical sciences or engineering. He will be younger than 40, physically and mentally adaptable to space flight, and will have 1500 hours of flight time.

Bombers and *Minuteman* . . . are what AF Chief of Staff Gen. Thomas White believes to be the best war deterrents. He told the Armed Services Committee that aircraft in the air plus *Minuteman* at widely dispersed bases would provide a strong deterrent force.

One explanation . . . of Khrushchev's boast of "serial production" of ICBM's is that the Russians have so much confidence in their long-range weapon that they have "frozen" its design.

One hit, one "solar orbit" miss . . . seems to be the world lunar program for Feb. 27-28. The Army plans to fire its 13-pound payload past the moon into solar orbit, while the Soviets seem ready to try to impact a multi-thousand-pound payload on the moon.

Army has abolished . . . position of Assistant Secretary for Civil and Military Affairs, giving its responsibilities to Assistant Secretary Dewey Short (Manpower, Personnel and Reserve Forces).

McElroy's statements . . . to the press have done little to clear up the future of several missiles. He said the *Jupiter-Thor* controversy could go either way, depending on requests from overseas allies. Final number of overseas squadrons probably will be eight. He said the status of *Nike-Zeus* is not certain. "We haven't got *Zeus* and we don't know when we will get it," he said. McElroy did clear up one area—the overall air defense program will be under NORAD. Army would control close-in defense with *Nikes*. McElroy said policy on excess funds voted by Congress is to hold off spending as long as possible in view of possible urgent use late in year, and buying of military hardware may be cut through better advanced planning, heightened capability and improved use of equipment.

12 *Polaris* submarines . . . will be completed or on the ways by 1961, McElroy told the House Appropriations Defense Subcommittee. He said that in addition to the nine FBM subs already provided for, money would be sought for three more.

The number of missiles . . . aboard the Fleet Ballistic Missile submarine never has been officially announced, but 16 *Polaris* IRBM's is conceded as a sound estimate. The Navy discounts reports that later submarines will be large enough to carry 50 missiles.

Puzzled Congressmen . . . were told at a recent intelligence briefing that the Defense Department assumes that the Russians do not have an ICBM because they have not fired one recently. "We think that they are having trouble," Congressmen were told. "Couldn't it be," asked one less-than-satisfied Congressman, "that they are through testing and now in production?"

The Stans memorandum . . . which forbids witnesses appearing before congressional committees from asking for additional funds or disagreeing with the budget as outlined by the Administration is doing little to keep the word from getting across. Major witnesses thus far have followed the order and said in so many words they were not asking for more money—and then proceeded to say that certain programs are not strong enough.

High-*altitude* missile . . . launching sites seem improbable in the U.S., according to DOD spokesmen. While they would increase ICBM range, logistical problems probably would cancel out their advantage.

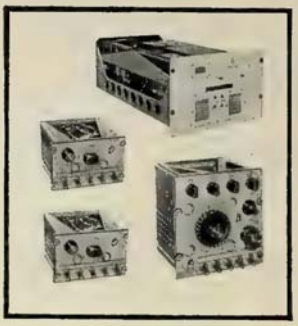
U.S. will show off . . . some space hardware in Moscow at the American National Exhibition beginning July 4. It is being planned jointly by the State and Commerce Departments and USIA.

COMMUNICATIONS...

Radio Set AN/ARC-57 . . . designed and developed by *The Magnavox Company*, in conjunction with the Air Force, is an essential UHF communications system, providing the utmost in performance and reliability for the CONVAIR B-58.

It clearly demonstrates *The Magnavox Company's* ability to produce and work as a prime contractor on a complex weapons system.

MAGNAVOX capabilities are in The Fields Of Airborne Radar, ASW, Communications, Navigation Equipments, Fusing and Data Handling . . . your inquiries are invited.



PRODUCTS
THAT SPEAK FOR
THEMSELVES

Magnavox

MAKES THE B-58 TALK!

COMMUNICATIONS | RADAR | DATA HANDLING | ASW | MISSILES

THE MAGNAVOX CO. • DEPT. 43 • *Government and Industrial Division* • FORT WAYNE, IND.

industry countdown

Detection system for *Subroc* . . .

may be *Julie* or *Jezebel* under development by Daystrom and Bell Labs. Both systems which fire small explosive charges from AS aircraft or submarine torpedo tubes reportedly are in advanced state of development and wanted by Navy. They can even detect submarines concealed by density layers.

Republic scientists . . .

have evolved a new mathematical method for determining lunar and interplanetary trajectories which reportedly is accurate to .0002%.

Contracts totalling $110 million . . .

have been received by GE for *Atlas* missile guidance systems. Total contractual agreements in the GE program now total about $193 million.

Indian Head Propellant Plant . . .

is producing some of the ingredients used by Allegheny Ballistics Lab. in its development work for a double base propellant for possible use on *Polaris*. Planning is underway for modification of facilities for pilot line production, and an architectural and engineering contract award is expected soon.

Defensive network of *Bomarcs* . . .

is apparently still many months away, as evidenced by Lear, Inc.'s Astrionics Division backlog of 124 data link receivers scheduled for delivery by August. The receivers are an important part of the *Bomarc's* guidance system. A *Bomarc* base requires either 56 or 112 of the area defense missiles for optimum capabilities.

Rocketdyne has shifted . . .

1200 people from five separate facilities in a move to consolidate activities. Most personnel from the service division will move from the San Fernando Valley facilities to the former site of Atomics International in Van Nuys. Rocketdyne conducted 4085 rocket engine tests at its field laboratory during 1958, using an average of 315 tons of liquid oxygen per day.

Better than 90% reliability . . .

is being obtained with the *Bullpup* air-to-surface missile, a Navy spokesman says. While early evaluation versions of the missile turned in a performance approaching 100%, first production-line missiles were only about 20% effective, the spokesman said. However, this was rapidly rectified by prime contractor Martin-Orlando. This will allow development to operational forces this spring.

Four companies share . . .

in the design and construction of the first two *Titan* bases being built at Vandenberg AFB and Lowry AFB near Denver. Costing $50 million each, the ICBM facilities will be built by: Daniel, Mann, Johnson & Mendenhall of Los Angeles; Rust Engineering Co. of Pittsburgh; Leo A. Daley Co. of Omaha and Mason, & Hangar-Silas Mason Co. of New York. Plans call for launching facilities to be built later at Omaha, Spokane, Topeka and Cheyenne.

$31.4 million for *Terrier* III . . .

has gone to Convair Division of General Dynamics. The advanced version of the surface-to-air missile will incorporate improved guidance and will top the 20-mile range of the present *Terrier*. The all-weather air defense weapon will be used on ships formerly scheduled for *Terrier* II.

Budget-bypassed *Regulus* II . . .

within 30 days will begin new duties as a target drone at PMR. *Regulus* II is also being eyed as a possible target at Canaveral for *Bomarc*, and a NATO weapon.

To clear up the situation . . .

regarding Thompson Ramo Wooldridge Inc., the Air Force has issued the following statement: "Space Technology Laboratories Inc. and TRW may now bid on contracts for which STL has systems engineering and technical direction responsibility without the approval of the Assistant Secretary of Air Force for Materiel." This applies generally, AF said, to prime and first tier sub-contracts but leaves the door open in case there should be an imperative reason for TRW bidding on even an STL-involved project. Inversely, of course, TRW may bid on any contract in which STL is not involved.

FEBRUARY 2, 1959—VOL. 5, NO. 5

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

U.S. Research Aims at Space Lab

by Clarke Newlon

WASHINGTON—A representative of the science-management group heading the nation's missile and space exploration activities—a man who prefers not to be identified—has told m/r that the present goal of all major U.S. astronautics research is the establishment of a manned scientific laboratory in orbit about the earth or upon the moon.

This has yet to be announced publicly, but the fact that it is being planned is an answer to many critics of U.S. astronautics progress who believe the country must start with a well-defined objective in space exploration.

It is conceivable, the source told m/r, that such a project could be assigned to the military services as a defense requirement, a category for which Congress is inclined to allocate more money. He said such a base might serve as both a science laboratory and a military installation.

His own preference is for setting up the laboratory on a space platform 300 to 500 miles above the earth. He said this would be a good location because it would be easy to contact and resupply and because it would be between the earth and the first Van Allen radiation belt. Other scientists favor the moon, he conceded, because it provides a ready-made solid base already in orbit.

• **Billion-dollar project**—Such a laboratory would cost at least $1 billion, he estimated, considerably above the combined space budgets of government space agencies at the present, although the cost probably would be spread out over more than one year.

While the science laboratory would be only a stepping stone into future space exploration, it does provide a goal toward which the present varied and sometimes confusing U.S. space projects can be pointed.

"We have at present," the source said, "several projects to put a man in space. There isn't much doubt we can do this. But after we get him there—and bring him back—what then? Generally, I believe, you will find that both the civilian scientists and the military leaders agree that the greatest achievement we could make at this time would be to get a space lab established from which we could learn enough to proceed further."

• **New theory urged**—Said another scientist:

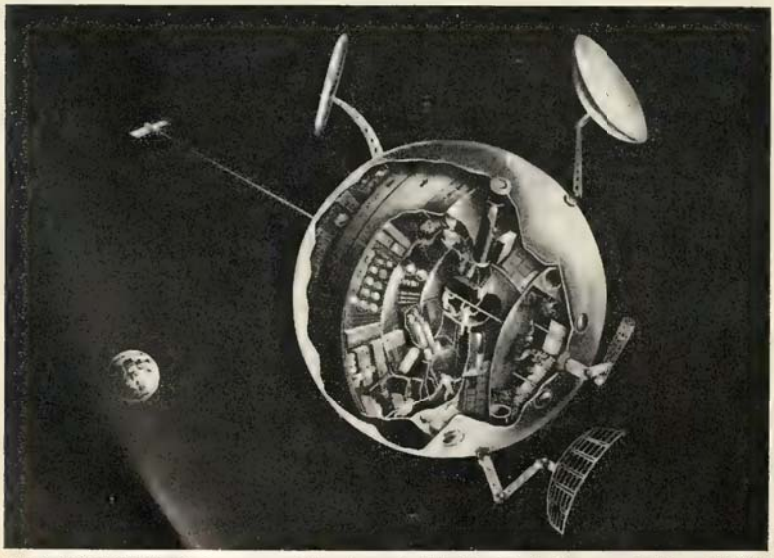
"In the field of physics, a new comprehensive theory encompassing electromagnetic phenomena, gravitational phenomena and the nature of fundamental particles and nuclear forces is urgently needed.

"At present we have Maxwell's equations for electromagnetic phenomena, (and also the Einstein/Planck equations for photo-electric effect), Einstein's equation for gravitational phenomena, the quantum theory (quantum mechanics, wave equations) for behavior at the microscopic or nuclear level.

"One comprehensive theory and set of equations tying all of these phenomena together would constitute a breakthrough in theoretical physics probably of greater importance than any other achievement in the entire history of the science."

Since many of the laboratory observations needed to provide important input data for derivation of such a theory might be better acquired from a space platform in orbit or from a lunar base than from the surface of the earth, he added, early establishment of a space platform or lunar base becomes the first major space-age objective.

Such a space laboratory would



ONE CONCEPT of the space laboratory is this by Rocketdyne, weighing 250,000 pounds. As pictured with a crew of 50, it would need about 15 million pounds of thrust to be placed in orbit, and undoubtedly would be put up piecemeal. The sphere, about 60 feet in diameter, could orbit at low altitude (300 to 500 miles) or as high as 22,500 miles.

provide almost unlimited possibilities for studies in the astro-medical, astrophysics and astronautical fields. Once through the atmosphere a relatively unimpressive telescope will reveal more than the greatest observatory on earth.

As another example of information to be gained, scientists pointed out that observation of the distribution of matter in the universe would enable them to determine curvature of the space-time continuum and arrive at a better theory of the origin of the universe. Still another subject for study, they noted, is the origin and nature of primary cosmic rays or particles.

• **A base camp**—Dr. I. M. Levitt, director of the Fels Planetarium, Franklin Institute, inclines toward believing that the scientific space platform will come first and provide a stepping stone toward similar locations on the moon—and other planets—even to eventually colonizing them. He points out that transporting supplies of any kind to the moon would be tremendously expensive. Because every pound so transported requires several pounds of fuel and hardware for the trip, he says, extensive loads cannot be carried until propulsion is greatly improved.

• **Likely powerplants**—Although a final decision is far off, it is probable that the million and a half-pound-thrust clustered Rocketdyne engine project at the Huntsville ABMA may be used eventually for such a project. Another possibility is the million-pound-thrust single-chamber engine for which NASA has just awarded a $102-million development contract to Rocketdyne.

While the single-chamber engine could be clustered also, to provide a tremendous thrust, its development is expected to take from four to six years, while the ARPA-sponsored project at ABMA has a time table of from 12 to 18 months.

Under present plans, ABMA will cluster about eight of the 160,000-pound-thrust engines to produce a giant capable of lifting a 3000-pound payload to an ultimate speed of 22,000 mph. At least one additional stage would, of course, be required to place the payload in orbit.

ABMA will build the entire booster around the clustered engine with its own in-house capability at Huntsville. The Army's Dr. Wernher von Braun, who is in charge of the cluster enterprise, is himself an advocate of the space laboratory.

Another early concept of the space science laboratory visualized it as a 24-hour satellite, that is, one designed to orbit once each 24 hours with the earth, thus remaining over the same spot on our planet.

Congress . . .

Hassle Over Size of Red Lead

by Erica Cromley

WASHINGTON—The scramble to investigate the nation's space-defense posture has begun on Capitol Hill with a gloomy-rosy tug of war between Administration officials and Congressional critics. Defense Secretary Neil McElroy's "no positive evidence" statement regarding Russia's lead on operational ICBM's moved Sen. Stuart Symington (D-Mo.) to charge that the United States will trail Russia in long-range military missiles by four to one in 1961.

The controversy is getting top priority on Democrat-controlled Capitol Hill with at least five House and Senate committees investigating the nation's defense and space programs.

The House Committee on Science and Astronautics' inquiry is slated to start in mid-February and continue off and on throughout the Congressional session.

The emphasis reportedly will be less on laying blame than on boosting the rate of progress.

Most spectacular of the Congressional Space probes will undoubtedly be the Senate Space Committee hearings, in conjunction with the Defense Preparedness Committee. Senate Democratic Leader Lyndon Johnson heads both groups.

Johnson said the hearings will seek to determine if the United States is doing everything it reasonably can in the exploration of outer space and in defense against military aggression.

The House Government Operations Military Subcommittee is planning an inquiry into the management of the U.S. missile program.

The Senate Armed Services Committee is studying the Nation's general defense posture, while its Subcommittee on Central Intelligence is making an appraisal of Soviet missile progress.

• **Other investigations**—Other upcoming Congressional probes include investigation of the weapon system concept coupled with a study of military procurement policies generally. Conducted by the Hebert Investigations Subcommittee of the House Armed Services Committee, the hearings will look into "loopholes in the law" which limit competitive bidding.

• **Procurement bill**—Meanwhile, a bill to streamline military procurement practices was introduced by Sen. Leverett Saltonstall (R-Mass.). The ranking Republican member of the Armed Services Committee said the major purposes of his bill are to reduce lead time in new weapon development and to speed up the "decision-making process."

Other recent Congressional developments include:

—An indication that the House Appropriations Committee will get into the defense-probe act during its budget hearings with a look-see into contractors' relations with the military.

—A report on former government employes now working for the defense industry, being prepared by the Library of Congress for Rep. Edith Green (D-Ore.).

—A charge by the House Small Business Committee that the "real culprit" behind the decline of small manufacturers' role in the defense picture is the weapon system concept, which the committee says gives the major companies control of all subcontracting. The Senate Small Business Committee also called for more opportunity for smaller firms to share in research and development contracts.

Astronautics Tests

Jan. 21—First production-line *Jupiter* made fully successful 1700-mile flight from Cape Canaveral in the 14th test flight (including the *Juno II* lunar probe). Nose cone was tracked by Operation *Gaslight* team but no effort was made to recover.

Jan. 23—*Thor-Able IV* launched in unsuccessful nose cone re-entry test. Second stage, topped with sharp, tapered nose cone (reportedly a *Minuteman* test failed to ignite.

Jan. 27—Telephone-launched *Bomarc* fired from Canaveral at F-80 target. Successful.

Jan. 27—*Atlas* launched from Canaveral on what was believed to be a 4,500 mile "routine" test shot. On basis of early telemetry, test achieved most "objectives," AF said.

Jan. 31—*X-15* was scheduled to be carried aloft by *B-52*, but no drop was planned.

Polaris AX-4 flight of Jan. 19 reportedly failed as a result of temperature build-up from aerodynamic heating, forcing a malfunctioning of sensitive controls located on the body of the missile. Missile was range-destructed.

ASTRONAUTICS in the news . . .

Polaris **AX-4 is positioned on launching pad at Cape Canaveral prior to its Jan. 19 firing. Missile is transported to site by a trailer erector. Crane then lifts it to top of pad.**

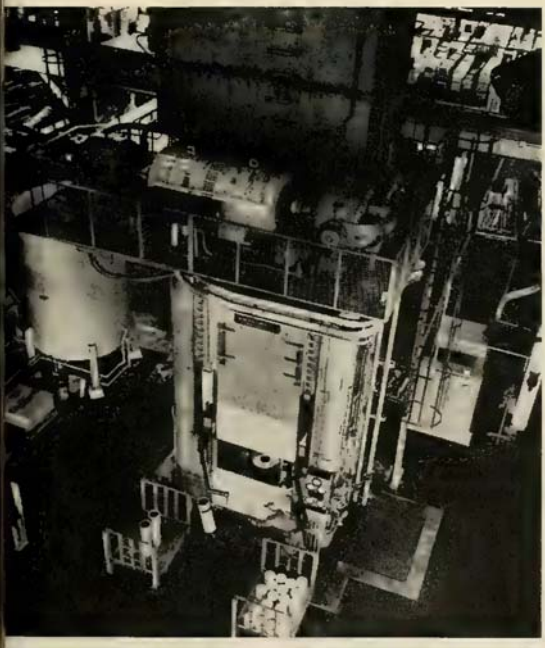
UMBILICAL CORD attached ready to fire, the gantry crane is moved away. The AX-4 was the 26th flight of the *Polaris* test program. Flight was reported a "partial success" after malfunction caused range destruct.

FINAL CHECKS on the *Atlas* main engine cluster are conducted by technicians at the Propulsion Field Laboratory of Rocketdyne. During 1958 Rocketdyne conducted 4,085 large engine tests.

ATMOSPHERE ENTRY simulator at Ames Research Center, Moffett Field, Calif. Air flowing through the trumpet-shaped nozzle in the center gradually changes in density in the same way the earth's atmosphere changes in density with altitude.

Genie, MB-1, rocket-powered air-to-air missile with nuclear warhead capability is positioned under the wing on an F-89. Missile is also carried in special weapon bays of the F-101, F-102 and F-106.

"WORLD'S LARGEST" fiberglass radome designed and built by Goodyear Aircraft Corp. for the Missile Detection Systems Section of GE, measures 68 feet in diameter and stands more than seven stories high. It can be erected by six men in 80 hours.



NEW 2,500-TON vertical hydraulic impact press recently installed at the Cressona, Pa. works of Aluminum Company of America. Alcoa is now equipped to produce impacts in sizes up to 12 inches in diameter and 60 inches in length.

FACTORY TEST of the *Jupiter* IRBM at the Army Michigan Ordnance Missile plant, operated by the Chrysler Corp. The plant which produces *Redstone* and *Jupiter* missiles on parallel assembly lines, has 2.1 million square feet of floor space.

STATIC TESTS OF ENGINES and other components are conducted at 4,000-acre Santa Cruz facility.

Lockheed Emphasis Is Systems Management

Perfecting ability in systems management is setting pace at Lockheed Missiles and Space Division whose sales this year will be one-third corporation's total.

by William O. Miller

SUNNYVALE, CALIF.—"The essence of making a missile is taking thousands of parts and putting them together into a reliable weapons system—and this integration is not done by component manufacturers."

L. Eugene Root, a vice-president of Lockheed Aircraft Corporation, employs this philosophy as manager of the fast-growing Lockheed Missiles and Space Division. The name was changed recently to incorporate the word "space," although the old short title "LSMD" still stands.

"Of course the component manufacturer plays a very important part, but beyond the component or article itself you have the greater problem of assembly. and integration, of testing, ground handling, training and the other prerequisites to the delivery of a complete and reliable product," Root continued. "All this requires a great deal of management competence and long-range planning."

This is Lockheed's forte, the LMSD general manager said—ability in complete systems management. Ample evidence is the increase in missile and satellite development revenues from 7% last year to 31% of the company's total sales this year.

"This ability presently is dedicated to two of the nation's six D-X priority projects—the Navy's submarine-launched *Polaris* and the ARPA's satellite program *Discoverer*," Root said, adding that the two top-priority projects are the only programs physically handled at Sunnyvale. Other Lockheed missile projects including the *X-17*, the air-launched ballistic missile concept, Kingfisher drone and *X-7A* are at the Van Nuys facilities.

• **Greatest ability**—Lockheed is emphasizing systems management, Root continued from his offices in Sunnyvale.

"I know of no plans now to expand our in-house capacity to develop and produce all the components of a missile such as the guidance and electronics and propulsion units," he said. "We must, however, have a high capability in these areas and maintain large staffs of knowledgeable personnel as a prime contractor for putting together complete missile systems."

"Those who forecast a concentration of abilities in the big companies fail to reckon with the problems of starting such divisions from scratch," he continued. "On an economic and competitive basis, the capabilities of the experts on these fields—giants of American industry—must be considered."

Better than 60% of the items going into missiles at Lockheed are procured from other sources—both large and small businesses. For *Polaris*, as an example, propulsion is being supplied by Aerojet General and General Electric will produce the guidance system being developed by Massachusetts Institute of Technology.

• **Subcontracting**—As the *Polaris* system manager, LMSD supervises and coordinates the efforts of 739 subcontractors.

"One of our major tasks is to have full knowledge of capabilities and where they are," Root said. He pointed out that 80% of 20,000 work orders

NET CATCHES scale model of Navy's *Polaris* in underwater launching tests.

for the first six months of 1958 went to small business concerns. These totalled more than $30 million and represented 42% of total purchases from other companies.

The rapid expansion to almost a third of Lockheed's total sales in less than five years would have been impossible, Root says, without the ability to draw on the parent corporation and its other divisions.

• **Parent company**—Though Lockheed-built planes have been flying since 1913, and Lockheed Aircraft Company came into being in 1926, the history of today's $460-million corporation really began in 1932. In that year, in the depths of the depression, seven men including present Chairman of the Board and Chief Executive Officer Robert E. Gross and other senior officers bought their bankrupt predecessor for $40,000. That same management through 27 years has made Lockheed one of the nation's 100 largest companies and one which ranks fourth in government business—$755.1 million during the fiscal year ending last June 30.

With corporate offices in Burbank, the California Division has plants in Maywood and Palmdale; the Missiles and Space Division in Sunnyvale has installations in Van Nuys and Palo Alto; and the Georgia Division has two plants. There are four service subsidiaries in the aviation field.

• **Why LMSD?**—LSMD was an outgrowth of a group of specialists from the company's preliminary design section in the engineering department set up 10 years ago to work on guided missiles.

In 1953, it was decided to form a separate corporate entity and in the next year Lockheed Missile Systems Division was established. In March, 1954, the growing division was moved from Lockheed's main Burbank plant to a 77-acre site at Van Nuys, still site of much of the division's operations.

As the work load increased, more space and facilities were needed. In 1956 the headquarters was moved and research and development laboratories were set up at two San Francisco Bay area sites. A 26-acre site in Stanford University's industrial park was chosen for the research and development center. Administrative offices and other activities were set up on a site originally taking in 275 acres adjacent to the Navy's Moffett Field at Sunnyvale. The Sunnyvale property has been expanded until today it occupies 645 acres.

In the same year, LMSD took over 4,000 acres in the nearby Santa Cruz mountains for static testing of missile systems and their components, mainly propulsion units. Within the Santa Cruz facility are test areas for the *Polaris* and the *Discoverer* satellite, in addition to administration buildings.

Field bases are maintained at Air Force Missile Test Center, Alamagordo, N.M., Air Force Missile Test Center, Patrick AFB, and Vandenberg AFB.

• **$300 million business**—Figures for the calendar year 1958 have not yet been released, but Lockheed missile and space contracts from Air Force, Navy and Army are expected to top $300 million. In the first three quarters of the year, contract awards totaled $275 million. Missile sales reached $214 million for the first nine months of 1958, second only to sales of military planes and spares, which were $293 million, or 43% of the corporation's total sales.

More than 14,000 persons are employed by LMSD, 10,200 at the Sunnyvale facilities and the nearby Palo Alto research and development laboratories.

• **Team concept**—Backing up Root is a team of the best in the nation—scientists, technologists and, equally important—administrators. H. J. Brown and Willis M. Hawkins, assistant general managers, are Root's right hand men.

"We've invested heavily in our people," said Hawkins. "In this way we have been able to acquire quickly the talent in depth required for work in the missile and space field."

Hawkins estimated that there is a 30% greater talent span in missile work than in aircraft, but went on to say that the same increased talent depth would be required as aircraft get more complex.

"The missiles system management concept is under attack from a number of directions," Hawkins said, "but we believe that it is the only way to do what we must."

"There are several reasons this is true—to permit utilization of all the knowledge and capabilities we have in the nation, to permit competition, and to be able to evaluate where you are going."

Hawkins said small business is highly expert on certain small elements. Under the missiles system management concept they can be fully utilized.

"One of the big problems," Hawkins said, "is finding a way to evaluate what you are doing, and where you want to be when. After this, 75% of the monitoring will be done by your customer, the government."

As explained by Stanley W. Burris, manager of the XN Weapon System, which is the Lockheed designation for *Polaris:*

"We are concerned with the 'erosion of the project year'—how much are we getting in useful return for what we are doing—and to determine this we have gone to outside sources. This includes operations analysis, cost fac-

L. EUGENE ROOT (right) discusses *X-17* with Stanley W. Burris, manager of the Lockheed team working on *Polaris*.

LOCKHEED TECHNICIAN checks nose cone in spark-heated tunnel at the Palo Alto Scientific Research Laboratory.

tors, and working to rule out obsolescence at maturity."

Balance of effort, Burris said, is most important. He pointed out that there are three areas to be considered: the missile or flying elements, the non-flying or support elements, and the system synthesis and operational crew elements.

"Operational countdown time is the only real measure we have for measuring progress on the degree of balance obtaining at any point in time," Burris explained. "Through this balanced effort, we obviate traditional practice which heretofore has pushed development of flying hardware before non-flying hardware, resulting in too late a start on support hardware, and delinquent starting of operational requirements studies."

• **Other LMSD projects**—In addition to the two DX priority projects—*Polaris* and the military satellite program—major projects underway include:

X-17—completed as a project eight or nine months ago. Though contract has been completed, this solid-propellant vehicle which successfully flew 92% of all its launches in the Air Force launches and 100% in early *Polaris* program studies, is believed to have continuing value as a research tool. It has played a major role in solving re-entry problems.

X-7A—volume production this year has been the same as last on this recoverable ramjet test vehicle. The Air Force recently awarded a contract of some $8 million for continued flights testing engines and components of other missiles. Lockheed believes it has many possibilities as a research tool.

Q-5—target drone in the supersonic speed range evolved from the *X-7*. *Q-5* incorporates a Firing Error Indicator which registers theoretical hits and angle of pass, and a Target Area Augmentation device which permits modification of radar pattern to simulate plane or missile larger than itself.

WS-117L—A $7-million building is being built adjacent to main offices at Sunnyvale to house personnel working on the *Discoverer* satellite. First launchings of the *Discoverer* satellites are to be carried out at Vandenberg AFB.

ALBM—Lockheed built the missile recently launched from a B-58, and is presumed to be one of the three contractors working on the air-launched ballistic missile system.

Space vehicle projects—Lockheed has proposed satellite laboratory which could be operational within 10 years (m/r Jan. 19, p. 19).

Human engineering—In conjunction with its space vehicle programs in which Lockheed is implementing the complete systems approach, broad studies are underway in the field of human engineering and crew fatigue.

X-17 **WAS FIRST ballistic missile to prove nose cone could survive re-entry of Earth atmosphere.**

• **Polaris**—Under the Navy's Special Projects Office headed by Rear Adm. W. F. Raborn, Lockheed is the prime contractor and missile system manager.

"Lockheed has fitted into role of missile system manager in a very fine, efficient and successful manner," Admiral Raborn says, "They make a fine partner and that is just what we consider them—the Lockheed people are doing an outstanding job."

The *Polaris* or XN personnel are housed in the Naval Industrial Reserve Ordnance Plant. This building, built for the Navy on land at Sunnyvale deeded over by Lockheed, is government-owned. It houses the Navy's *Polaris* administrative group. Either the Naval Inspector of Ordnance, Capt. W. A. Hasler or his deputy, attends the meetings scheduled regularly each Monday morning in Raborn's office in Washington.

One of the most important divisions in the Navy building is Test Management and Operations headed by Lockheed's E. E. Christensen. The mission of this group begins when the first two parts of the missile are brought together and concludes when the launch data has been analyzed and changes are recommended. Included are the test facilities at Cape Canaveral where test firings are carried out.

F. J. Bednarz, responsible for development and design, said current *Polaris* flights are still development tests. He added that 22 of the first 26 launchings are considered successful. While no definite programs are in the works for extending the range of *Polaris*, operations analysts are doing "down-the-road" thinking, he said.

• **Research and development**—Heavy emphasis is placed on research and development with the center of activities at the Palo Alto laboratories.

Dr. Louis Ridenour is LMSD's chief scientist.

Efforts of research and development are in direct support of current prospects and as Smelt put it, "We consider ourselves the store house for the state of the art. Our teams move right from the laboratory into projects."

Over 2,600 persons are employed in research and development in Palo Alto, at Sunnyvale, Van Nuys, and at Menlo Park, Calif., where about 100 persons under Dr. Sidney Brown work in the advanced system organization on development of new ideas.

Lockheed, in addition to meeting military requests for proposals, devotes 25% of the effort and some $7-10 million a year to independent exploratory research. Some $30 million is invested in equipment.

Adhering to the idea that at present application is secondary to developments, Lockheed research and development teams are exploring the entire spectrum of missilery including nuclear physics, atomic and ionic physics, cryogenics, hypersonic aerodynamics, advanced propulsion, structures and materials, electromagnetic propagation and radiation, solid state electronics, communication theory, mathematics and computer research.

The main computing center is located here where data from *Discoverer* will be cranked into two Univac digital computors. Located at Sunnyvale, in conjunction with the Space Communications Laboratory, is one Model 1709 computor by IBM, with an additional one on order.

In processing data from *Discoverer* shoots, orbital data will be handled at Palo Alto and telemetry at Sunnyvale.

Smelt said the guideline in all R&D is to keep ahead of developments so that Lockheed is ready to move into the next phase, while supporting current projects.

Lockheed, through the Missiles and Space Division, is keeping abreast both human and scientific developments in efforts to produce better weapons for defense and launch man into space. Plans for the future are made with the conviction that the trend from manned aircraft to unmanned missiles will result in greater advances for commercial aviation and industry as a whole.

NYC Tests Missile Transport

by Frank G. McGuire

NEW YORK—A system of missile transport which reportedly reduces maximum shock during transit to 2g, or less than that encountered during air transport, has been devised by the New York Central Railroad. The method involves employment of large air bags inflated and located about the missile for maximum protection and cushioning.

As a result of tests, the railroad says its system is a "feasible solution to the reliable, versatile transport of missiles and related sensitive components" whether the missile is encapsulated or not. The method is immediately adaptable to widely varying sizes, shapes and weights of missiles and component containers.

The car used in the tests was a standard baggage car having an internal length of 70 feet and eight-foot-square doors at each end. Missiles exceeding these dimensions can be accommodated in open-top cars. No alterations were made to the car used in the Central's tests.

Loading is accomplished by rolling the missile-supporting dolly along easily-removable tracks laid on the floor of the car. The tracks consist of steel angles to guide the dolly wheels. An industrial truck is used to move the dolly in and out of the car. After being placed in the car, the missile's weight is taken up by the inflated air bags and does not rest on the dolly.

Where a loading platform is not available, the missile, together with its normal support frame, is raised by a crane and swung into the car end first. When the front wheels on the support frame rest on the tracks in the car, one sling is removed and the other end of the missile supported by the crane until the rear pair of wheels on the frame rest on the tracks in the car.

The supporting air bags measure four by seven feet, and the side and lateral restraining bags measure four by five feet. Maximum working pressure of the bags is 10 psi, and burst pressure is 28 psi. Test information indicates that pressure loss due to leakage will not exceed 13% in 30 days.

The tests involved both regular road service and switching impacts at speeds up to 10 mph with three baggage cars having brakes set. After all switching, impacts and transport from Cleveland to Toledo, Detroit and return to Cleveland, the missile had moved less than two inches in any direction. No restraining devices were used. Dynamic displacement amounted to 18 inches during a 10 mph impact, then returned to almost-normal position.

WITH AIR PILLOWS deflated, the New York Central's replica of a large missile is pulled easily from a baggage car, under a new system of missile transportation which protects components for shock and acceleration.

The total weight of the Central's mock missile was 16,000 lbs. It measured 69′ 5″ overall length by 77″ cylinder diameter and had a 106″ fin span.

Sedov Compares Weights Of U.S./Soviet Rockets

WASHINGTON—Leonid I. Sedov of the USSR Academy of Sciences sharply criticized the inclusion of the *Atlas* weight in figures given for the *SCORE* "talking satellite," and in so doing, made some comments on Soviet rocket weights.

In an interview with a Pravda correspondent, Sedov declared that "to create a sensation, the weight of the U.S. satellite was combined with the weight of the four-ton carrier-rocket which placed it in orbit." He noted that the carrier rockets used in the Soviet satellite launchings also entered into orbit and stayed there for some time. He pointed out that the payload of the U.S. satellite is 1/57 the weight of the orbiting carrier rocket.

"The weight of the carrier rocket is no indication of the exploratory potentialities of the scientific apparatus container and of the payload the rocket can carry. That is why the weight of the carrier rockets for Soviet satellites was not published," Sedov stated.

He continued that "if one takes the relation of the weight of the payload to the weight of the carrier rocket to be equal to 57, as is the case for the U.S. satellite, it will be found that the weight of the last stage of the third Soviet satellite, which traveled around the earth for six months, must be more than 75 tons, instead of the four tons given for the U.S. satellite

"In as much as we are speaking about the weight of Soviet carrier rockets, I must tell you that although their weight, placed in orbit, was less than 75 tons, it was considerably more than four tons, and this applies not only to the third Soviet satellite, but also to the first and second. I can report that the weight of the first Soviet artificial satellite which was placed in orbit and circled the earth for two months was much more than four tons."

1,985 Basic Research Grants Budgeted for NSF

WASHINGTON—A record number of scientific basic research grants and graduate science student fellowship will be handed out in Fiscal Year 1960 if Congress approves the President's budget request for the National Science Foundation.

The budget asks for $160,300,000 for the Foundation, in comparison to $136 million appropriated in 1959 and $49,750,000 appropriated in 1958.

The Foundation's proposed budget would allow grants for 1,985 basic research projects to educational and other non-profit institutions by July, 1960. Some 1,760 basic research grants will have been funded by the end of June.

Some 2,893 graduate science students and teachers will continue their education under Foundation fellowships. This compares to 2,793 students and teachers for the previous year.

Another 28,000 high school and college science teachers would attend Foundation-supported science institutes with FY 1960 money.

Digitronics Corp. Sells Two Component Divisions

In view of the rapidly expanding volume of commercial data handling equipment, Digitronics Corporation has sold two of its component divisions.

The Digital Magnetic Tape Transport Division was sold to Fairchild Camera & Instrument Corp., while Eastern Precision Resistor Corp. purchased the Delay Line Division.

Missile Conference Set for May

WASHINGTON—The Second Annual National Missile Industry Conference, the country's most impressive gathering devoted to the missile business man, is entering final planning stages.

Spokesmen for the conference, to be held May 25-27 at the Sheraton Park Hotel here, expect a record attendance of key personnel engaged in the research, development, production, budgeting, utilization and publicizing of United States rocket and space exploration projects.

The conference, sponsored by the National Rocket Club of Washington, will be accompanied this year by the National Space Age Industry Exposition in the Sheraton Park's exhibition hall.

The three days of conferences will be under the leadership of committee chairman Lt. Gen. Ira C. Eaker (Ret.), vice-president of Douglas Aircraft Company. Selection of other key industry men for committee membership is being made.

• **Tentative program**—Two panel discussions—one in the morning, the other in the afternoon—are planned for each day of the conference. Here is the tentative program:

May 25—Morning—Government Roles and Responsibilities—NASA; moderator, Warren R. Smith, Fairchild Engine and Airplane Corp.

Afternoon: Congress and Astronautics; moderator, C. Lincoln Jewett, Arthur D. Little, Inc.

May 26—Morning: Government Roles and Responsibilities—ARPA and the Services; moderator, Erik Bergaust, MISSILES & ROCKETS magazine.

Afternoon: Small Business and Subcontracting; moderator: James J. Haggerty, Jr., Aircraft Industries Association.

May 27—Morning: Space Medicine and Industry; moderator: Robert D. Ladd, Marquardt Aircraft Co.

Afternoon: Business Forecasting; moderator: Edward W. S. Hull, Diversey Engineering Co.

Luncheons are scheduled for Monday, May 25, and Tuesday, May 26. On Monday, the Space Age Luncheon will tie in with the morning panel on the National Aeronautics and Space Administration. Chairman Norman L. Baker, associate editor of MISSILES & ROCKETS, has made arrangements to have a key NASA official as luncheon speaker and guest of honor.

The Missile Industry Luncheon on Tuesday will be a follow-up of the morning panel on the Advanced Research Projects Agency. One top ARPA official will address attendees. An award will be presented at each luncheon to persons who have made outstanding contributions in work falling under the cognizance of the agency being honored. Col. Nelson P. Jackson, USAF (Ret.), is chairman of the Missile Industry Luncheon.

Dr. Walter Dornberger will be speaker for Goddard Memorial Dinner

• **Exposition**—The National Space Age Exposition will be held in the Sheraton Park's exhibition hall throughout the conference under the auspices of the National Rocket Club. Manufacturers in the missile and space exploration program have been invited to participate along with ARPA, NASA, Army, Air Force and the Atomic Energy Commission.

• **Goddard Dinner**—Climaxing the conference and exposition will be the annual Dr. Robert H. Goddard Memorial Dinner on Wednesday evening, May 27. The Conference's only formal affair will include a reception honoring Mrs. Esther C. Goddard, widow of the rocket pioneer. Speaker for the dinner will be Dr. Walter R. Dornberger, Technical Assistant to the President of Bell Aircraft Corporation, last year's Missile Industry Luncheon guest of honor and speaker.

Program Chairman Erik Bergaust, editor of m/r, said that the three awards which will be presented at the Goddard Memorial Dinner (in addition to the two luncheon awards) will be the Borg-Warner Industry Award, presented by the Borg-Warner Corp.; the Robert H. Goddard Memorial Trophy, presented by American Aviation Publications (MISSILES & ROCKETS Magazine), and the Space Flight Achievement Award, presented by Daniel, Mann, Johnson and Mendenhall.

Dr. Goddard is to the Space Age what the Wright Brothers were to aviation. Born in Worcester, Mass., in 1882, Dr. Goddard became a teacher of physics at Clark University in Worcester. In 1914 he was granted two U.S. patents which are still basic to rocketry. From then until his death in 1945 he kept at rocketry through ridicule, New Mexico launching failures and finally a cancer operation after V-E Day.

• **NRC**—The National Rocket Club, sponsor of the National Missile Industry Conference and Space Age Industry Exposition, is "pledged to United States leadership in rocketry and astronautics." It was founded Oct. 4, 1957, as an informal luncheon club for exchange of unclassified information on rocketry and astronautics between members of the industry, press, government and the military.

In the spring of 1958 the club co-sponsored with the National Capital Section of the American Rocket Society the first National Missile Industry Conference and the Dr. Robert H. Goddard Memorial Dinner.

1-1.5 Meg Engine May be Operational in Six Years

NEW YORK—Thomas F. Dixon, chief engineer of Rocketdyne, estimates that the 1-1.5-million-pound-thrust single-chambered engine will not be available for operational use for at least six years.

Dixon, during the presentation of a paper entitled, "A look at Rocket Development for the Next Twenty-five Years," at the Institute of Aeronautical Sciences Symposium on Aero-Space Technology, said the single-chamber engine "will require tremendous development efforts, and larger test stands. Turbo-machinery capable of power outputs of small municipalities will be required to feed the propellants to the (combustion) chamber.

"Stable combustion chambers will have to be built with chamber densities many times that of existing engines. Plumbing, valves, etc., will be beyond the range of current experience."

The chambered cluster now under development at ABMA should be operational by 1960, Dixon said. The Rocketdyne engineer further estimated that a cluster of six of the 1-1.5-million-pound engines would not be available until 1970, with a cluster of 10-12 of the units operational by 1972.

Dixon projected his predictions still farther into the future with an estimate of nuclear rocket availability by 1975, an ion rocket by 1970 and a thermo nuclear engine by 1985.

20 ICBM Squadrons in Budget

WASHINGTON—The 1960 Fiscal Year budget includes funds for initial and/or continued financing of 20 squadrons of U.S.-based intercontinental ballistic missiles—10 missiles to a squadron, a total of 200.

Nine of the squadrons will be of the Convair-built *Atlas*, the other 11 squadrons of the Martin-built *Titan*. A new guidance system will permit placing the *Atlas* on underground "hardened" sites, the same as *Titan*. First *Atlas* wing will be activated in Fiscal 1960, others to follow as fast as possible.

To make the money available for these 5500-mile missiles with their megaton-strength nuclear warheads, the Air Force drastically cut back procurement of B-52 bombers in the 1960 budget. Only 59 or 60 of the big bombers will be bought, enough to provide for the 14th wing expected to come into being during that era. At one time the Air Force was aiming at 20 or 21 wings.

• **Cutbacks**—In the Department of Defense portion of the budget, $6.795 billion is allocated for aircraft and $3.764 billion for missiles. Reduced spending for missiles is explained by the elimination of some (*Rascal, Regulus II, Goose, Redstone* and *Corporal*) and the phasing out of the IRBM *Thor* and *Jupiter*. Also, it was said, with much of the research, development and testing work finished, missiles will simply cost less to produce.

Broken down by services, the aircraft and missile rocket budget shows (in millions):

	Army	Navy	USAF
Aircraft	$6,795	$0,085	$1,866	$4,845
Missiles	$3,764	$0,406	$0,658	$2,700

The missile programs of the three services will be about as follows:

Air Force: *Atlas* and *Titan* programs accelerated, with *Titan* probably up 50 per cent and probably half a billion in ground support for the two; purchase of the *Bomarc* in operational quantities, including the new 400-mile production model; three-quarter billion hike in *Minuteman* funds; acceleration of air-to-ground ballistic missile; continued procurement of ground-to-air *Mace* and air-to-air *Hound Dog, Falcon* and MB-1 *Genie*.

Navy: Most importantly, continued development of *Polaris* weapon system, including building three more *Polaris* submarines and development of *Polaris* missile; buy *Sparrow III* and *Bullpup* for naval aircraft, *Tartar, Terrier* and *Talos* for the fleet. Continue development of *Eagle* and *Subroc*.

Army: Expanded program for ground-to-ground *Pershing* and *Nike-Zeus*, the anti-ICBM; Army will continue to buy *Nike-Hercules* for air defense and *Hawk*, low-level air defense.

The aircraft program of the three services:

Air Force: Will introduce first squadron of Convair B-58 Hustlers during 1960, buying about 40; will cut back Boeing B-52 purchases to 59 or 60 along with some 90 KC-135 tankers; support program includes purchase of turbojet and turboprop transports. North American chemical bomber program, as well as F-108 will be accelerated. Inventory will drop to 102 wings with just under 20,000 aircraft, 65% jets.

Navy: Will buy approximately 665 aircraft, maintaining about a 50% jet inventory totalling 9200 planes. The Seamaster program will be dropped. McDonnell's F4H-1 will go into production. Some 600 anti-submarine aircraft will be modified to include improved detection equipment.

Army: With only $87 million, Army will purchase fewer helicopters while fixed-wing aircraft will be mostly turboprop observation craft. Inventory on June 30, 1960 will be about 5363 aircraft—2558 helicopters and 2805 fixed-wing.

The National Aeronautical and Space Administration and the Advanced Research Projects Agency have budgets of $485 and $455 million respectively, although probably less than $700 million of this will go for actual space enterprises. The chief NASA space projects are:

Project *Mercury*, to place man in space; *Vanguard* and other space probes including the inflatable sphere and the cosmic ray satellite; million-and-a-half-pound-thrust engine; fluorine fuels.

European Group Studies Building U.S. Missiles

GENEVA—NATO has announced that studies have been made by a group of European manufacturers on the possibility of building U.S. guided missiles in Europe. The companies concerned, all designated by their governments, are: Ateliers de Constructions Electriques, Belgium; Telefunken, Germany; Finmeccanica, Italy; Philips, Netherlands; and Compagnie Thompson-Houston, France.

Some European sources have suggested that this group of manufacturers will be entrusted with the European production of the Raytheon *Hawk*. However, while it is known that *Hawk* is one of the projects studied by the European group, it is by no means certain that merely the member companies of the groups would be involved with the production of this missile.

U.S. Agencies Silent on *Lunik* Tracking

by Frank McGuire

WASHINGTON—If there is any official information available about the performance of the Soviet Union's space probe—*Mechta* (Dream)—United States agencies are not about to admit it.

Few agencies, with the notable exception of NASA's Jet Propulsion Laboratories, will flatly say they positively identified the vehicle through radio contact, and no one actually will admit having sufficient contact to track it.

When asked specifically if any military or other government installation had succeeded in tracking and/or positively identifying *Lunik*, the Defense Department issued a reply saying only that the frequencies had been monitored and a report given to DOD by the stations involved.

Several other facilities say they heard something, but it was not on the announced frequency that *Lunik* transmitted on; or it was an altogether different signal from the one recorded by Radio Moscow and rebroadcast; or it was much too weak to have been identified as anything like telemetry.

RCA Communications, Inc. reported a signal monitored on 70.2 mc which sounded like telemetry but was not the same signal broadcast by Moscow. Also, 70.2 is not among the frequencies listed by Moscow as being in use aboard *Lunik*. RCA could name no one who had reported positive contact.

Smithsonian Astrophysical Laboratory withdrew an earlier statement that it had photographed the vehicle. A spokesman for SAL said: "To the best of my knowledge, it was not identified photographically. We originally thought so, but found it was not."

Jodrell Bank radio telescope in England was quoted as saying it had "probably" identified the vehicle, but a British Embassy official told m/r that "if Jodrell Bank had definitely identified the thing, someone here (at the embassy) would certainly know about it, and we have heard nothing."

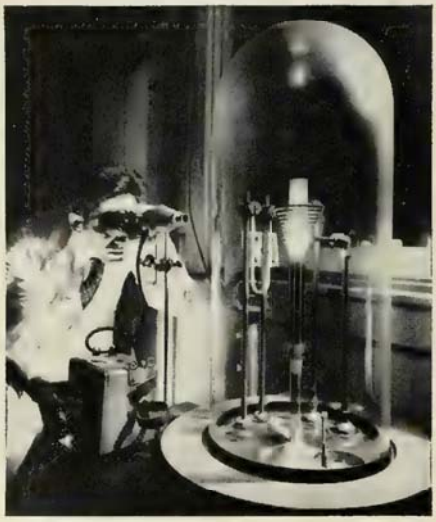
Tape recordings of the signals heard by various facilities are being analyzed by electronics experts experienced in telemetry to attempt a solution to the question.

The entire situation has become of great interest, not because there is any conclusive evidence in either direction, but because there is not.

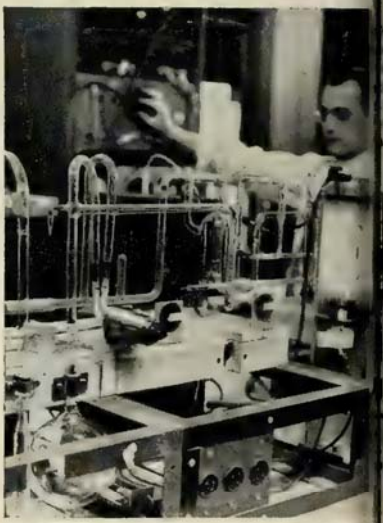
Westinghouse is spending $185 million for research and development in 1959

HERE ARE SOME CURRENT PROJECTS . . .

HIGH TEMPERATURE ELECTRICAL INSULATION. Effective for long periods at 500° C—eventual applications to 1000° C now contemplated. Demonstration motor shown above is running red hot. *Aircraft Equipment Department, Materials Engineering Departments, and Research Laboratories*



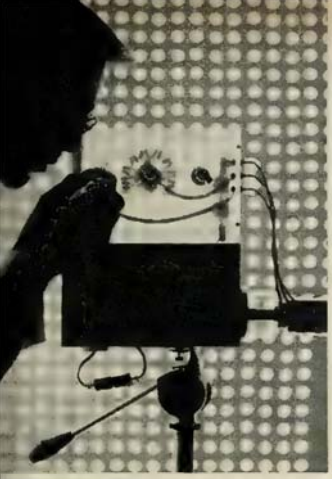
SPECIAL METALS. Westinghouse spearheads research in refractory alloys with one of the country's largest programs in special metals. Westinghouse is nation's principal supplier of a number of special defense-application metals. *Materials Manufacturing Department, Aviation Gas Turbine Division and Lamp Division*



HIGH-VACUUM RESEARCH. Extensive high-vac research conducted since 1947. Current area investigation include electrical and chemical pu ing in ultra high-vacuum range and compo development for large high speed pumping syst Results being applied in advanced electronic de development. *Air Arm Division and Reser Laboratories*

UNDERWATER SONICS. Current Westinghouse projects being conducted in laboratories and at sea are investigating various types of "scatterers" and their effect on the underwater transmission of sound. Also under development: acoustical torpedo controls and an acoustical mine identification system. *Ordnance Department and Research Laboratories*

NON-ROTATING 360° RADAR ANTENNA. Only the feed point moves. Princi involved will permit economical construction of very large high gain scann antennas. Application of inflation techniques will permit lighter-weight long-ra air-transportable radar. Working models already built and evaluated. *Electron Division and Research Laboratories*

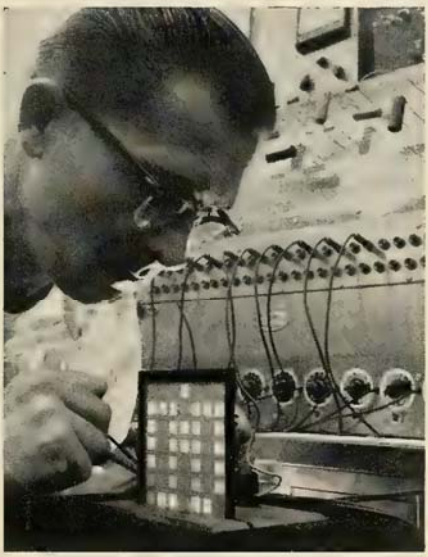


HT AMPLIFICATION, through electron bom-dment induced conductivity. Extremely sen-e. Principle especially useful for satellite nnaissance devices. Efficient working mod-have been developed. ***Electronic Tube sion, Astronautics Institute and Research oratories***

NUCLEAR RESEARCH. At the Westinghouse Testing Reactor, engineers are preparing high intensity radiation tests on a wide range of materials to determine their structural, chemical, and nuclear stability. This is a necessary prelude to using these materials in certain atomic power applications now under development. ***Atomic Power Department***

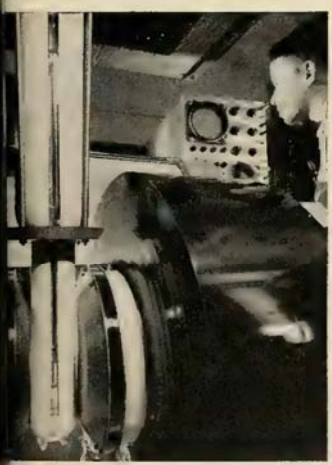
INFRARED research projects include: *thermal imaging* — working models in advanced development; *ultrasensitive doped crystal detectors* — advanced test models; *photo-electric magnetic detection* — working model. ***Air Arm Division, Semi-Conductor Department, Materials Engineering Departments, and Research Laboratories***

E-DOPPLER RADAR is in advanced devel-nt in three major areas of application at inghouse. Research is continuing to open ew potentials. Westinghouse is the owledged leader in this field. ***Air Arm ion***



NEW DATA DISPLAY DEVICES. Electroluminescent cells, individually controlled, form flat picture. Model has oversize cells for demonstration; latest techniques produce cells only 1/16" across. Similar tote board display, capable of high-speed read-out of digital inputs, in production. Both devices can be erased instantly or retained and studied for long periods. ***Electronics Division, Rayescent Lamp Department and Research Laboratories***

THERMOELECTRICITY. Westinghouse recently developed the first efficient material to produce electricity directly from heat at high temperatures (1100° C). In addition, other thermoelectric material under development can be used for cooling purposes, including very light-weight applications. Forty Westinghouse scientists now on this project. ***Materials Engineering Department and Research Laboratories***



-NOISE MICROWAVE AMPLIFICATION. inghouse scientists have developed vari-low-noise solid-state amplifying devices, MASER and non-linear reactance types. ess in recent years was speeded by prior s of research in low-temperature and solid-physics. ***Air Arm Division and Research ratories***

For information on these and other research projects, write to Mr. E. W. Locke, Director, Customer Relations, Westinghouse Defense Products Group, 1000 Connecticut Avenue, N.W., Washington 6, D. C.

Westinghouse

DEFENSE PRODUCTS

AIR ARM DIVISION
AVIATION GAS TURBINE DIVISION
ELECTRONICS DIVISION
AIRCRAFT EQUIPMENT DEPARTMENT
ORDNANCE DEPARTMENT

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

Black Knight Engine Described

by Anthony Vandyk

LONDON—British security has permitted details to be released on the Armstrong Siddeley Gamma rocket engine used in Britain's *Black Knight* re-entry test vehicle. It has a total thrust of 16,400 lbs at sea level, rising to nearly 19,000 lbs. outside the earth's atmosphere due to drop in back pressure.

In November, 1955, the Royal Aircraft Establishment initiated development of *Black Knight*, a re-entry test vehicle for which it had produced a preliminary design based on existing Gamma engine components developed by the R.A.E. Rocket Propulsion Department at Westcott (now the Rocket Propulsion Establishment). To obtain adequate thrust for the vehicle, four Gamma units were required and it was realized that with some modification these could be used to control the vehicle in a very simple manner. The R.A.E. retained design authority and appointed Saunders Roe as the main contractor for the vehicle; and Saunders Roe placed a contract with Armstrong Siddeley for the rocket engine.

Armstrong Siddeley began the design of an engine incorporating four Gamma units, modified from the original RPD design, in order to obtain experience of their behaviour. While entirely satisfactory for experimental purposes, the units required further development before they could be considered suitable for use in the re-entry test vehicle.

In the Armstrong Siddeley Gamma engine the four combustion chambers are arranged uniformly around the central vehicle support and are mounted on trunnions so that they may be rotated about axes that radiate from it. A hydraulic actuator, fitted to each chamber to control the angular movement, receives instruction from the guidance equipment.

• **No roll**—The vehicle is not intended to roll during flight and therefore two diametrically-opposed chambers are rotated together to control pitch, and the other two to control yaw; to correct any tendency to roll, all four chambers are rotated in the same direction. Pitch and yaw are arbitrary terms for this vehicle because its flight path is almost vertical.

The combustion chamber trunnions are hollow, and through the inboard trunnion hydrogen peroxide (HTP) is pumped into the outer shell of the combustion chamber. To cool the inner shell, which contains the flame and would otherwise rise to 2500°C, the HTP is passed through a clearance between the two shells before it enters a catalyst pack at the top of the chamber. This pack consists of silver-plated nickel gauzes and in it the HTP is decomposed into a mixture of superheated steam and oxygen with which kerosene ignites spontaneously.

The kerosene is fed into the chamber through its outboard trunnion and is admitted into the combustion chamber as soon as a pressure rise indicates decomposition of the HTP. Prior to this instant, nitrogen is blown through the fuel passages to prevent reaction in them between HTP and the incoming fuel. The nitrogen for this is obtained from a ground installation, which is disconnected automatically as the vehicle rises from the launcher pad.

• **Common manifold**—Each combustion chamber is fed with propellants by its own turbo-pump unit, the four units being joined at the center by a common HTP manifold to form a rigid cross which is attached to the structure of the vehicle at each of the fuel pump suction elbows. The centrifugal impellors of the HTP and fuel pumps are mounted at opposite ends of the same shaft that carries the turbine rotor.

HTP decomposed in a separate catalyst pack provides a jet of hot gas which impinges on the axial flow turbine to drive the pumps. To start the engine, HTP is supplied under pressure for this purpose from a ground installation which is disconnected automatically as the vehicle rises from the launcher pad. By this time the HTP pump pressure is large enough to supply the HTP for the turbine through a control valve.

The complete engine compartment weighs some 700 lbs.

Missile Shapes and Ladies' Figures

A REMARKABLE SIMILARITY between some of the shapes required for rocket and missile components and for milady's current attire has been noticed by Spincraft, Inc., Milwaukee spinning firm specializing in the former field. So they put an artist to work with these results and conclusions. The trapeze look is inspired by the conical spinning on the *Honest John*. The sheath is a missile nozzle component. The chemise is a spun cylinder for a missile first stage.

Space 'Progress' by 1969?

by Paul N. Means

WASHINGTON—How far into space will man have ventured by 1969?

This question was posed to the nation's leading space experts by the staff of the House Astronautics and Space Exploration Committee. Their answers are contained in a committee report released recently.

Man during the next 10 years, according to the consensus of the experts, will have set foot on the moon, will be sending expeditions to Mars and Venus, will attempt "soft landings" of instrumented packages on other planets, will have orbited a large space station which itself will stage rockets toward the moon and planets, and will be using earth satellites for commercial communication and meteorological purposes.

The experts caution, however, not to expect too much progress in the immediate future—and too little progress later.

"A common error" (in forecasting progress), according to George L. Haller, vice-president of General Electric Co., "is that of being too optimistic about what can be achieved in a few years and too cautious about the developments to be expected in 30 years."

Before the 20th century expires, the experts see man traveling at close to the speed of light, and using such esoteric devices as nuclear power, ion rockets, solar boiler rockets, plasma jets, photon rockets, magnetic propulsion and braking systems, and solar sails.

Predictions in any phase of science is hazardous, but the experts point out that progress in space research seems to have outstripped predictions in the past.

Most agreed that the rate of progress lies less with technology than it does with the attitude of the people.

• **Motivation**—"The hero of this age," according to George S. Trimble of the Martin Co., "will not be the space traveler, but rather the man or men who successfully figure out how to motivate 170 million American people actively to do battle with a part of their environment that they just began to hear about, that they really did not know was important."

Specific estimates of the date which man will first set foot on the moon varied from seven to 15 years.

Dr. Herbert L. York, new Director of Research and Engineering for the Department of Defense, thinks man can first set foot upon the lunar dust in "just about 10 years (perhaps in as little as seven, if a very high priority were placed on this goal.)"

Others, including ABMA's scientific director Wernher von Braun, believe that manned flight around the moon is possible within a decade, but that a two-way flight to the moon, including landing, would take place a few years thereafter.

The experts were in disagreement as to whether propulsion systems and space knowledge would be sufficient to send man to Mars and Venus within a decade, but there was general agreement that these planets, and also Jupiter would have their atmospheres probed by instrument payloads by 1960.

• **Short distance this year**—To send man into space for a short distance will be accomplished in the very near future—possibly in 1959. And within five years, according to Brig. Gen. H. A. Boushey, Air Force Director of Advanced Technology, orbital refueling and restaging will be under way.

According to Gen. Boushey, 1965 will see manned maintenance, repair, and resupply space vehicles in use for military, commercial and scientific purposes.

By the end of the next decade, man will have constructed and orbited a large space station, and will be preparing for controlled space flight. According to Dr. Walter R. Dornberger, rocket expert for Bell Aircraft, such vehicles up to the end of 1969 "will be mainly up to 650 miles this side of the radiation cloud at operation times of two or three weeks.

Within the next 10 years, space vehicles will be used for communications, television, weather, and astronomy.

Communications satellites could establish a truly global TV service with vital political, commercial, and cultural consequences, according to English scientist and author Authur C. Clarke. According to Clarke, the impact of television in Asia and Africa (made possible by communication satellites) could be overwhelming. "It may well determine whether Russian or English is the main language in the future . . . the TV satellite is mightier than the ICBM."

Accurate world weather predictions, according to the experts, and some resulting control of weather will be affected in the next decade through the use of meteorological satellites.

Other commercial applications of satellites includes the formation of a global post office, which could deliver mail almost instantaneously.

• **New fuels**—Beyond the next decade, there will be new fuels developing 10 to a 100 times a million pounds of thrust, enveloped in packages able to withstand a temperature of 10 million degrees. The experts do not underestimate the obstacles in producing such propellants and envelopes, but are confident that such technical capability is within our grasp in the 20th Century.

The state of the art in propellants in 1969, according to JPL's director Dr. William H. Pickering, will be such that reliable chemical engines will have thrusts of several million pounds, prototype models of atomic rocket engines will be undergoing static tests, ionic propulsion systems will be in the advanced experimental stage, and more efficient and reliable solar-energized power sources having an almost indefinite lifetime will be produced.

What are the potentials in space? The assumptions, conjectures and speculations that the experts make include some wilder than Jules Verne or the creator of Buck Rogers have conceived.

Dr. Eugen Sänger of the Technical University of Stuttgart talks about an ultimate space weapon similar to the "death ray." She describes this device as a "stationary ultraviolet searchlight" which might exert a radiation pressure by means of high-energy beams and thus be able to destroy "flying objects up to a distance of several hundreds of miles in a fraction of a second."

A relativity check with atomic clocks, according to NASA scientists, could prove or disprove time-gravity aspects of relativity, such as whether or not a 1,000 years would have passed on earth in the course of a 22-year space flight to a star a thousand light years away at a speed close to the speed of light.

France Forms Committee For Astronautics Research

PARIS—The French government has established a committee to evaluate the nation's potential in space research and to oversee any programs which may develop as a result of the committee's proposals and recommendations.

An annual report will be submitted to the government by the committee, which is composed of: the Chairman of the Committee of Scientific Action for National Defense; the President of the Office Nationale d'Etudes et de Recherches Aeronautiques (French counterpart of NASA); the head of the Observatory of Paris; the head of the National Committee for Scientific Research; the head of the administration supervising universities and special schools; the head of Cultural and Technical Matters of the Department of Foreign Affairs; and a representative of the Ministry of Finance.

Estimating Missile Expenditures — —

Unfortunately there are no definitive answers — — but with forward planning company resources could be directed to proper business success.

by Douglas S. Evered
Missile Division, North American Aviation, Inc.

LOS ANGELES—If businessmen involved in the U.S. missile effort knew what the levels and applications of future missile funds would be, they could strengthen their competitive positions and bolster their capabilities.

Unfortunately, definitive answers to these questions are not forthcoming.

The military cannot answer them with great certainty because far more than purely military considerations enter into deciding how much shall be spent and for what projects. For example, most people will agree that generous funding of missile projects is an outcome of East-West tension—but how can we be sure that the Soviets will not switch to a political-economic offensive? Such a move might dictate re-directing our national effort and diverting funds into economic countermeasures.

Then again, economy moves sometimes take hold in Congress or the Administration, causing program cuts or stretch-outs. Still another factor is the occurrence of some technological breakthrough such as thermonuclear development, which paved the way for a large-scale ballistic missile effort by making practical warheads available.

These and other factors add up to a formidable series of obstacles in the way of reliably predicting future missile business.

Nevertheless, a good deal of consideration must be given to the questions of how much and for what. A company must spend sizable amounts of its own money today studying projects which will provide its business five to ten years from now.

• **Prologue**—In predicting how much missile money will be available, it is sometimes useful to look back over the history of missile expenditures and draw inferences for the future. Curiously enough this approach, though neglecting other factors, produces results which coincide with many authoritative estimates by aviation and missile economists. Statistically, it would appear that by 1965, for example, we may expect an annual expenditure of $6.6 billion for missiles (bases, ground electronics and *Polaris*-carrying submarines excluded).

Similarly, analysis of the past use of missile funds shows a relationship between the airframe, guidance, propulsion, nose cone and ground support equipment. Projecting into the future with the same statistical methods, it would appear, for example, that missile frame expenditures will be about $2.08 billion by 1965.

The trouble with such statistical projections is that their accuracy, if it occurred, would be coincidental rather than well-founded in the determining factors. Because they fail to take into account legislative attitudes, the international climate, changing operational concepts, technological developments and the state of the economy—to name salient considerations—such projections are unacceptable to the critical appraiser.

• **Projection model**—We can find interesting solution to the prediction problem by constructing a model using selected choices among the variables. For example, in the matter of the international climate, we can look at the next five years as a period with or without a global conflict, with or without local conflict, or with or without an arbitrated East-West settlement.

An acceptable assumption might be to anticipate no global conflict but a high probability of local conflict.

As for legislative attitudes, a selection could be made between Congressional attitudes which would result in a sizable increase in appropriations—for example, an incease to $55 billion dollars annually in keeping with the recommendations of the Rockefeller Report, attitudes which would stabilize appropriations around current levels, and attitudes which would promote sharp reductions.

Obviously, the choice here is related to the choice made for the international climate, which governs legislative attitudes and resulting appropriations. A favored choice for the model would be that of appropriations stabilized between $40 and $42 billion annually for the next five years.

• **Difficult to predict**—Changing operational concepts will undoubtedly appear and will be difficult to predict, being an outcome both of new technological developments and of demands imposed by international commitments. However, several changes are incipient and should be included in the model. These reflect increased concern with local conflicts, orbital type military activity, the submarine threat, and defense against ballistic missiles.

A backward glance at the history of missile expenditures in terms of the desired operational capabilities is helpful in constructing the model. It takes time to achieve capabilities, and the span of effort and accompanying expenditures generally extend into the future. In other words, existing programs must be projected as part of the process of assembling a reasoned prediction of future missile business.

Each area now receiving effort must be looked at in terms of continuing operational requirements. For example, will the air-to-air missile field expand, contract or remain about the same during the next five years? The big determinant here is the future of the manned interceptor as opposed to the surface-to-air missile. With the exception of the planned long-range interceptor, the F-108, it appears that the surface-to-air missile will steadily take over the interceptor role.

Although this might seem to herald contraction of the air-to-air missile market, increased performance requirements of future air-to-air missiles such as *Eagle* and *GAR-9* probably will offset the decrease in the number of missiles actually put into inventory and the expenditures involved.

• **Low-level air-breather**—The surface-to-surface air-breathing missile field has declined as preference for ballistic delivery has grown. Apart from the dark horse of an extremely low-level weapon system, most com-

petent observers predict the decline will continue.

Air-to-surface missiles are expected to expand. With the steady improvement in techniques of bomber interception, the role of the ASM as an aid to penetration and as a stand-off weapon through the IRBM range is almost certain to grow. Moreover, ASM's probably will be used more and more as armament for fighter bombers and helicopters in local conflict problems.

Long-range surface-to-surface ballistic missile programs, with the recent addition of *Minuteman,* now number six. Until they are operational, say by 1963, rising expenditures are inevitable. However, it appears that land-based IRBM's may be de-emphasized considerably, beginning in 1960, due to the political undersirability of relying on overseas bases.

Only Britain and Italy have shown willingness to accept IRBM's and the total number of missiles involved is less than one hundred. By contrast the increasing attractiveness of the ICBM as a deterrent weapon, and the possibilities for more sophisticated versions, underline the probability that *Minuteman* will not be the last of the line.

Surface-to-surface tactical missiles are entering their second generation. Emphasis is being placed on mobility, simplicity, improved C.E.P.'s and wider use in tactical problems of the Pentomic Army. Gaps in the spectrum of tactical missiles will have to be filled in the next few years. Expenditures will probably increase to cover at least two new programs in addition to the replacement of existing systems.

• **Expansion for SAM**—Surface-to-air missile expenditures face continuing expansion under the strong pressure for AICBM capability. A logical extension of air defense is anti-satellite work. We should anticipate almost a doubling of surface-to-air missile spending by 1965, assuming technical solutions to the AICBM problem. However, a considerable portion of such funds could go to those who solve the detection and discrimination problem.

The anti-submarine warfare role of the missile is beginning to come into its own. *Subroc* is the first of this breed and further effort undoubtedly will accompany a breakthrough in the detection problem.

This leaves the area of orbital-type military activity. Here, the further one looks into the future the harder it becomes to separate manned and unmanned efforts. However, there is little doubt that orbital activity will stimulate the missile business. Payload vehicles aside, it is clear that the booster vehicle production will increase substantially in the next five years. Boosters to be powered by the recently-initiated large engines development programs have yet to become the subject of actual projects. These will be forthcoming and will constitute a big share of large future expenditures.

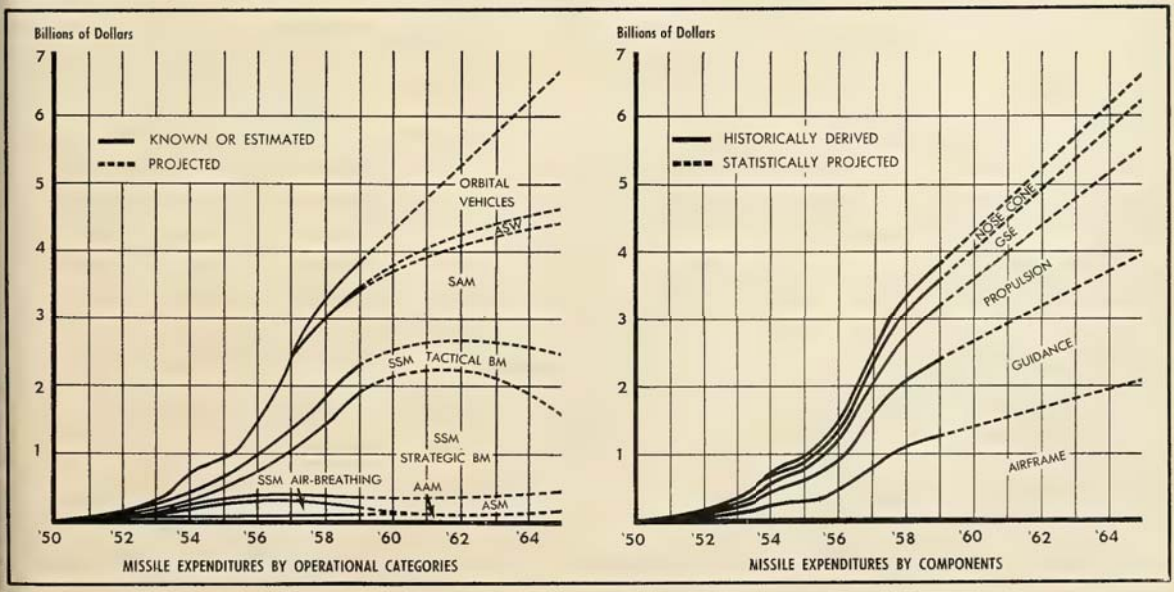
In describing the features of a business prediction model it must be pointed out that many of the nuances which would be fed into such a model for missile industry usage have been left out of this discussion. (For example, classified technical or intelligence data would be very important. And of course these have been omitted). But from the standpoint of comparing purely quantitative estimating methods with those including qualitative considerations, the results of the two analyses show that the levels of expenditures predicted are almost certain to be reached.

• **Component spending**—As for statistical projections of components expenditures, there are strong reasons to doubt that the historical division of expenditures will remain the same. The trend towards solid propellants is already taking a share of the frame segment of expenditures because the motor cases are themselves part of the frame. Similarly, greater sophistication in guidance techniques—such as the blending of inertial, mid-course and terminal guidance requirements for long-range missiles—will change the proportion of funds going in that direction.

It must be concluded that the component spending picture in the future will change considerably. Contrast, for example, the GSE costs of a fully-hardened ICBM base with those of an air-launched IRBM system. In many operational situations the actual weapon delivery method can hardly be described as being fully resolved.

The significance of these considerations to a company in the missile business cannot be overemphasized. Only with forward planning can company resources be directed into the proper areas with a reasonable probability of success.

Projected Expenditures for Missiles



Chemical Industry Expands for Astronautics

by Alfred J. Zaehringer

WASHINGTON—Although there were strong recession tides during most of 1958, the U.S. chemical industry—sparked in part by the growing missile business—spent a whopping $1.4 billion to expand its facilities. This compares to $1.7 billion in 1957.

In this construction, there was a notable trend toward bolstering research and development centers plus expanding the chemical specialties field for missiles and rockets. The chemical industry is increasingly feeling the impact of the missile and space programs.

The accompanying table shows specialized propellant facilities for chemical expansion in the missile-space field. Some 58 new facilities have been built at a cost of many millions of dollars. Dollar costs are shown only for larger items.

All material used was gathered from such Washington sources as the American Chemical Society, Business and Defense Services Administration, and the Manufacturing Chemists Association.

Prominent chemical construction related to the missile field in 1958 included expansion in air cryogenies, specialized solid and liquid propellants, and expanding missile metals and materials for missile electronics.

• **Air cryogenics leading**—A large portion of the overall expansion was devoted to enlarging the Nation's production capacity for air products. Biggest item was for LOX, followed by liquid nitrogen and argon. Helium, still in government hands, remained in tight supply for now and the near future.

For example, Air Products, Inc., built four plants in Pennsylvania; Air Reduction Sales constructed plants at Acton, Mass., Denver, Kansas City, and Lorain, O. Linde Co. built facilities at Aurora, Minn. and Fontana and Pittsburgh, Pa. National Cylinder Gas Co. facilities are at Compton, Calif., Erie and Philadelphia, Pa., while Southern Oxygen Co. built a facility at Bladensburg, Md.

Not all of the LOX expansion will go into missiles, but much of the new construction will be in areas that could be accessible for future missile development.

• **Specialized propellants follow**—Notable among liquid propellant expansion were construction of facilities for producing liquid fluorine and a new plant for high-strength hydrogen peroxide. Most liquid plant capacity, however, was in the area of high-energy fuels—the boron hydrides. Two solid propellant plants were also built.

Not reflected were the newcomers to the solid game under ARPA contract: American Cyanamid, Dow Chemical, Esso Research & Engineering and Minnesota Mining & Manufacturing.

Some highlights from the expanding facilities for producing new metals and materials is best illustrated by the following:

Alco Products, Inc., nuclear research lab at Schenectady; Allegany Ludlum Steel Corp., special steels research lab at Breckenridge, Pa.; Beryllium Corp., metal production plant at Hazelton, Pa.

CBS Laboratories, research lab at Stamford, Conn.; E. I. DuPont de Nemours & Co., delrin and teflon resin plant at Parkersburg, W.Va., and North Carolina silicon facility; Foote Mineral Co., silicon metal facility at Exton, Pa.

General Atomic Div., nuclear research center at San Diego; GE's R&D center for nuclear energy at Pleasanton, Calif.; Merck & Co., silicon facility, Danville, Pa.; National Res. Corp., tantalum facility at Cambridge.

Olin Mathieson aluminum mill at Hannibal, Mo.; Sylvania research lab at Towanda, Pa.; Union Carbide Plastic Co., liquid epoxies plant at Marietta, O.; and National Distillers niobium and tantalum pilot plant at Cincinnati.

SPECIALIZED PROPELLANT FACILITIES

COMPANY	LOCATION	COST $ MILLION	NOTES
ALLIED CHEMICAL CO.	Metropolis, Ill.		Elemental fluorine.
AMERICAN CYANAMID CO.	New Castle, Pa.		Ammonium nitrate plant.
AMERICAN POTASH & CHEMICAL CORP.	Aberdeen, Miss.	4.5	Sodium chlorate.
APACHE POWDER CO.	Benson, Ariz.	1	Anhydrous ammonia: 30 tons/day capacity.
CALLERY CHEMICAL CO.	Lawrence, Kan.	4	High-energy boron fuel plant.
	Muskogee, Okla.	38	Tonnage boron fuel plant.
FOOD MACHINERY & CHEMICAL CORP.	Buffalo		Becco Chemical R&D facilities for government & armed forces.
GIRDLER CONST.	Model City, N.Y.		Hydrogen plant for Olin Mathieson boron fuel plant.
	Muskogee, Okla.		Nitrogen, hygrogen, carbon dioxide plant for Callery Chemical.
GRAND CENTRAL ROCKET CO.	Redlands, Calif.	1.725	Mixing, assembly, test & offices for solid propellants. Capacity of 1 million lb./month.
HERCULES POWDER CO.	Wilmington, Del.	0.75	Concentrated nitric acid: 50 tons/day.
HOOKER CHEMICAL CO.	Columbus, Miss.	1	Addition to sodium chlorate plant. Production up to 22,000 tons/year.
LINDE CO.	Linden, N.J.		High-purity hydrogen.
MISSISSIPPI CHEMICAL CORP.	Yazoo City, Miss.	1.8	Ammonia & nitric acid plant. 30 tons/day ammonia, 150 tons/day nitric acid.
MONSANTO CHEM. CO.	Monsanto, Ill.		Amines.
OLIN MATHIESON CHEMICAL CORP.	Model City, N.Y.	46	Organic boron fuel.
	Niagara Falls, N.Y.	4.5	HEF-2 boron fuel plant.
PENNSALT CHEMICALS CO.	Portland, Ore.		Ammonium perchlorate plant.
	Portland, Ore.		Sodium chlorate plant.
PETROLEUM CHEMICAL INC.	Lake Charles, La.		Anhydrous ammonia, 100,000 tons/year.
SHELL CHEMICAL CORP.	Norco, La.		Hydrogen peroxide plant.
STANDARD OIL CO. (IND.)	Seymour, Ind.		Expansion of solid propellant R&D facilities.
VALLEY NITROGEN PRODUCERS, INC.	Helm, Calif.	9	Anhydrous ammonia: 150 tons/day capacity.
WYANDOTTE CHEM. CORP.	Geismar, La.	26	Ethylene oxide & intermed. plant, 40 million lb./year.
	Wynadotte, Mich.		Propylene oxide plant.

Some significant areas of chemical expansion.

Theodolites Determine Azimuth for *Jupiter*

Optical-electronic combination provides method for automatic alignment and monitoring of inertial guidance systems.

NORWALK, CONN.—One of the most important tools in the hands of the people responsible for launching inertially guided missiles, such as the *Jupiter*, is the azimuth alignment theodolite. This tool, basically an optical-electronic system consisting of an intricate arrangement of lenses, mirrors, beams of light and a closed electronic circuit, provides a method of automatically aligning and monitoring the inertial guidance system.

By lining up the missile's inertial guidance system with predetermined and highly accurate directional "bench marks," the theodolite system becomes an indispensable means of setting one of the most crucial elements in the programmed trajectory of a long range missile—a correct azimuth heading.

The direction the missile will fly in azimuth is determined by the physical orientation of the missile motion measuring devices at the instant of launch. A basic requirement of the *Jupiter* guidance system is to orient these measuring devices properly at launch, and maintain an accurate space-fixed reference during the entire guided portion of the flight. This requirement is met by the missile inertial platform manufactured by the Ford Instrument Company.

The guidance package contains the sensing devices used by the missile, and acts as the basic source of intelligence for the guidance system computers.

Since the missile system is entirely free of external sources of guidance from launch to impact, the azimuth command given to the missile in the form of orientation of the inertial platform is irrevocable after the missile leaves the pad. It is therefore of the utmost importance that this command be given accurately, in order to take full advantage of the guidance possibilities of the inertial platform.

After the missile has been aimed along the correct azimuth line, the properly aligned guidance system continues to perform its vital functions.

• **Determines variables**—Before engine cutoff, the guidance system, by means of sensitive accelerometers and computers, determines the variables necessary to solve a cut-off equation. When these variables satisfy the equation, signals shut down all thrust. The platform on which these accelerometers are mounted are precisely orientated in inertial space by the gyros that were automatically aligned by the theodolite before launch. These precise acceleration-measurements are used to calculate the missile's speed and position.

Seconds of arc error cause significant flight path error when dealing with terrestrial and celestial distances. The importance of critical azimuth adjustment is stressed by the fact that only a 20-second error (one second of arc equals 1/1,296,000th part of a circle) in the azimuth heading of a 1500-mile-range missile means an off-target impact of about 0.15 miles. It can be appreciated that these infinitesimal adjustments for correct alignment can only be accomplished through the use of optics. Optics work within tolerances of 1/10th of a wave of light and a wave is equal to .000011 of an inch.

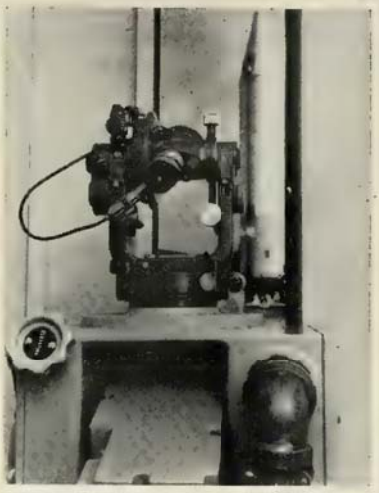
Alignment theodolites are now operational at a number of missile sites and are also being used in the production, testing and alignment of stable platforms.

The Perkin-Elmer Azimuth Alignment Theodolite was developed expressly for the problem of highly accurate reference of inertial guidance systems with given geographical references. The theodolite automatically detects discrepancies in the alignment of the basic monitored equipment by continuous observation of the reflections from a mirror mounted on the stable platform of the inertial guidance package. Such rotational discrepancies cause error signals which are applied as corrective signals to the drive elements of the monitored equipment via a closed loop system between theodolite and missile.

The monitoring optical system consists of two modulated light sources, a telephoto lens as the objective, a beam-

SHORT range Perkin-Elmer theodolite monitors auxiliary prism in missile base during weather conditions which interfere with primary theodolite.

MODEL 523 Theodolite seen through window in front of Craig hut.



UPPER portion of same theodolite seen from inside of hut.

dividing "Vee" prism and a photomultiplier tube.

The light from two glow discharge lamps—electronically modulated at 400 cycles in phase opposition—in the monitoring system is reflected from a mirror or prism mounted on the stable platform on the guidance system. The two lamps are each imaged at the focal plane of the telephoto objective by separate condenser systems, and a prism-shaped mirror reflects the beams along the optical axis of the objective lens.

• **Angular displacement**—The resultant signal produced by the photomultiplier is a function of the angular displacement of the monitored mirror from the autocollimated or "squared on" position. This signal is also 400 cps, whether in phase or 180 degrees out of phase, with the reference voltage, depending on the direction of deviation.

The tie-in to the geographical reference is achieved by use of a high-quality survey theodolite incorporating an accurate azimuth circle and sighting telescope. The desired angle between the sighting or "reference" line of sight and the "monitoring" line of sight is set off using the azimuth circle. The "zero" setting of the circle is determined by autocollimating both systems from a common test mirror.

If the monitored mirror is rotated in azimuth even "slightly," the returning beams will not be centered on the optical axis and, depending on the degree of rotation, will pass through a slit—ground and polished on the apex of the prism—and strike the photomultiplier. In this manner, an error signal output is produced which, in phase relationship, is representative of the direction and magnitude of azimuth deviation.

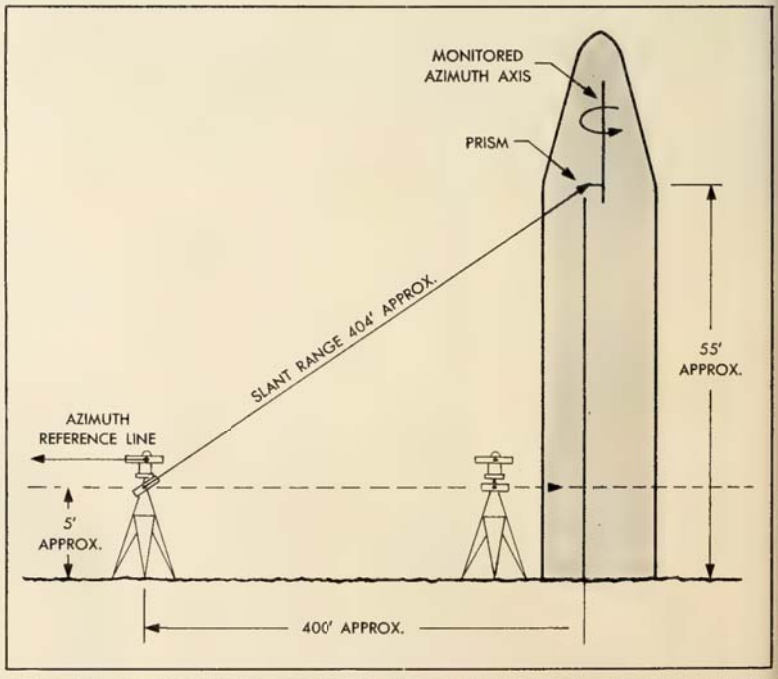
Error signals are fed to the stable platform to drive the platform back to conformity with the beam of light and thus the correct azimuth heading. The entire closed loop relationship, therefore, is automatically self-correcting. As a result, these signals counteract any tendency of the platform to move away from the very important established heading. The platform is controlled automatically within very small limits and over relatively long periods of time. The error signals generated by the theodolite may also be recorded to obtain long-term data for use in making corrective adjustments.

The Intermediate Range Theodolite for the *Jupiter* manufactured by Perkin-Elmer Corp., represents a variation from other alignment theodolite units in production by the company.

The monitoring problem imposed by the *Jupiter's* dimensions, position, and guidance system required the particular physical location of the theodolite in respect to the monitored axis. The reference line of sight is established with a standard surveying theodolite slightly modified for mounting on the top of the main instrument housing.

Aperture and focal length of the *Jupiter* theodolite is increased to 4″ and 36″ respectively because of increased distance requirements. Electronic unit consists of amplifier, preamplifier and power supply-modulator.

The major sections of the instrument are constructed of mechanite castings for rigidity and stability over the wide temperature ranges encountered. All exposed small parts are stainless steel for corrosion resistance. The the-



ARRANGEMENT of monitoring set-up, showing primary and auxiliary theodolites.

odolite is mounted on a special pedestal.

• **How it works**—Characteristics of the output signal are as follows:

1. *Phase*—in phase or 180° out of phase with respect to the 115-volt 400-cycle reference voltage supply within 10°.

2. *Maximum Output Impedance*—500 ohms.

3. *Frequency*—400 cycles sinusoidal voltage synchronized with the 115-volt 400-cycle reference voltage supply.

The power requirements are as follows:

400 watts—60 cycles or 400-cycle 115 volts power source.

1.0 watt—400-cycle 115-volt signal supply.

Two theodolites are used with the *Jupiter*; the "primary aiming" intermediate range model 523, and an "auxiliary" short range model 169. The short range unit is stationed 3 to 4 feet from the foot of the missile and sends beams to an auxiliary prism monitoring unit (with the same heading as the top prism) in the base of the *Jupiter*. This monitoring unit is directly connected to the launching ring on which the missile is positioned. A second auxiliary monitoring prism is also attached to the launching ring at an angle representing a second target point.

Purpose of the short range theodolite—expendable due to its proximity to missile blast during launch—is to take over alignment adjustment in the event of poor weather conditions which might interfere with or distort the beam path to the nose section.

New, Compact Unit Converts Data in Flight

NEW YORK—A small, compact analogue-to-digital converter about the size of two quart milk cartons has been announced by Gulton Industries Inc., of Metuchen, N.J. The company claims the development means that for the first time information on speed, radiation and temperature can be accurately converted and telemetered from satellites, missiles and rockets while in flight.

Advantages of the converter are its small size and weight (less than seven pounds), an estimated accuracy of 0.1% and an operating temperature range from about 20° to 175°F. Gulton spokesmen said in-flight conversion would permit immediate action on such vital factors as missile pitch, without going through time-consuming conversion on the ground. The converter can handle 12 items of information, through 12 channels.

Coupled with the company's new physiological medical transducers, the converter can serve as an electronic "doctor" to measure reactions of men and animals to high speed and other aspects of space travel. The new transducers, also small in size, include a breathing rate transducer, heart and pulse rate indicator, skin temperature probes and a galvanic skin resistance transducer.

The company built the converter under contract from a government agency it declined to name. A spokesman said the company has orders for 150 converters.

Tube Said to Run Years On Weak Solar Power

NEW YORK—A new electronic tube unveiled here recently may lead to earth-satellite radios that will run for years on power from weak solar batteries, its makers claim.

The manufacturers, Tung-Sol Electric, Inc., of Newark, N.J., say the device is the first major improvement in vacuum tubes in 30 years. They expect it to be available to the armed forces within a few months and to the general public within a year.

The principle of the new instrument was discovered in 1952 by Dr. Dietrich Dobischek, a scientist at the U.S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J. Tung-Sol has been working with the Signal Laboratory on the project since 1956.

It operates with a cold cathode as an electron emitter. All other tubes use hot cathodes to boil electrons out, and thus use a great deal more power. The new tube is said to use only a tenth the power of standard tubes when operating, and to "idle" on five millionths of a watt. It needs no warm-up period such as standard tubes require, but it has a built-in tungsten-filament "starter" to give it the boost it needs to start functioning.

Laboratory tests at Tung-Sol indicate that the tube will withstand the high radiation of space and operate over a temperature range from liquid air to red heat. Transistors, which are also cool and require little power, cannot withstand such extremes of radiation and temperature. Tung-Sol believes it can build cold-cathode tubes rivalling transistors in tiny size.

A drawback of the new tube is that it operates only at 300 volts or above. But its total electric consumption is said by the makers to be small enough that weak solar batteries can operate it.

The tube's cold cathode is nickel-coated with magnesium oxide—dried milk of magnesia. A high-voltage field, rather than heat from high electric power, causes the electron flow from the cathode. Components of the cold cathode, unlike those of the hot cathode, are said to be physically and chemically inert, which accounts for the tube's long-wearing qualities.

Tung-Sol hopes that the new tube will lead to improvements in home radio and television, in radar, in many military applications, and in such fields as lighting and television screens.

Electronics Buying Shows Quarterly Increase

WASHINGTON—Defense electronics procurement during the first quarter (July-September 1958) of the current fiscal year dropped from the fourth quarter of fiscal year 1958, Electronics Industries Association, reports. The figures for the first quarter of fiscal year 1959, however, show a $32 million increase over the corresponding period.

Using a specific formula to extract the portion of military spending for electronics from all major defense procurement categories, EIA reports total expenditures in the July-September 1958 period at $958 million, indicating a decrease of $229 million—or about 20%—from the $1,187 billion reported for the fourth quarter of fiscal year 1958.

"LARGEST" tracking radar antenna afloat.

CENTRAL CONTROL room of Army's "missile measurement ship."

3000-Mile Radar May Be on Tracking Ship

by Peer Fossen

BALTIMORE—The Army's "missile measurement ship" or "floating laboratory," the S.S. American Mariner, is en route to her destination somewhere in the South Atlantic. Equipped with the latest and most advanced radar, other electronic, and optical missile tracking and in-flight measurement gear, the vessel is said to be capable of collecting the most precise data yet obtained at sea.

According to spokesmen from Radio Corporation of America—systems management contractor—the vessel will work "far off regular sea lanes" within the Atlantic Missile Range which extends from Cape Canaveral some 5,000 miles southeast to Ascension Island. She can operate independently for 40 days, and will carry a scientific staff of some 50 scientists, engineers and technicians in addition to the ship's crew of 51 men.

RCA Service Company has supplied experienced electronic operations personnel from its missile tracking activity at Canaveral. Barnes Engineering Co. is prime contractor in charge of design and operation of non-radar measuring.

• **Potent radar**—The S.S. American Mariner carries two sets of high-power tracking radars, which RCA calls the most accurate tracking radar in the world. Neither RCA nor the government is willing to reveal the exact tracking range of the radar, but a distance of "hundreds of miles" is indicated. A Department of Defense release, however, says the scientific staff will continue precision observation and data collection of a missile performance "from its ascent to remote altitudes in space, through all levels of the earth's atmosphere to the final plunge to earth or sea."

If this is the case, it is fair to assume that the vessel might carry radars capable of tracking over ranges exceeding 1000 miles, and if ICBM tests are in the program, radars with 3000-mile capability could be involved. Development work on 3000-mile radars was announced more than a year ago.

• **To close gap**—A small fleet of vessels like the S.S. American Mariner, equipped with long-range radar, could fill the gap in our detection of northbound missiles—such as ICBM's launched from the Antarctic—and activate in-time defenses.

The S.S. American Mariner's role as a link in anti-missile defense is also emphasized by the part Barnes Engineering Co. has in her instrumentation and operation. Barnes was one of the companies responsible for the success of last summer's Operation *Gaslight*—considered a major accomplishment in anti-missile research (m/r, July 14, p. 14). The company's field measuring crew on board the ship is expected to amplify and extend the *Gaslight* research.

One piece of equipment developed by Barnes for the *Gaslight* experiment was a meteor-type spectral camera using six individual cameras to attain a view of approximately 70° vertically and 100° horizontally. Other instruments included specially-designed radiometers.

The S.S. American Mariner project is sponsored jointly by the Advanced Research Projects Agency and the U.S. Army Ordnance Missile Command. Lt. Colonel Harry W. Stulting, of Redstone Arsenal, is the official Government representative on board the ship.

Information obtained by the scientific staff of the missile measurement ship will be shared by all branches of the Armed Services. Valuable information on missile firings from the Atlantic Missile Range will be contributed by the Air Force. Agencies participating in the planning and direction of this comprehensive missile and satellite measurement project include the Advanced Research Projects Agency of the Department of Defense, and the Army Rocket and Guided Missile Agency of the Army Ordnance Missile Command.

when and where

FEBRUARY

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

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

Conference for Manufacturing and Engineering Management, Computer and Data Processing in Industry, Purdue University, Lafayette, Ind., Feb. 12-13.

Heat Transfer Div. of American Society of Mechanical Engineers, Third Annual Symposium on Thermal Properties, Purdue University, Feb. 23-26.

1959 Engineering Exposition, Balboa Park, San Diego. For information, contact exposition office at 422 Land Title Bldg., San Diego. Feb. 26-Mar. 1.

MARCH

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

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

Second Western Space Age Conference and Exhibit, Great Western Exhibit Center, Los Angeles, March 5-7.

Western Space Age Conference and Exhibit. For information: Domestic Trade Dept., Los Angeles Chamber of Commerce, 404 South Bixel St., Los Angeles, March 5-7.

Gas Turbine Division of the American Society of Mechanical Engineers, Turbine in Action, Cincinnati, March 8-11.

Third Annual Shock Tube Symposium, Old Point Comfort, Ft. Monroe, Va. For details: Armed Forces Special Weapons Center, Kirtland AFB, Albuquerque, N.M. Attn.: SWRS R.R. Birnkoff, March 10-11.

American Society for Metals, 11th Western Metal Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, March 16-20.

The American Rocket Society, 1959 Sectional Meeting, Daytona Plaza Hotel, Daytona Beach, Fla., March 23-25.

Institute of Radio Engineers, National Convention, Coliseum and Waldorf-Astoria Hotel, New York, March 23-26.

Polytechnic Institute of Brooklyn's Ninth International Symposium, Auditorium, Engineering Societies Bldg., New York, March 31-Apr. 2.

Society of Automotive Engineers, National Aeronautic Meeting, Hotel Commodore, New York, March 31-Apr. 3.

APRIL

Conference on Electrically Exploded Wires, sponsored by the Thermal Radiation Laboratory of the Geophysics Research Directorate of the Air Force Cambridge Research Center, Somerset Hotel, Boston, Apr. 2-3.

1959 Nuclear Congress, Municipal Auditorium, Cleveland. For information: Engineers Joint Council, 29 West 39th St., New York, Apr. 5-10.

American Welding Society, 1959 Welding Show and 40th Annual Convention, International Amphitheatre and Hotel Sherman, Chicago, Apr. 7-10.

Air Force Association's World Congress of Flight, Las Vegas, Nev., Apr. 12-19.

American Society of Tool Engineers, Annual meeting, Schroeder Hotel, Milwaukee, Apr. 18-22.

American Rocket Society, Man-in-Space conference, Hotel Chamberlain, Hampton, Va., Apr. 20-22.

Institute of Environmental Engineers, 1959 Annual Meeting, LaSalle Hotel, Chicago, Apr. 22-24.

American Rocket Society, Controllable Satellites Conference, Massachusetts Institute of Technology, Cambridge, Apr. 30-May 1.

missile business

by Reed Bundy

Two major union leaders have warned that the missile and aircraft electronics industries may be headed for disaster unless they get the same minimum wage regulations the Government applies to the aircraft industry.

Al Hayes, president of the International Association of Machinists, and Walter P. Reuther, president of the United Auto Workers, told the U.S. Labor Department that "failure to include missiles and specialized electronics systems in the definition which will be used to establish a new minimum wage for the industry could seriously hurt the industry, its employes, and ultimately, our country's race for supremacy in missiles and space vehicles.

"It is entirely possible," they declared, "that a wrong decision by the Department . . . could demobilize many aircraft plants and throw scores of thousands out of work."

The IAM and UAW represent about 500,000 aircraft and missile workers. In this case, they have joined with the Aircraft Industries Association in asking the Labor Department to extend regulations under the Walsh-Healey Act—now covering aircraft manufacturers—to production of all missiles including electronic systems and subsystems used in missiles and aircraft.

House investigators are blaming the weapons system concept for what they consider unfair Pentagon treatment of small contractors. The Hebert Investigations Subcommittee of the House Armed Services Committee is expected shortly to begin a thorough probe of military procurement.

Rep. Carl Vinson (D-Ga.), chairman of the parent committee, says he's afraid there may be "too many loopholes" in the law. He reported that of five million contracts awarded by the Department of Defense last year, only 275,000 resulted from competitive bids. He wants a "tightening up" of the law to prevent so many negotiated contracts.

A committee spokesman said the coming investigation will take a hard look at what he called "soaring costs" under the weapons system procurement concept—and air charges that industry receives a virtual "guaranteed profit."

More than 50% of the dollars spent on missile systems go for ground support equipment, according to B. J. Meldrum, special assistant to the general manager of Chrysler's Missile Division. In a recent Detroit speech, Meldum said present missiles often are the simplest elements in their own systems. He said the picture will change, however, when solid and prepackaged liquid propellants are further developed.

An up-to-date list of missiles and missile contractors has been published by The Value Line Investment Survey, of New York. It shows 75 missiles, compared to 61 last July, and 59 prime contracting companies, compared to 45 six months ago. The investors concede that because of security regulations, the list is not necessarily a complete one.

The list carries the name of each missile accompanied by the manufacturers of its frame, powerplant and guidance system.

RCA has begun building a major missile and radar center at Van Nuys, Calif., and expects to begin moving in by late summer. The new facility, located on a 50-acre tract 15 miles northwest of Los Angeles, will include engineering, production and administrative buildings to handle RCA's growing weapons and radar business. The firm is prime contractor for the Air Force's BMEWS and holds a contract for the electronic check-out and launching system for the *Atlas*, under sub-contract to Convair.

Sylvania Electronic Systems, a Division of Sylvania Electric Products, Inc., will move late this month into a new 30,000-square-foot building in Waltham, Mass. The building will house the division headquarters and a new systems fabrication facility.

book reviews

ROCKET TO THE MOON by Erik Bergaust and Seabrook Hull, 270 pp., $5.95, D. Van Nostrand Company, Inc., Princeton, N.J.

A hard-hitting book written in absorbing journalistic style by two editors of MISSILES AND ROCKETS magazine. The first chapter especially is devoted to an examination of why we were not first in space. It presents the facts as the authors see them and they pull very few punches.

Most of the book, however, is devoted to the moon and to moon exploration. The authors do a very fine job of giving space to various competing theories concerning the origin of the surface features of the moon.

Moving away from the purely scientific controversies, it is on the question of the military value of the moon base where opinion again becomes dominant. Here the authors are careful to quote experts from both sides, from those who argue that the lunar base will be valuable for controlling the earth, and that we cannot afford to let anyone else establish a lunar base, all the way to the other point of view which denies that the lunar base would have any appreciable military value.

Since scientific exploration of the environment of the earth and of the lunar surface has to come first in any case, much of the book is devoted to a discussion of the problems that face us. There is an excellent and well-informed discussion on the rockets, followed by a chapter called "What's the Delay?"

Here again the authors state opinions on how a space program ought to be run. They illustrate very effectively and amusingly their point that much could have been done by now with available rockets; they manufacture an imaginary occurrence in which the "Cool-Cola Company" launches a rocket at the moon from a merchant ship in the Pacific using nothing but available commercial rockets.

This, the authors say, could have been accomplished in 1956. But actually the first attempt to send a vehicle close to the moon was made two years later in August, 1958. This exciting event is described in great detail and the reader feels that he is a spectator and participant.

All of this, plus the many quotations from authorities, make the book topical, exciting and controversial. The reader may not agree with every point of view put forth by the authors but he will have a hard time putting the book down once he has started.

Dr. Fred Singer

missile people

The National Aeronautics and Space Administration has appointed **Ernest W. Bracket** Director of Procurement and Contracting. NASA's laboratories will continue to let many of their own contracts, but Bracket will direct overall policy. He was formerly Contract Specialist and Consultant to the Director of Procurement and Production at Air Materiel Command Headquarters, Wright-Patterson AFB.

Dr. Wernher von Braun has received the nation's highest civil service award —the Gold Civil Service Medal. President Eisenhower made the award to the Army's ballistic missile expert for "brilliant leadership" in satellite and weapons programs. He told Von Braun: "We're proud of you."

Ten top scientists and engineers, have been selected by the staff of the Pacific Missile Range at Point Mugu to act as members of the Pacific Missile Range Advisory Committee. They will help PMR and Navy in Planning long-range objectives, functions, and capabilities, and in evaluating performance and progress. First meeting of the committee will be Feb. 18-20. **Dr. A. B. Focke,** Technical Director of PMR, will act as chairman. Committee members are: **Dr. W. R. Brode,** Science Advisor, Department of State; **Capt. Walter S. Diehl,** USN (Ret.), Consulting Engineer; **Dean William L. Everitt,** School of Engineering, University of Illinois; **Willy A. Fiedler,** Head of XN Development Technical Staff, Lockheed Aircraft Corp.; **Dean L. E. Grinter,** dean of Graduate School and Director of Research, University of Florida; **Dr. C. C. Lauritsen,** Professor of Physics, California Institute of Technology; **Dr. Fred C. Lindvall,** Chairman of the Division of Civil, Electrical and Mechanical Engineering and Aeronautics, California Institute of Technology; **Dr. Wm. B. McLean,** Technical Director, Naval Ordnance Test Station, China Lake, Calif.; **Capt. Grayson Merrill,** UNS (Ret.), General Manager, Fairchild Astrionics Division; **Dr. Royal Weller,** Vice President of Engineering, Stromberg-Carlson Co.

Several new assignments have been announced in the management of United Aircraft Corp.'s Research Department to expand work in basic research and the physical sciences. **Wesley A. Kuhrt** is chief of research activities; **Richard C. Molloy,** chief of technical operations; **George F. Hausmann,** chief research engineer; **Irving Twomey,** chief of test operations; **Stuart L. Crossman, Jr.,** chief of computational services, and **Arthur E. Wethebee, Jr.,** departmental services.

space age

by Norman L. Baker

Project Confusion—If U.S. progress in space development is measured by the number of projects, we are on our way. A pathetic facet of our mad dash in so many apparently uncoordinated directions is the confusion encountered in attempting to wade through the plethora of project names. For example: Project *Mercury* is the title of NASA's man-in-space (MIS) program. ARPA will experiment on its own with vehicles of Project *Discoverer* although ARPA and NASA are supposedly involved in a coordinated program. The flight of Gordo the monkey in the nose of a *Jupiter* IRBM, without a project designation, was apparently not an official experiment of either agency's programs. Yet the animal test is unquestionably an important phase of the overall man-in-space agenda. Project *SCORE* on the other hand is related to the experiments that will be conducted during the Project *Discoverer* program but seems to have been given a separate definition and task as a prestige afterthought.

Now it's projects within projects—Confusion's latest catalyst is the establishment of Project *Centaur*. Sponsored by ARPA, *Centaur* is the design, development and construction of an upper stage for the *Atlas* booster slated for incorporation in advanced phases of the *Discoverer* and *Mercury* programs and Project *Midas*. Project *Centaur* will also make it possible to send payloads the size and weight of *Lunik* (or *Mechta*) to the moon, Venus and Mars.

The recon satellite program meanwhile has almost lost its identity (perhaps intentionally) by its habitual designation switch. It began with the title of *Big Brother*, then went through such names as *Pied Piper, Sentry, Baby Sentry, Discoverer* and finally Project *Midas*—most ludicrous of all (Midas was the stupid, greedy, mythological king who was given the golden touch).

ARPA's big push—The United States' first mega-thrust-plus space vehicle, utilizing clustered *Jupiter* engines, has been designated *Juno V*. Reportedly with a cluster of 8-10 engines, it may be 23 feet in diameter and 72 feet long. Total thrust may be about 1.3-1.5 million pounds. Recovery of the booster would be attempted by parachute descent at sea. Propellant tanks would provide buoyancy after expulsion of propellant residue and automatic sealing of outlets.

First flights of animals and men in the *Mercury* program may be made in the nose of modified *Jupiters*. Short-range ballistic flights (similar to the Gordo experiment) reportedly are scheduled to start before summer. This program should follow closely the parameters selected for the earlier ABMA Project *Adam*.

Lunik **progress report**—On Jan. 15 the Soviet's artificial asteroid reached its perihelion. According to Russian calculations the vehicle was 90,914,400 miles from the sun after traveling 18.63 million miles from the earth. This places *Lunik's* closest approach to the sun inside the earth's orbital path and 585,600 miles nearer the sun than the first position calculations released by Russian scientists. *Lunik's* higher orbital velocity (approximately 20 miles/sec. for *Lunik* compared with earth's current velocity of about 18.7 miles/sec.) will, in a few weeks, swing it out beyond the orbit of the earth. (Correction of estimated *Lunik* data appearing in this column of Jan. 12: At *Lunik's* aphelion, Mars will be trailing the probe by approximately 105 degrees.)

An American astronaut has really projected his prognostications into the cosmos by hinting that perhaps the Russians will attempt to recover *Lunik's* payload, as physical proof of the achievement, at its next close approach to the earth sometime in 1964.

propulsion engineering

by Alfred J. Zaehringer

Ceramic reactors, now under design development, may play a big role in future *Kiwi* atomic rocket engine. This approach would, conceivably, allow an operating temperature of 3000-5000F—giving an I_{sp} in the 300-600 second range.

New fluorine oxidant, N_2F_4, is being suggested by Ethyl Corp. as a potent rocket chemical. More performance gains are seen to stem from oxidizers than from fuels.

Annular diffuser for ramjets, is the subject of a Navy patent for dumping boundary layer air to prevent uneven burning and consequent varying thrust. An annular scoop about the inlet diffuser vents the boundary air. Remaining "smooth" air goes straight through for combustion.

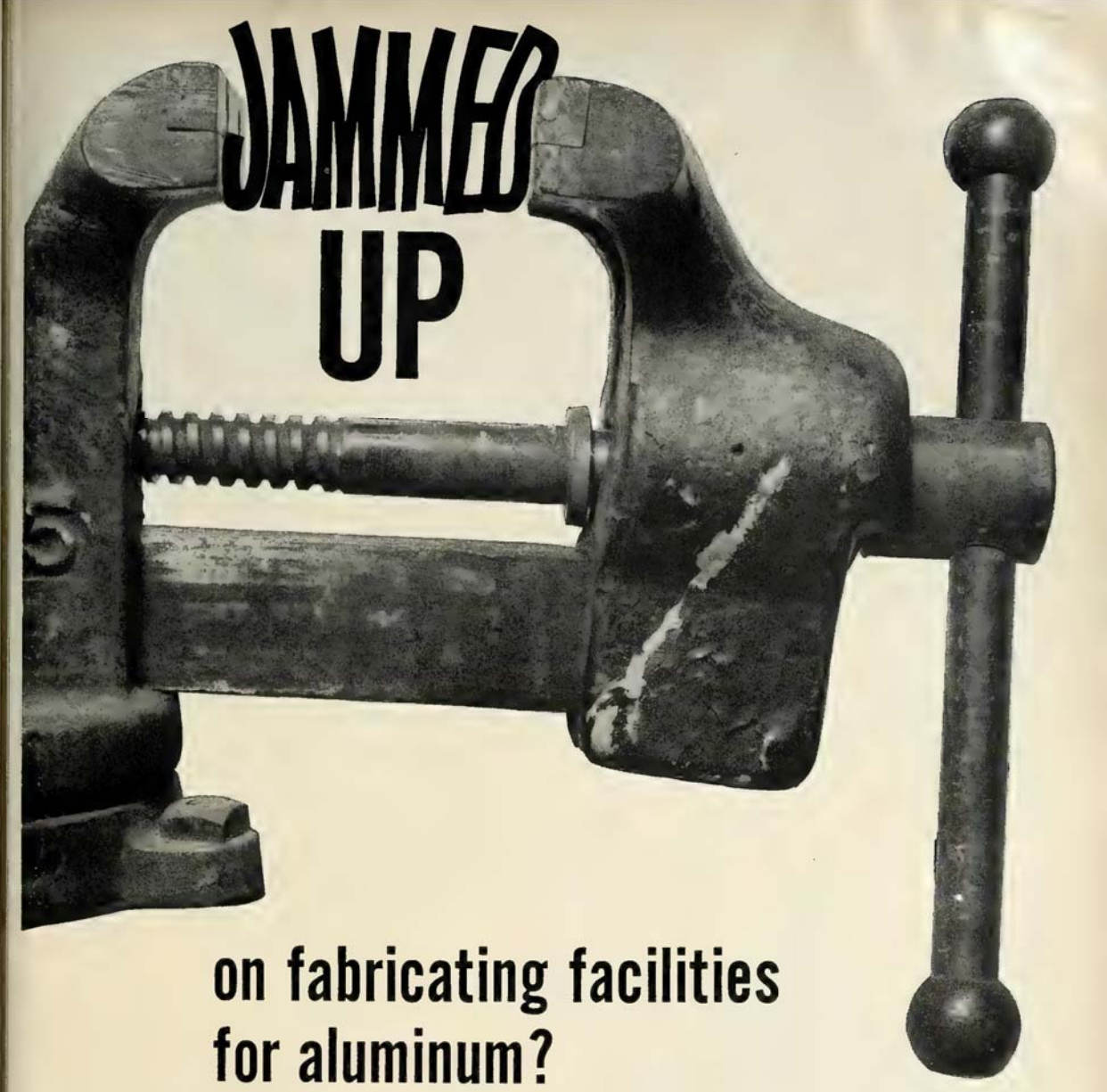
New "impossible" solid propellants will be shaping up. Farrington Daniels of the University of Wisconsin reports two new solid propellant possibilities. Both are based on the fact that solids can "store up" additional energy when bombarded by nuclear radiation. This energy, plus that released on regular chemical reaction, would be obtainable in combustion. Oxidant crystal solids could, thus, store more energy. Some crystals, for example, have had their energy content increased by over 100 calories per gram. Then, fuels such as graphite on neutron exposure could store up an extra several hundred calories per gram. Eventually, by such a radiation process, the energy content of a solid propellant could be increased 10-100% merely by irradiation. This, plus normal chemical energy would be released on combustion. If stability could be effected, present high energy solids in the 275 second range could be upgraded to 300 seconds. It is possible that the additional energy "kick" could be applied just before firing if large fluxes are obtainable. Such "hot solids" might even be able to compete with the exotic solids.

Aging of solid propellants has taken on a new importance with the coming operational models of *Polaris* IRBM and *Minuteman* ICBM. According to a Stanford Research Institute study, field replacement of the motor would be the optimum way to eliminate performance variations due to solid propellant aging. Design, thus, should allow for an easily replaceable motor.

Fuel-binders being offered by Goodrich Chemical Co. are based on "Estane" polyurethanes and "Hycar" (copolymer of butadiene and carboxylic monomer). Both castable and extrudable polymers are offered for solid propellant production. The urethanes contain over 26% oxygen and 7-9% hydrogen. The company maintains a composite solid propellant program at its Development Center at Avon Lake, Ohio with basic research being carried out at its Research Center in Brecksville, Ohio.

Continuous blender, called the Impingatron, looks good for certain solid propellant processing since it is designed for mixing a large amount of solid (oxidant) with a small amount of liquid (polymeric fuel-binder). A product of O'Brien Industrial Eqpt. Co., of San Francisco, the machine can handle 400 cubic feet of mix per hour. Solid particle sizes handled vary from micron range to 20 mesh.

Big business in small rockets. The Denver firm of Model Missiles reports that in less than one year, it has produced 200,000 of its Type A-4 solid motors that deliver one pound of thrust for one second. Other models are available.



on fabricating facilities for aluminum?

Let ALCOA'S JOBBING DIVISION Be YOUR Subcontractor!

WANT TO stretch your aluminum fabricating facilities, particularly during peak production periods?

THEN CALL on Alcoa's "custom-service for *manufacturers*"—the Alcoa Jobbing Division. From a single, tiny component to the most complex subassembly, consider Alcoa's Jobbing Division for any part of an aluminum fabricating job. In the field of aircraft and missile components, especially, Alcoa's facilities and experience are unmatched anywhere in the world.

COST . . . ? Frequently *less* than your own cost-accountants would report for a do-it-yourself job. For Alcoa *already* has the major facilities for production—plus the facilities and skills for tooling-up at rock-bottom costs.

WANT TO know more . . .? Write Aluminum Company of America, 2029-B Alcoa Building, Pittsburgh 19, Pa., for 16-page booklet on the available facilities of Alcoa's Jobbing Division. Facilities at *your* service . . . for welding, rolling, brake-forming, bending, spinning, finishing, testing and other services. You'll be surprised how much Alcoa can help you *lighten* your load!

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Your Guide to the Best in Aluminum Value

Watch "ALCOA THEATRE" Alternate Mondays NBC-TV
"ALCOA PRESENTS" Every Tuesday ABC-TV

contract awards

ARMY

$13,000,000—**Sperry Rand Corp.,** Salt Lake City, for missile.

$9,000,000—**Sperry Rand,** for missile R&D.

$3,795,730—**North American Aviation, Inc.,** Canoga Park, Calif., for design and development (three contracts).

$2,383,173—**Thiokol Chemical Corp.,** Redstone Div., for unspecified number of improved *Sergeant* solid propellant rocket motors. (Contract awarded for NASA.)

$947,640—**California Institute of Technology,** for research and development (two contracts).

$910,000—**Waltham Precision Instrument Co.,** Waltham, Mass., for instruments.

$585,000—**North American Aviation, Inc.,** for rocket engines.

$442,072—**Firestone Tire & Rubber Co.,** Los Angeles, for repair parts.

$296,435—**General Electric Co.,** Phoenix, for computation facility operation.

$143,033—**Dale Products Inc.,** Albuquerque, N.M., for testers.

$127,580—**Interstate Electronics Corp.,** Anaheim, Calif., for transponders.

$120,818—**Douglas Aircraft Co., Inc.,** Santa Monica, for repair parts.

$97,955—**J. A. Jones Construction Co.,** Atlanta, for demolition and steel piling for static test tower modification at Redstone Arsenal.

$69,633—**Gilfillan Bros., Inc.,** Los Angeles, for repair parts.

$62,886—**Heat Exchangers, Inc.,** Chicago, for testers.

$49,541—**Ampex Corp., Professional Products Div.,** Redwood City, Calif., for tape recorder.

$32,042—**Todd Shipyards Corp.,** New Orleans, for cylinder assemblies.

AIR FORCE

$710,210—**Boeing Airplane Co., Pilotless Aircraft Div.,** for technical data for *Bomarc* components, (13 contracts).

$297,672—**Union Carbide Corp., Linde Co. Div.,** New York, for liquid oxygen.

$200,000—**Harvard College,** for mathematical research and computation.

$197,713—**Northrop Aircraft, Inc., Northrop Div.,** Hawthorne, Calif., for rocket mission evaluators, and data.

$163,062—**Ampex Corp.,** Redwood City, Calif., increase in funds.

$109,506—**Sundstrand Machine Tool Co.,** Rockford, Ill., for transmission assemblies, frequency and load controllers and data for support of the *Snark*.

$104,712—**University of Alaska,** College, Alaska, for studies on the tracking of artificial earth satellites.

$43,000—**Harvard College,** for research toward investigation of solar phenomena.

NAVY

$1,785,234—**Babcock Radio Engineering, Inc.,** Costa Mesa, Calif., for transmitters, test harness and related equipment.

$1,221,486—**Radiophone Co., Inc.,** Monrovia, Calif., for telemetric data recording sets.

$674,725—**Temco Aircraft Corp.,** Dallas, for acquisition and installation of test facilities for the *Corvus*.

$513,935—**DuBrow Development Co.,** Burlington, N.J., for telemetric data receiving sets.

$269,500—**Collins Radio Co.,** Cedar Rapids, Iowa, for communications equipment, handbook and test bench harness.

$254,377—**McKiernan-Terry Corp.,** Harrison, N.J., for launching cylinder sealing strips.

$250,000—**The Gabriel Company, Electronics Division,** Needham Heights, Mass., for omnidirectional UHF drone command antennas.

letters

Lunik Errors

To the Editor:

In your article *"Lunik* becomes Solar System's Tenth Planet," you have some very important errors that should be corrected. You say "seven and one-half months from now *Lunik* will be somewhere between the orbits of Mars and Jupiter in the asteroid belt," and "at the aphelion of its 15 month orbit it will be 214.75 million miles out from the sun and about 120 million miles from the earth." None of these statements are true. *Lunik* will never go beyond the orbit of Mars into the asteroid belt. According to the latest data on the orbit it will have an aphelion of approximately 122.54 million miles.

Robert Citron and John Porter
Space Flight Committee
Pacific Rocket Society
11950 Allin St.
Culver City, Calif.

To the Editor:

In the article *"Lunik* Becomes Solar System's Tenth 'Planet'," Jan. 12, 1959 issue, the values given for the perihelion and aphelion distances and the period of *Lunik* are not consistent. The given perihelion and aphelion distances of 91.5 and 214.75 million miles represent a semi-major axis of 1.65 au. An application of Kepler's harmonic law gives a period of 770 days for the vehicle, rather than the stated 447 days.

Also, the random usage of "perigee" and "apogee" is disturbing. These as you are aware, apply strictly to geocentric orbits, whereas perihelion and aphelion apply to heliocentric orbits.

Paul E. Koskela
Aeronutronic Systems, Inc.
1234 Airway
Glendale, Calif.

You are both right. An early Tass report of the diameter of Mechta's orbit of 214.75 million miles was misquoted as the aphelion of the man-made asteroid. Deadlines prevented the editors from correcting the error. (See Space Age, Jan. 19, p. 29).

How Many Moons?

To the Editor:

As a subscriber and supporter of your publication, I must take issue with the editorial in your Dec. 15 issue. This is a piece of emotional writing which blithely ignores facts and is guilty of misrepresentation, either by direct statement or through innuendo.

1. The United States has placed three satellites in orbit, not two.

2. The planned program suggested in the editorial is virtually the exact program now being followed.

3. The editorial contradicts itself by stating, in the final paragraph, that there is no one agency through which all projects clear. A previous paragraph states that the National Space Council decides on which space projects shall be attempted, and in what priority . . . There is no gain saying the fact that we have a definite governmental space organization—NSC at the head, with sub-divisions for military (ARPA) and civilian (NASA) projects.

I would like to point out that "space" is not a magic word—merely an extension (with some changes) of the medium through which we've been flying for some 55 years. While control of space by any one nation (if this is possible) is a serious matter, it wouldn't necessarily be a decisive military factor . . .

Leon Cooper
Space Technology
Laboratories, Inc.
Los Angeles

We're both wrong. At the time of writing it was four satellites—Explorer 1, 3, 4 and Vanguard.

Nuclear Rockets

To the Editor:

The Missiles and Rockets report of Soviet nuclear rocket development was very interesting, but credibility would be improved if you could state the sources of your information and obtain further details.

In the same article a minor faux pas occurred when the schematic drawing of the AEC's *Kiwi-A* nuclear rocket showed it firing horizontally, whereas the actual photograph indicates clearly that the Rocketdyne-built nozzle exhauts vertically upward.

In "Propulsion Engineering," on Jan. 5, two errors apparently "crept in." First, the University of Heidelberg would obviously not use a fission reactor as a source of beta particles for its experiments on magnetic focusing of beta particle jets. Second, the estimate of fuel costs for an airborne reactor system of $250-500 million for an initial mass of 35-65 pounds must have assumed a cost per pound of V-235 about 1000 times higher than the official AEC rate.

Despite such occasional slips, m/r has a generally excellent record for being accurate and informative.

W. C. Cooley
20553 Parthemia St.
Canoga Park, Calif.

The schematic of Kiwi-A was prepared some months previously, but we decided to use it anyway even though it was firing horizontally. The University of Heidelberg tells us this is the case, and Russian documents—although perhaps outdated—did give that cost estimate.

Livable Planets

To the Editor:

The article entitled "One Hundred Million Habitable Planets in Universe" by George Rhodes, Special Correspondent in a recent issue was extremely interesting. May I please have further information on the availability of Doctor Calvin's study.

John A. Laansma
Flint, Mich.

The study was undertaken for the Atomic Energy Commission.

Optical Guidance

To the Editor:

Raymond M. Nolan in his "Astrionics" column in the Dec. 29 issue mentions speaker reference to optical line-of-sight guidance to parallel inertial guidance in space travel.

Could you please supply me with the name of the speaker, title and date of the speech, and the proper contact to write to for a copy of this paper? Perhaps you could supply me with a copy?

George Lawrence
Scientific Apparatus Makers Assn.
Washington, D.C.

Copies of the speech available from Parks Air College, St. Louis University, E. St. Louis, Ill.

Regulus II Facts

To the Editor:

Regarding your Washington Countdown in the Jan. 12 issue, Mach 2 *Regulus II* not only is America's only supersonic airbreather, but with altitude operating capabilities in excess of 60,000 feet it far exceeds *Mace* in altitude as well as speed.

John J. Johnson
Chance Vought Aircraft, Inc.

A double check of the services resulted in a statement by Navy spokesmen that Regulus II has an operating altitude of 60,000 feet, while Air Force officials gave no precise figure but said Mace's operating altitude is in excess of 35,000 feet.

Operations Research

Mathematicians, Physicists and Engineers with experience or strong interest in Operations Research on large-scale automated systems will be interested in the major expansion program at System Development Corporation.

SDC's projects constitute one of the largest Operations Research efforts in the history of this growing field. The projects are concerned primarily with man-machine relationships in automated systems in a number of fields, including air operations. The application of new and advanced digital computer techniques is particularly important in optimizing these man-machine relationships.

Senior positions are among those open. Areas of activity include: Mathematics, System Analysis, Forecasts, Cost Analysis, Operational Gaming, Design Analysis, Performance Evaluation.

Those who have professional questions or desire additional information are invited to write Dr. William Karush, Head of the System Development Corporation Operations Research Group at 2414 Colorado Avenue, Santa Monica, California.

"Method for First-Stage Evaluation of Complex Man-Machine Systems"

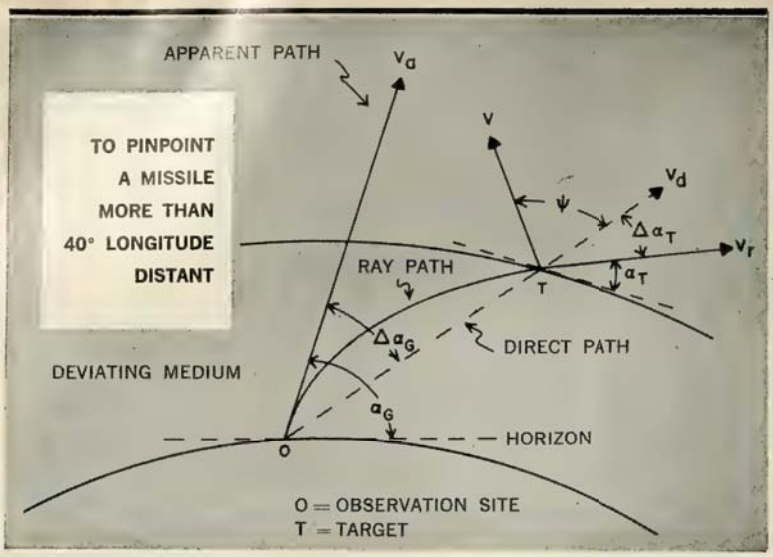
A paper by I. M. Garfunkel and John E. Walsh of SDC's Operations Research Group is available upon request. Address inquiries to Dr. William Karush at System Development Corporation.

SDC

SYSTEM DEVELOPMENT CORPORATION

Santa Monica, California

11-72F



Engineering Opportunities of a High Order in Creating Complex Identification & Tracking Equipments at General Electric's Missile Detection Systems Section

To locate a 15,000-mph missile despite complicating factors such as the varying refractive index of the troposphere and ionosphere, a high degree of systems sophistication is of paramount importance.

Growth opportunities commensurate with the creative and analytical demands implicit in such requirements are open now for experienced electronic engineers at G.E.'s Missile Detection Systems Section in these areas:

- Research & Development of New Detection Techniques
- Initiation & Development of Proposals
- Definition and Direction of Equipment Design
- Engineering Liaison with Military & Engineering-Manufacturing Sub-Contractors

Positions at Several Levels for Electronic Engineers

SYSTEMS DEVELOPMENT ENGINEERING
(At least 4 years' experience)

RADAR SYSTEMS
SYSTEMS ANALYSIS
DATA ANALYSIS
ELECTRONIC COUNTERMEASURES SYSTEMS

SYSTEMS EQUIPMENT ENGINEERING

ANTENNA DESIGN AND DEVELOPMENT
RF COMPONENTS DEVELOPMENT
UHF AND MICROWAVE RECEIVER DEVELOPMENT
DATA REDUCTION EQUIPMENT D & D
VIDEO DISPLAY DEVELOPMENT
COMPUTER APPLICATIONS

Salaries fully competitive, commensurate with experience
Write in confidence to Mr. James P. Kinsella, Div. 43-WE

Missile Detection Systems Section
HEAVY MILITARY ELECTRONICS DEPT.

GENERAL ELECTRIC

Court Street, Syracuse, New York

Advertiser's Index

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

REGIONAL OFFICES:

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

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

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

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

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

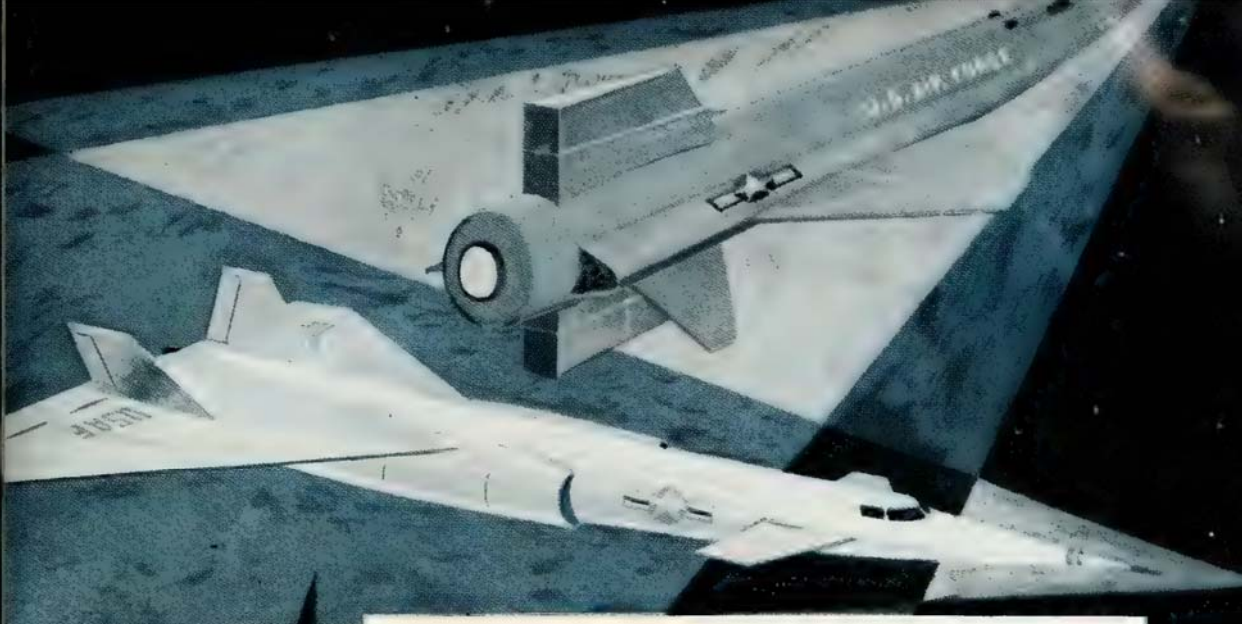
Florida: 208 Almeria Ave., Coral Gables, Fla. Richard D. Hager, advertising sales representative. Phone: Highland 4-8326.

Canada: Allin Associates, 12 Richmond Street East, Toronto 1, Ontario. Phone: Harbour 6898. Allin Associates, 1487 Mountain St., Suite 4, Montreal, Que.

Geneva: American Aviation Pubs., 10 Rue Grenus, Geneva, Switzerland. Anthony Vandyk, European Director. Cable address: AMERAV GENEVA.

London: Norall & Hart Ltd., 28 Bruton Street, London W. I., England. Phone: Grosvenor 8356.

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



HIGH-SPEED GEAR PUMPS
FOR THE NEXT GENERATION
OF AIRCRAFT · MISSILES · SPACECRAFT

High performance hydraulic pumps by Eastern are uniquely suited to the exacting operating requirements demanded in the craft of tomorrow.

Check these Eastern gear pump features — do they suggest a solution to your present design problem?

Small size: Eastern gear pumps are the smallest, lightest made. Airborne servo system pump shown delivers 1.5 gpm @ 1500 psig — measures only 1⅞" X 1⅞" X 2¾", weighs 9 oz.

Wide performance range: pumps available have theoretical displacements from .0016 to .0419 cu. in. per revolution — flow from .025 to 2.0 gpm, pressures from 0 to 2000 psig, at speeds to 24,000 rpm. Weights with motor range from 1.5 to 8.5 lbs.

Unaffected by extreme environments: rugged, reliable Eastern units take loads to 50g in stride — shrug off temperature differentials to meet MIL specs.

Flexibility, economy: mass-produced components can be teamed into the precise configuration you need. Creatively-engineered custom pumps also available.

Contact Eastern for creative contributions to help you solve your hydraulic pump or power problems. Write for Bulletin 360 — your complete new guide to Eastern aviation products.

Eastern AVIATION PRODUCTS

EASTERN INDUSTRIES, INC.

100 SKIFF STREET • HAMDEN, CONN.

West Coast Branch Office: **1608 Centinela Ave., Inglewood 3, Calif.**

HYDRAULIC POWER • ELECTRONIC COOLING • REFRIGERATION-TYPE COOLING • PRESSURIZATION-DEHYDRATION • SERVO-VALVE HYDRAULIC SYSTEMS •

Which of these nuts meets YOUR *requirements*

This chart shows the most used NAS standard and special, low-height, lightweight, self-locking nuts. All meet Specification MIL-N-25027(ASG). Series numbers of the alloy steel, 550° F. nuts are shown in bold face type; series numbers of the CRES, non-magnetic, 900° F. nuts, are shown in light face type.

HEX

96
97

196

FLOATING CLINCH

TIMESAVER

13680

FIXED ANCHOR

12600
12700

12610
12710

12620
12720

15600
15700

15610
15710

15620
15720

FLOATING ANCHOR

TIMESAVER

13600
13700

TIMESAVER

13610
13710

TIMESAVER

13620
13720

TIMESAVER

136R
137R

FLOATING SPACER

TIMESAVER

13601
13701

TIMESAVER

13611
13711

TIMESAVER

13621
13721

MINIATURE ANCHOR

MA12600
MA12700

MA12610
MA12710

MA12620
MA12720

MA12640
MA12740

MINIATURE FLOATING

M13600
M13700

M13601
M13701

M136R
M137R

SELF SEALING DOME

14630H

14633H

14634

14650H

M14630H
M14730H

GANG CHANNEL

TIMESAVER

C136
C137
PLAIN

C1363
SELF-ALIGNING

CN1463H
SELF-SEALING

Detailed information on all nuts shown here is contained in Nutt-Shel's LIGHTWEIGHT NUTS brochure.

Write for it.

Nutt-Shel
An SPS Company

2701 South Harbor Boulevard
Santa Ana, California
Telephone Kimberley 5-9311