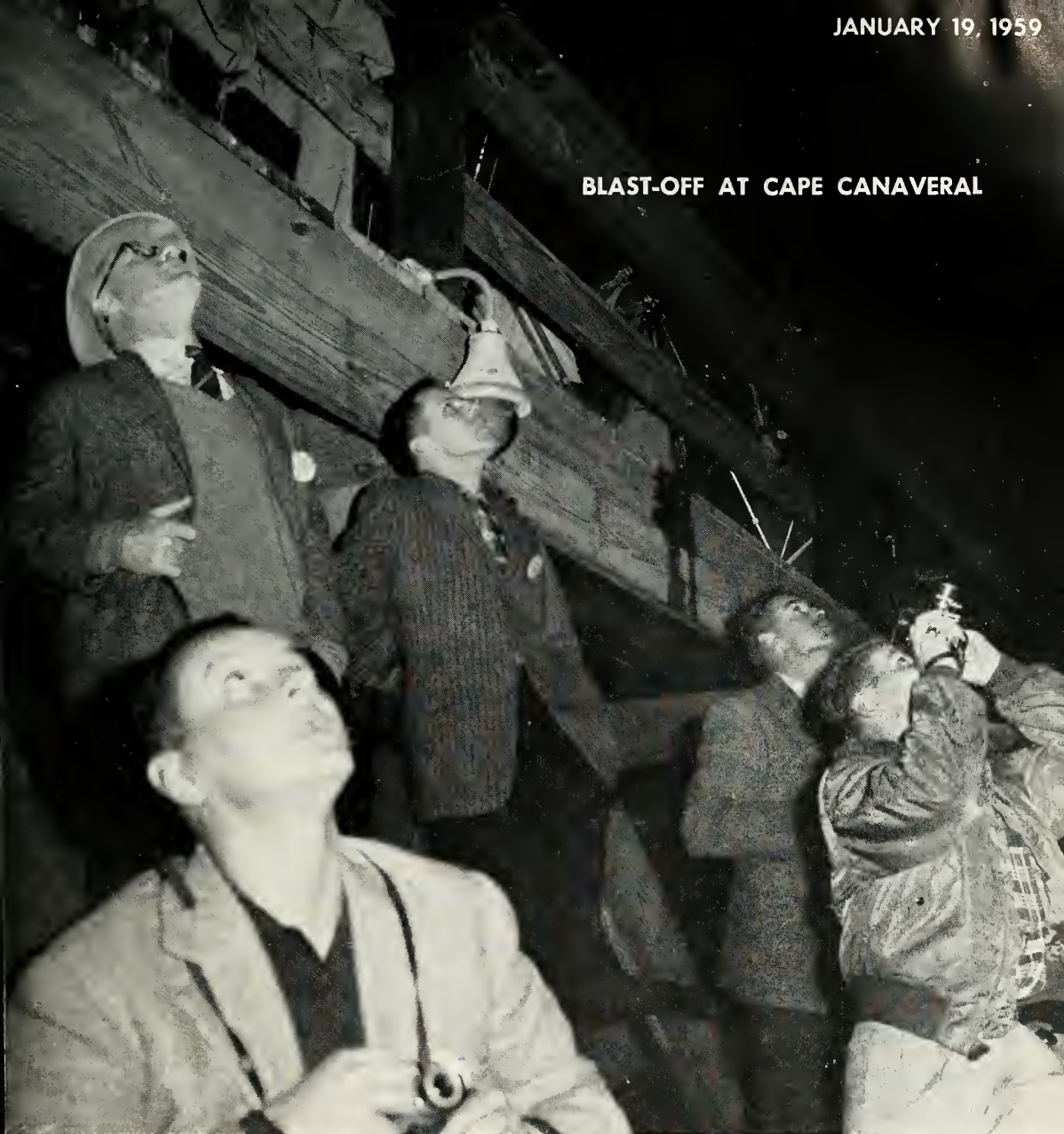


BLAST-OFF AT CAPE CANAVERAL



missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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missiles and rockets, January 19, 1958

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS



COVER: Biggest "rubberneakers" at Canaveral missile firings are the newsmen. (See p. 18)

JANUARY 19 HEADLINES

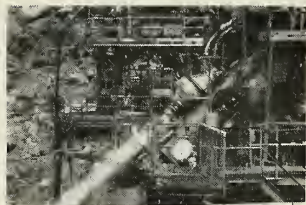
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UNDERGOING TESTS at Rocketdyne using conventional fuels is *Kiwi-A*, part of *Rover* program.



THIS GADGET is providing new measurement techniques at Martin for gyro drift. (See p. 22)

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Lockheed Space Station Interesting Government Agencies

Satellite laboratory could be in operation in 10 years; Cost estimate is put at \$2.163 billion19



TUGS AND taxis are part of Lockheed's proposal for manned space laboratory. (See p. 19)

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RADAR SYSTEM for *Nike-Zeus* will require this mammoth ball bearing, supporting million lbs.

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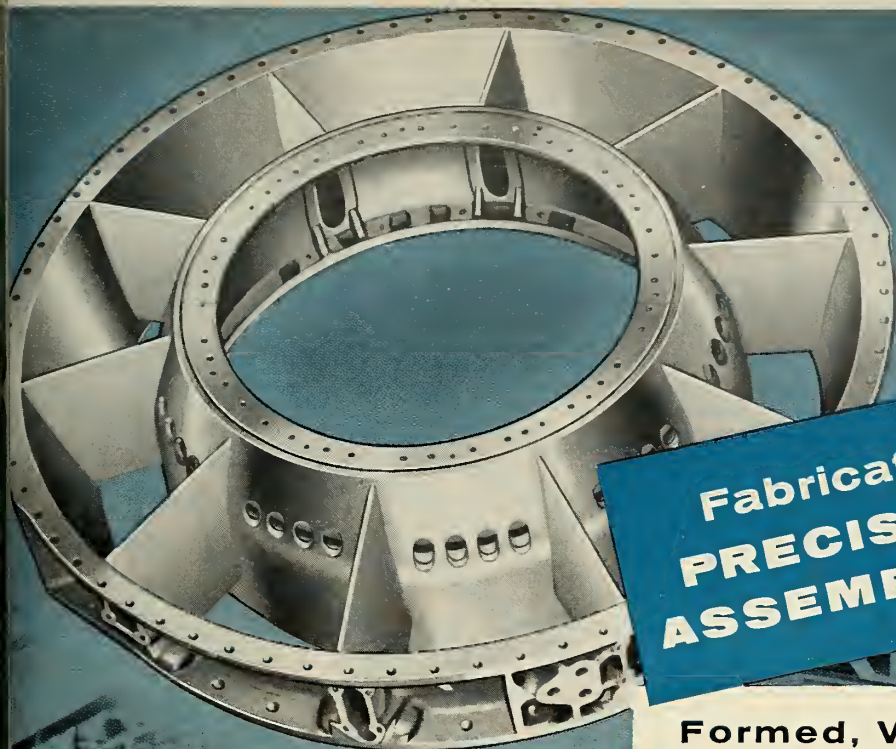
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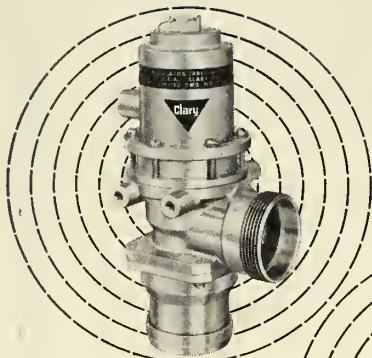
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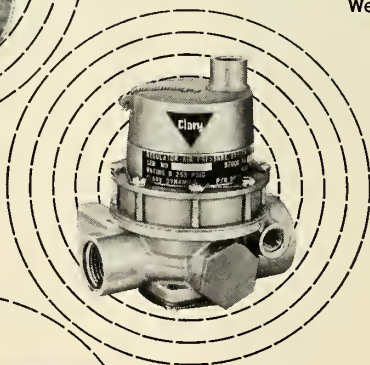
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In My Opinion . . .

. . . members of the 86th Congress must familiarize themselves with some rough and basic problems before they start legislating and politicking in the areas of space flight and missiles. It is gratifying that the House Select Committee on Astronautics and Space Exploration understands the importance of the military aspects of space flight, stressed in the recent RAND Corporation Report. Certainly, it is gratifying that the Committee sees fit to endorse the report, which disagrees with published opinions of some "experts" and flatly declares that satellites can be used as bombing platforms and weapon carriers and that nuclear bursts can be effective in space.

It is only to be expected that members of the House and Senate committees during the past year were able to learn a bit about astronautics. But how much time were other legislators able to devote to the subject? In the end, their opinions will decide the destiny of this country. These representatives—just like every man and woman in the country—must take the time necessary to fully grasp the scope of the missile and space age.

It is particularly important that members of the new Congress learn about the urgent need for boosting and streamlining our current and active missile programs, and how these programs fit into the total defense pattern. This is not an easy task; it puzzles the most competent experts in the Department of Defense. Duplication of efforts in some missile programs is wasteful, in others it is useful. Some research and development programs lead our missile builders nowhere, other research shows them the road to advancement and success. Certain missiles are advanced enough to merit stepped-up production; other missiles should have been cancelled long ago.

Our lawmakers cannot be expected to familiarize themselves with all of our missile systems. But they must be expected to seriously study the "big ones," which represent billions of dollars every year and are weighing factors in the shaping of overall defense strategy.

Perhaps the greatest danger in judging the feasibility of these missile systems—the IRBMs and the ICBMs—is that so many of us tend to jump to conclusions when a single one of these missiles is fired or misfires. In the wake of the first "unsuccessful" tests of the *Titan*—which followed our glamorous propaganda satellite, the *Atlas*—we have heard many so-called experts call for cancellation of the *Titan* program. This attitude is not only immature, it is downright dangerous. The *Titan* program, in its present accelerated status, is very promising. A recent tour of *Titan* development facilities has proven this to us. The *Titan* program is in high gear and must be continued.

Finally, members of Congress should take time out to study the feasibility of the *Polaris* program—another advanced weapons system which does not have the support it deserves. *Polaris* is just as advanced as *Titan*—perhaps further advanced. And the concept itself is the most advanced of all long-range missile systems. This program must get more financial support from Congress. We have programmed less than half the amount of submarines needed to make the *Polaris* weapons system completely global and self-sustained as a complete deterrent if other forces become inadequate or paralyzed by instant attack. It takes very little expert knowledge of missilery to understand the importance of pushing both *Titan* and *Polaris*—in addition to *Atlas*, *Minuteman*, *Jupiter*, *Thor* and *Pershing*.



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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.

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MISSILE DIVISION 
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washington countdown

Contract for Dyna-Soar . . .

may be awarded around April 1—three months in advance of original July 1 target date—because of good preliminary work by the competing teams, Martin and Boeing.

Competition is keen . . .

on the *WS-199* air-launched ballistic missile under feasibility test. Martin's two-stage solid has been launched 1000 miles from B-47. Lockheed's single-stage version reportedly has gone 230 miles. Former is touted as adaptable for B-47, B-52, B-58 and C-135. Latter, for high-altitude aircraft such as B-58, reportedly could be available within two years. Air Force may give go-ahead within 30 days.

DOD missile management . . .

may be investigated by the House Government Operations Committee. The probe is prompted by AF's refusal to surrender its Inspector General's investigation of ballistic missile program management.

Nixon disagrees . . .

with the House Space Committee's estimate that the Soviet Union has a 12-to-18-month lead in space development. The vice-president was quoted as saying we are ahead in missiles and catching up fast in other phases. But Sen. Stuart Symington (D-Mo.) challenged Nixon to furnish comparative percentages on USSR/U.S. missile strength. Symington also charged that DOD has no intention of releasing funds voted this fiscal year for *Minuteman* and *Hound Dog*.

The Polish People's Republic . . .

is reported to have successfully launched an experimental rocket weighing 9.6 lbs. It was approximately 32 inches long and 2.5 inches in diameter, utilizing 2.2 lbs. of solid fuel. Launching was made from an inclined ramp about 10 feet long at an angle of 80°. Tracking was by theodolite located at three points. A report also indicates that Polish scientists are testing the first stage of a meteorological rocket.

Upper stage for Atlas . . .

probably will utilize hydrogen and oxygen in P&W's development. Convair last week received contract to develop and build the upper stage. Development time of engine

and the stage probably will be in excess of two years, but should give satellite orbital capability of several thousand pounds under ARPA's *Discoverer* program.

Soviets made certain . . .

there would be no question as to who launched the first space vehicle if the pieces are ever found. The *Lunik* rocket carried a sphere of pentagonal segments marking it as USSR property and noting the launching date. If the sphere strikes something, it will break into smaller fragments, each bearing USSR inscriptions.

Resignation of Dudley Sharp . . .

Assistant Secretary of Air Force for Materiel, effective Jan. 31, does not mean USAF will abolish this office under the reorganization of DOD. The duties of another assistant secretariat probably will be divided between a colleague and the under secretary.

When news leaked . . .

about the Air Force requesting seven additional *Titan* squadrons, the USAF legislative liaison office was the whipping boy. Colorado congressmen (the *Titan* is assembled at Denver) thought they should have made the announcement. The money, incidentally, is very likely to be appropriated despite possible DOD and Budget Bureau objections.

Training to snatch satellites . . .

out of the air is the USAF 6593 Test Squadron flying Fairchild C-119s out of Hickam AFB, Hawaii. Led by Maj. Joseph C. Nellor, the squadron is practicing two techniques: capturing the satellites (first *Discoverer* and later *Mercury*) as they float-down by parachute; and pinpointing the descending vehicles for recovery by helicopter or seacraft.

Sparrow III carries warhead . . .

50% more powerful than any other air-launched guided missile, Navy says. Other vital statistics of Raytheon missile include 1500 mph speed, average range of five miles and all-weather capability.

Fly in the ointment . . .

delaying transfer of Chincoteague Naval Air Station to NASA is Sen. Harry F. Byrd (D-Va.). Byrd is concerned about his 760 constituents employed at the 2,340 man Naval base who will be out of jobs.

**Air Force
"Sunday
Punch"**

ATLAS



Boosted into space by the fiery thrust of three huge rocket engines, the seven-story Atlas intercontinental ballistic missile roars upward from its Cape Canaveral launching pad. Quickly it sheds the frost encrusting the liquid oxygen tank and races to its predetermined destination in the far reaches of the globe. In its size and range and capability, the Air Force Atlas is a

commentary, for all the world to heed, of the necessity to maintain the peace. RCA's Missile and Surface Radar Department has been privileged to design and develop ground check-out, launch control and cabling equipment as a major subcontractor to Convair (Astronautics) Division of General Dynamics Corporation, the Atlas prime weapons systems contractor.



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CAMDEN, N. J.

industry countdown

Lockheed's latest contract . . .

will continue flights of the X-7 ramjet test vehicle through 1959. The contract may be in excess of \$8 million when it is finalized sometime next month. The X-7, equipped with one Marquardt ramjet similiar to the one used on the *Bomarc*, is testing components that will be used on advanced interceptor missiles.

Silica Gel has proven . . .

to be a versatile chemical in several space experiments. The desiccant or drying agent, produced by W. R. Grace & Co., Davison Chemical Div., reports that it has been used to maintain favorable conditions for animals sent into space, and to protect mechanisms prior to launching. For example, STL reportedly used the gel to absorb respiratory moisture in the mouse capsule in the *Thor-Able* flights. Martin reportedly is using about 35 pounds on each *Vanguard* for protection of components.

An air gage tracer lathe . . .

built especially for the missile and space industry, will be delivered this week to Diversey Engineering Co. With a swing of 86 inches and 25 feet between centers, the lathe reportedly is capable of handling the largest rocket motors—*Polaris*, *Pershing* and *Minuteman*. Lathe could handle, with modification, Diversey said, diameters in excess of 10 feet.

Johns Mansville has made its bid . . .

as major competitor in the expanding fiber glass industry by acquiring L.O.F. Glass Fibers Co. of Toledo. The new division, a research, development and production facility, will take the strain off seven plants now operated by Johns-Manville. Current J-M glass sales are \$25 million a year, in addition to normal sales of other products of more than \$300 million annually.

Subroc motor . . .

will be designed and developed by the Eltkon Div. of Thiokol Chemical Corp. The subcontract from Goodyear, is reported to be slightly under \$5 million, and will include loading and firing of test units. *Subroc* may be fired from above or below the surface, will detect submarines at long range, compute their course and speed, and will set an intercept course.

Billion dollar year . . .

has been forecast for Lockheed Aircraft Corp. in 1959. With net earnings 10 percent above last year's level, the company expects a broader participation in the missile and space market than in 1958. Almost 3000 of Lockheed's employees are working in fields directly related to missiles and space.

First shipment of *Honest John* . . .

rockets for the West German armed forces are now being installed for training purposes. The training versions of the Douglas-Emerson Electric missile will be equipped with cement warheads. U.S. forces will retain possession of the atomic warheads.

Busy economy axe . . .

penetrated the R&D program of the *RAT* anti-submarine missile with cancellation of the program at the end of existing contracts. Librascope, Inc., developers of fire control and providing over-all management, and Cle vite, developer of the torpedo, after completing a Navy award of \$15 million, will not have their R&D contracts renewed.

Modification of ABMA's . . .

12-story-high vertical test stand is underway by Jones Construction Co., of Atlanta. The change is designed to accommodate the 1,300,000-lb.-thrust Rocketdyne cluster of *Jupiter* engines. The construction firm's \$97,954 contract calls for dismantling, demolition work, and driving of piling.

"Worth their weight in gold . . ."

is the way President Eisenhower described "certain bombers"—later identified as the B-58 Hustler, in his State of the Union message. At the current rate of production, the B-58, weighing in at 47,000 lbs., costs \$26.7 million or about \$567 per pound. Gold costs about \$500 per pound.

About \$35-million per copy . . .

is what the President figures *Atlas* will cost, "on the firing line." Air Force spokesmen, however, estimated the cost at \$20 million each, including ground support equipment, and its off-the-shelf cost at \$2 million.



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RAND Report Should Guide 86th Congress

Soviet space lead estimated at 12 to 18 months; U.S. will require 5 years to catch up, Congress told. Report says satellites can be used as bombers and atomic explosions can be effective in outer space.

by Paul Means

WASHINGTON—The "Space Handbook" drawn up by RAND Corp. as a man's guide is likely to find use also as a blueprint for an 86th Congress anxious to expand and speed up America's space effort.

The document, released by the House Select Committee on Astronautics and Space Exploration, envisions attempts at landings on the moon, Venus and Mars, and manned satellites orbit around the earth within the next five years—using modifications of present missile hardware.

It flatly disagrees with published opinions of other experts and declares that satellites can be used as bombing platforms and that atomic bombs can be effective in airless outer space.

In the last, busy week of its existence, before being replaced in the new Congress by a Standing Committee on Space and Astronautics, the select group took two other actions underlining the urgency of the picture.

It issued a final report saying among other things that the Soviet space lead appears to be from 12 to 18 months—and that it will take the U.S. five years to catch up.

And it released a statement by Chairman John W. McCormack (D-Mass.) warning that "we can't afford to have a Pearl Harbor in outer space . . ."

• **Definitive work**—The RAND report, which the Committee will send the nation's high schools and interested educational institutions, is one of the most definitive treatises on space technology and applications yet to appear in lay language.

The 225-page document breaks down space technology into 17 areas, with extensive studies of space environment, trajectories and orbits, vehicles, propulsion and propellants, guidance, communication, observation, landing and recovery, space stations and extra-

terrestrial bases, and the effects of nuclear weapons in space.

It also applies present technology to the problems of orbiting and instrumenting observation, meteorological, navigation, communication and bombing satellites. It attempts to define the immediate possibilities of scientific space exploration.

• **Hardware exists**—By modifying present missile hardware, the report asserts, the U.S. can orbit satellite payloads of 10,000 pounds at 300-mile altitudes, or 2,500-pound payloads at 22,500-mile altitudes.

It says the same hardware can also land, intact, 1,000 pounds of instruments on the Moon, Venus and Mars, probe the atmosphere of Jupiter with the same payload and place a manned satellite around the earth, recoverable after a few days of flight.

Present hardware requires "additional work of a very substantial nature, the report warns, but "with diligence and reasonable luck, the overall rocket machinery necessary to attempt any of these flights could be available in a few years—probably less than five."

Within the next five years, new engine developments "should" allow us to "look forward to the day when the payloads listed above will be five to 10 times greater," the report said.

RAND'S handbook asserts that a bomb shot from behind a 350-mile-high satellite with a velocity of 1,000 feet per second—the approximate speed of a 75-mm field gun's shell—will cover a distance of 6,300 miles.

It claims that guidance under these conditions would be no more difficult than that with the surface-launched ICBM, except that exact location of the satellite would be necessary.

The advantage of satellite-bombers, according to the report, is that they could be launched under favorable conditions long before they are needed.

Multi-megaton nuclear bombs which produce sufficient radiation to

kill a man can be used effectively against manned space vehicles over long distances, the report states. Even though the effects of an atomic blast are almost neutralized in vacuum-approaching space, it says, the radiation would travel farther than in the dense lower atmosphere.

Other information revealed in the report:

• The Russian 1120 pound *Sputnik II* had a total orbiting weight (including final stage rocket) of from 4.4 to 6.6 tons.

• The Russians will soon announce a successful manned-rocket flight.

• A fairly good Russian guidance system is indicated by the slight deviation in perigees (from 139.5 to 141.3 miles) of *Sputniks I* through III.

• The major Soviet satellite launching site is on the Kyzyl Kum Desert, 248 miles southeast of the Aral Sea.

The Committee's final report states that "according to the best available estimates it will take the United States 12 to 18 months to do what the Soviet Union is doing now."

Moreover, according to the Committee, it will take the United States "at least five years to catch up in the sense of doing equivalent things in space at about the same time."

Chairman McCormack pointed to the recent Soviet cosmic rocket as a symbol of the urgency of maintaining a strong and consistent effort in space research and exploration.

The report's major criticism of present space programs is that decisions are based on short-run budget pressures.

"To be effective, the American space program must be long-range, flexible and continuous, with special emphasis on research," the report declares.

The Soviet Union, according to the report, boosted its scientific research outlay by 15 per cent. In view of its present space lead, the U.S., according to the report, "cannot afford to do less."

Other shackles holding down the nation's space program, according to the report, are undue security restrictions, lack of scientific and technical cooperation among the nations of the free world, and science education.

McDonnell Gets Mercury Award

by Clarke Newlon

WASHINGTON—"The conquest of space is such a fantastic, gorgeous and colossal subject that it's hard to know where to begin." The words were those of President James S. McDonnell of the McDonnell Aircraft Corporation.

Actually he knew very well where to begin. First, by creating a corps of design engineers comparable to any in the industry; second, by enlisting the cooperation of top people in top industries in the allied field; third by dumping a third of a million dollars into the project before bids were solicited in December. "We started last Spring," says McDonnell, "and hit the deck running."

The result was that when technical appraisers from NASA's Langley Research Center and the Air Force came to award the first contract for *Project Mercury*—placing the first man in space—it went to the comparatively small (20,000 employees, among them 5,000 engineers) McDonnell company instead of one of the industrial giants among those 12 companies which bid.

In making the award announcement, Dr. T. Keith Glennan, NASA Administrator, said that McDonnell's proposal was accepted after a careful assessment of the technical value of the proposals, facilities, experience and other qualifications.

• **\$15 million contract**—The initial contract will be for a dozen satellite capsules (with equipment) and their subsystems—for \$15 million. This will probably be only a starter if the first few experiments prove successful. And it will, of course, include none of the cost of the booster, probably the *Atlas*, or for any of the ground handling equipment.

"This first capsule," McDonnell told m/r after the award, "will be what has become known as a conventional satellite." First passengers in the first few experimental flights will be animals, he said, with finally a man to be placed in space. The program, McDonnell said, will be "greatly accelerated" although he did not expect the first man up before at least two years. Who this first man will be, he said, will be NASA's problem, not McDonnell's.

The capsule (m/r, Nov. 10, p. 13) will be equipped for either water or earth landing, will have both drogue and landing chutes, a very sophisticated communications and control system, with the pilot having full command.

Collins Radio Co. will develop complete electronic instrumentation. Minneapolis-Honeywell will supply sta-

bilizing and control systems.

It will have a high aerodynamic drag, non-lifting in type, designed to withstand any known combination of acceleration, heat loads and aerodynamic forces during boost or reentry. It will have a blunt leading face covered with a heat shield.

A closed loop control system consisting of an attitude sensor with reaction controls will maintain orbital attitude and establish the angle for retro-firing, reentry or abort.

Retro-rockets for reentry can be fired by the pilot or from the ground. Emergency systems will allow escape in case of misfiring. Ground and booster equipment will determine the original orbit; both ground and capsule equipment will guide it thereafter. Communications equipment will include two-way voice radio, a command receiver and tracking telemetry. The orbit will be nearly circular, 100 to 150 miles up with a 24-hour lifetime.

NASA's project chief for *Mercury* will be Robert G. Gilruth. McDonnell's engineering manager of *Mercury* will be John F. Yardley, with E. F. Peters and G. F. Weber assisting for capsule design and equipment and electronics, respectively. Keeping a watchful eye over all will be L. M. "Mike" Weeks, chief of preliminary design engineering and Ray Tepping, assistant—and Jim McDonnell.

Congress Sees Urgency in Space-Missile Goals

WASHINGTON—The opening week of the 86th Congress was similar in mood to the post-*Sputnik* high-temperature sessions early last year. The heat generator this time was *Lunik*; heat conductor: next year's elections.

Ascent of Russia's man-made planet on the eve of Congress' opening set off demands for new approaches, more money and an investigation of space-defense policies. Recriminations against the Administration's attitude on this hot issue will get louder as the powerful Democratic majority goes into high gear.

The new chairman of the House Committee on Science and Astronautics said he would call for an immediate investigation to determine "where we stand" in the space race. Chairman Overton Brooks (D-La.) said that while he was not "being critical of anyone," the nation's space program must be conducted on an urgent basis.

• **Change in signals**—Proponents of bills which had been given slim chance of squeaking through this year

were suddenly optimistic. Example: the measure introduced by Sen. Hubert H. Humphrey (D-Minn.) to create a Department of Science. Feeling had been that last year's crop of new agencies and councils should be given a chance to operate a year or two before another agency was set up or any change were made. Supporters claim *Lunik* may have given their cause a decisive shot in the arm.

Foes of the science department plan had argued that establishment of the new Federal Council for Science and Technology made an additional agency unnecessary. But supporters pointed out that while the council aim is to "promote closer cooperation among Federal agencies" in research areas, it has no policy-making authority.

• **Crash program urged**—Sen. Henry M. Jackson (D-Wash.) urged crash program to snatch space leadership from the Russians. He charged the Administration with a "business as usual" approach in a situation calling for "dramatic" action.

Jackson, a member of the powerful Armed Services Committee, scored penny-pinching in defense planning. "We are going to have to spend more money," he declared. "There is no substitute for it."

Other Congressional critics have been similarly vocal about what they call the Administration's mania for putting economy above defense need. They will look for inadequacies in the proposed \$41-billion defense budget with fine-toothed combs.

Other proposed defense measures boosted by *Lunik's* impact include the bill by Sen. Leverett Saltonstall (R-Mass.) calling for major military procurement changes involving weapon system management, easing of renegotiation inequities and liberalization of patent rights in the NASA Act.

About the Cover

Space means different things to different people and to these newsmen watching the blast-off at Cape Canaveral it means the tense, breathless moment when the countdown voice reaches the climax—"three, two, one."

There is the second of silence, the whoosh of flame and the unbelievable beauty of the slim, fire-tipped missile cleaving the black sky into space. This week's cover picture shows newsmen on the bleachers one mile from the firing pad at that moment. Above them newsreel cameramen are similarly poised, equally tense, muttering to each other the warning: "Don't move. Don't move. You'll shake the cameras."

Lockheed Space Station Interesting U.S. Agencies

Satellite laboratory could be
in operation in 10 years; Cost
estimate put at \$2.163 billion.

by Norman L. Baker



WASHINGTON—A Lockheed proposal to place a "permanent" manned satellite laboratory in operation within 10 years reportedly is interesting government agencies.

Estimated cost of the station is \$2.163 billion. This includes development, construction, and launching, but does not allow for major breakthroughs of the state of the art.

The necessary engineering know-how has been developed and hardware either available or under development for an immediate start on a serious, coordinated program to put the laboratory in orbit, Lockheed scientists say.

In a highly detailed report, based on 18 long months of study, Saunders B. Kramer and Richard A. Byers of Lockheed's Missile Systems Division propose a launching system, satellite vehicles and operational procedures in line with established engineering techniques. The report was presented before the American Astronautical Society's fifth annual meeting.

Unlike many previous proposals, the report makes no reference to plans or designs far from the threshold of acquisition. For example, throughout the entire operation—from launch and assembly of prefabricated components in orbit to the transfer of personnel to the completed station—the men would be sheltered from the space environment in cabins with simulated earth conditions.

No clumsy, asphyxiating space suits with impracticable magnetic shoes are suggested for "protecting" the satellite's assembly and staff personnel. Kramer and Byers say it is time for space engineers to forget such "science fiction" schemes except for emergency equipment.

The outstanding feature of the system, assuring maximum personnel protection and working flexibility, is the "astrotug," a vehicle employed in the assembly of the space station. The cylindrical prepackaged compartments to be joined later to form the satellite would be launched separately and guided to a rendezvous point on the same orbit. "Astrotugs," with a crew of three, would then be used to round up, assemble, and activate the space station.

The men who assemble and staff the space station would travel into orbit aboard the "astrotugs" and earth-space taxis (re-entry vehicles). Return to orbit would be made aboard the re-entry vehicles. All components would be launched in the nose of a basic three-stage rocket with a recoverable first stage.

• **Concept philosophy**—The multi-manned satellite laboratory and space embarkation exploration platform could not be launched into orbit by a single vehicle using current propulsion systems. Hence, Kramer and Byers propose that the station be sent up in segments for attachment and integration later. Each section would be a self-sufficient unit. The first one would carry provisions to support several men for a number of months.

The sections would be prefabricated on the ground. Each would be a sealed compartment, with coupling devices and air locks at both ends. All would be self-sufficient to some extent, and most would be pressurized before going into orbit.

A number of sections would be launched and bunched together by ground control before men were placed in the orbit to complete the assembly.

Following the first group of sections,

a small, multi-manned maneuverable satellite, the "astrotug," would be guided to the cluster. Operating like a railroad switch engine, the "astrotug" would collect and join the sections. It would carry supplies to maintain three men for seven days, time needed to assemble the first components.

A separate re-entry vehicle would follow the first tug into orbit to stand by while the initial group completes its task. Air locks on both tug and re-entry vehicle would permit transfer of men and materials. Each subsequent group of compartments and crew sent into orbit would have at least one re-entry vehicle placed into orbit with it.

• **Orbit establishment**—To insure maximum life of the satellite free from drag forces of the atmosphere, an orbit 500 miles out, below the radiation belt, is suggested as the minimum altitude.

The first, or pilot, compartment would carry a transponder to identify itself as the homing target. In addition to establishing a coordinate reference for positioning data for the other compartments, this unit would be equipped with ranging radar for determining the spacing of the compartments in orbit, a nitrogen propulsion system for controlling its attitude and orbit, and a computer-memory unit for computing corrections to maintain proper spacing of the compartments.

After the compartments went into orbit, a ground-controlled thrust maneuver would correct the actual orbit to coincide with the standard orbit.

With the pilot compartment established in orbit, three compartments would be launched in a salvo. The third stage of each rocket would home in on the pilot compartment for proper positioning. Collisions would be avoided by choosing a closing point

one or two miles from the pilot compartment.

Next, the first re-entry and "astro-tug" vehicles would be sent aloft. The homing technique would be repeated with the manned vehicles free to maneuver after they reach the proper spacing.

The re-entry vehicle would be housed in the final stage of the three-stage rocket and fired into the 500-mile orbit in 6-10 minutes. During this phase of the operation the pilot would have no control except as a monitor or a back-up to the programmed flight path. In case of a malfunction, the ground control operator could override and take control of the automatic system.

The return trip is estimated at two to four hours, based on the "g" limitations of personnel and the maximum temperatures which the structure could endure. Re-entry attitude would be critical and Kramer and Byers doubt that an inertial system can retain its reference axes to the degree necessary for re-entry over the period it will be in orbit.

They propose a satellite control reference platform that would establish coordinates with respect to the local vertical and orbital plane and feed its output continuously to the caged stable

platform in an autopilot. Integrating accelerometers would be fixed to the vehicle structure to measure and integrate accelerations along each of the three vehicle axes.

• **Re-entry maneuver**—In returning to earth, retro-thrust applied to the vehicle would enable it to descend on transfer ellipse. The control platform would give continuous attitude, altitude, and velocity data to the pilot display and autopilot stable platform.

Turbojets started as the vehicle entered the subsonic would supply thrust for subsonic flight to rendezvous with a mother airplane. The pilot could override the automatic control system for landing aboard the mother airplane or for emergency landing.

• **"Astrotug" operation**—In the course of the "astro-tug's" operation as the assembly vehicle, its crew would be charged with locating, identifying, capturing, and returning to the assembly point each of the 23 compartments in the sequence required for assembly.

Kramer and Byers estimate that maximum dispersion, by the time the first "astro-tug" arrived, would be held down to a few miles.

With the pilot compartment fixing the position of station assembly, the "astro-tug" would acquire the second compartment on its radar or infrared

search equipment. Using its navigation computer, the "astro-tug" would travel to the compartment, return it to the assembly point, and join it to the first compartment. The coded transponder aboard each compartment would provide identification for order of assembly.

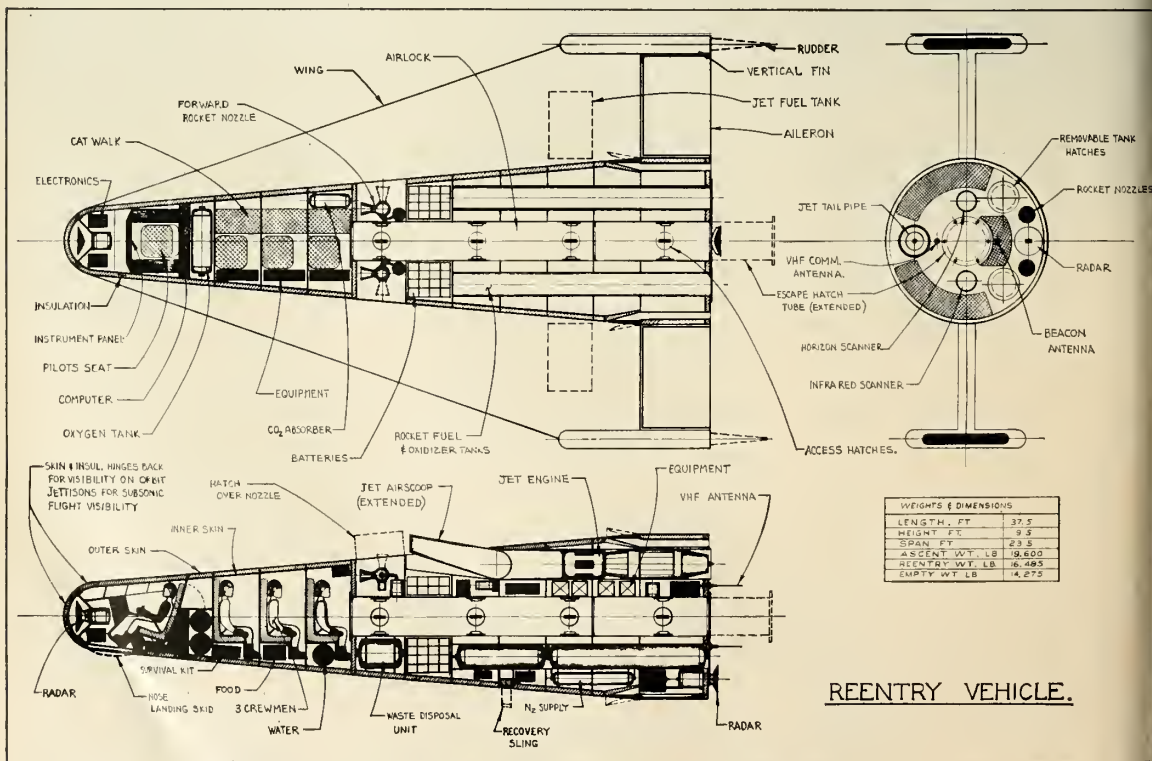
• **Re-entry vehicle design**—The re-entry vehicle would be an outgrowth of an advanced delta-winged airplane combining the features of a hypersonic glider and a subsonic powered aircraft.

Pilot observation would be through a windshield protected during re-entry by hinged thermal doors. A full circular horizon scanner would provide optical orientation while in orbit.

Power for orbit maneuvering would be provided by "throttleable" rocket engines. Using fluorine and hydrazine as propellants, the engines would have a thrust of 200 pounds.

Two solid propellant rockets with a total thrust of 18,000 pounds and a burning time of 20 seconds would initiate re-entry. For flexibility in the recovery operation, the vehicle would be equipped with a jet engine system yielding a 100-mile range.

Basic re-entry features of the system are predicated on the establish-
(Continued on page 32)



REENTRY VEHICLE for Lockheed-proposed space station could carry crew of four.

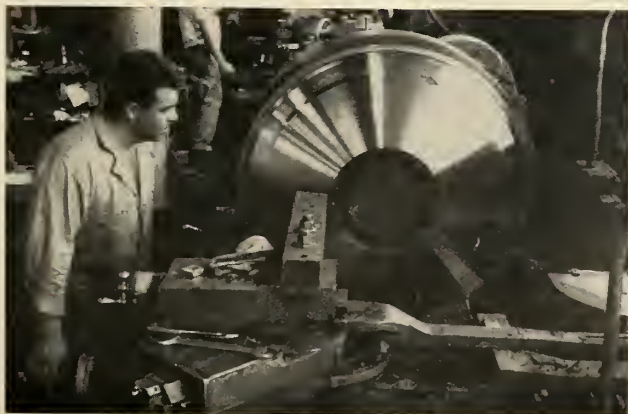
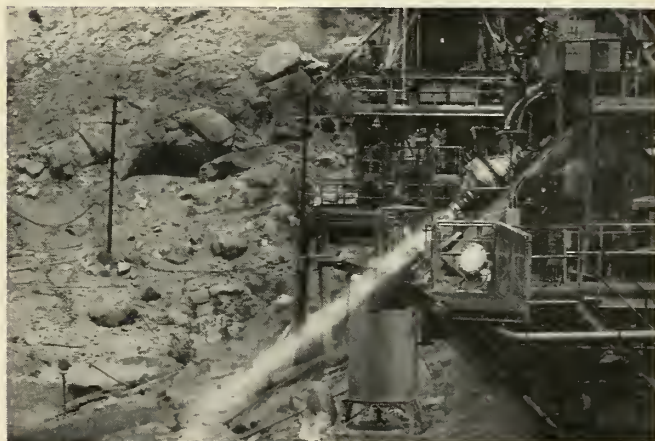
astronautics in the news...

PANORAMIC VIEW of weather conditions is shown in this composite of five photographs taken by a camera rocket fired from Wallops Island, Va. Photographs taken from an altitude of 86 miles, show an area of 1000 miles extending, left, from Nova Scotia to hundreds of miles south of Bermuda. Cameras operated at shutter speeds of 1/2000 of a second.



THIS BALL bearing made by Kaydon Engineering Corp. is 13 feet 9 inches in diameter. Designed for the *Nike-Zeus* radar system, it will hold weight of one-million pounds.

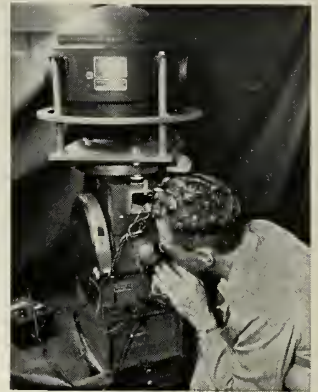
FIRST ROCKET engine nozzle for the *Kiwi-A* (Project *Rover*) atomic engine system undergoes static firing test at Rocketdyne with conventional propellants before being shipped to the Los Alamos Scientific Laboratory.



Polaris ROCKET MOTOR casing part being machined by Diversey Engineering Co. for Aerojet-General Corp., propulsion system prime contractor for the fleet ballistic missile. Of large diameter by present-day standards, it still is not high compared to some of the solid propellant motors now in the works, such as *Minuteman* where Aerojet shares propulsion development position with Thiokol Chemical, Allegany Ballistics Lab. and Grand Central Rocket Co. Parts are machined from very high-strength steel alloys and must be finished to extremely high tolerances.

Gyro Drift Demanding New Measurement Techniques

by **Ralph Hookway**
Electronics Department,
The Martin Company



GYRO MUST be mounted on rigid and precise turntable.

BALTIMORE—With the newer long-range missiles requiring more exacting drift rates for gyros in inertial systems, industry today is faced with the task of providing new measurement techniques

to keep pace with developments.

In pre-missile days when gyros were widely used in short-range blind-flying devices, they could drift as much as five degrees an hour and still do

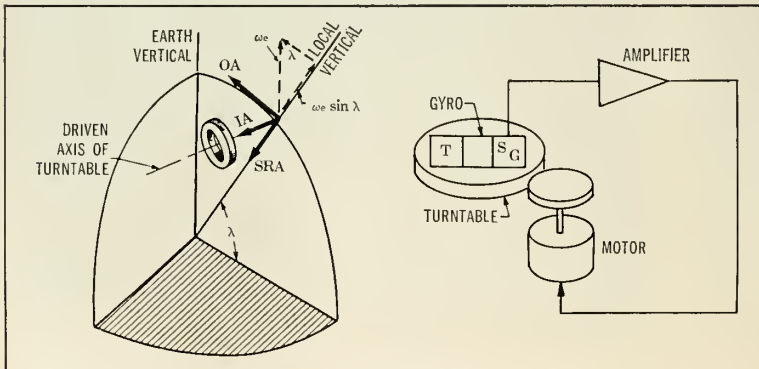
their job satisfactorily. But today's newer missiles, demanding a rate of less than 0.05 degrees an hour, bring new requirement standards.

This article will summarize drift measuring techniques for systems used in the TM-76 *Mace* which has a fairly long flight time in an acceleration environment of essentially 1g. Ballistic missile systems which experience high accelerations for short flight-time periods, will not be considered.

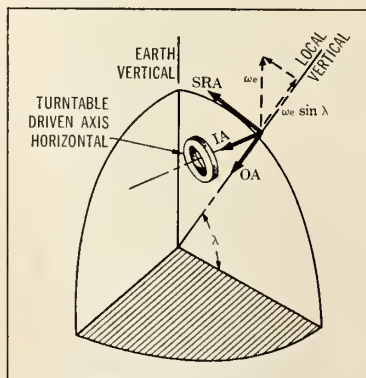
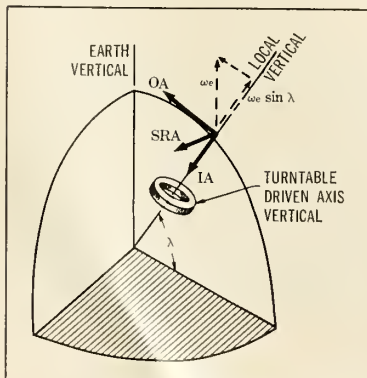
• **Drift causes**—By definition, drift rate is that angular velocity about the input axis (with respect to inertial space) which is necessary to keep the gyro output signal constant (near zero) when no signal current is applied to the torquer. It results from design limitations and imperfections in manufacture, such as very small, residual unbalances which produce a torque which in turn, generates a drift rate.

Stray torques are also introduced by the electrical lead-ins to the floor bearing friction, and the self-induced magnetic fields at the pick-off arm torquer. In typical inertial instruments the torque producing the characteristic drift rate is very small. For example, a gyro with an angular momentum of 10^5 gr-cm²/sec when subjected to a torque of only 0.02 gr-cm²/sec² displays a drift rate of 0.05 deg/hr. For a 1 cm arm, this torque is produced by a mass of only 2.47×10^{-5} grams.

Since the torques are so small and can be measured only with the gyro completely assembled, a technique has been developed which, in effect, uses the assembled gyro to test itself. Stat-



TURNTABLE-MOUNTED gyro is used to measure total drift rate U_1 in *Mace*.



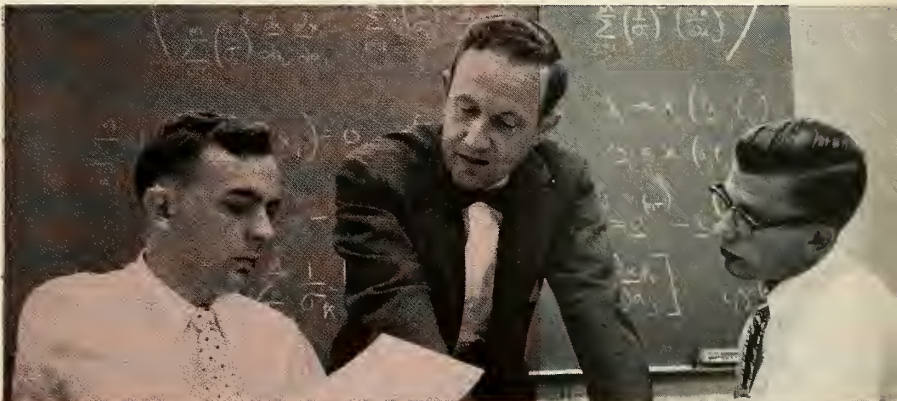
DIAGRAMS 2 (left) and 3 (right) determine drift rates U_2 and U_3 .

New electronics frontiers

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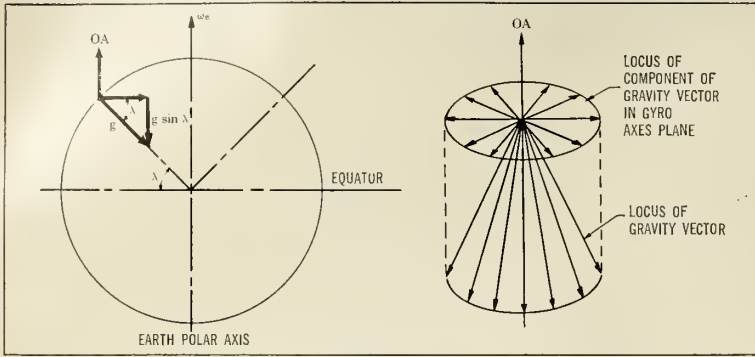
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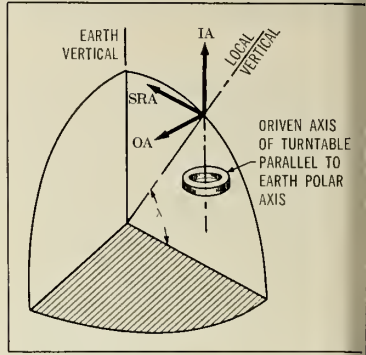
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LOCUS OF GRAVITY vector relative to gyro axes.



ALIGNMENT of gyro axes in Mac

inputs are earth's rotation and gravitational field.

Total drift rate includes a gravity-sensitive component (gravity-caused deflections of the gyro structure which introduce stray torques) and a non-gravity-sensitive component which accounts for all other torques. To fix the maximum value of the gravity-sensitive component (important in the calibration of guidance systems), a method must be devised to separate the non-gravity-sensitive component from the total measured drift rate.

• **Test formula**—One technique is to measure the two components separately, apply a correction to remove apparent drift due to the vertical component of earth rate at the latitude of the test site, and then calculate the maximum gravity-sensitive drift rate from the relation:

$$(Ug)^2_{\max} = (U_1 - U_2)^2 + (U_2 - U_3 - W_e \sin \lambda)^2 \quad (1)$$

where $(Ug)_{\max}$ = maximum gravity-sensitive drift rate

U_1 = total drift rate measured with SRA vertical and OA oriented north-south

U_2 = total drift rate measured with IA vertical and OA oriented north-south

U_3 = non-g-sensitive component measured with OA vertical and SRA oriented north-south

W_e = earth's angular rate
 λ = latitude of the test site.

From the geometry of U_1 , U_2 , U_3 , (Diagrams 2 and 3), some requirements of test accessories can be deduced. The gyro must be mounted on a very rigid and precisely built turntable (see photo). High-precision optics are needed to measure table rotation to within a few seconds of arc. Since tests usually take several hours, there should be a means of simultaneously recording table position and accurate time base.

Total drift rate U_1 is measured by

mounting the gyro on the turntable as shown in Diagram 1. The input axis is parallel to the driven axis of the table, which is horizontal and pointed east-west. When rotated about its output (turntable) axis so that the spin reference axis is vertical, the gyro does not see any component of earth's rate. A servo loop is then formed by using the gyro pickoff signal to drive the turntable as shown in the right of Diagram 1.

The table is driven at a rate which just keeps the gyro output nulled. This rate is a direct measure of gyro drift rate for the orientation under test.

Total drift rate U_2 is determined with the gyro mounted on the same turntable with turntable and gyro input axes coinciding parallel to the local vertical as shown in Diagram 2. As before, OA is aligned north-south. In this orientation, there is an apparent drift rate arising from the vertical component of W_e which lies along the gyro input axis in addition to the drift rate resulting from structural deflections. This component of earth rate has the magnitude of:

$$W_{ev} = W_e \sin \lambda$$

This relation shows that the better the gyro the more accurately the latitude of the test site must be known.

• **Exact location**—To keep errors small relative to the drift rates being measured, the test site location should be known so accurately that the vertical component of earth rate is no greater than about 1/10 of the expected drift rates. The following shows typical values of the survey accuracies required for various classes of gyros:

Autopilot directional gyros:	
Typical Drift Rate	Allowable Site Error
1 to 10 deg/hr	0.5° to 5°
Directional gyros for polar navigation:	
Typical Drift Rate	Allowable Site Error
0.1 to 1	3 min to 30 min

Inertial navigator gyros:	
Typical Drift Rate	Allowable Site Error
0.001 to .1	2 sec to 3 mi

It is now possible to define U_3 the drift rate measured by orienting the gyro so that its OA is vertical, SRA horizontal and pointed north-south. IA and the driven axis of the test turntable are horizontal, pointing east-west as shown in Diagram 3. The local gravity vector lies along the OA so that no gravity-induced torques are applied. Nor is there a component of earth rate to account for.

From this testing procedure, you get the maximum drift rate to be expected from a gyro in an lg gravitational field regardless of its orientation. While a measure of gyro quality, this data is not directly useful in pre-launch adjustment of certain inertial guidance systems, since it does not duplicate the time history of the relationship between the gyro axes and the local vertical which will occur in flight.

• **Geometric system**—The Macdonald inertial system is of the geometric type, however. Here the gyro reference is fixed in inertial space at the launch point vertical while accelerometers track the local vertical throughout the flight to indicate the earth central angle between launch point and present position. Distance traveled over the surface of the earth is easily obtained.

In general, orientation of the local gravity vector relative to the gyro axes varies during flight. Since the gyro drift rate varies with the orientation to gravity, to achieve the utmost accuracy from the guidance system the drift measured should be corrected for sensitivity of the gyro to gravity orientation. Gyro coefficients to be used in data inserts in the guidance system obtained by tumbling tests.

The same type of test table (photo of missiles and rockets, January 19, 1960)

s used. One of the gyro axes (and the able axis of rotation), however, is ligned parallel to the polar axis of the arth. Under these conditions the locus f the gravity vector relative to the gyro axes is as shown in Diagram 4. wo minor effects, which can be nelected, are the 365-day cycle of the arth about the sun, and the change f earth's gravity due to the motion f the moon in its 29-day orbit.

The gyro axes can be aligned as own in Diagram 5 and the gyro pick-off signal can be used to drive the table and hence the gyro pickoff to null. This procedure fixes the gyro in inertial ace while a component of the gravity ector rotates in the plane defined by e output and spin axes.

Results of this test can indicate the performance of a geometric inertial uidance system. Total angular motion ported by the gyro in a given time eriod is compared with the actual ngular motion of the earth in the same ne. The difference is due to the drift te of the gyro, which is reflected in stem performance at the rate of 1 in of difference after an hour long st run for 1 mi of error in navigation ter one hour's flying.

Another type of tumbling test can e performed with the gyro output axis rallel to the earth's polar axis and e test turntable axis. The gyro is "aged" by using the signal pickoff to ve the gyro torquer (after proper mplication). The test table is rotated some multiple of earth rate, but this ation is not seen by the gyro since e component of it appears along the ro input axis. Recording the torquer rrent as the orientation of gravity rries varies gives a measure of gyro ift.

Eglin Telemetry Contract is for \$500,000

PRINCETON, N.J.—A contract of ore than \$500,000 for supplying ee telemetry ground-station systems for the Eglin Gulf Test Range, a., has been awarded by IIT laboratories to Applied Science Corp. of Princeton.

The project calls for a 300-mile lectronic "scoreboard" for testing mis- es and aircraft, including *Bomarc*. e ground station equipment will be ed at three separate range sites for eiving, reducing and recording tele- etered flight-test data.

Each system will contain FM/FM, M and PW equipment, simulta- eously handling data signals from ee aircraft or missiles and from three nes. Each aircraft or missile will e able to transmit to each site four ntinuous data channels and up to 90

iles and rockets, January 19, 1959

channels of time-division commutated data. Each drone will be able to transmit to each site four continuous data channels.

A central control section will provide flexible patching facilities for programming ground station equipment allocation to meet the requirements of the test range.

Thermoelectric Generators Have 6% Efficiency

ST. PAUL, MINN.—Thermoelectric generators with an operating efficiency of about six per cent have been developed by Minnesota Mining and Manufacturing Co. The generators use heat applied to semi-conducting materials.

The company has been in pilot plant production of semi-conductor elements and sub-assemblies for more than a year, a spokesman said, and now has adapted the material to complete, operative generators.

One of the generators is a five-watt unit about the size of a quart fruit jar, which reportedly operates at six per cent efficiency and is intended for use with an isotope heat source. This unit is designed to be cooled by air.

Similar units are being designed for cooling with water or by radiation, the company said. Additional generator types are to be built this year.

Standard Navigation Aids Could Guide Space Travel

COLUMBUS—Even though chances of hitting a planet with a ballistic shot are slim, a manned space vehicle capable of in-flight corrections could reach a planet with existing navigation equipment.

Arthur S. Cosler Jr., executive director of Ohio State University's Mapping and Charting Research Laboratory, who made the statement, emphasized that the vehicle would have to be powerful enough to carry such instrumentation.

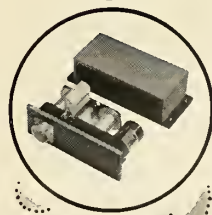
The University is conducting research on navigation techniques for interplanetary space flight on an Air Force contract granted to its research foundation. The objective of the project is to examine all potential sources of space navigation information.

Some of the possibilities being considered include: taking bearings on planets; sending out radar signals from an earth-fixed station or from a satellite; using charts of the intensities of electron or ion clouds in space, or maps of magnetic field strength and direction in space. One conclusion already reached is that a space vehicle would need to alter course during flight to

Beattie-Coleman built 100 g's into the MPR-13 Programmer

Resistance to high shock loads is just one of the amazing pluses of the Beattie-Coleman MPR-13 punched Mylar tape Programmer. The MPR-13 is the accepted standard for multi-channel programming because of its compatibility with most missile guidance systems... and performs with an accuracy of one part in 50,000 under these high "g" loads! Programs can be initiated or altered in a few minutes with millisecond precision for either repeat cycling or random operations.

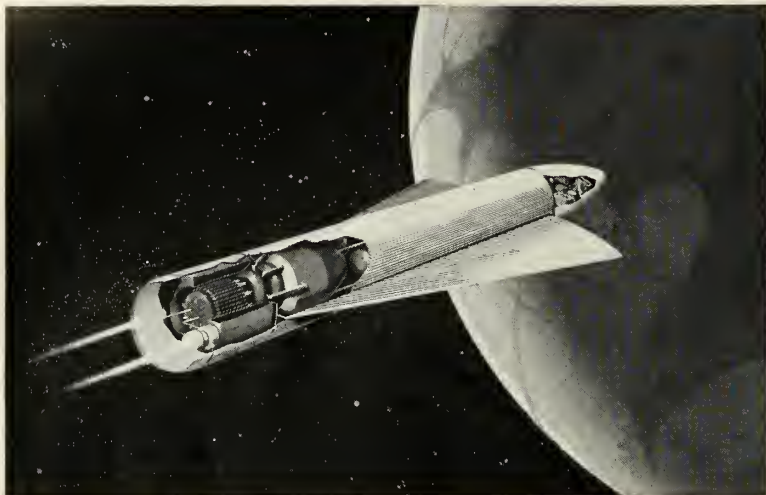
The rugged Beattie-Coleman MPR-13 Programmer weighs 3 lbs. 10 ounces, is 2"x3"x6". More information is available on request.



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COUNT DOWN!

for the conquest of space



ROCKETDYNE ENGINEERS HAVE MADE MORE THAN 50 TRIPS TO THE NEIGHBORING PLANETS

Through the ship's viewing port looms a breathtaking sight—a gigantic red crescent spanning some 30° of deep black sky. A television camera, passenger on this strange new chariot, stares intently at a sight never before seen by man and beams home to Earth his first crude view of the planet Mars.

From dream to drafting board

Less than a decade will pass before this age-old dream of man is realized. Bold steps toward such an exploration of Space are underway now. An experimental ion rocket engine will soon be placed in operation at Rocketdyne's Propulsion Field Laboratory in the Santa Susana mountains. From this research tool will come design data for the efficient, low-thrust freight engines for Outer Space. These engines will be capable of operating for months at a time, and will make pos-

sible extended reconnaissance of the Solar System and detailed studies of the phenomena of Space.

But what of the journey itself?

Rocketdyne engineers have made more than 50 trips to the neighboring planets on huge computer machines. In these paper trips, they have studied the gravitational effects of as many as seven planets at a time. By watching closely the effects of such forces on their low-thrust ion vehicle they determined thrust programs to reach various planetary objectives. They showed the trip to Mars could be made with thrust to vehicle-weight ratios as low as 1 to 10,000.

Testing in Space conditions

Rocketdyne has been at work on ion rocket engines since 1955. While many difficult design problems yet need to

be solved, extensive new facilities and three years of exhaustive studies are being applied to the job. Rocketdyne scientists will operate their experimental ion engine in simulated space conditions to unlock important answers to thrust chamber design, power conversion systems, nuclear heat sources, and propellants.

Hardware for defense and science

Today the operating hardware in the field of high-thrust rocket engines is designed and built by Rocketdyne: propulsion systems for the Air Force's Atlas and Thor, and the Army's Redstone and Jupiter... and for scientific missions such as the Explorer satellites and the NASA space probes conducted by the Air Force and Army. Based on this unequalled experience, Rocketdyne is already probing far into the future. Engineers are already at



PROBING TOWARD THE PLANETS

Heaved bodily into Space by the Rocketdyne-powered Thor first stage, the Pioneer starts on its 80,000 mile sortie toward the moon.

work on the next and succeeding generations of high-thrust rockets, and high-specific-impulse engines to supplement chemical rocket performance.

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FOR OUTER SPACE

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A DIVISION OF NORTH AMERICAN AVIATION, INC.

missile electronics

orrect for navigational and ballistic
rors.

• **Loss unlikely**—Cosler said there
as little chance of a manned rocket
coming lost in outer space even with
e standard navigation aids now avail-
able, provided the vehicle could man-
e to carry them all. The navigation
ds are necessary, he explained, be-
use a prime difficulty in intercepting
e moon or a planet with a ballistic
ot is man's inexact knowledge about
e true distances in space. He said
calculations of interplanetary distance
e based on a distance from the earth
the sun which carries a margin of
ror of several thousand miles.

On another point, Cosler said that
uch more must be learned about how
an will function in space before sci-
tists can decide what navigation
quipment must be automatic.

Amphenol and Borg Firms Merge Electronics Output

CHICAGO—Two major Midwestern
electronics firms, Amphenol Electronics
Corp. and the George W. Borg Corp.,
have merged into Amphenol/Borg Elec-
tronics Corp., with combined assets of
more than \$37 million.

Arthur J. Schmitt, Amphenol's pres-
ent, is chairman of the board and
resident of the new company and
George W. Borg, chairman of the Wis-
consin firm, is chairman of the execu-
tive committee.

The consolidation was approved by
stockholders of both companies in
meetings held Dec. 30. It was effective
Dec. 31.

The merged companies, with head-
quarters here, will have total floor
space of a little more than 1 million
square feet when Amphenol's new Chi-
go plant is finished. The figure ex-
cludes divisional plants in Connecticut
and California.

Amphenol is a major supplier of
connectors, cables and other electronic
components for missiles. Borg pro-
duces precision potentiometers, direct
reading counting dials and electronic
instruments.

RCA Adds Space For Its Growing Missile Business

Radio Corporation of America has
leased a two-story brick building at
Roydon, Pa., to provide space for its
expanding military business.

The new plant, containing 74,000
square feet of floor space, is situated
on about seven acres of land 20 miles

northeast of central Philadelphia.

The new facility, combining one-
and two-story construction, will be
under the jurisdiction of RCA's Mis-
sile and Surface Radar Dept., Moores-
town, N.J., and will provide supple-
mentary space for rapidly expanding
activities at that location.

missile people

Dr. Patrick Conley has been ap-
pointed manager of the Westinghouse
Electric Corp.'s Air Arm Div. Dr. Con-
ley, technical director on the Defense
Products Group headquarters staff, suc-
ceeds **Dr. S. W. Herwald**, former man-
ager of the Air Arm Division, who
was recently named vice-president for
research.

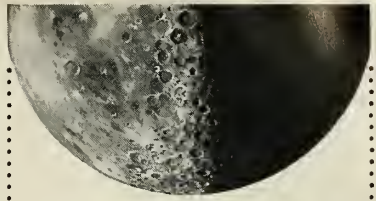
Rep. Overton Brooks (D-La.),
slated to head the House Science and
Astronautics Committee is known as a
"progressive Southern Democrat." Long
a member of the House Armed
Services Committee, Brooks is highly
respected by Defense Department of-
ficials who come to committee hear-
ings well-prepared for his searching
questions. It is expected he will leave
the Armed Service Committee.

Dr. Siegfried J. Gerathewohl, auth-
ority on weightlessness and a contribu-
tor to m/r, has joined the Von Braun
team at the Army Ballistic Missile
Agency. He will work under **Dr. Ernst
Stuhlinger**, ABMA's director of the Re-
search Projects Laboratory. Dr. Gera-
thewohl left the School of Aviation
Medicine where he has conducted ex-
periments on the effects of weight-
lessness in space flight after coming
to this country from Germany 11 years
ago.

Henry E. Billingsley has been ap-
pointed director of the Office of Inter-
national Cooperation of the National
Aeronautics and Space Administration.
He was formerly chief of the Western
European Division in the Defense De-
partment's Office of Internal Security
Affairs.

George M. Bunker, president and
chairman of the board of the Martin
Co., has been elected to Bulova's board
of directors.

Dr. Allen E. Puckett has been
named a vice-president and director of
the systems development laboratories
of Hughes Aircraft Co. **Lawrence A.
Hyland**, vice-president in charge of
engineering, has been appointed vice-
president in charge of systems manage-
ment. **Dr. Nathan I. Hall**, vice-pres-
ident and director of systems develop-
ment laboratories, has been named to
fill Shank's former post.



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Our Advanced Design Group is
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manned exploration of Outer Space.
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physics, magneto-hydro dynamics,
and plasma physics comparative per-
formance of electrical propulsion sys-
tems, new methods of developing
thrust from electrical propulsion sys-
tems, and direct conversion processes.

Chemical Physicists

To make studies on propellants for
ion propulsion. Experienced in elec-
tronics, atomic physics, and physical
chemistry.

Physicists

Primary activities will be in the
field of ion sources and high vacuum
techniques. Experienced in particle
accelerators, ion sources, and elec-
tronics.

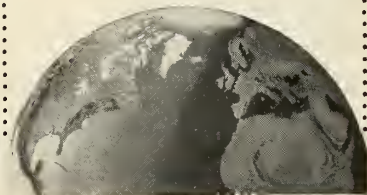
Electrical Engineer

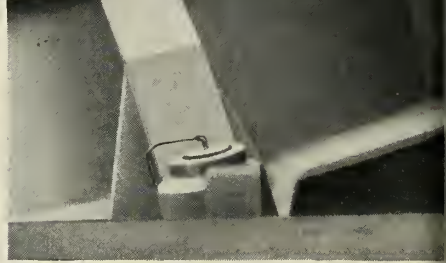
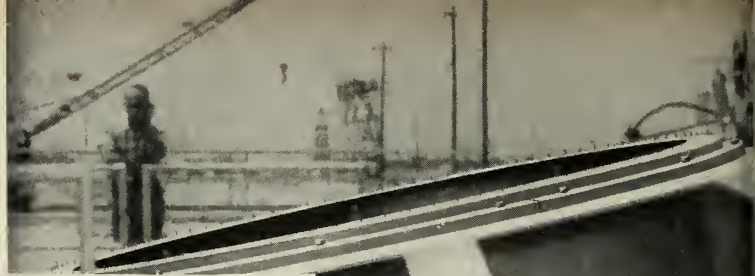
Analysis of electrical power gen-
erators, preliminary stages designs of
permanent magnet, AC induction and
electrostatic generators.

Please write: Mr. D. A. Jamieson,
Engineering Personnel Dept., 6633
Canoga Avenue, Canoga Park, Calif.

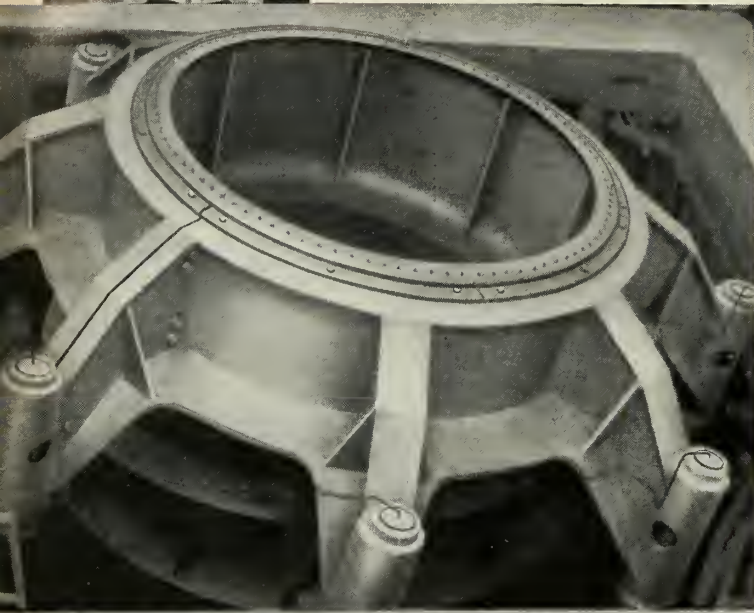
ROCKETDYNE

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FIRST WITH POWER FOR OUTER SPACE





"Shaker" pitching



"Shaker" rolling

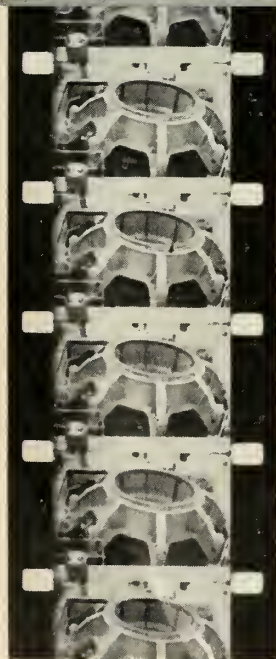
"Shaker" — Loewy's giant rocking horse — paves way for ballistic missile firing at sea

The giant ship motion simulator called "Shaker" has come to life. Designed and built by Loewy-Hydropress under prime contract with the U.S. Navy for its Fleet Ballistic Missile Program, the 40-ft.-tall rocking horse moves up and down, fore, aft and athwart under the electronic fingertips of a distant operator in a thick-walled concrete blockhouse.

"Berthed" at Cape Canaveral not more than 800 feet from the beach and nested in a 47-ft.-deep pit, "Shaker" performs all the important movements of a seagoing vessel. Sliding up and down, she imitates the vertical heave motion. Tilting port and starboard, she acts out rolling. Rocking forward and backward, she duplicates pitching. An intricate mechanism of giant gyrating joints makes these rock 'n' roll moves and their innumerable combinations possible. By proper setting, the typical behavior of an oceangoing vessel in seas ranging from calm to stormy can be recreated precisely by "Shaker."

Polaris, the Navy's Fleet Ballistic Missile, will soon be tested on "Shaker."

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space age

by Norman L. Baker



Charting *Lunik's* orbit—The tenth "planet" of the solar system (actually a man-made planetoid or asteroid) reached its perihelion of 91.5 million miles about Jan. 14 and began its decelerating swing out and around the sun. About one million miles from the earth at its closest approach to the sun, it is slowly being overtaken by the earth at the rate of about .181 degrees a day.

After earth and *Lunik* reach conjunction (possibly sometime this month) the earth will rapidly pull ahead of the Russian probe, overtaking it again in roughly 5.43 years. Sometime in early 1964 *Lunik* will make its first close approach to the earth. Even then the distance will be far beyond the earth's gravitational attraction.

Estimated planetary data—*Lunik*—or *Mechta* (dream), as the Soviets later tagged it—left the earth with a burnout velocity of 25.7 miles per second (in relation to the sun). At its closest approach to the moon (4,660 miles), its velocity had been reduced to 20 miles per second. As the probe moved away from the earth-moon field the sun's attraction upped the velocity to 20.1 miles per second at the perihelion. By the time it reaches its aphelion of 123.25 million miles on Sept. 9, its orbital speed will be reduced to 15.1 miles per second and it will be more than 33 million miles from the earth. This will put *Lunik* within 5-6 million miles of the closest approach of Mars' orbit to the earth's orbit (Mars at that time will be tailing *Lunik* by about 145 degrees).

Moon impact attempted—There's increasing evidence that Soviet scientists attempted to send their payload into an intercept with the moon. The earliest Tass announcement of *Lunik's* estimated arrival time in the vicinity of the moon was three hours later than the actual time of arrival. The moon moves about the earth approximately one diameter every hour (orbital velocity: 2287 mph, diameter: 2160 miles)—in three hours the moon would have traveled 6861 miles.

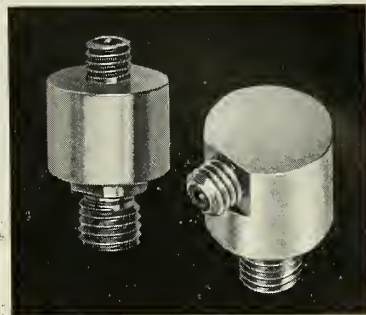
***Lunik* led the aft side of the moon by 6820 miles, indicating (based on the average orbital velocity of the moon with a miss of only 41 miles) the Soviet scientists had definitely planned to impact the lunar surface. A later Russian announcement admitted the rocket vehicle attained a greater velocity than had been desired.**

The fact is that an artificial asteroid can be put into orbit around the sun by simply launching it in any direction and at any velocity greater than the escape velocity of the earth-moon system. Giving *Lunik* a short life-time (62 hours) radio power system when solar power could have been supplied (*Sputnik III* was so equipped) does not seem reasonable if an orbit of the sun had been planned as the major objective.

Space flight capabilities—The RAND Corp., in a scientific analysis for the Select Committee on Astronautics and Space Exploration, outlined what could be done with U.S. ballistic missiles in five years or less. Using adaptations of basic IRBM and ICBM hardware, the report said, would permit the following experiments:

- 1) Orbit satellite payloads of 100-10,000 pounds at 300 miles altitude.
- 2) Orbit satellite payloads of 25-2500 pounds at 22,000 miles.
- 3) Impact 50-3000 pounds on the moon.
- 4) Land, intact, 10-1000 pounds of instruments on the moon.
- 5) Land, intact, more than 1000 pounds of instruments on Venus or Mars.
- 6) Place a 1000-lb. instrument probe in the atmosphere of Jupiter.
- 7) Launch and return men from orbit around the earth.

Avoid false test results with GLENNITE internally ungrounded accelerometers



Now you can avoid one of the major causes of false test results — spurious "ground loop" voltages — by using *internally ungrounded* GLENNITE accelerometers.

These units contain sensitive seismic elements *internally* insulated from the mounting stud by rugged ceramic insulation. You can employ a *single point ground* at the data handling or recording equipment by using a combination of these accelerometers with ungrounded GLENNITE amplifiers and filters.

GLENNITE accelerometers are available in uni- and triaxial models — wide acceleration and temperature ranges.

A complete line of associated ungrounded electronic equipment includes filters, amplifiers, connectors and other related units.

For complete data on Gulton instrumentation systems — grounded or ungrounded — contact your local Gulton representative or write us direct.

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From transducer to readout, Gulton is capable of meeting all your instrumentation needs. If you have a measurement problem, why not call in a Gulton Instrumentation Engineer. His broad experience in shock and vibration measurement can prove invaluable to you.

GULTON INSTRUMENTATION DIVISION



Gulton Industries, Inc.

Metuchen, New Jersey



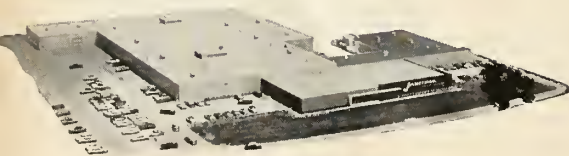
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Couplings are furnished in titanium as well as stainless steel; sizes range from 1" to 36" diameter. Janitrol coupling reliability is firmly based on a unique combination of research, design, testing and manufacturing facilities capable to handle complete systems including heat exchangers, coolers, and controls.

Call the Janitrol representative near you for help early in the design stage.

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JANITROL



astrionics

by Raymond M. Nolan

Latest entry in the lightweight inertial guidance field is Nortronics' LINS (Lightweight Inertial Navigation System). Starting with a design objective of 35 lbs. for the platform, Nortronics engineers came up with a 30 lb. package. The platform uses the Minneapolis-Honeywell MIG (miniature integrating gyro) gyros and Nortronics-designed digital accelerometers. All preamplifiers and some of the accelerometer electronics are enclosed on the platform. The unit operates at 130°F ambient with integral heaters taking the MIG up to its operating temperature of 180°F. The remainder of the system is packaged in two boxes—one for digital circuitry and one for analog circuitry.

Power for the system is straight 400-cycle because the design was for a Century series lightweight fighter. However, company engineers feel that they can accept the battery input which would be required for missile applications with more ease than the 400-cycle.

A DOD official recently threw a little cold water on the Sperry SINS (Shipboard Inertial Navigation System) now being checked out on the USS Compass Island and planned for use on *Polaris* submarines. The complaint isn't with the equipment itself, which reportedly easily operates to specifications, but with the requirements that some people are talking about in DOD. According to reports, there is some feeling now that SINS should operate with no appreciable drift for about 30 days. This is a considerably greater time than the equipment is designed for.

However, some people in industry say that this isn't a worry. Their solution is a high-speed stellar corrector which would adjust the inertial system in the first few minutes after *Polaris* leaves the water. This would eliminate, they say, the requirement for long-range, ultra-precise navigation equipment with an almost impossible to attain remembering capability. Whether or not these objections and solutions have filtered back to the Special Projects section of BuOrd or to Lockheed is not known.

Competition for the successor to the Aerophysics *Dart* continues hot with reports that a demonstration of the French *SS-11* was recently held by the Marines at Quantico and that licensing rights for the German *Kobra* have been picked up by a U.S. manufacturer. This makes three contenders for succession rights, all foreign. In addition, the English Vickers type 891 has been licensed for manufacture in this country and is rumored to be under evaluation now. The Vickers missile has been officially named the *Vigilante* by Vickers-Armstrong. This goes along with V-A practice to tab all their products with names beginning with V.

The *SS-11* demonstration was labeled by some observers as a limited success and by others a dismal failure. At any rate, the French had several failures, including one for wire breakage and another which would not leave the helicopter-borne launcher. However, the few missiles that did operate without malfunction were on target.

Whatever the outcome, the U.S. will be getting a bargain in the wire-guided, anti-tank missile it chooses since all three are essentially fully developed. Some minor redesign might be necessary to comply with military specs, but manufacturers and importers of the missiles are keeping their fingers crossed since they are in general agreement that too much tinkering around was what really killed the *Dart*.

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Capacitance:	500 µmf
Temperature Ranges:	-100° F. + 525°F
Sensitivity:	5 mv/g min.
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GULTON INSTRUMENTATION DIVISION



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Industries,
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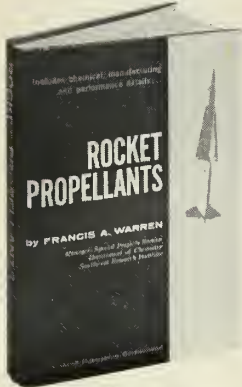
Metuchen,
New Jersey

In Canada: Titania Electric Corp. of Canada, Ltd.
Gananoque, Ontario

Includes chemical, manufacturing and performance details...

ROCKET PROPELLANTS

by FRANCIS A. WARREN
Manager, Special Projects Section,
Department of Chemistry,
Southwest Research Institute



1958,
228 pages,
\$6.50

The purpose of this book is to provide technical men with basic information on the materials being used to propel the rockets and missiles of today, and to recount in an objective manner the fascinating story of rocket fuel development.

It contains the composition, manufacturing methods, and performance details of both solid- and liquid-propellants used in rockets, from small signal units to the largest missiles currently being launched. The book also includes chapters on propellant burning, ignition and igniters, and the various rockets that use each kind of fuel. There is comprehensive information on safety in the propellant manufacturing plant, and quality control of the product.

A final section looks to the future of the present fuels, and reviews the theories that may lead to new ones, such as ion and photon propulsion, and anti-gravity.

CONTENTS: Propellant Systems; Propellant Ingredients; Solid-Propellant Manufacture and Processing; General Performance Characteristics; The Burning of Propellants; Ignition and Igniters; Solid-Propellant Rockets; Liquid-Propellant Rockets; Safety; Evaluation and Quality Control; The Future of Propellants.

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... space station

(Continued from page 20)

ment of radiation equilibrium conditions. Kramer and Byers emphasize that these conditions are being studied intensively under *Dyna-Soar* and problems encountered in designing the re-entry vehicle should be similar to those of the boost-glide vehicle.

• "Astrotug" design—The work-horse in the satellite construction would consist of two double-walled pressure vessels 10 feet in outside diameter, 9 feet inside, 20 feet long, and weighing over 20,000 pounds fully loaded. The vessels would include compartments for the crew, and mounting surfaces for external equipment such as radar, antennas, and search lights.

Propellants for the rocket would be the hypergolic combination of fluorine and hydrazine to ensure reliable ignition in a vacuum.

• **Booster rocket system**—The three-stage booster rocket would be 180 feet long, with a base diameter of 18 feet and a first-stage fin span of 52 feet. The fins would stabilize the first stage during ascent, and act as lifting surfaces during recovery. Four turbo-jet engines mounted on the aft section of the first stage would supply supplemental power during launch and sustainer power for the return to base of the expended stage.

Launch gross weight of the booster would be approximately 300 tons with a payload weight of 20,000 pounds.

The engine for the first-stage system would be a 1.16 million-pound thrust unit operating at a chamber pressure of 600 psi. Kramer and Byers selected a "plugged-nozzle" design being developed by General Electric. Burning time for the engine would be 90 seconds.

The second-stage propulsion system would have a 321,000-pound thrust engine burning a hydrogen-fluorine combination for 200 seconds. Third-stage engine would be similar to second-stage with a thrust of 76,000 pounds for 175 seconds.

• **System schedule**—Kramer and Byers say success in the space-station development will depend on information to be supplied by four major programs. These are the *X-15* probes extending into 1964, Man-in-Space orbiters, 1960-65, *Dyna-Soar*, 1961-66, and a minimum space station (one or two men), 1962-67.

Answers supplied by these programs should, according to the Lockheed scientists, be sufficient for initiating an orbit rendezvous development. The multi-manned scientific space station would be possible by early 1964, with an operational station by 1968.

MISSILE ENGINEERING

The "collapsing of time" concept has taken on added significance as a result of the current international situation. In Tucson, Arizona, Hughes has established the Tucson Engineering Laboratory for the purpose of shortening the elapsed time between missile development and its effective tactical use. This activity, established over 2 years ago, has proven that the quasi-simultaneous development and production of missiles can become a feasible reality.

The Tucson Engineering Laboratory is now expanding its scope of operations. Mechanical Engineers, Electrical Engineers, or Physicists who like to work on urgent problems and who have the ability and enthusiasm to constantly improve the product and its reliability, will find this an ideal environment. Specific areas of interest include: missile system analysis, infrared and radar guidance systems, electromechanical and hydraulic control systems, missile and test equipment and electronic circuit design.

An added advantage: Tucson's dry, healthful climate. Investigate by sending resume to Mr. W. A. Barnes at:

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contract awards

AIR FORCE

y Ballistic Missile Division:
1,000,000—Crosley Division, Avco Manufacturing Corp., Cincinnati, for new type of Command Receiver.

y Ogden Air Materiel Area, Hill AFB, Utah:
533,036—Boeing Airplane Co., Pilotless Aircraft Division, Seattle, for technical data for Bomarc missile components (six contracts).

y Strategic Air Command:
400,000—Telecomputing Corp., Los Angeles, for data processing services at Vandenberg AFB, Calif.

ARMY

y U.S. Army Ordnance District, Philadelphia:
847,350—Western Electric Co., Inc., New York City, for Nike spare parts (nine contracts).
17,800—Princeton University, Princeton, N.J., for research and development on guidance.

y U.S. Army Engineer Research and Development Laboratories, Ft. Belvoir, Mo.:
511,189—General Mills, Inc., Mechanical Division, Minneapolis, for automatic tracking theodolite equipment for artillery survey system.

y U.S. Army Ordnance Missile Command, Redstone Arsenal, Ala.:
300,000—Southern Associated Engineers, Inc., Huntsville, Ala., for 75,000 manhours of technical services in missile and rocket programs.
253,568—Recordak Corp., Subsidiary of Eastman Kodak Co., New York, for microfilming of drawings and mountings of images into aperture cards and full operation of microfilming facilities for ABMA.
34,377—The William Brand and Co., Inc., Willimantic, Conn., for cable.
29,659—Reynolds Metals Co., Inc., Richmond, Va., for aluminum tubing, angle, sheet and plate.
46,189—John B. Moore Corp., Nutley, N.Y., for solvent oxylene.

y District Engineer, U.S. Army Engineer District, Fort Worth:
134,092—Suggs Construction Co., Big Spring, Tex., for storage of base of rocket assembly at Big Spring AFB.

missiles and rockets, January 19, 1959

high-energy fuel briefs from Callery

Successful start-up for new Muskogee, Oklahoma plant — Callery is successfully operating the first of four major processing units at the new \$38,000,000 Navy HiCal plant at Muskogee, Oklahoma. This plant will provide many times the production capacity of any existing high-energy fuel facility.

Lawrence, Kansas plant producing tonnage quantities of HiCal — All of the immediate capacity of the Lawrence plant is now under military contract. However, we do hope to have some HiCal available in the near future for *authorized users*. If you — or your program — qualify, we'd welcome an opportunity to discuss the technical aspects of using these fuels for your project.

Write for new HiCal-3 Handling Bulletin.

R & D on new fuels and propellants? — Callery's R & D experience may prove helpful in attaining your long range objectives. Our current exploration in a number of new phases of development may coincide with one or more of your pet projects. Project teams with up-to-date facilities at their disposal can now be assigned to new programs. We'd like to talk with you about those areas of mutual interest in which Callery is best qualified.

Pyrophoric ramjet fuel: Triethylborane — TEB is spontaneously flammable in air. However, it does not react with water, and this is a distinct handling and operational advantage. TEB — with much wider flammability limits than hydrocarbons — virtually eliminates engine flameouts at high altitudes. Some of the advantages of using TEB as a primary ramjet fuel in place of hydrocarbon-fueled ramjets are: higher altitude operation, increased range, improved fuel economy and reliability, and lower cost vehicles.

Write for Technical Bulletin C-310 and Handling Bulletin C-311.

New 15-minute Triethylborane-Tributylborane fire-fighting film available for loan. Just write 9600 Perry Highway, Pittsburgh 37.

Washington, D. C. office opened by Callery — Fuel and propellant users in the Washington, D. C. area may now avail themselves of technical service at this new Callery office: Room 709, DuPont Circle Building, 1346 Connecticut Avenue, N.W. Phone Richard A. Carpenter, Manager, ADams 4-4200.

Note: Our recently opened office in Dayton, Ohio offers specialized technical assistance on fuels and propellants to interested parties in that area. Contact Anthony C. Hummel at 2600 Far Hills Avenue, phone AXminster 3-2752.



Richard A. Carpenter
Manager, Washington Office
Callery Chemical Company

**CALLERY**
CHEMICAL COMPANY
9600 PERRY HIGHWAY
PITTSBURGH 37, PENNSYLVANIA

IMPORTANT ANNOUNCEMENT TO
ALL ENGINEERS—EE, ME, AE, CE:

A New Organization Now Forming at General Electric to Integrate and Direct Systems Management of Prime Defense Programs

From within General Electric, and from industry at large, talented scientists and engineers from diverse disciplines are coming together to form the nucleus of the new Defense Systems Department.

The responsibilities of this new group encompass management of theoretical and applied research as well as advanced development on major terrestrial and space-age systems.

Engineers and scientists interested in exploring the broad new possibilities in the Defense Systems Department are invited to investigate current openings.

*Direct your inquiry
in confidence to Mr. E. A. Smith
Section G*



DSD

DEFENSE SYSTEMS DEPARTMENT
GENERAL ELECTRIC

300 SOUTH GEDDES STREET
SYRACUSE, NEW YORK

when and where

JANUARY

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

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

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

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

Columbia University and Sylvania-Corning Nuclear Corporation, First International Symposium on Nuclear Fuel Elements, Columbia University, New York, Jan. 28-29.

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.

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

MARCH

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

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

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

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.

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AVCO ANNOUNCES



New NASHVILLE Division

*Structures for tomorrow's
aircraft and missiles*

To make ready for the future, Avco Manufacturing Corporation has created a new division at its Nashville plant devoted to design, development and production of aircraft and missile structures and assemblies.

Avco's new Nashville Division (formerly a part of the Crosley Division) boasts an enviable 17-year record of building components for some of the country's most important aircraft, including the B-52, B-47 and B-36.

Today it produces components for these aircraft:

Convair 880 jet airliner—horizontal and vertical stabilizer; wing tip, leading and trailing edges and flaps.

C-130 Hercules transport—complete empennage.

F-102 Delta Dagger—wing trailing edge.

F9F Cougar—horizontal stabilizer, flaperons and flaperettes.

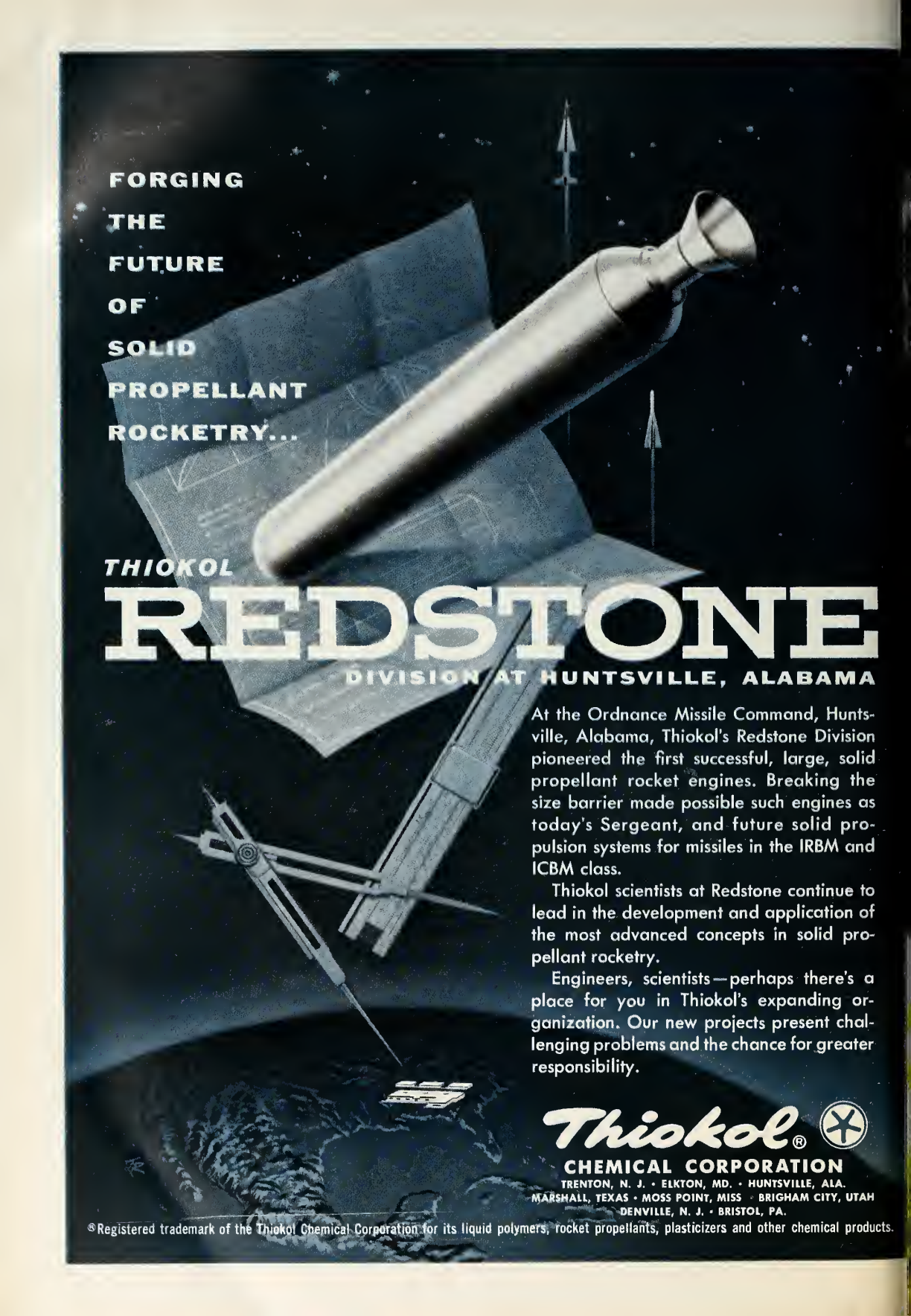
Looking ahead, the Nashville Division has prepared itself to contribute to the Mach 3 aircraft and Mach 10 missiles that soon will go into production as part of the nation's defense effort.

The Nashville Division's skilled personnel have demonstrated their know-how in producing Avcomb, contoured stainless steel honeycomb panels. They long ago proved themselves in the production of aluminum honeycomb structures, and other advanced manufacturing techniques, such as metal bonding and chemical milling.

**Avco/Nashville:
proven . . . ready for tomorrow**

For further information, write:
General Marketing Manager—Structures,
Nashville Division, Avco Manufacturing
Corporation, Nashville, Tennessee.

Avco // **Nashville**



**FORGING
THE
FUTURE
OF
SOLID
PROPELLANT
ROCKETRY...**

THIOKOL

REDSTONE

DIVISION AT HUNTSVILLE, ALABAMA

At the Ordnance Missile Command, Huntsville, Alabama, Thiokol's Redstone Division pioneered the first successful, large, solid propellant rocket engines. Breaking the size barrier made possible such engines as today's Sergeant, and future solid propulsion systems for missiles in the IRBM and ICBM class.

Thiokol scientists at Redstone continue to lead in the development and application of the most advanced concepts in solid propellant rocketry.

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