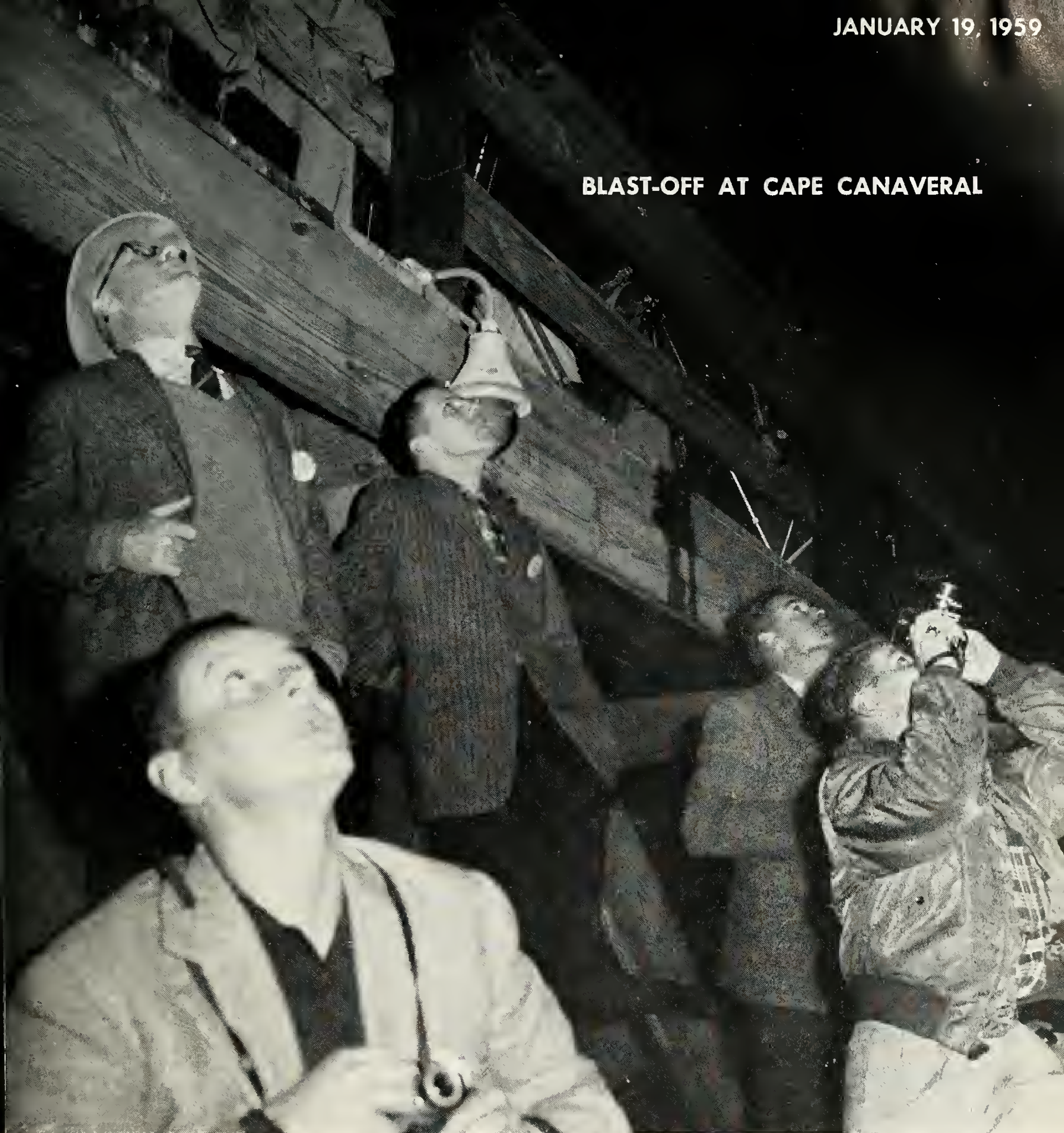
JANUARY 19, 1959



BLAST-OFF AT CAPE CANAVERAL

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

...speaking of

Missile Ground Support ***EQUIPMENT***

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Operated by the Air Defense Command, a Boeing Bomarc climbs skyward from its launcher. FMC is building ground support equipment for this supersonic missile.

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Ordnance Division

Missile Equipment Section 1-L

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missiles and rockets Vol. 5, No. 3, Jan. 19, 1

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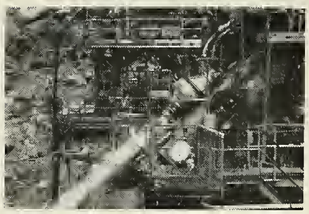
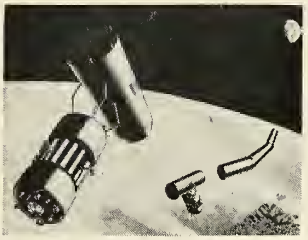
missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

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

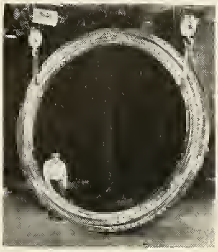


UNDERGOING TESTS at Rocketdyne using conventional fuels is *Kiwi-A*, part of *Rover* program.

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



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



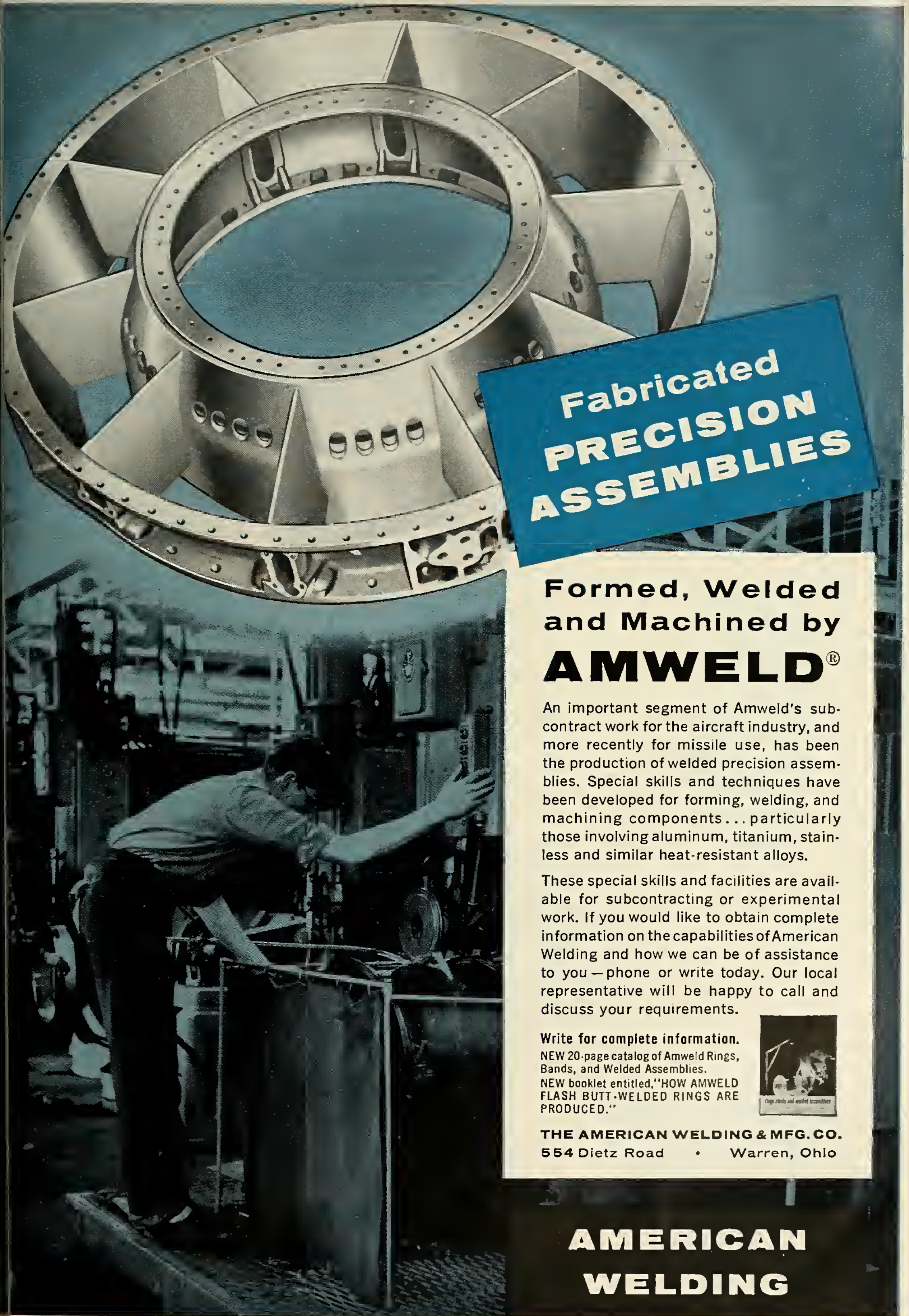
RADAR SYSTEM for *Nike-Zeus* will require this mammoth ball bearing, supporting million lbs.

JANUARY 19 HEADLINES

ASTRONAUTICS-ENGINEERING

MISSILE ELECTRONICS

DEPARTMENTS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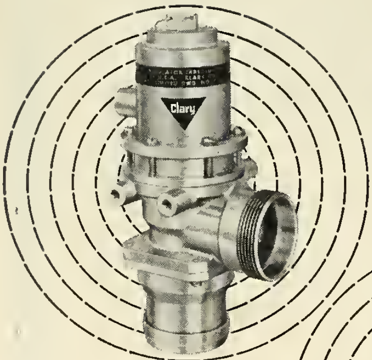
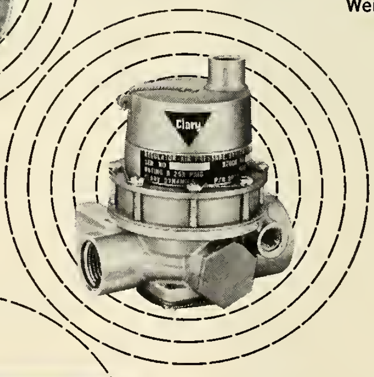


ABSOLUTE PRESSURE REGULATOR maintains an outlet pressure of 18½ to 20 PSIA with variations in flow rate from 3 to 350 SCFM under 30 to 100 PSIA inlet pressure and −65°F. to +350°F.

Weight: 2.1 pounds Length: 8.55 inches
Tube Size: Inlet: 1.50 inches
Outlet: 2.00 inches



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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.

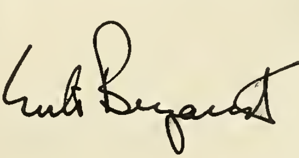
It is only to be expected that members of the House and Senate committees during the past year were able to learn a bit about astronautics. But how much time were other legislators able to devote to the subject? In the end, their opinions will decide the destiny of this country. These representatives—just 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.*



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 rang

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

Bendix Systems Division, working with six ot Bendix Divisions and major aircraft and propulsi organizations, directed all phases of development wo up to and including prototype construction and testi

Bendix Systems Division welcomes inquiries and prepared to provide full information to the Armed Forc

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

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.

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 Elkton 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 Clevite, 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.

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 Hand-ok" drawn up by RAND Corp. as a yman's guide is likely to find use also a blueprint for an 86th Congress xious to expand and speed up merica's space effort.

The document, released by the ouse Select Committee on Astro-utics and Space Exploration, en-sions attempts at landings on the moon, enus and Mars, and manned satellites orbit around the earth within the xt five years—using modifications of esent missile hardware.

It flatly disagrees with published inions of other experts and declares at satellites can be used as bomb-g platforms and that atomic bombs n be effective in airless outer space.

In the last, busy week of its exist-ce, before being replaced in the new ongress by a Standing Committee on ace and Astronautics, the select oup took two other actions under-ing the urgency of the picture.

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

And it released a statement by hairman John W. McCormack (D-ass.) warning that "we can't afford have a Pearl Harbor in outer ace . . ."

• **Definitive work**—The RAND re-rt, which the Committee will send the nation's high schools and in-ested educational institutions, is one the most definitive treatises on space chnology and applications yet to ap-ar in lay language.

The 225-page document breaks wn space technology into 17 areas, th extensive studies of space environ-ent, trajectories and orbits, vehicles, opulsion and propellants, guidance, mmunication, observation, landing d 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 Kyzl 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 stabilizing 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.

Retrorockets 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: th measure introduced by Sen. Hubert H Humphrey (D-Minn.) to create a De partment of Science. Feeling had bee that last year's crop of new agenci and councils should be given a chan to operate a year or two before an other agency was set up or any chang were made. Supporters claim *Luni* may have given their cause a decisi shot in the arm.

Foes of the science departme plan had argued that establishment the new Federal Council for Scien and Technology made an addition agency unnecessary. But supporte pointed out that while the council aim is to "promote closer cooperatio among Federal agencies" in researc areas, it has no policy-making au thority.

• **Crash program urged**—Se Henry M. Jackson (D-Wash.) urged crash program to snatch space leade ship from the Russians. He charge the Administration with a "business usual" approach in a situation callin for "dramatic" action.

Jackson, a member of the powerf Armed Services Committee, score penny-pinching in defense plannin "We are going to have to spend mo money," he declared. "There is no sub stitute for it."

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

Other proposed defense measur boosted by *Lunik's* impact include th bill by Sen. Leverett Saltonstall (R Mass.) calling for major military pr curement changes involving weapo system management, easing of reneg tiation inequities and liberalization 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 pro- osal to place a "permanent" manned tellite laboratory in operation within years reportedly is interesting gov- nment agencies.

Estimated cost of the station is .163 billion. This includes develop- ent, construction, and launching, but es not allow for major breakthroughs the state of the art.

The necessary engineering know- w has been developed and hardware either available or under develop- ent for an immediate start on a seri- s, coordinated program to put the oratory in orbit, Lockheed scientists y.

In a highly detailed report, based long months of study, Saunders B. amer and Richard A. Byers of Lock- ed's Missile Systems Division pro- e a launching system, satellite ve- les and operational procedures in e with established engineering tech- ques. The report was presented be- e the American Astronautical So- ty's fifth annual meeting.

Unlike many previous proposals, report makes no reference to plans designs far from the threshold of quisition. For example, throughout entire operation—from launch and embly of prefabricated components orbit to the transfer of personnel the completed station—the men uld be sheltered from the space ironment in cabins with simulated th conditions.

No clumsy, asphyxiating space suits h impracticable magnetic shoes are gested for "protecting" the satel- 's assembly and staff personnel. Kra- r and Byers say it is time for space ineers to forget such "science fic- " schemes except for emergency ipment.

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 "astrotug" 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 "astrotug'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 "astrotug" arrived, would be held down to a few miles.

With the pilot compartment fixing the position of station assembly, the "astrotug" would acquire the second compartment on its radar or infrared search equipment. Using its navigation computer, the "astrotug" 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.

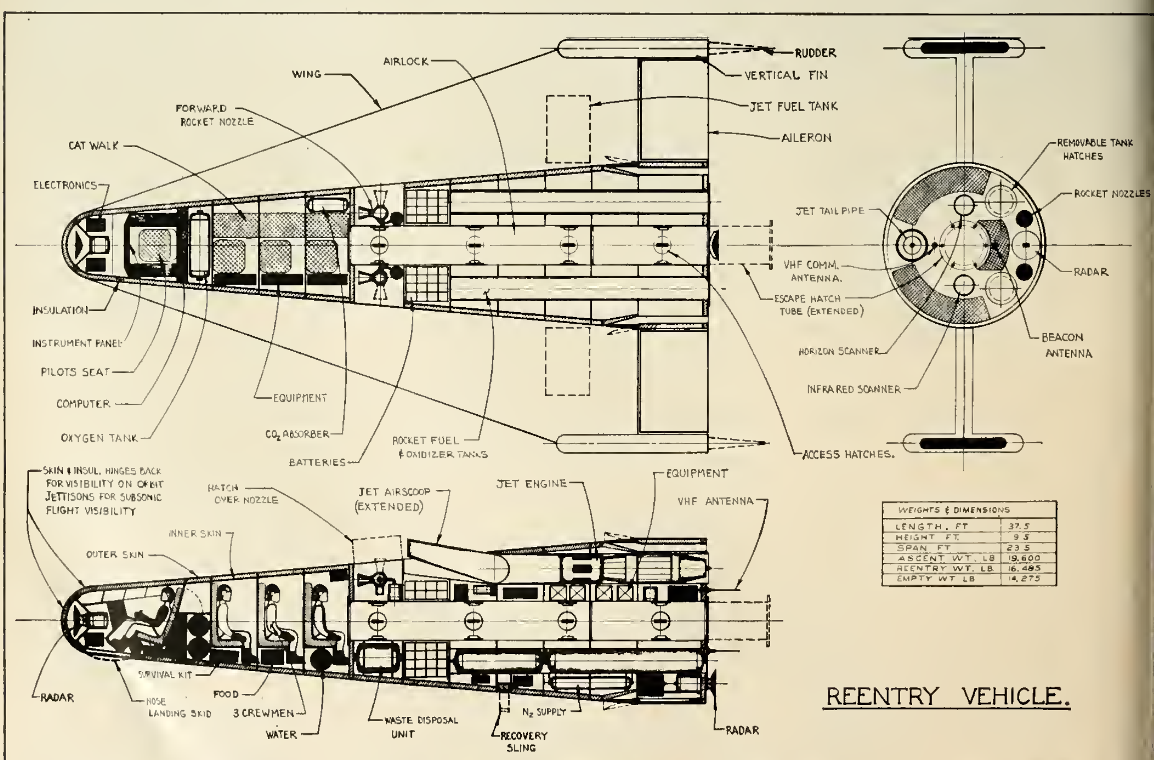
Pilot observation would be through a windshield protected during re-entry by hinged thermal doors. A full circular horizon scanner would provide optical orientation while in orbit.

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*)



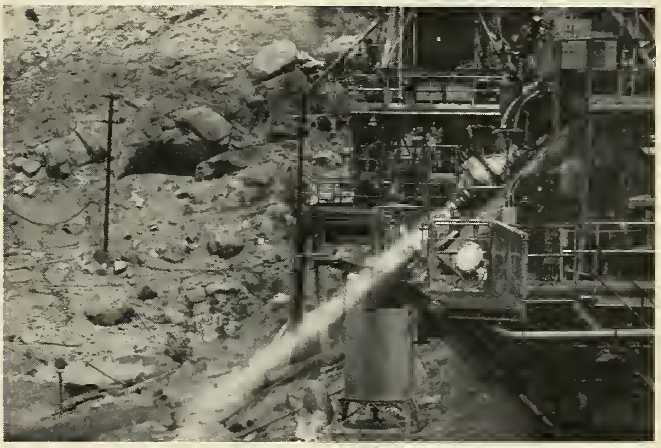
REENTRY VEHICLE for Lockheed-proposed space station could carry crew of four.

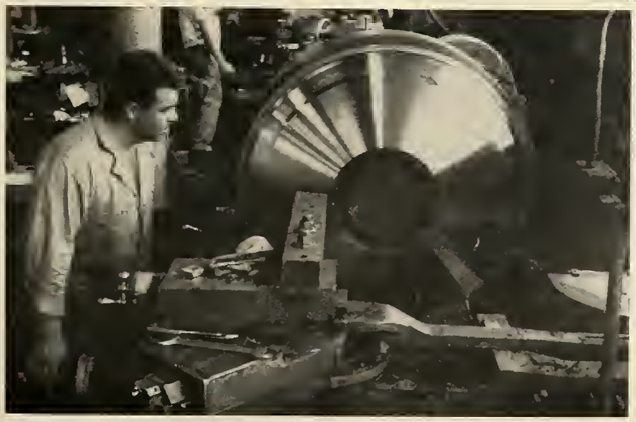
astronautics in the news . . .

ANORAMIC VIEW of weather
onditions is shown in this com-
osite of five photographs taken
a camera rocket fired from
Vallops Island, Va. Photographs
ken from an altitude of 86
iles, show an area of 1000
iles extending, left, from Nova
cotia to hundreds of miles
uth of Bermuda. Cameras op-
ated at shutter speeds of
2000 of a second.

THIS BALL bearing made hy 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 hefore being shipped to the Los Alamos Scientific Laboratory.

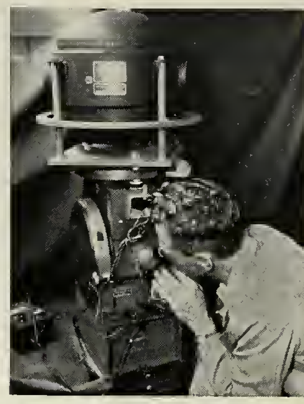




Polaris ROCKET MOTOR casing part heing machined by Diversey Engineering Co. for Aerojet-General Corp., propulsion system prime contractor for the fleet ballistic missile. Of large diameter hy present-day standards, it still is not hig compared to some of the solid propellant motors now in the works, 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 he finished to extremely high tolerances.

Gyro Drift Demanding New Measurement Techniques

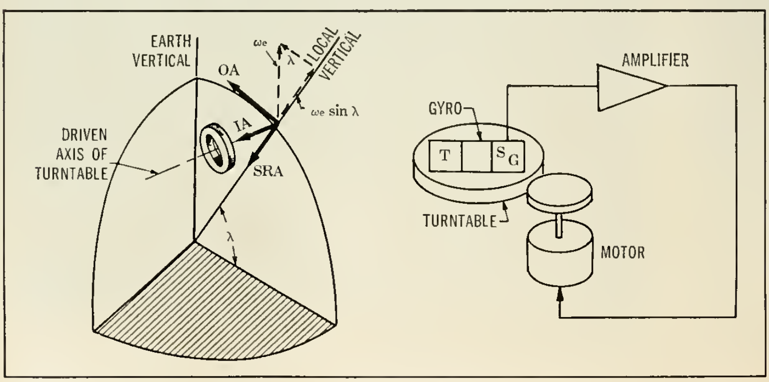
by **Ralph Hookway**
Electronics Department,
The Martin Company



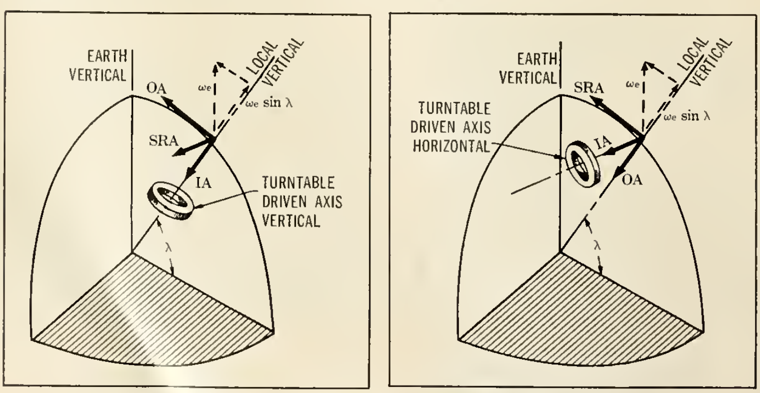
GYRO MUST be mounted on rigid and precise turntable.

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' newer missiles, demanding a rate o less than 0.05 degrees an hour, brin new requirement standards.



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.

This article will summarize dri measuring techniques for systems use in the TM-76 *Mace* which has a fairl long flight time in an acceleration er vironment of essentially lg. Ballisti missile systems which experience hig accelerations for short flight-time pe riods, will not be considered.

• **Drift causes**—By definition, dri rate is that angular velocity about th input axis (with respect to inerti space) which is necessary to keep th gyro output signal constant (near zerc when no signal current is applied t the torquer. It results from design lin itations and imperfections in manufa ture, such as very small, residual in balances which produce a torque whic in turn, generates a drift rate.

Stray torques are also introduce by the electrical lead-ins to the floa bearing friction, and the self-induce magnetic fields at the pick-off a torquer. In typical inertial instrumen the torque producing the characterist drift rate is very small. For exampl a gyro with an angular momentum 10^5 gr-cm²/sec when subjected to torque of only 0.02 gr-cm²/sec² d plays a drift rate of 0.05 deg/hr. a 1 cm arm, this torque is produc by a mass of only 2.47 x 10^{-5} gram

Since the torques are so small a can be measured only with the gy completely assembled, a technique h been developed which, in effect, us the assembled gyro to test itself. Stat

New electronics frontiers

Advanced systems research, to meet the demands of complex modern weapons systems, is among the many new activities that attract engineers and scientists to IBM. This research encompasses over-all planning of methods for the detection of flying objects . . . feasibility studies of guidance, detection and defensive systems . . . specification of radically new equipment for terrestrial and stellar navigational problems. Academic studies of logistics, operations research, information and communications theory are also part of this new research at our Kingston facility.

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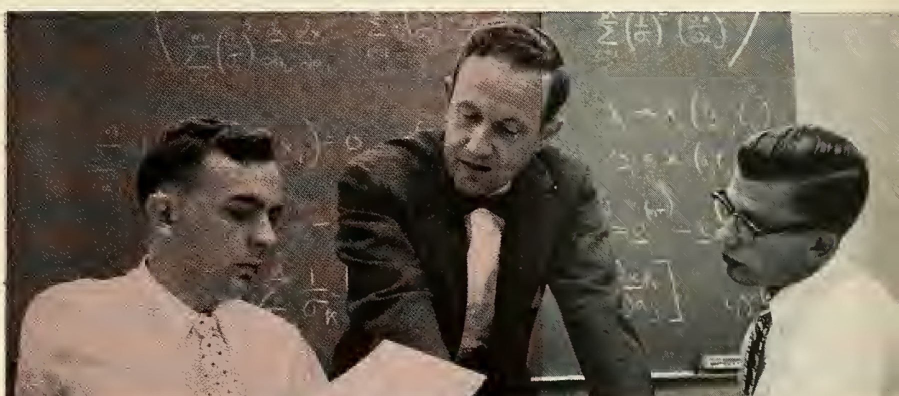

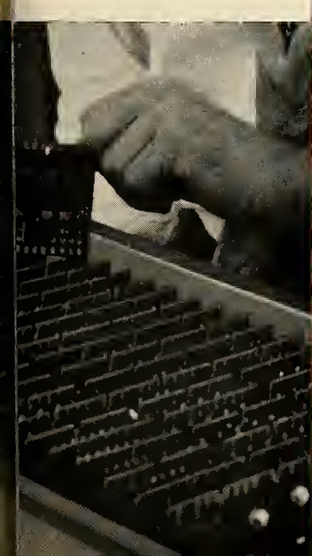

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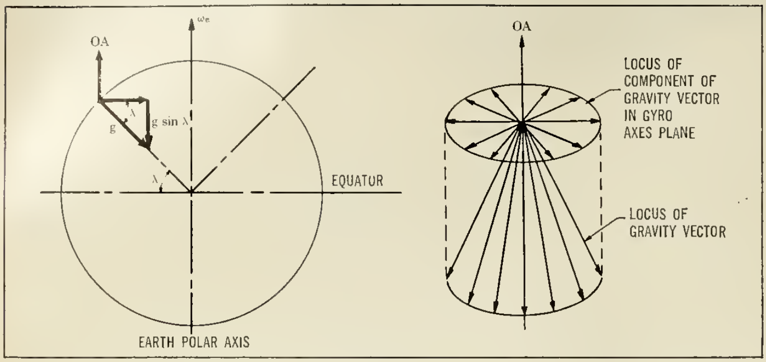
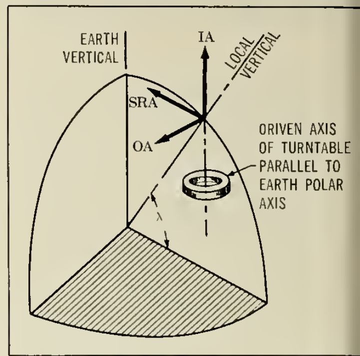


LOCUS OF GRAVITY vector relative to gyro axes.



ALINEMENT 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-g-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:

$(Ug)^2 \max = (U_1 - U_3)^2 + (U_2 - U_3 - W_e \sin \lambda)^2$ (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:

$W_{ev} = W_e \sin$

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 Err
0.001 to .1	2 sec to 3 mi

It is now possible to define U_3 the drift rate measured by orientir the gyro so that its OA is vertical, SR horizontal and pointed north-south. I and the driven axis of the test turntab are horizontal, pointing east-west shown in Diagram 3. The local gravi vector lies along the OA so that r gravity-induced torques are applie Nor is there a component of earth ra to account for.

From this testing procedure, get the maximum drift rate to expected from a gyro in an lg gravit tional field regardless of its orientatio While a measure of gyro quality, th data is not directly useful in pı launch adjustment of certain inert guidance systems, since it does not d plicate the time history of the relati between the gyro axes and the lo vertical which will occur in flight.

• **Geometric system**—The *Mace* i ertial system is of the geometric ty however. Here the gyro reference fixed in inertial space at the laun point vertical while acceleromet track the local vertical throughout flight to indicate the earth central an between launch point and present pc tion. Distance traveled over the surf of the earth is easily obtained.

In general, orientation of the lo gravity vector relative to the gyro a varies during flight. Since the g drift rate varies with the orientation gravity, to achieve the utmost accur from the guidance system the d measured should be corrected for s sitivity of the gyro to gravity orier tion. Gyro coefficients to be used data inserts in the guidance system obtained by tumbling tests.

The same type of test table (pho

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 yro axes is as shown in Diagram 4. 'wo minor effects, which can be ne- lected, 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 iown in Diagram 5 and the gyro pick- ff signal can be used to drive the table nd hence the gyro pickoff to null. This rocedure fixes the gyro in inertial pace 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 erformance of a geometric inertial uidance system. Total angular motion ported by the gyro in a given time eriod is compared with the actual igular motion of the earth in the same me. 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 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 ive the gyro torquer (after proper nplification). The test table is rotated some multiple of earth rate, but this tation is not seen by the gyro since component of it appears along the ro input axis. Recording the torquer rrent as the orientation of gravity ries varies gives a measure of gyro ift.

glin Telemetering ontract is for $500,000

Princeton, N.J.—A contract of ore than $500,000 for supplying ee telemetering ground-station sys- ns for the Eglin Gulf Test Range, ., has been awarded by ITT lab- atories to Applied Science Corp. of nceton.

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

Each systm will contain FM/FM, M and PW equipment, simulta- usly handling data signals from ee aircraft or missiles and from three nes. Each aircraft or missile will able to transmit to each site four tinuous data channels and up to 90 channels of time-division commutated data. Each drone will be able to trans- mit 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.

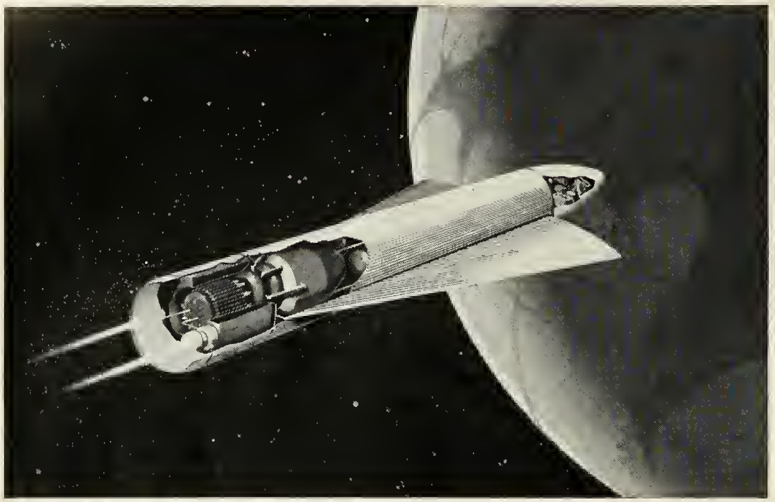
Arthur S. Cosler Jr., executive director of Ohio State University's Mapping and Charting Research Laboratory, who made the statement, emphasized that the vehicle would have to be powerful enough to carry such instrumentation.

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

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

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.

FIRST WITH POWER FOR OUTER SPACE

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

›rrect 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- ›le, 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 lculations 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 uipment must be automatic.

mphenol and Borg Firms lerge Electronics Output

CHICAGO—Two major Midwestern :ctronics firms, Amphenol Electronics ›rp. and the George W. Borg Corp., ve merged into Amphenol/Borg Elec- ›nics Corp., with combined assets of ›re than $37 million.

Arthur J. Schmitt, Amphenol's pres- ent, is chairman of the board and esident of the new company and eorge W. Borg, chairman of the Wis- nsin firm, is chairman of the execu- e committee.

The consolidation was approved by ›ckholders of both companies in eetings held Dec. 30. It was effective ec. 31.

The merged companies, with head- arters here, will have total floor ace of a little more than 1 million uare feet when Amphenol's new Chi- go plant is finished. The figure ex- ıdes divisional plants in Connecticut d California.

Amphenol is a major supplier of nnectors, cables and other electronic mponents for missiles. Borg pro- ices precision potentiometers, direct ading counting dials and electronic struments.

CA Adds Space For Its rowing Missile Business

Radio Corporation of America has ised a two-story brick building at 'oydon, Pa., to provide space for its panding military business.

The new plant, containing 74,000 uare feet of floor space, is situated 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 Missile and Surface Radar Dept., Moorestown, N.J., and will provide supplementary space for rapidly expanding activities at that location.

missile people

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

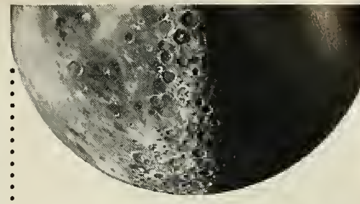
Rep. Overton Brooks (D-La.), slated to head the House Science and Astronautics Committee is known as a "progressive Southern Democrat." Long a member of the House Armed Services Committee, where he is second-ranking member, Brooks is highly respected by Defense Department officials who come to committee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

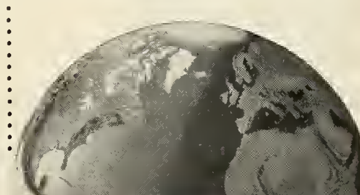
Dr. Siegfried J. Gerathewohl, authority on weightlessness and a contributor to m/r, has joined the Von Braun team at the Army Ballistic Missile Agency. He will work under **Dr. Ernst Stuhlinger,** ABMA's director of the Research Projects Laboratory. Dr. Gerathewohl left the School of Aviation Medicine where he has conducted experiments on the effects of weightlessness in space flight after coming to this country from Germany 11 years ago.

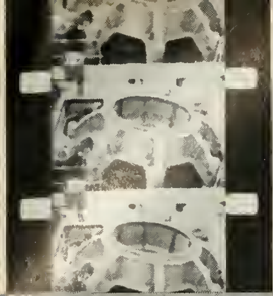
Henry E. Billingsley has been appointed director of the Office of International Cooperation of the National Aeronautics and Space Administration. He was formerly chief of the Western European Division in the Defense Department's Office of Internal Security Affairs.

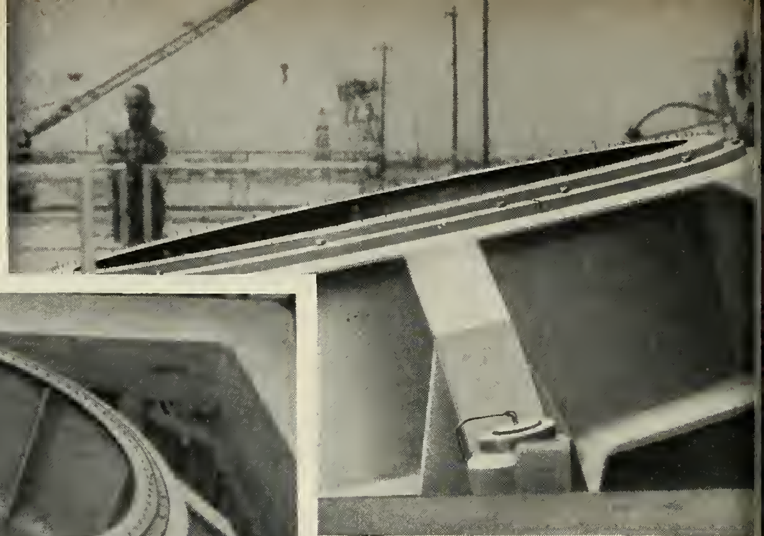
George M. Bunker, president and chairman of the board of the Martin Co., has been elected to Bulova's board of directors.

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 management. **Dr. Nathan I. Hall,** vice-president and director of systems development laboratories, has been named to fill Shank's former post.



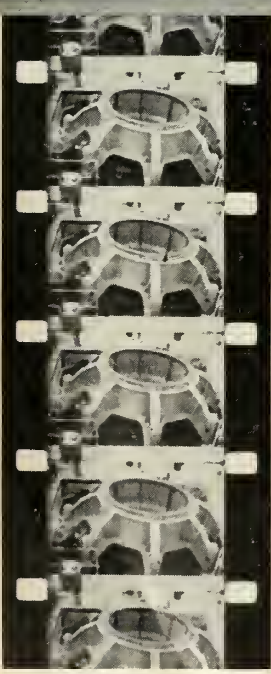






"Shaker" pitching

"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."

For creative engineering and design, research and development in your defense and industrial contracts, direct your inquiries to us at Dept. S-1.

Loewy-Hydropress Division

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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 lifetime (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.

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*.

. . . 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 reentry vehicle should be similar to those of the boost-glide vehicle.

• **"Astrotug" design**—The workhorse 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 boster 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 turbojet 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.

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, Jtah:

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, Philaelphia:

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, 'a.:

511,189—**General Mills, Inc., Mechanical Division,** Minneapolis, for automatic tracking theodolite equipment for artillery survey system.

y U.S. Army Ordnance Missile Comand, 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 Engieer District, Fort Worth:

134,092—**Suggs Construction Co.,** Big Spring, Tex., for storage of base of rocket assembly at Big Spring AFB.

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.

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.

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

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