missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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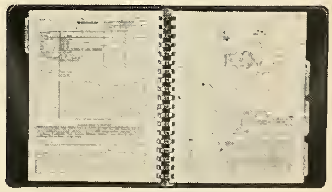

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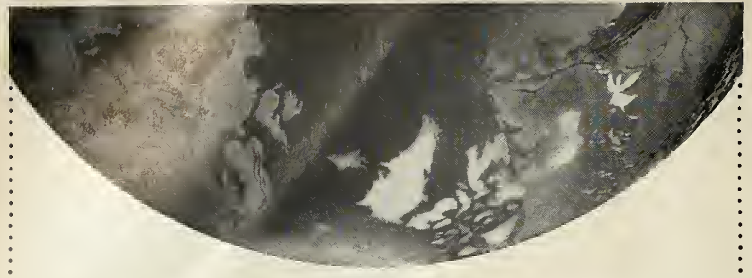

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

MAY 4 HEADLINES

SPECIAL SECTION

MISSILE ELECTRONICS

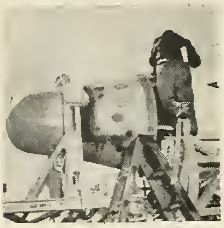
ASTRONAUTICS ENGINEERING

THE MISSILE WEEK

DEPARTMENTS

COVER: Boeing's *Bomarc-B* will take over much of the U.S. air defense job in competition with Western Electric's *Nikes,* (p. 15)

CREW inspects flotation bag used in recent recovery of AF *Thor-Able* nose cone from the South Atlantic.



RE-ENTRY vehicle is attached to afterbody of the *Discoverer II* prior to successful launch on April 13.

LARGEST titanium head shape ever formed was made by Lukens Steel for Wright Aeronautical Div., Curtiss-Wright Corp.

NAVY launches *Polaris* vehicle from Cape Canaveral April 20 in reportedly successful test of primary flight objectives.

The Golden Field of Missile Support

One of the most critical tasks facing the missile procurement people today is making Congress, the Services, the civilian administrators of the military, and the public realize that the tremendous cost of the program lies not in the missile itself but in its support equipment.

Under that hard stand from which the *Thor* or *Jupiter, Atlas* or *Titan* is launched are miles of pipe, tubes and conduits. Under the stand or in the blockhouse and other shelter units are pumps of all kinds for liquid nitrogen, hydrogen and oxygen. There are pumps for gases, high- and low-presssure valves from a quarter of an inch to two feet in size. There are structural steel and sheet steel, tons of concrete, other tons of reinforcement, instruments of all kinds—sensors, recorders, gauges and computers. There are generators for electrical power, highly-automated check-out equipment, tubes, transistors and dials, trucks and hoists and fork lifts and elevators—and on and on and on.

One *Titan* will cost approximately $2 million. A launching complex for a squadron of nine *Titans* will cost about $45 million. Sites for other missiles can be cheaper. Cost of *Atlas* locations will depend upon the degree of hardening, that is, protection. But multiply the cost of ICBM sites under any reasonable formula and you come up with an entirely new segment of American industry which inevitably will run into billions of dollars.

This fact has not escaped the giants of American industry: big steel, aluminum, the automobile colossi, the big foundries, the heavy equipment people. Said a Pentagon colonel in procurement:

"I was at an official party the other night. One of the top officials of U.S. Steel—not a division man but a top official of the parent company—backed me into a corner and questioned me for fifteen minutes on how to get into the support equipment business."

Many of the big companies now looking over this field find themselves handicapped (unlike the big aircraft firms who have had an eye on it all along) by the lack of technical know-how. They are looking around for smaller companies with technical competence. Object: purchase, merger or simply to work as a team.

The services are looking just as hard for this same competence and particularly for new methods, for many of the construction problems they face involve new problems where new techniques are demanded—at least, new techniques would be welcome.

The *Minuteman,* for instance, will be operational in two to three years—but long before that time the Air Force must have trained crews and prepared sites to receive it. The *Minuteman* is a solid-fuel inter-continental missile with an approximate one megaton warhead. Its site is a hole in the ground—an inverted silo, some 100 feet deep, lined with concrete. Under present plans the *Minuteman* will be manufactured (by Boeing) by the hundreds. And each *Minuteman* means a hole in the ground lined with concrete.

Digging that hole in the ground (multiplied several hundred times) is going to be a pretty expensive business. So is lining it with concrete strong enough to protect it up to, say, 100 psi from a near miss.

It can be done with present methods, but the military would like to see someone come up with a new method of producing the hole—maybe by drilling, maybe by reducing the earth to liquid and sucking it out. Anyway—just so it is efficient and cheap. Said another Pentagon official:

"The man who can come up with a way to dig a 100-foot hole 20 feet in diameter for $50,000 is going to be digging more damned holes than this country has ever seen. And—mark my words—he won't be a big guy. He'll be a little guy with an idea."

The same thought applies to lining the silo with reinforced concrete. Come up with a new method, a new idea, a way to do it fast and cheaply and there'll be a golden reward.

It all adds up to the fact that ballistic missile cost is like the iceberg, four-fifths submerged. The weapon itself will get easier and easier to build as the skills in such spacecraft advance, but there is an equal—and for the moment, greater—need for advanced ingenuity in the parallel field of missile support equipment.

Clarke Newlon

Missiles and Rockets will begin a series of articles shortly relating in detail the problems facing the nation in the building of missile bases, how the giants of industry view those problems and the steps they are taking to deal with them.

the missile week

washington countdown

IN THE PENTAGON

ARPA is fighting back to maintain its existence. However, the battle appears to be getting rougher—and more open. Many Pentagon foes of ARPA took heart from the demand by Maj. Gen. Bernard A. Schriever, newly-named Air Force R&D commander, that ARPA be abolished.

• • •

Some experts are betting the best the Navy can hope for in its *Polaris* program is a 1200-mile operational missile by the end of next year. But they say an 800-mile missile is far more likely.

• • •

The Army's satellite detection fence that went into operation in late March is reported to be working perfectly. The fence detected and located the orbit of the *Discoverer II* satellite shortly after it was launched April 13. Informed sources say the fence is capable of detecting any satellite whether or not the satellite is radioing a signal. . . .

• • •

The Air Force has completed a series of pre-contract tests of air-launched ballistic missiles at Cape Canaveral. Award of a contract for an Air Force ALBM is considered imminent.

ON CAPITOL HILL

Congressmen are reading a hair-raising report put out by the House Military Operations Subcommittee. The report—the most authoritative of its kind to date—warns that Russia has a good and steadily improving civil defense system. And it says the better Soviet CD gets the more America's deterrent strategy is undermined. But don't expect Congress to do much about it. The solution would cost billions.

• • •

Watch for a congressional investigation of how much—or how little—about the nation's space programs is being told the bill-footing taxpayers. The House Information Subcommittee can be expected to look into the matter.

• • •

The whole GOP strategy to hold the line on spending hundreds of millions more for ICBM's is being endangered by the White House. The GOP problem: President Eisenhower's insistence that Congress authorize hundreds of millions more for missiles for America's NATO allies. The foreign aid increase—little of it to come in FY 1960—was recommended by the President's own foreign aid advisory committee.

AT NASA

Present schedule for the U.S. man-in-space program is: (1) a short-range flight down the Atlantic Missile range in a *Redstone;* (2) a simple orbital flight in the Project *Mercury* space capsule; (3) an advanced orbital flight in a maneuverable space vehicle; (4) an orbital flight of several days by a maneuverable vehicle manned by seven men; (5) a permanent manned orbiting space lab; (6) a manned flight to the vicinity of the moon; (7) manned landings on and return from the moon; (8) interplanetary flight.

• • •

Systems engineering on the Project *Mercury* vehicle will be done by NASA's Space Task Group and not the Air Force's Space Technology Laboratory as had been reported earlier. STL will be consulted about the *Atlas* booster, but the Space Task Group will do the actual mating of the various components and will recommend to NASA who the subcontractors should be.

AROUND TOWN

Diplomats are speculating on the effect of possible British entry into the East-West space race. The British are considering the possibility of using for satellite launching their new liquid *Blue Streak* missile which is still under development. One reason that some Englishmen are pushing a British space program is to halt the departure of British space experts for America.

• • •

Russia's next bid for leadership in space may not be a manned satellite as many have believed after all. Instead, Russia is reported to have given top priority to launching a spy-in-the-sky satellite—for peaceful purposes, of course.

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industry countdown

Douglas gets ALBM

Douglas Aircraft Co., Inc., will get the hotly-contested contract for development and prototype production of *WS-138*—the air launched ballistic missile. Air Force selection boards made the decision following a stiff pre-contract competition (Washington Countdown, p. 9). The selection of Douglas was on the desk of Air Force Secretary James Douglas as M/R went to press. The secretary was expected to make the announcement of the contract on his return from a trip away from Washington.

STRUCTURES

To accelerate *White Lance*—an advanced *Bullpup* packing nuclear warhead—Air Force is asking $6.5 million in 1960 FY. Under development by Martin-Orlando, *White Lance* reportedly will have packaged liquid engine by Thiokol. It may also have television-type guidance system, although there are reports this type guidance may be shelved.

• • •

Hypersonic wind tunnel producing speeds up to Mach 10 is being constructed at Army's Aberdeen Proving Ground. New unit is in addition to existing APG Mach 5 installation.

• • •

Expect Chairman Carl Vinson (D-Ga.) of the House Armed Services Committee to muster a strong floor battle for permanent continuation of the Renegotiation Act. Vinson is adamantly opposed to any change in present strict provisions, despite urging of DOD and industry. AIA and EIA say they could live with the law if authority of Renegotiation Board is clipped to keep it from challenging incentive earnings and basic earnings on defense contracts.

• • •

NASA $24 million prime contract for *Delta* launching vehicle goes to Douglas Aircraft Co. With revamped Aerojet-General liquid-fueled first and second stage engines and Allegany Ballistics Laboratory solid third stage, *Delta* is designed to put 250-pound payload in 300-mile orbit or send 110-pound payload on deep space probe in 1960-61.

Nuclear-powered carrier Lexington is deploying to Atlantic fleet with the first operational squadron of aircraft armed with the air-to-surface *Bullpup*. FJ-4B's and VA-212's can each carry five of the 540-pound missiles.

PROPULSION

With the Army, Wyandotte Chemical has developed new solid propellant L-1, said to have 10% to 15% better performance rating than existing solids and a specific impulse of 260+. Composition is nitroglycerine, nitrocellulose, polyurethane, ammonium perchlorate, aluminum, magnesium oxide and 2-nitrodiphenylamine.

• • •

Behind AEC's abrupt start-and-stop buying of quantities of lithium and lithium compounds, principally from Foote Mineral Corp. and the Lithium Corp. of America, is this explanation: AEC was using lithium hydroxide in cooling loops of *Kiwi* reactors—and suddenly shifted back to sodium hydroxide when it couldn't lick the corrosion problem.

ELECTRONICS

Present concepts of radio propagation may be revised on the basis of Ohio State University's measurements of *Sputnik III* signals, which indicate ionosphere depth of thousands of miles. If electron density diminishes at such a low rate with distance outward from the earth, as researchers have concluded, then ionoscatter path lengths may be increased significantly. DOD and NATO may find itself with a surplus of its newly-established ionospheric scatter mode stations around the globe.

• • •

Breadbox to sugar cube size reduction is visualized in Westinghouse breakthrough in growing germanium crystals as thin, flat ribbons for miniaturized electronic space vehicle equipment. ARDC has awarded the company a $2 million contract for further molecular electronic development.

ASTROPHYSICS

New theory has been proposed by Dr. Harold C. Urey that the moon may have molten interior with erupting volcanoes giving off gas and changing its exterior surface. The theory gives support to Russian observations, previously greeted with skepticism, of gaseous eruption from the lunar Crater of Alphonse.

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

Strategic Ready Reserve Studied

Contractual personnel would maintain and operate complex weapon systems even in tactical use under proposed plans

by Donald E. Perry

WASHINGTON—Top Defense planners are seriously studying highly classified missile industry proposals which, among other things, would involve creation of what may be known as a Strategic Ready Reserve of trained and experienced contractual personnel to substitute for uniformed servicemen in firing complex missile hardware in event of war.

At least three prime weapon system contractors have submitted views which are being studied by the Joint Chiefs of Staff, Pentagon manpower utilization branches and the war colleges of the principal services, M/R has learned.

If a decision were made for retaliatory "button pushing," contractual personnel would immediately become military personnel subject to current Armed Forces regulations. The military-missile forces conceivably could be reduced to a skeleton force of technologically competent career officers.

An ultimate goal in the proposals is future weapon systems contracts including tactical staffing and operation in addition to design, development, manufacturing and testing.

All but the first are now done by weapon system prime contractors, many of whom feel that if war comes tomorrow contractor personnel will have to do the firing because of lack of sufficiently trained service personnel.

The dollar volume of prime contracts would swell to super-high figures, but on the other hand, industry spokesmen have told M/R, standing Armed Forces, their training and subsistence would be reduced far below the present 1.5 million manpower figure.

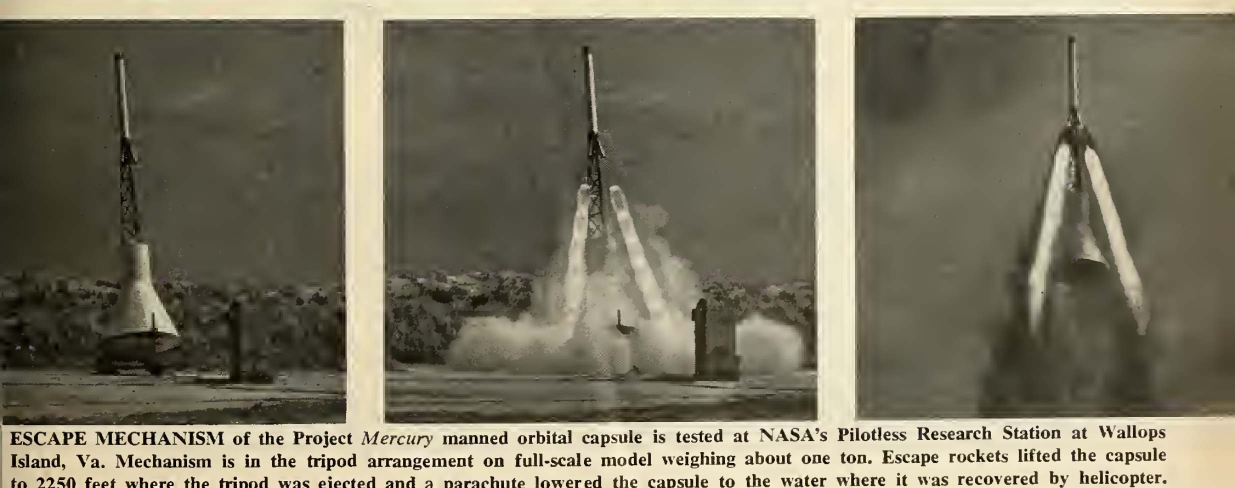
• **The problems**—Defense planners are seriously worried about the ability of military personnel to maintain and operate complex weapon systems. Training costs of service personnel climb to astronomical new highs each year. Coupled with this is the problem of service personnel turnover. After costly expenditures for training, servicemen join the ranks of industry when they are trained and experienced, thus depriving the military of their services at a time of maximum usefulness.

Another problem area is mobilization of reserve forces. Planners are ruling out any quick mobilization during all-out missile warfare. The time factor will not permit recruitment and training in complex weaponry or transport to aggressive warfare stations and duties. One proposal for utilization of manpower in reserve programs would be assignment to minor defensive roles and responsibilities and to take over duties presently vested in the virtually ineffective Civil Defense organization.

These reserve forces would thus be used in a point defense concept with the Strategic Ready Reserve force manning critical posts.

• **When will it come?**—Industry spokesmen believe that the first test of the Strategic Ready Reserve Force could come in the fleet ballistic missile program. The Navy is quietly wondering whether service personnel can be trained—and retained—with the technological qualifications to operate and service the hardware and support equipment necessary for instant retaliation.

MERCURY CAPSULE TESTS AT WALLOPS ISLAND



ESCAPE MECHANISM of the Project *Mercury* manned orbital capsule is tested at NASA's Pilotless Research Station at Wallops Island, Va. Mechanism is in the tripod arrangement on full-scale model weighing about one ton. Escape rockets lifted the capsule to 2250 feet where the tripod was ejected and a parachute lowered the capsule to the water where it was recovered by helicopter.

COVER STORY:

Bomarc Will Soon Move into U.S. Air Defense Role

Boeing surface-to-air missile goes to first base this fall, may displace Nikes

by James Baar

WASHINGTON—The Era of the *Bomarc* is almost at hand.

In less than six months the first base for the Boeing surface-to-air missile is scheduled to be opened at McGuire AFB, N.J.

At any time now the first greatly-improved *Bomarc-B* will streak from Cape Canaveral where the new model will begin undergoing flight tests.

Within the next year to two years squadrons of nuclear warhead-packing *Bomarcs* will be stationed across the nation at from seven to 14 air defense bases—most probably more.

The first two will be equipped with the more than 200-mile range *Bomarc-A*. The rest will be equipped with the more than 400-mile range *Bomarc-B*.

• **Air Force vs. Army**—The final number of bases to be set up hangs on the outcome of the bitter competition between the Air Force's *Bomarc* and the Army's Western Electric *Nike-Hercules*.

Gen. Thomas D. White, Air Force chief of staff, has said 40 *Bomarc* bases could protect the entire country from attack by manned aircraft.

The first two *Bomarc* bases are expected to have 60 launchers. The rest are expected to have about 30.

Bomarc-B's at any one base will be able to hit targets within a half-million square mile area. The entire area of the United States is about 3 million square miles.

However, any *Bomarc* base-building program of such magnitude would be certain to mean the end of the *Nike-Hercules* program. And, at least at present, nothing of the sort is being planned by the Defense Department.

• **Defense in depth**—Defense Secretary Neil H. McElroy told Congress only recently that both weapon systems are needed: the 75-mile range *Nike-Hercules* for point defense; the much longer range *Bomarc* for area defense.

McElroy said the *Nikes* and *Bomarcs* used in combination with manned interceptors provide the nation with "defense in depth."

Richard E. Horner, Assistant Air Force Secretary, said the *Bomarc* could be used to do "the *Nike* job." But he said it "would not give its greatest defense capability per dollar in that kind of task."

However, a recently completed report by former Assistant Defense Secretary Louis Furnas gave the *Bomarc* an enthusiastic boost. The result is expected to be a speed-up in the program—including the release of more funds for base construction and possibly the naming of three more base sites.

• **Bases to date**—At present a total of 14 base sites have been chosen. The first four and the order in which they are scheduled to be completed are: McGuire; Suffolk County AFB, N.Y.; Otis AFB, Mass.; and Dow AFB, Maine.

The 10 others chosen are: Langley AFB, Va.; Kinross AFB, Mich.; Niagara Falls Municipal Airport, N.Y.; Truax Field, Wis.; Duluth Municipal Airport, Minn.; Paine AFB, Wash.; Camp Adair, Oregon; Travis AFB, Calif.; Vandenberg AFB, Calif.; Ethan Allen AFB, Vt. But of the last 10 funds have been released only for Langley, Kinross and Duluth.

By the end of next month the Army is scheduled to have 62 battalions of *Nikes*—both the 35-mile *Ajax* and the *Hercules*—protecting key targets around the country.

• **Ten-year program**—The *Bomarc* program dates back to 1949. The first production unit of the *Bomarc-A* was completed in December, 1957.

The *Bomarc-A* is powered by an Aerojet-General liquid rocket and two Marquardt Aircraft ramjet engines. The *Bomarc-B* is powered by a Thiokol solid propellant rocket and improved Marquardt ramjets.

Both models travel at speeds greater than Mach 2.5. Both fly at altitudes of about 70,000 feet.

The appearance of both models is the same. They are 47 feet long, have an 18-foot wing span and weigh about 15,000 pounds.

More than a year ago much more advanced "C" and "D" models were contemplated by Boeing, but the plans were scrapped on grounds that they were not feasible.

• **Guide and Guided**—The *Bomarc* is integrated with the IBM-SAGE computer system which is used to fire the missile and guide it to the vicinity of its target. The computer then releases control and the missile's target-seeker homes on the target.

No actual collision is necessary. The *Bomarc* is armed with a proximity fuse.

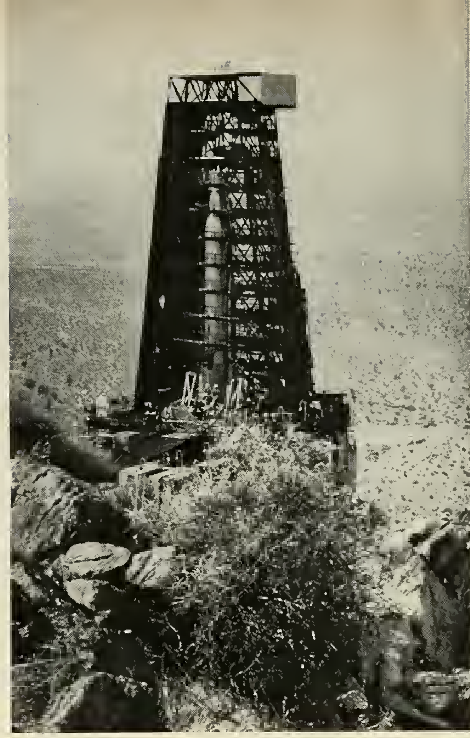
A test *Bomarc-A* has been launched from Cape Canaveral by a SAGE computer 1500 miles away at Kingston, N.Y., and successfully guided to its target.

Bomarc-A's also have been fired in salvos at different targets from the Air-Proving Ground at Eglin AFB, Fla.

The *Bomarc-B's* are scheduled to be tested for about a month at Cape Canaveral. Then the testing will be switched to Eglin. The Air Force anticipates little difficulty.

The Story Behin

THE DEATH OF A MISSILE



One of 40,000 parts fails and a 75-foot bird of space blows up to end a rare association between man and machine—as photographed exclusively for Missiles and Rockets by Cornell Capa

by Erica M. Karr

A two-inch newspaper story, datelined Edwards Air Force Base, March 27, gave this explanation of the explosion opposite: *A captive Atlas missile exploded on its test stand here today. There were no casualties. The same Atlas—Model 60—had completed numerous other test firings at the base. The missile was destroyed. Cause of the accident was not disclosed. The missile had performed most of its test objectives when the accident occurred.*

Story behind this story developed in the blockhouse where famed photographer Cornell Capa was set up to snap "the new breed of young white-collared engineers" who build on man's space hopes. The "routine test," after two days of false starts, had ended in the worst ground disaster ever suffered by an *Atlas*, and the new breed of men, after months of working closely with their massive steel bird, suffered with it. Capa catches the spirit of the blockhouse story from the first "pep talk" briefing, through the moment when the deafening explosion shook the ground and blew up $2-million worth of missile.

At first the Air Force reported only that "nothing fundamental or systematic" was involved in the blow-up but—as later pieced together from Air Force and other sources—the complete story is both human and dramatic.

The captive test firing was first attempted on March 26 after completion of prefiring preparations. This try was called off when electrical difficulties were encountered in the propellant system and traced to "excessive moisture in an electrical connector." The connector was replaced and countdown operations for the firing started at 10:55 the next morning. All went well until T-minus 55 minutes when a hold was called to check the booster engine's auto pilot null position. All clear again, and the count was recycled to T-minus 60 minutes and continued without further difficulty.

At 1:35 p.m.—T-minus O—a normal engine start and the transition to main stage operation were achieved. Then one of the tubes in the "spaghetti" tube network of the engine cracked, spewing out a small stream of fuel, and causing a fire followed by a small explosion in the engine's thrust section. This was recorded at 43 seconds. At 54 seconds, a larger explosion and fire destroyed the missile.

"Disabling of equipment and controls," resulting from initial explosion, was given by the Air Force as the cause of the final explosion. It was later reported by other sources that the sensor for the ground pressurization system had stopped indicating, allowing an excess of pressure to build up.

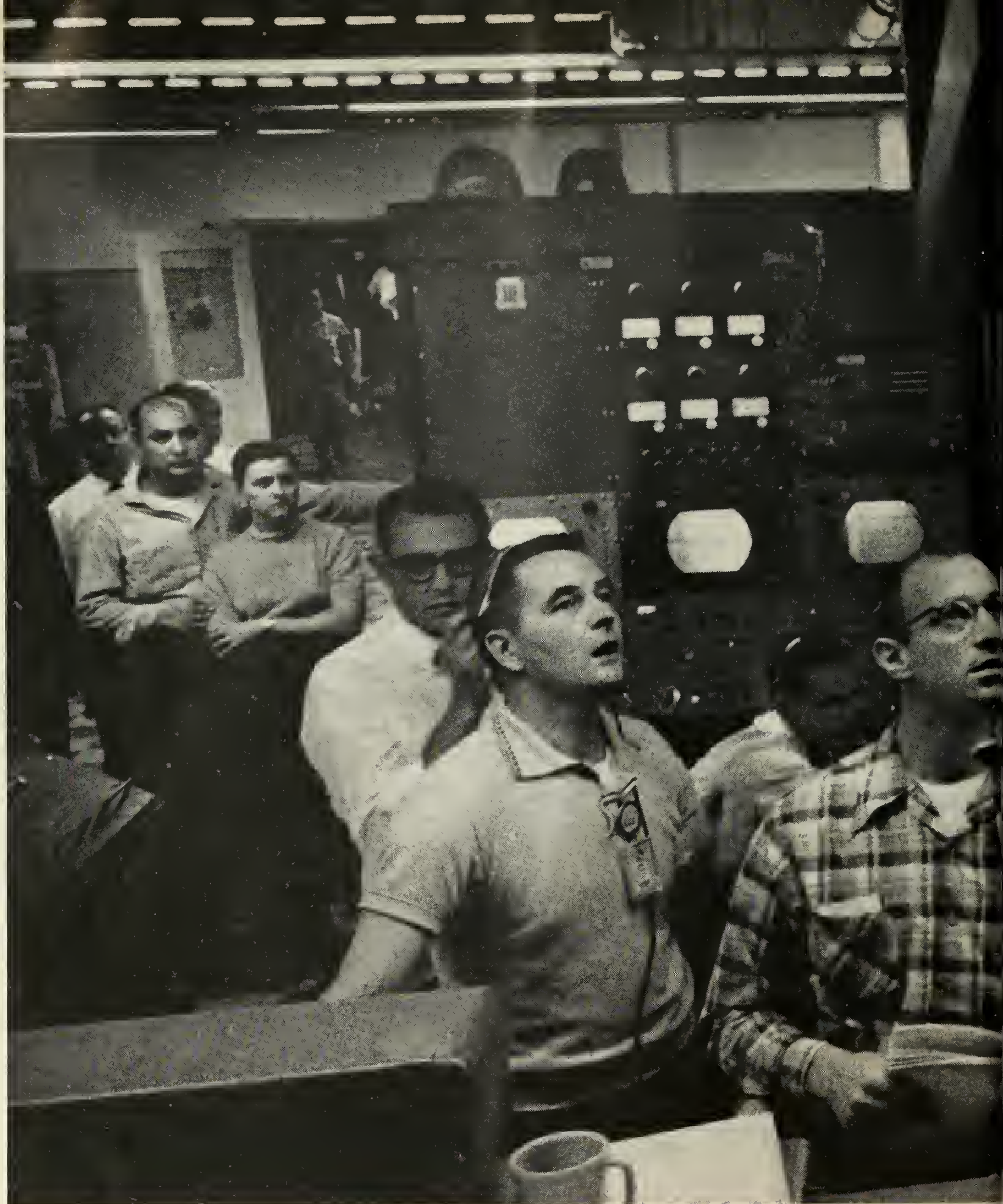
Air Force ended its report with this statement:

(Continued on page 20)

PRE-TEST BRIEFING has air of a before-the-game pep talk as all hands get a run-through on aims, roles, timing and a bid for close cooperation.

YOUNG MEN with big decisions. A new industry gives birth to a new breed of crew-cut, white-collared, creative engineers to man the drawing boards, run the checkout and countdown consoles, decide whether or not to call off, and later to analyze test results.

SORRY SQUATTERS get word that electrical d ties in propellant system will hold up test. Next d was delayed again to check booster engine's null pc



BAD NEWS at 1:35 p.m. explosion, recorded on the television monitors is reflected in the faces of the blockhouse crew as the reality of the catastrophe sinks in.

"Because of elaborate safety precautions, no personnel were injured and damage was confined to the test stand and superstructure and nearby ground support equipment."

Questioned after the explosion, spokesmen at Convair Division, General Dynamics Corp., where the missile is under production, said the *Atlas* had undergone "hundreds" of such tests and that this was the first time one had exploded on the ground. "We've been real lucky for quite a while on engines," a spokesman said. "When you're dealing with thousands of parts (more than 40,000 not counting subsystems), any one of these can fail. But that's what the tests are for—to find any weak spots."

He pointed out that in *Atlas* tests the same failure has never shown up more than twice. "By the third run, we have always had that particular bug licked."

A top Convair official expressed "high confidence" in *Atlas'* reliability. "The *V-2* achieved 80% reliability out of 4000 flights," he said. "I have no doubt we will achieve at least this. We are awfully close to that now and this is still a development program."

The moment of truth—

Reason why failure of one missile part can end n such a major catastrophe is the amount of energy nvolved. An *Atlas* burns in 15 seconds about the ame amount of fuel as that of a DC-7 on an entire cross-country trip.

While the explosion rocked the countryside it also rocked the men in the blockhouse. Even more than the representatives of Convair; Rocketdyne, which builds the *Atlas* engine; the Air Force's Ballistic Missile Division, and Space Technology Laboratories, the technical men who had worked closely over a period of many months were visibly affected. Said one: "I knew every pore of that bird."

That theirs is not "just another job" is quickly evident to the blockhouse observer. The challenging needs of the new space field have given rise to a new type of technician and engineer determined to meet them. Sporting crew cuts, white collars, bow ties and a sense of purpose and dedication, many of them live with their jobs 24 hours a day. Some admit waking up out of a sound sleep to ponder a problem. Others dream about them. Emotional involvement with their machines is common among them and when one fails there is a sense of personal

NOTHING LEFT but the beak of the bird in its nest. Ground crew man takes last look. Another will one day lift the first U.S. manned capsule space

CAPT. DAVID FRAZER, BMD representative, and Donald Fagan of Convair confer with fire marshal.

disappointment. When one disintegrates before their eyes, as in this case, it is taken like the passing of an old friend.

A rare team spirit pervades the blockhouse. It is keenly felt first during the pre-test briefings, when all hands, including the outside crewmen, are given a run-through in an atmosphere of a before-the-game pep talk. Every eye is riveted on the test conductor as he explains aim of the test, timing, roles and asks for a perfect record with everybody giving it everything he has: "Your full cooperation and attention is essential."

It would be in keeping with the tenor of the scene if he wound up the meeting with the rousing admonition: "Our team must win!"

In this *Atlas* test things moved like, and by, clockwork until the first delay, then picked up again until the second holdoff broke the tension. As the countdown started again, from a relaxed beginning, the technicians were soon busy again directing their full attention to the job at hand.

At T-O, all eyes were on the television monitor.

First reaction, as the moment of truth hit, was one of complete disbelief, then reluctant recognition followed by speculation on the cause of the explosion. The fire marshal gave assurances that no one was hurt and the job of gathering up the yards of recording paper that charted each minute phase of the operation was begun.

Last to leave the blockhouse was test conductor Donald Fagan of Convair. The men filed out leaving him slumped behind his console and went to take a last look at the smoking and torn hulk of what was left of their once proud space machine.

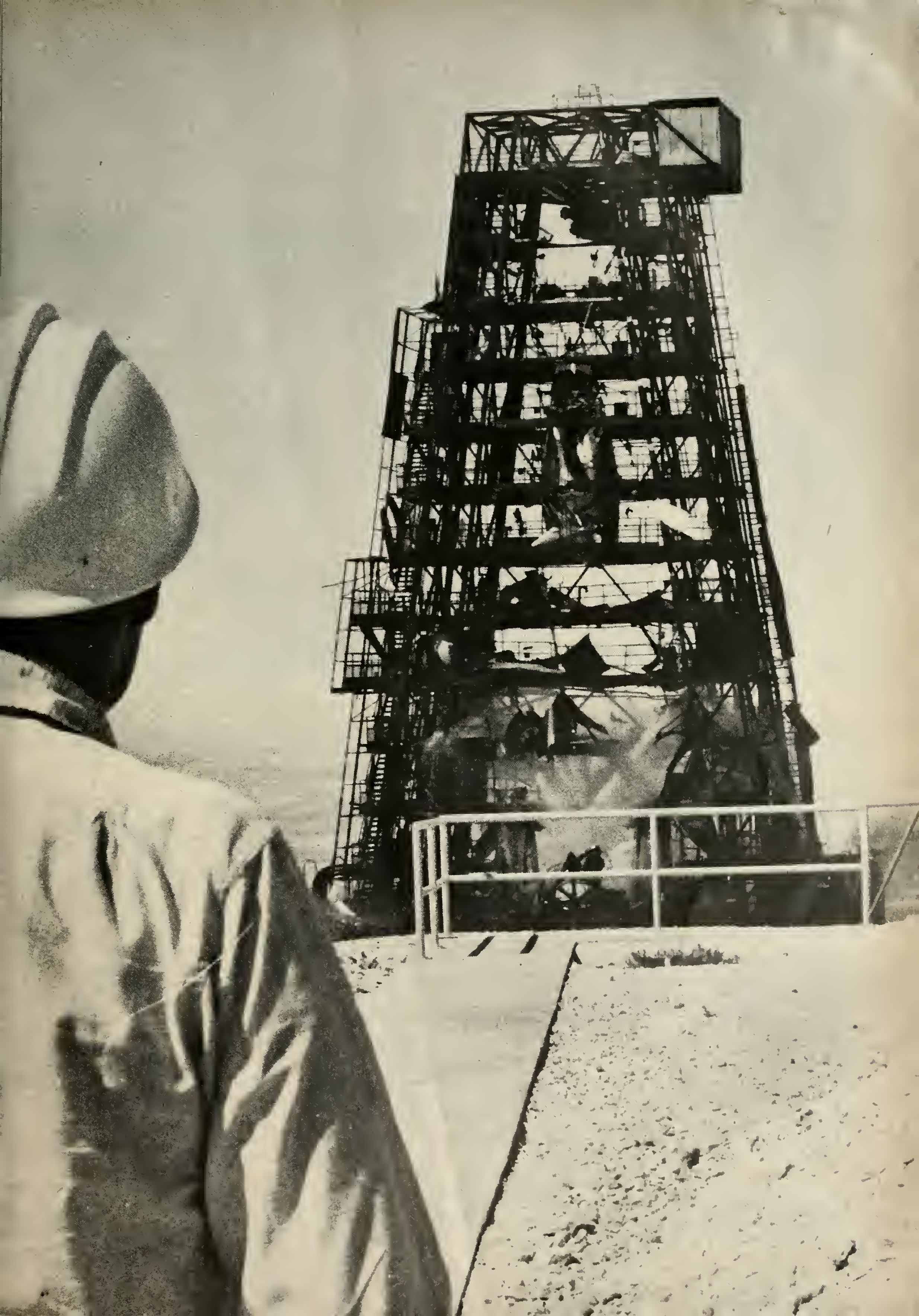
Atlas has now undergone 23 test flights. Out of the last 14, which had complete systems, nine were reported to have been completely successful with four of the 14 recorded from 25% to 90% successful.

An *Atlas* powered by Rocketdyne engines will lift the first U.S. manned space capsule, *Mercury*, under contract from the National Aeronautics and Space Administration.

Atlas fabrication began in San Diego in 1955 with first engine tests run at Edwards in June 1956. Completed missiles were delivered to Sycamore and Cape Canaveral that fall.

Convair's associate contractors, in addition to Rocketdyne, include General Electric Co. and the Burroughs Corp., radio-inertial guidance (to be followed by American Bosch Arma Corp., all-inertial guidance), General Electric Co. and Avco, nose cone; and Sundstrand Turbo Division (formerly American Machine and Foundry), airborne accessory power supply.

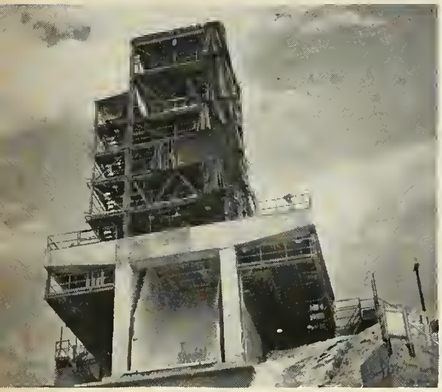
EPITAPH for a missile is written on yards of recording paper which closely charted each test step.

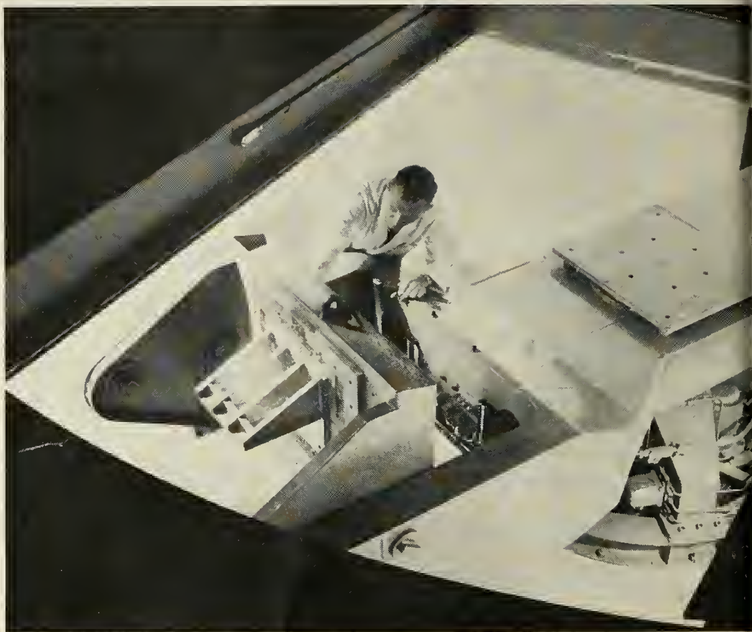


(left) Navy Polaris AX-1 flight test vehicle at beginning of launch. Lockheed's Polaris fleet ballistic missile is more than a year ahead of original schedule.

(below left) One of the Santa Cruz test stands with dynamic thrust mount to simulate flight environment. Vibration oscillator functions during static firings.

(below right) Large centrifuge for environmental testing has unique shaker attachment to provide vibration simultaneously with high G-loadings.





TEST / Expanding the Frontiers of Space Technology

Testing is a vital part of every stage in the development of missile and space programs at Lockheed Missiles and Space Division.

The Division maintains one of the most completely equipped missile and space test laboratories in the world. Equipment includes: altitude, temperature and humidity chambers; shaker and vibration systems; G-accelerators; and apparatus capable of performing chemical, metallurgical, plastic, heat transfer, hydraulic, pneumatic, shock, acceleration, sinusoidal and random vibration, structural, electrical, and electronic tests. Static field testing; research and development testing on controls; testing in ordnance and hydraulics and high-pressure gas and propulsion systems are conducted at the 4,000 acre, company-owned test base in the Ben Lomond mountains near Santa Cruz, California.

Flight testing is conducted at Cape Canaveral, Florida; Alamogordo, New Mexico; and Vandenberg AFB near Santa Maria, California; in a unique manner. All components and sub-systems of a new project are initially tested on known-performance, production missiles. Thus, when the final system is ready for first flight, its individual components already have flight-tested reliability. This new concept of flight testing has enabled Lockheed to produce extremely complex missile systems in record time and at greatly reduced expense.

Underwater launch tests—including studies of cavitation, wave simulation and skip motion—are carried on at the Sunnyvale facility and at the Navy test base on San Clemente Island. In addition, structural and other tests are performed at Hunter's Point Naval Shipyard, California.

If you are experienced in any of the various phases of testing, we invite your inquiry. Positions also are available in physics, mathematics, chemistry, or one of the engineering sciences. Write: Research and Development Staff, Dept. E-29, 962 W. El Camino Real, Sunnyvale, California. U.S. Citizenship required.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics." NATIONAL MISSILE INDUSTRY CONFERENCE AWARD

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How Far to Go with Redundancy?

Duplication seems to be on the increase in industry, but many experts call for limits on the expensive and risky practice

by Charles D. LaFond

WASHINGTON—Many design engineers are questioning the wisdom of unrestrained or unnecessary use of circuit and equipment redundancy. It is admitted that by careful investigation and analysis, weak spots in an electronic system can be predicted and should be strengthened or compensated for. But how far should this be permitted to go?

Is it better for the design engineer to duplicate relatively high-fail-potential equipment or circuit elements without limit—or should more time and effort be spent in creating better circuit design with more reliable and longer-lived components? This is not meant to imply that redundant configurations should not be used, but that their use should not be the excuse for avoiding the betterment of conventional circuits.

The use of redundant circuitry for achieving higher equipment reliability appears to be on the increase. Just how much industry is using it at present is not known, but certainly a great deal of time, effort, and money is being spent in studying the feasibility of duplicating equipment and circuits in electronic systems.

The requirement for redundancy is based on the sometime need for systems in which no single component failure can be permitted to cause a system failure or even severe performance degradation.

For those not too familiar with the term, there are several kinds of redundancy:

- Parallel-redundancy involves the use of two (or more) identical units or "chains" of equipment. If a unit fails, its counterpart still provides adequate performance. With proper design, some of the unit pairs produce an additive output; that is, together they achieve a higher-than-minimum performance.
- This same system, employing parallel-redundancy, may have some units that cannot be operated together. Here, standby-redundancy can be employed. The duplicate equipments are connected in such a manner that one is in operation while the other is a "hot" operating spare, or standby. Some type of failure-detector switching device is included for control.
- Circuit-redundancy is an internal type of duplication. As a result of careful analysis during developmental stages of an equipment, the failure probability of some subsystem circuitry may be determined to be too high. To correct this, an additional circuit is added (where possible) for each weak link. Necessary relay or switching circuitry must be included also.

Since redundancy is a method for improving reliability, the latter should be explained. Reliability can be defined as the probability of a unit performing its function as designed for a minimum time period and under given operational environments.

- **Past use**—Parallel and dual backup equipments have been employed successfully—albeit expensively—for many years. Commercially, the radio and television industry has utilized extensively the philosophy of operating standby systems. Equipment and maintenance costs are far outweighed by the potential losses in advertising money and audience in case of station failure or rapid transmission degradation. The military currently is a principal advocate of this concept for obvious reasons.

Because equipment reliability is

Antennas for BMEWS

GIANT RADAR tracking antennas are being built by Goodyear Aircraft for the Air Force BMEWS installation. Mounted on 30-foot pedestals in 140-foot diameter radomes, the antennas are among the largest ever made. They will provide a radar fence in the Far North to detect and track enemy ICBM's as they appear above the horizon.

The work is being done by Goodyear under a multi-million-dollar contract with RCA, system prime contractor. Air Force AMC has primary responsibility for the project.

not always high enough for their needs, the extra costs must be weighed against such factors as the saving of human lives and achieving minimum warning time for retaliatory offensive operations.

• **Redundancy studies**—Studies performed at Hughes Aircraft Company have shown that internally redundant systems using standard parts are considerably more reliable than conventional systems using specially chosen components. But they have indicated that although the failure probability can be reduced by a factor of "hundreds or more" system redundancy should be used with great discretion.

These systems, said S. Nozick of Hughes, are heavier, larger, and require more maintenance. He stated that internal redundance should be favored only when system failure is very critical in terms of human life or money. External functional redundance—the technique of relying on all or part of another system to replace functionally the failed system—should be considered by designers as an alternative to internal redundance.

Speaking of a well-integrated developmental team designing a highly reliable system with a suitable redundant configuration, Nozick said: ". . . a closely coordinated group with high morale can invent its way out of the problems that usually arise." He also warned that consideration must be given to the fact that parallel or redundant circuitry might relax the control required on components or subsystems during equipment construction and component specification.

• **Future reliability**—In the present state of the art of redundant circuit design, the requirement for specially trained engineering groups needed to develop these systems is paramount. Although reliability can be improved substantially, redundancy is always expensive and frequently inadequate.

The answer to achieving higher reliability seemingly does not lie with redundant design as we know it, but the technique is an effective and existing tool.

One potential source for increasing circuit redundancy, especially in missilery, is in the future use of semiconductor "solid-circuitry" developed by Texas Instrument Co. and Westinghouse. Because of the small size and weight and very low power needed, these functional circuits may offer a vastly different kind of redundancy in years to come.

New Way to "Grow" Germanium

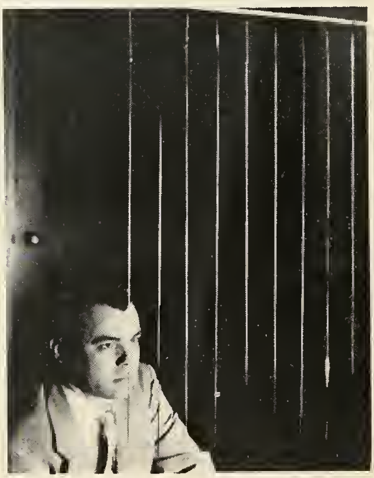
ANDREWS AFB, Md.—Westinghouse Electric Corporation's process for "growing" germanium crystals in uniform, thin, flat ribbons has earned it a $2-million development contract from the Air Research and Development Command. In addition, Westinghouse's use of this material to create "functional" solid state circuits is another step toward revising current electronic design concepts.

In announcing the contract award by Wright Air Development Center, Maj. Gen. John W. Sessums, Jr., commander ARDC, said it was part of a broad program effort in this new field of molecular electronics.

The development centers on the method of growing the crystals, since the final product eliminates the need for tedious and costly slicing and polishing heretofore required. Westinghouse scientists said the manufacturing technique permits growing the material in the exact form in which it can be used for practical application in transistors and other semiconductor components.

A result of a new knowledge of the structure of material, the company believes the new method will radically improve existing transistor manufacturing processes. Westinghouse already envisions machines turning out finished transistors at high speed directly from on input of raw germanium and the two or three other materials needed to complete the device.

The new technique for growing germanium was the work of two Westinghouse research physicists, Dr. R. L. Longini and Dr. A. I. Bennett, both of the laboratories' solid state physics department.



DR. BENNETT, codeveloper of new growth process, and the new germanium ribbons.

"The ease of processing dendritic germanium into usable form contrasts sharply with present practices," the Westinghouse scientists said. "To process conventional germanium ingots into useful form, they must be sliced into thin wafers somewhat like a loaf of bread is cut into slices. Because germanium is so hard and brittle, the cutting is done with a diamond-tipped saw, and each slice has to be three to five times the desired thickness simply to keep it from shattering.

"The slices must then be ground down to the required thickness, further cut into small squares, and finally polished. Only then is the germanium ready to be fashioned into finished transistors or other devices. As a result of all this cutting and polishing, about 80% of the original ingot is thrown away as germanium 'sawdust.' "

Not only is dendritic germanium of the proper thickness for direct use, said the scientists, but its ultra-smooth, mirror-like surfaces need no grinding or polishing of any kind.

• **Functional circuits blocks**—Research results to date indicate that the new process and the use of functional semiconductor circuits may lead to the development of outer-space electronic equipment 1000 times smaller and lighter than anything now in existence. In describing foreseeable products resulting from the Air Force's development program, Col. Clarence H. Lewis, director of ARDC's Electronics Directorate, said the concept could take the average pocket-sized transistor radio circuitry excluding the power supply and speaker down to the size of the head of a match."

In use, these very small pieces of crystal could perform the functions that now require as many as a dozen present-day components using conventional circuitry, Col. Lewis said. He added that two possible functions of the minute equipment are the sensing of environmental conditions and transmitting the data to any desired location. Feasibility studies are being conducted on infrared, reconnaissance, flight control, communications, and other military applications.

As an example of the size and weight reductions possible under the ıew concept, Col. Lewis said that the nost modern system used today to neasure the intensity of light in space ıas a volume of about one cubic inch ınd a weight of approximately seven grams.

The Air Force has conducted demonstrations with a Westinghouse light elemetry subsystem which has a volume of 0.001 cubic inch and a total veight of 0.2 gram. This equipment ıot only measures change in light inensity but also produces a signal capıble of transmission to relate the degree of change in intensity.

The number of component parts in he telemetry subsystem was cut from 4 to 1 and the number of soldered connections was reduced from 15 to 2, hereby offering a tremendous potential o reliability, Col. Lewis said.

Ohio State Team Makes Low-Cost Radio Telescope

WASHINGTON—A unique radio telescope being built by a "professor-student" team of Ohio State University will permit mapping the sky at a minimum cost.

Scheduled to be ready for operation in 1960, the telescope will consist of a fixed paraboloidal antenna, a flat tiltable reflector, and associated radio receiving equipment. Both 360 feet long, the fixed dish is 70 feet high and the tiltable antenna is 100 feet high. Collecting area of the latter is equivalent to that of a 170-foot diameter steerable dish and it costs about 90% less.

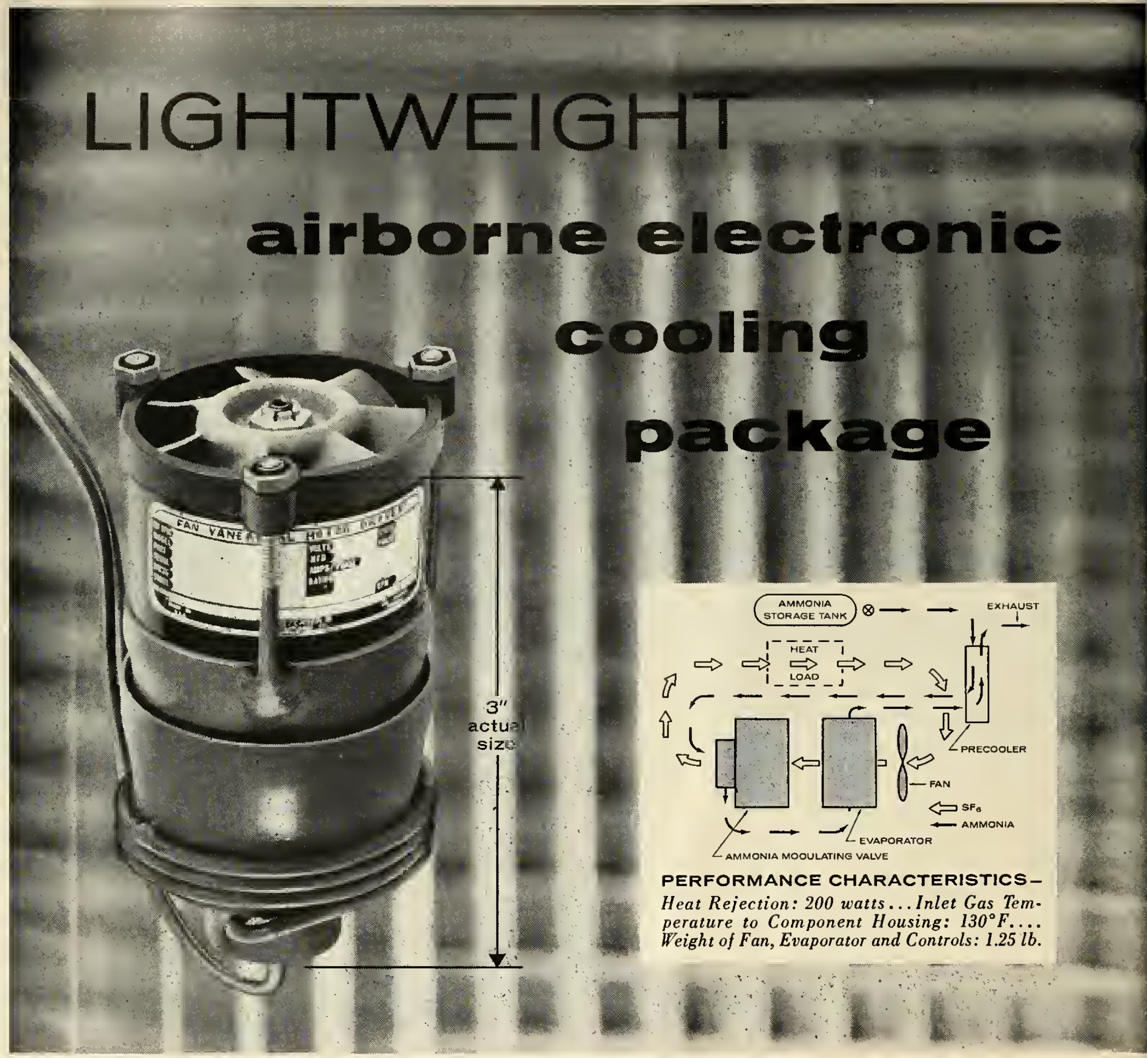
Under the direction of Dr. John D. Kraus and three non-student assistants, the system is now in construction. The project is supported by three National Science Foundation grants totaling $272,650 and two university grants totaling $21,600. A 20-acre site has been donated by Ohio Wesleyan which also will control the surrounding land to prevent any operational interference.

Radio waves from the sky area under observation will be received on the tiltable antenna, reflected horizontally to the fixed dish, and then directed to the receiver system for recording.

All components of the telescope will be in fixed position on the ground. The earth's rotation brings new radiation sources in the sky into the field covered by the telescope. In a 24-hour period, a narrow band entirely across the sky can be "mapped." Changing the angle of the tiltable reflector will move the band of observation up or down, so that eventually a large part of the sky can be fully mapped.

The design of the telescope is sufficiently flexible to capture and identify radiation from a wavelength of 21 centimeters up to about 20 meters. The geometry of its design provides that regardless of the angle of the tiltable reflector, radiation striking it will be deflected via the fixed antenna to the receiver. Structural problems arising from mounting receivers high in the air on movable antennas are also avoided in Dr. Kraus' cost-saving design.

This telescope will not be able to follow an object across the sky as well as steerable dish antennas can, but will depend primarily upon the earth's rotation for its collecting area.



Spans the gap between direct ambient cooling and closed cycle systems

• *This AiResearch open-cycle cooling unit* is designed for environmental conditioning of electronic and electromechanical equipment in problems of low total heat dissipation aboard aircraft and missiles.

Much lighter and less complex in operation than closed cycle systems, this compact package is recommended when required total heat dissipation is low... large heat loads for short periods of time, or small heat loads for long periods of time. It also replaces direct ambient cooling systems when ambient sink is not low enough or not easily available.

Ammonia in this expendable evaporative system cools sulfur hexafluoride (SF_6) which passes over the hot electronic components. The SF_6 then recirculates for cooling, and the ammonia is dumped overboard.

Applications of this system include: inertial guidance system cooling, missile transient cooling, and spot cooling where ambient sink is not available.

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'Quite sure' Bell-Martin will land contract . . .

BELL'S Dr. Walter Dornberger, "a man of stereophonic sound."

'Father' of *Dyna-Soar* Awaits AF Decision

by Erica M. Karr

WASHINGTON—An Air Force Source election Board is sifting data to de- ide which of two pooled-company eams will get the *Dyna-Soar* contract.)ptimistic reports say the decision will e made by mid-June. Others close to he project indicate a more realistic et is after July 1.

During the last two weeks of April, ɅF evaluation teams, numbering close o 100 technical experts, descended on 'he Martin Co. in Baltimore and the 3oeing Airplane Co.'s Pilotless Air- raft Division in Seattle for an on-the- pot appraisal to guide the 20-man election board. Winner of this two- vay contest will walk off with a con- ract which may eventually total $650 nillion to develop *Dyna-Soar* (from lynamic soaring).

The Air Force has asked Congress or $109.8 million in new obligational uthority for *Dyna-Soar* in Fiscal Year 960, with actual expenditures to run o $73 million in that period.

The manned boost-glide vehicle will ɪave a global capability. Initially, it vill be developed as a prototype test ystem to explore the flight region ɪeyond that of the *X-15*, and extend- ng to near-satellite velocities and alti- udes.

It will be a ground-launched, step- ype vehicle, initially boosted to very ugh altitude and speed by ballistic mis- ile boosters which fall away from the npowered, man-carrying last-stage ;lider. It will be a "laboratory" for ;athering information needed in later pace development work.

One military role envisioned for ater versions is in the "missile storage n space" concept. Idea would be to ɪave earth continually ringed with or- ɔiting hydrogen-missile-carrying *Dyna- Soars* which would be controlled from ɪ space station, eliminating the need for vulnerable ground facilities and advance warning systems. These could be unleashed for instant retaliation wherever needed. It is estimated that $1.2 billion annually could maintain such a defense network.

• **Line-ups**—Each of the two competing industrial giants is backed up by a group of companies ready to pool their technical resources in a new approach to system building—the company team concept as opposed to the prime-subcontractor systems. On the Martin-Bell team are Bendix, Minneapolis-Honeywell, AMF and Goodyear Aircraft. Boeing, which also has Goodyear on its team, has in addition North American Aviation, Aerojet, Chance Vought Aircraft, General Electric, RCA, and Ramo-Wooldridge.

Dr. Walter Dornberger, originator of the *Dyna-Soar* project, and recently named as engineering director of Bell Aircraft's Niagara Frontier Division, is sure that the contract will go to the Martin-Bell team. If so, the ex-German rocket expert will direct work on development of the glider vehicle. Asked "If not?", Dornberger replied: "Then we will work on another version of *Dyna-Soar* or satellite interceptors, rescue ships, maintenance and supply ships, a shuttle rocket to space stations or the final stage of a moon rocket."

• **Dornberger's vision**—Dr. Dornberger is a longtime booster of the team approach to space flight and raised some eyebrows during last year's meeting of the National Missile Industries Conference when he said in a speech: "We cannot afford competition for contracts to build space ships.

"In the coming years we will see only a few industrial combines able to develop big space ships. By pooling facilities, brains and manpower, they alone will provide the necessary capability and productive power to which the nation may hand the technological responsibility in the Space Age."

Dornberger is an old hand at new concepts, dating back to 1930 when he found himself heading a small group in Germany's Army Ordnance Division which had been directed to make modern weapons out of rockets. Later, the man who was to become Wernher von Braun's boss directed the 17,000-man Peenemunde rocket operation which developed and launched the *V-2's* during World War II.

Dornberger began pushing the idea of the rocket-boosted glider soon after he came to Bell Aircraft in 1950. Bell, in turn, started pushing it with the Air Force in 1952 when it was called *Bomi* for bomber-missile; but it was not until Russia launched *Sputnik I* that the Pentagon worked up any enthusiasm and got the ball rolling.

• **Forceful**—The father of *Dyna-Soar* is a man of strong opinions who expresses them in clipped, colorful, German-accented pronouncements illustrated with forceful gestures. Said one science reporter after a Dornberger press conference: "He's the world's only human who speaks in technicolor and stereophonic sound."

Although his Prussian manner and opinionatedness rub many newspapermen the wrong way, his sweeping assertions always make lively copy. Sample quotes:

Education—*Our system is all wrong. Everyone who has the brains and guts should get a higher education despite lack of money.*

Vanguard—*Vanguard was a mistake. We should have used existing hardware. We would have had a satellite up sooner.*

Goals—*The future problem is no longer to bring a couple of tons of payload into orbit but to bring 20, 30 or even more tons at any spot in space with the correct direction and speed.*

Manned vs. unmanned—*Space can only be utilized effectively by manned vehicles. An automatic space vehicle would necessarily have to be so complex that the possibility of its failure in space would be tremendous. Space will be conquered by man and not by machines.*

Anti-missile missiles—*Practically useless. Out of 100 ballistic missiles shot at us, 90 would get through with the present state of the art on anti-missile missiles.*

Long-range planning—*We should agree on a line of priorities for the next 20 years to survive as a free nation. Priorities should run in this order: (1) long-range ballistic missiles; (2) data-gathering research vehicles for cis-lunar space; (3) all weapon system, manned or unmanned, in cis-lunar space; (4) data-gathering research vehicles for trans-lunar space; (5) space vehicles for commercial application; (6) prestige flights; (7) stunt flights.*

Space Race—*Russia may put a man-carrying satellite into orbit within the next year. It may take us three years to do this.*

Royalties for scientists—*Creative thinking and imaginative engineering should be paid for . . . the government should guarantee a share in the profit of later production for the original creative mind.*

Need for speed in the space race—*I have lost two world wars. I did not come to this country to lose World War III.*

• **Nazi failure**—If the Nazi wheels had listened to Dornberger, the history of World War II might well have been different. But despite Dornberger's urging, Germany's rocket-weapon program went into high gear too late.

Getting it off the ground had been for a long time literally a go, no-go proposition. Gen. Prof. Dr. Karl Becker, head of the Board of Ordnance, had trouble laying his hands on the money needed to launch this "outlandish" idea; finally in 1932 he ordered all Ordnance divisions to contribute 10% of their budget to Dornberger's project.

In all it cost $300 million to develop the *V-2*.

There was not much in the way of previous rocket research and the team had to start from scratch: How big? How much payload? What distance? "I sat down with Von Braun and an artilleryist and we arbitrarily decided to make the payload 100 times that of the Parisian 10-pound gun with over twice its distance of 50 miles. Size was determined by the tunnels and streets through which it would be transported."

First successful firing of the *V-2* was not until October, 1942, and there were 36 more before they achieved a second successful firing—"A lot exploded on the ground; we had no telemetering system, either, to tell us what was wrong."

When problems came up, Dornberger said, "I put my men in a room and told them 'You get nothing to eat until you come to a conclusion.' By 1943 they had achieved 50% reliability, by 1945—78% and they were firing 30 a day.

Von Braun, now director of the Army's missile development at Redstone Arsenal, recalling his early years with his old chief, told M/R:

"Dr. Dornberger and I first met in 1932 when I was a student at the Technical University of Berlin, and it marked the beginning of 13 years of close association and the beginning of a rocket development program with far-reaching implications.

"Selling the new ideas of rocket propulsion and promoting and fighting for the support of adequate programs to fully develop its potentials, was a tremendous undertaking. It required courage, dedication and passionate perseverance. Dr. Dornberger led us from the shortcomings of our 1932 presentations and transformed our youthful enthusiasm into sober engineering plans.

"He is a man of profound technical knowledge, imagination and the ability to combine the technically feasible with the militarily sound and practicable. These, together with his personal tolerance and warmhearted understanding for the capabilities, limitations and personal problems of his associates, made Dr. Dornberger the greatest single force behind German rocket development. And he shared with his younger associates the deep fascination for the limitless challenge of future space exploration.

"He was to me a courageous, fatherly friend who, in many dangerous and critical situations, in particular during the declining months of Hitler's Germany, never let me down. On more than one occasion he helped me at considerable risk to his own safety."

After the war Dornberger came to the United States as a missile design consultant for the Air Force at Wright-Patterson AFB, and in 1950 joined Bell in a similar post.

He was appointed technical assistant to Bell's president in 1957, and was named to his new post April 13th this year.

Today, Dornberger, whose life for the most part was focused high above the clouds, has completed long-range plans for ending it there: "I want to be the first man buried in space. When I die I want my ashes put in a glass urn and carried up by a manned space capsule to orbit in eternity." "Von Braun said he will take them up there," said Dornberger, eyes twinkling. He added mischeviously: "Von Braun says it will be an urn with a hook and every year on the anniversary of my death he will soar up and hang a wreath on it."

Dyna-Soar: First Maneuverable Spacecraft

Dyna-Soar's early explorations through the atmospheric fringes will erase many of the question marks confounding man as he plans for space exploration. The rocket-boosted glider will be a bridge between aerodynamic and space flight. It could be used for bombing, reconnaissance and scientific and commercial missions.

The domain of the *Dyna-Soar* will be that area between the ceiling for air-breathing engines—almost 19 miles up—and the floor for satellites—slightly over 93 miles up. Excursions out of this area will pose some problems, not the least of which will be temperature.

The glider's return to earth will be controlled from the ground, as will positioning in orbit.

In its early flights, *Dyna-Soar* probably will be unmanned and will be recovered after several orbits by an automatic system already demonstrated by Bell Aircraft. However, even when manned, it will be brought back by automatic control.

Presentation of information may offer a stiff challenge. Re-entry involves velocities from satellite down to sonic, aerodynamic lift varying from 1 or 2% to 100% of weight, and accelerations and temperature changes which are limited by the structure and payload. Processing this information to adjust the re-entry path will be an important system requirement.

Accuracy requirements for the boosted phase can be greatly diminished if the vehicle has the maneuvering capability to modify or correct an initial orbit or trajectory. This would reduce the amount of ground or airborne information needed, and the sophistication of components. The correction would be pilot-controlled

ARTIST's conception of a later-day *Dyna-Soar* with lentil configuration entering the earth's atmosphere at a 90° angle.

• **Configuration**—What will *Dyna-Soar* look like? The work of Julian Allen and A. J. Eggers indicates that blunt shapes with high-pressure drag would be most efficient for skip gliding since these characteristics minimize aerodynamic heating, particularly for relatively light vehicles. Later variations of this concept include the lentil configuration which would enter the atmosphere at an angle of attack of 90°. in this way acting as a blunt shape. Another possibility is a blunt-nosed vehicle, which after achieving entry would rotate to 180° so that a low-drag "tail" becomes the leading element. Bell's *Dyna-Soar* reportedly will have the blunt-nosed Allen configuration.

Dyna-Soar will not skip as it glides down at slow deceleration and its shape will be based on a high lift-over drag factor. The Lentil configuration will probably emerge in one of the later *Dyna-Soar* versions.

Bell Aircraft's mock-up of *Dyna-Soar*, still under security wraps, was viewed by the Air Force's evaluation team on its appraisal visit to The Martin Co., Baltimore, last week.

• **Human factor**—Keeping the pilot comfortable under the space-equivalent conditions he faces in *Dyna-Soar* means that for the region near or below the glider's flight planners must cope with the vapor pressure of body fluids in mammals—47 mm Hg (63,-000 ft.). Oxygen supply will not be as much of a problem as in orbiting vehicles because flights can be short.

Acceleration and vibration will be similar to those in the launching and flight of a satellite and can be kept to similar levels during re-entry. One aim is to allow the crew to function without confinement of pressure suits or thermal shields.

• **Power**—Early versions of the glider could be satisfactorily launched by existing rocket boosters—*Titan*, for example. However, later versions will be larger and heavier to achieve maneuverability in space; hence increased booster capability will be necessary. Thought must be given to recoverable boosters, apart from the already recoverable final stage, for economy reasons. An air-breathing first stage might be used; then re-use would be a necessity.

• **Rendezvous**—To meet orbiting objects in space, the glider will need vernier adjustments in velocity. If the orbiting vehicle is radiating elctromagnetic energy, homing on this source could be achieved within the vehicle.

The power required for the glider to "jump" orbit is comparable to that in the original launch. In time these vehicles will be large enough to carry adequate propellants for making major modifications to orbits.

A vehicle weighing 11,000 pounds coming from a satellite orbit must dissipate 1.58×10^{10} kgm of energy (11.45×10^{10} ft. lbs.) before it lands. According to Dr. Everett T. Welmers of Bell Aircraft Corp., most of this must be achieved by radiation.

"A solution to this design problem which has been developed at Bell is the use of the 'double wall' structure," Dr. Welmers reports. "The outer wall, exposed to the airstream, is allowed to heat up to very high temperatures. Radiation from this surface back to space is approximately proportional to the fourth power of the temperature. The inner wall, which carries the structural loads, is shielded from the hot outer face by a layer of insulation and is further cooled by liquid passing through tubes attached to its surface. In this way all but a small percentage of the aerodynamic heating is re-radiated, the load-carrying structure is subjected to temperatures of about 200°F and thermal problems for equipment and crew inside the double wall become very simple."

The outer wall is of Inconel and can take over 2000°F. The inner wall is of aluminum.

Atmospheric density at 328,000 feet is such that the vehicle could maneuver at less than .01 g through aerodynamic forces. At 246,000 ft., aerodynamic pullout will be about one-third g's; at 180,500 ft., a maximum of about 2.5 g's. Below this altitude, structural limitations are likely to be more influential than aerodynamic forces.

• **Landing**—Between the time the pilot decides to land and actual touchdown *Dyna-Soar* will have traversed from one quarter to several times the earth's circumference. If re-entry and slowdown come off as scheduled, the vehicle, brought in by the automatic landing system, will be able to land within a rectangle of 2 x 5 miles. Tests at Bell Aircraft have achieved this with planes and guided missiles.

Both the Air Force and Navy have proposed that a coordinating body be set up for the Atlantic and Pacific missile range tracking networks—first for the *Mercury* project, then for *Dyna-Soar*. This is currently being discussed, at least by the Air Force and NASA.

• **Background**—Before the *V-2* program roared into high gear and halted work on it, the glide vehicle conceived by a German team under Dornberger's direction worked like this: The *A-9*, a variation of the *V-2*, was to carry under it another vehicle weighing 191 thousand pounds. Termed the *A-10*, this rocket booster would have a 50 to 60-second thrust to 440,000 pounds and a velocity of 2700 mph. At the *A-10's* burnout, the *A-9* would ignite. It would begin its supersonic glide at 35 miles altitude and travel a distance of 2500 miles.

This was based in part on the earlier work of E. Saenger and I. Bredt. Russia's glide-bomber work has resulted in the three-stage *T-4A* test vehicle. It is believed to have a 264,000-lb. liquid rocket first stage supplemented by two solid-propellant rockets. The second stage used the same liquid rocket and the third stage a 77,000-lb. rocket. It is estimated that take-off weight is over 231,000 lbs. and that it reaches a maximum altitude of 235 miles with ranges of 500 to 12,500 miles with top velocities of 5000-6500 m/sec. (16,400-21,300 ft/sec.)

Just how far the Russians have carried this program to date is not known.

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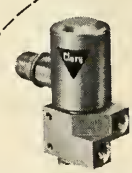

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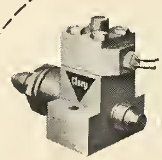

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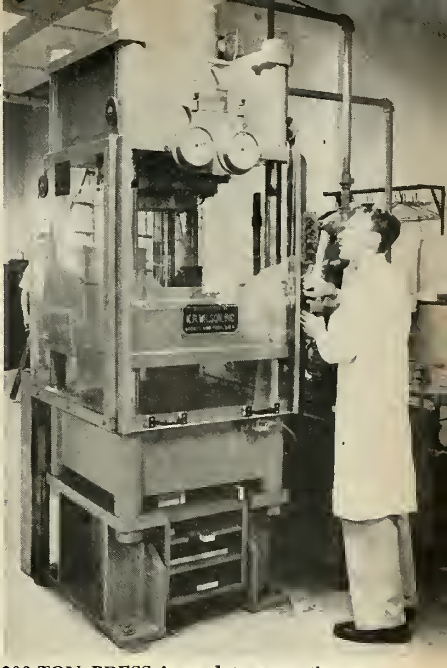
Manufacturers of business machines, electronic data-handling equipment, aircraft and missile components

Low-Cost Brazed Steel Honeycomb Structures

Martin's new hardened alloy solves problem of uneven filleting in brazing and allows opening of tolerances



200-TON PRESS is used to press the reduced powders of Al_2O_3 and matrix metal.

by Clarence A. Boyce, Jr.*

BALTIMORE—Brazing alloys available until now have made production of brazed steel honeycomb structures both difficult and expensive. The chief problem: uneven filleting caused by rapid flow of the alloy and its poor resistance to corrosion.

These limitations have been overcome in a new dispersion-hardened alloy developed by the Baltimore Division of the Martin Co.

The alloy is produced according to established powder metallurgy techniques. The initial distribution of the aluminum oxide in the metal matrix follows a method developed by R. H. Read while he was investigating the properties of dispersion-hardened copper. Read dispersed the aluminum oxide in copper oxide by wet milling the appropriate mixture.

This method is superior to mixing copper directly with alumina, because the latter method yields a smeared matrix and a non-uniform mixture. Since the oxide is harder than the parent metal, it is broken up readily without noticeable plastic flow and smearing.

Following the milling operation the mixture is heated in a hydrogen atmosphere where the copper oxide is reduced to copper while the alumina, being very stable, remains unaffected. The powder is then pressed and processed by the usual powder metallurgy techniques.

• **Fine screening**—In the development of the Martin brazing alloy, the copper oxide was replaced by another oxide. The mixture was ball-milled wet in a conventional mill for two to three weeks.

After drying, the powder was screened through a −180 mesh sieve to eliminate any large particles and treated in a hydrogen atmosphere at 75°-100°C for 2½ hours to reduce the oxide of the matrix to the metal, the alumina remaining unchanged.

The power was screened again through a −100 mesh sieve in preparation for briquetting. It was poured and leveled at a depth of 0.029 inches in a "push through" die having a rectangular opening of 1 3/8 x 4½ inches and

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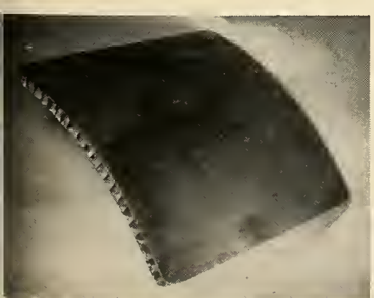
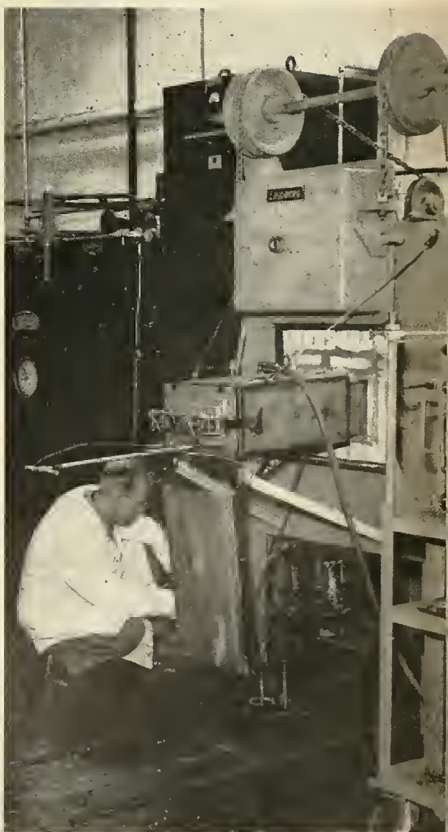
**Research Institute for Advanced Studies, The Martin Co.*



COMPLETELY BRAZED panel using aluminum oxide dispersion-hardened brazing alloy.



SMALL FURNACE is used to sinter briquetted powders at Martin Company's Baltimore facility.

pressed at 200 tons. The most desirable size for the finished briquette prior to sintering was 0.050 inch thickness. The briquettes were then sintered at 1700°C for two hours and reheated prior to the rolling operations for a minimum of five minutes at 1700°F.

With the roll opening set 0.008 inches less than the briquette thickness, each briquette was hot rolled in a mill. The roll opening was subsequently reduced 0.004 inches prior to each heating and rolling operation and each briquette was given three passes through the rolls after each heating cycle. The heating and rolling operations stopped when the material reached a thickness of 0.020 inches. It was subsequently cold rolled.

• **Fluxing agent needed**—By continually decreasing the roll opening until the rolls were completely closed, eventually the material was reduced to a foil 0.001 inches thick. The finished foil was then ready for evaluation as a brazing alloy.

In the preliminary tests the aluminum oxide dispersion-hardened alloy would not wet steel very readily at 1800°F and 1900°F. It was thus evident that a fluxing agent was required in conjunction with the new filler alloy.

A foil of 99.7% silver alloy containing 0.3% lithium was placed in contact with the dispersion-hardened foil and the combination placed between the skin and the honeycomb. During the brazing cycle the lithium in the silver-lithium foil was concentrated enough to flux the core and the skin very thoroughly. Thus a successful brazed joint was achieved.

• **Psi increased**—A difference was noted between the flow of the silver-lithium and the composite alloy consisting of a layer of silver-lithium and the dispersion-hardened alloy. Specimen of 17-7PH stainless steel brazed with the silver-lithium showed slightly more flow than the other specimens brazed with the composite material.

Secondly, evaluation tests indicated the strength of the lap joints containing the dispersion-hardened silver was around 17,000 psi, whereas the silver-lithium joint yielded shear strengths of 11,500 psi. Thus a definite strength increase was shown which prompted further investigation and application.

Honeycomb panel brazed with commercially available brazing alloy produced areas of no brazing caused by starvation of the top surface. However, no starvation appeared after brazing with silver dispersion-hardened material.

The Martin Company is proceeding to braze larger and more complex panels. It is continuing the investigation of other fluxing agents and techniques and adding particles other than aluminum oxide as the hardening medium.

• **No adhesive**—Extremes of high and low temperatures in the environment of supersonic weapons systems have clearly shown the need for new materials and manufacturing processes for the fabrication of aircraft and missiles that can endure this environment.

The design of the weapons systems that will be operational in the early 1960's is far ahead of the industrial ability to manufacture them. The selection of stainless steel as the material to be used in these systems, because of its characteristic resistance to extremes of temperature, has brought on the problem of how to join the parts of an assembly.

With slower flying aluminum planes, adhesive bonding was adequate since the operational temperatures were never high enough to affect the adhesive bond. But with temperatures high enough to require the use of stainless steel, an adhesive bond is rendered useless. The only solution is to use a metal joint capable of enduring such an environment.

Brazing seemed to offer the answer until experiments showed that available brazing alloys flowed too readily. This caused the bottom joint to be too heavy and the top joint too light or to have no braze at all. Also these fillers showed a poor resistance to corrosion which could not be tolerated.

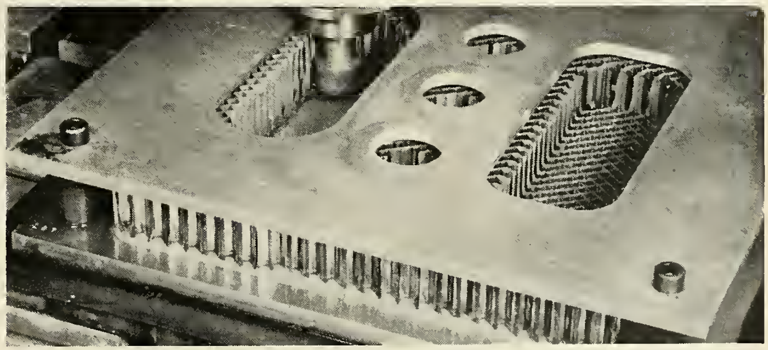
It was these deficiencies in the existing brazing alloys that convinced Martin that development of a new alloy was imperative.

• **Future significance**—Brazing accomplished with this new alloy shows that a sound, strong brazed structure with even filleting can be attained with none of the defects attendant on the use of other alloys. It also allows an opening of the tolerances since the sluggishness of the melted alloy allows it to stay where it is placed and bridge the increased gap between skin and core.

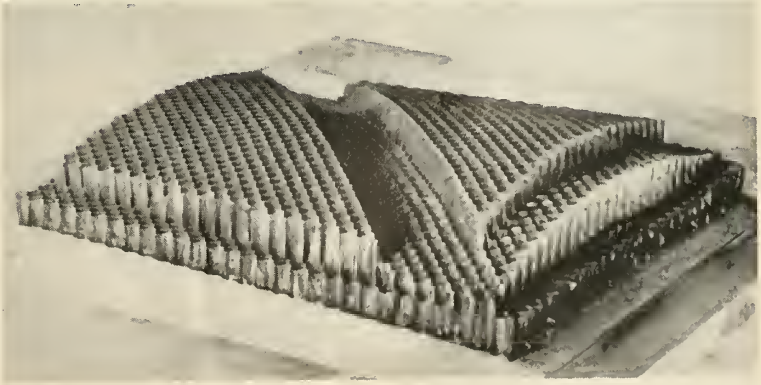
These properties were first suspected by Dr. Howard R. Peiffer during basic metallurgical experiments with silver at the Research Institute for Advanced Studies.

Important as this development is at present, its use in the missiles and space ships of the near future will show the real significance of this process.

Methods of Machining



DIAGONAL CUT on stainless steel honeycomb is made by using overlay template for cavity machining. Lower picture shows how spiral cut is made in contour machining.



Board Chairman George M. Bunker continues as Martin Co.'s chief executive officer. But under management realignment, former executive vp William B. Bergen becomes president and principal operating officer. Move frees Bunker for long-range planning.

In a top management reshuffle, Frank Pace, Jr. has been named chairman of the board of General Dynamics Corp. Succeeding Pace as president is former executive vice president Earl Dallam Johnson. Carleton Shugg, a senior vp and general manager of the Electric Boat Division, moves up to president of Electric Boat. Elevated from general manager to president of the General Atomic Division is Dr. Frederic de Hoffmann.

Page Communications Engineers has become a wholly-owned subsidiary of the Northrop Corp. The company, engaged in Army and Navy communications, says it is working on a system to produce long-range, highly reliable air-to-ground and point-to-point communications over distances up to 3000 miles.

MIT's Dr. C. S. Draper, pioneer inventor of inertial guidance systems, is taking over the vacant chairmanship of the National Inventors Council. He succeeds the late Charles F. Kettering. Homer H. Ewing of Du Pont's development department has been named council secretary.

New fast tax write-off certificates issued by the Office of Civil and Defense Mobilization include: Thiokol Chemical, Bristol, Pa., 70% of $1.3 million; Sylvania Electric Products, Mountain View, Calif., 60% of $920,000 and Aeronutronic Systems, Calif., 60% of $401,000.

Missile stress factors will be featured at the Society for Experimental Stress Analysis meeting starting May 20 in Washington.

United Aircraft Corp.'s Hamilton Standard division is creating a new department for the design, development and production of specialized missile ground support equipment. Heading up the new organization is Edwin D. Eaton, formerly chief of experimental operations . . . Temco Aircraft Corp. is establishing a new electronics division and separate divisions for missiles and aircraft and aircraft overhaul. And B. F. Goodrich Co. and High Voltage Engineering Corp. have joined in the formation of Goodrich-High Voltage Astronautics Inc. to produce ion propulsion engines for space vehicles.

AF's *Hound Dog*—supersonic jet-propelled guided missile—was launched successfully for the first time April 23 from an Eglin AFB B-52 bomber. A two-stage *Cree* test vehicle fired the same day at Eglin went to an altitude of 70,000 feet to test a deceleration parachute for the *Mercury* manned space vehicle. A malfunction after ignition April 28 stopped a scheduled *Titan* stage separation test just as the vehicle was to leave the launch pad.

NORTH AMERICAN's *Hound Dog* air-to-ground missile carried by a Boeing B-52 jet of the Strategic Air Command. The new missile is currently in operational test.

Cape Operating at One-Fifth Capacity

WASHINGTON—The Cape Canaveral Missile Test Center—one of the key elements in the nation's space and missile program—is operating at only one-fifth of its current capacity.

Maj. Gen. D. N. Yates, commander of the half-billion-dollar test center, told M/R that Canaveral's present overall facilities could handle five times the present number of rocket launchings "without spending another dime."

Some critics have charged the test center's capacity for handling rocket launchings was a roadblock to speeding up the nation's space program.

Yates said there are only two reasons why the center isn't launching more rockets:

• More launchings are not called for in particular rocket development programs.

• Or, additional rockets are not available.

Moreover, he said the center has room for increasing possibly 15 to 20 times the amount of testing including many new type rockets in the years ahead.

"We already are planning for test programs that we only are imagining," he said. "Huge rockets for space exploration projects that so far aren't even programmed."

Yates also said he thought the day is fast coming when both the U.S. Atlantic and Pacific Missile Ranges along with other missile ranges around the world must centrally coordinate their tracking and monitoring facilities.

"This type of coordination will be essential for such programs as Project *Mercury* and *Dyna-Soar,*" he said.

On other developments, Yates said:

• The United States can have a man in orbit within a "year or so" under the current man-in-space program. However, much remains to be done before the goal can be achieved.

• U.S. engineers have developed a successful method for cutting off operation of solid propellant rockets in flight. The method being used is classified.

• The Boeing *Minuteman,* when ready for testing from the Cape, will be fired from a model of the inverted silos that will be used later to house *Minutemen* at hardened ICBM bases.

• Planning is underway for building facilities for testing the Martin *Pershing* and the 1.3-million-pound-thrust *Saturn* at the Cape.

NASA Names Hagen to Coordinate Programs

WASHINGTON—John P. Hagen. Director of the *Vanguard* Division since its inception, has been appointed Assistant Director for Program Coordination of the National Aeronautics and Space Administration.

Hagen will serve as operations manager of NASA's Office of Space Flight Development, coordinating and reviewing the progress of the office's various scientific and technical programs.

The *Vanguard* program, which Hagen directed first for the Navy and then for NASA, is being phased out. The rest of the *Vanguard* staff will be integrated into the Beltsville Space Flight Center.

NASA Space Flight Center Named for Goddard

WASHINGTON—NASA Administrator T. Keith Glennan has announced that the agency's new 550-acre, 450-man Space Flight Center near Beltsville, Md., will be named for Robert H. Goddard, American pioneer in rocket research.

The Goddard Space Flight Center will perform NASA's basic space research and will be responsible for the development of satellites, space probes and vehicles, tracking, communications, and data reduction systems.

The Center's 100,000 square feet of laboratory and office floor space will be ready for occupancy in mid-1960. Its staff is now housed at the Naval Research Laboratories, at the Langley Research Center.

Organization of the new Center includes a director, not yet appointed, three major research and development groups headed by assistant directors, business administration and technical service departments.

The three major research groups, and their Assistant Directors, are:

Space Science and Satellite Applications—Directed by John W. Townsend, Jr., includes the Space Sciences, Theoretical Satellite Applications Systems, and Payload Systems Divisions.

Tracking and Data Systems—Directed by John T. Mengel, includes the Tracking Systems, Data Systems, and Support Divisions.

Manned Satellites—Directed by Robert R. Gilruth, includes the Flight Systems, Engineering and Specifications, and Operations Divisions, and also the *Mercury* manned space flight project.

Michael J. Vaccaro, former personnel director at the Lewis Research Center, has been appointed business manager of the Space Center.

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The DC-Pak is built to give thousands of hours of efficient, ouble-free operation. Made with only four major parts (and no ıoving parts), it requires an absolute minimum of maintenance. or example, even a dead short across the output for a full hour ill not harm the DC-Pak. Also input surge protection can be rovided.

Units can be supplied with either single or multiple output, epending upon the needs of the customer. For full details on ıese transistorized units—and how they can be tailored to your xact voltage and amperage requirements—write BENDIX AVIATION ORPORATION, EATONTOWN, NEW JERSEY.

*TRADEMARK, BENDIX AVIATION CORPORATION

Specifications of Typical DC-Pak Units

Power Output	100 Watts	50 Watts
Output Voltage	500—5% VDC, 200 MA	250—5% VDC, 200 MA
Input Voltage	24—30 VDC, 27.5 Nominal	24—30 VDC, 27.5 Nominal
Voltage Regulation	5%; half to full load	6%; half to full load
Max. Operating Temp. (Ambient)	+60°C.	+71°C.
Max. Mounting Base Temperature	+71°C.	+80°C.
Min. Operating Temp. (Ambient)	−40°C.	−40°C.
Storage Temperature	−65°C. to +100°C.	−65°C. to +100°C.
Max. Surge Voltage	80 V. Peak	80 V. Peak
Ripple	1% RMS	1% RMS
Efficiency	80% at 25°C.	80% at 25°C.
Weight	1 lb. 8 oz.	1 lb. 8 oz.
Size	5⁵⁄₁₆ x 2⅞ x 2¼	5⁵⁄₁₆ x 2⅞ x 2¼
Electrical Connection	Four-Pin Connector	Four-Pin Connector
Accessibility	All parts are completely accessible and interchangeable.	All parts are completely accessible and interchangeable.

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what's happening in Tucson?

TUCSON IS FREE of the tensions and hustle of big cities. Tucson offers its residents a truly cultural atmosphere in a dry healthful climate with an average of 11 hours of sunshine every day.

The University of Arizona, with an enrollment over 15,000, functions as the center of cultural activities—offering a variety of orchestral, choral and dance programs. The fine Tucson Symphony plays regularly at the famed Temple of Music and Art.

The Fine Arts Show and Photo Workshop climax the year's activities in the visual arts with exhibitions and symposiums. Tucson's reputation is attracting many fine artists who make this their home. The Fashion Fiesta in February displays the latest work of the Southwest's top designers.

Spring Training activities of the Cleveland Indians...the Saturday Evening Forum (the nation's largest community forum)...the world famed rodeos and Spanish celebrations...these and more make Tucson a stimulating, rewarding place to live...and work.

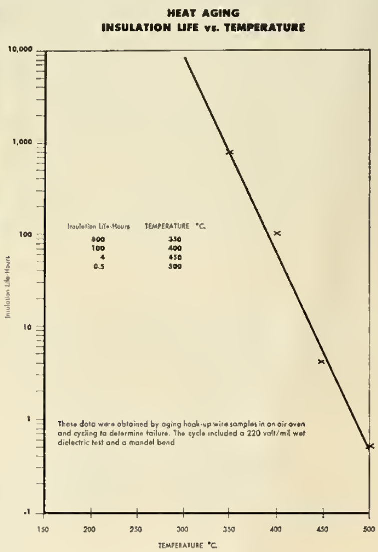
(For more details see opposite page.)

Teflon Insulation

To the Editor:

In a recent issue you published a letter from J. G. Lindberg concerning the electrical properties of wire insulated with "Teflon" (R) TFE-fluorocarbon resin at elevated temperatures. The letter left an erroneous impression that the electrical properties of "Teflon" TFE resins were greatly reduced at temperatures above 730°F.

We have run very extensive heat aging tests on wire insulated with "Teflon" TFE resin and find that it is continuously serviceable at 260°C (500°F). It is also serviceable for finite times at temperatures above 500°F as shown by the attached graph.



The table shows other typical values of dielectric strength at elevated temperatures. The values of the hours of expected life for hook-up wire have been substantiated for magnet wire insulated with "Teflon" TFE resins by other laboratories. It is interesting to note that at a temperature of 735°F the weight loss of "Teflon" TFE resin is extremely small. Its value is 0.071% per hour.

As a practical test we have subjected various samples of wire to overload currents. A coil of AWG #22 wire insulated with "Teflon" TFE resin and fabricated to conform to MIL-W-7139B construction was subjected to a current of 25 amps. The exterior of the insulation reached a temperature in excess of 425°C in 35 seconds. The temperature of the conductor was not measured.

Although vapors were evident, the wire continued to carry the current without fault until the test was terminated after two minutes. Other high-temperature resins similarly tested melted and faulted between conductors or burst into flames in less than one minute.

From these data it is evident that wir insulated with "Teflon" TFE resin has finite service life well above the 730° value of the reference letter.

Joseph C. Reed
Applications Technologist
"Teflon"
E. I. DuPont DeNemours & Co
Wilmington 98, Delaware

Reluctant Astronaut

To the Editor:

Rep. Leonard G. Wolf of Iowa report this verse is circulating at the Arm missile center at Huntsville, Ala.:

In the missile game we've won grea fame—
The world knows our Jupiter C
And what we've done with Explorer I
Medaris, von Braun and me.

O watch our smoke as we go fo broke
To solve the space mystery.
We have a thirst to be there first,
Medaris, von Braun and me.

Our skill we pride, we'll travel wid
Into space so wild and free;
To the moon, then to Mars, then t distant stars,
Medaris, von Braun and me.

When finally we've planned a spac ship that's manned,
And they call for brave men, tw or three,
To try first for the moon in tha metal balloon—
Call Medaris and von Braun—NO ME

—Ivan the Terrible

Sincerely,
Jay Holmes,
New York, N.Y.

Oversimplified?

To the Editor:

Your editorial, "Six Lines for th *V-2*," in the March 23, 1959, issue o M/R, tends to oversimplify an acute an complex problem. M/R's Managing Edito Don Perry, in the previous week's issu reported that "there is grave danger tha our military 'spec' writers may be en dangering the nation's defense by ove particularizing their orders to industry. This presents the side of the coin observe by industry.

The six lines defining the operationa parameters for *V-2* were written in despe ation. The master plan conceived tha World War II would be won with existin electronics, thereby releasing precious sc entists and engineers for the exploitatio of other fields. Germany, through a co certed drive at standardization, had re duced the military application of electro tubes to less than two dozen types. Ir ability to cope with the Allies' advance lectronics brought Germany to its knees. he frantic introduction of jet aircraft nd the *V-2* came too late.

What is the role and destiny of elec-ronics? Electronics is the key to the uture. Militarily, electronics is the brain overning the muscular reflexes that parry nd thrust the spear and whoever fails to naintain the pace is doomed. To hasten ne pace in obtaining tomorrow's weapons e have resorted to the weapons system vhich, in respect to Government Fur-ished Equipment (GFE), provides indus-ry a relatively unencumbered approach to ne development and production of the veapon.

Today, our military electronics con-ains in excess of 3000 electron tube ypes. Further, transistors and other spe-ial devices are running amuck. R&D and roduction are in many cases indistin-uishable. While I am generally in agree-nent with the precept that secondary con-iderations such as logistics support re-uirements shall not obstruct weapons de-elopment, I firmly believe that failure to dequately consider them will cost us early in operational availability, person-el and dollars.

Robert H. Byrne, LCDR, USN
208 Pacific Drive
Forrestal Village
North Chicago, Ill.

Compliment of a Sort

o the Editor:

May I congratulate you on your calm nd intelligent editorial of March 30th. M/R still has a long way to go on reliable eporting, but I now have the confidence hat it will make the grade.

Roy E. Marquardt,
President,
Marquardt Aircraft Co.

et's Accelerate

o the Editor:

Maj. William C. Mannix's very interest-ng article in your April 27 issue reminds ne of the gag we used to throw around he lab a few years ago:

"Our hero rammed it to the firewall nd accelerated to 17 microluxes."

As you may gather, a microlux is pre-isely Maj. Mannix's "optik." We chose his size for the same reasons he did—'s about Mach 1 and very convenient ll the way round.

I think that it is better to use the speed f light as the basic unit rather than /1,000,000 since no new units are used. n electronics, microfarads have been sed for years with no trouble. They are sually referred to as "mikes," "micro-nikes," etc. Lux actually has another ignificance, so why not name the unit nicrolights, or perhaps, micromannixs?

In any event, don't name it after Einstein—he's wrong.

Robert E. Span,
Ligonier, Pa.

contract awards

NASA

$24,067,500—**Douglas Aircraft Co., Inc.**, for development of the *Thor-Delta* launching vehicle.

NAVY

$41,200,000—**Bendix Aviation Corp.**, for work on *Talos* guided missiles.

$1,700,000—**Babcock Radio Engineering, Inc.**, Costa Mesa, Calif., for remote guidance systems for shipboard control of missile target aircraft.

$1,225,000—**Summers Gyroscope Co.**, Santa Monica, Calif., for gyroscopic units for guided missiles, mainly for spring-wound gyros for use in *Bullpups* (subcontracts from The Martin Co.).

$729,662—**American Bosch Arma Corp., Chicago Div.**, for *Talos, Tartar* and *Asroc* missile switchboards and weapons direction equipment action cutout switchboard.

$658,965—**Lansdowne Steel & Iron Co.**, Morton, Pa., for *Zuni* rocket heads and other items.

$320,000—**Ralph T. Viola**, Oxnard, Calif., for construction of missile handling buildings at Naval Missile Center, Point Mugu.

$144,998—**United Aircraft Corp., Norden Div.**, for synchros.

$44,956—**Thompson Ramo Wooldridge, Inc.**, for interference generators.

$43,000—**Massachusetts Institute of Technology**, for alloy development program based on chromium for use at elevated temperatures.

$33,300—**University of California**, for investigation of feasibility of shaping ductile ceramics by methods involving plastic flow.

$32,015—**Bendix Aviation Corp., Montrose (Pa.) Div.**, for synchros.

$30,398—**Collins Radio Co.**, for research on high-speed wingless VTOL aircraft.

ARMY

$8,671,100—**Western Electric Co., Inc.**, for supplemental R&D on *Nike-Zeus* system.

$1,131,680—**Kaminer Construction Co.**, Chamblee, Ga., for construction of dessicant drier system for the Propulsion Wind Tunnel, Arnold Engineering Development Center, Tullahoma, Tenn.

$1,000,000—**Temco Aircraft Corp.**, for wings and elevons for the *Hawk* missile (a follow-on order from Raytheon manufacturing Co.).

$750,000—**Allied Chemical, General Chemical Div.**, for research on high-energy oxidizers for advanced solid rocket propellants.

$709,656—**McDonough Construction Co. of Florida**, Miami, for construction of buildings and utilities at Eglin Gulf Test Range.

$313,276—**Western Electric Co., Inc.**, for *Nike* spare parts and components (three contracts).

$250,000—**Standard Construction Co.**, El Paso, Tex., for construction of telephone cable plant at White Sands Missile Range.

$216,369—**Raytheon Manufacturing Co.**, for electron tubes (four contracts).

$174,818—**Minneapolis-Honeywell Regulator Co.**, for components for *Honest John* adaption kit.

$151,254—**Tung-Sol Electric Co.**, Newark, N.J., for electron tubes (two contracts).

$128,775—**Kuthe Laboratories, Inc.**, Newark, N.J., for electron tubes.

$100,930—**McGregor-Michigan Corp.**, Detroit, for a complete tunnel, arc chamber and related steel structures for the Propulsion Wind Tunnel, Arnold Engineering Development Center, Tullahoma, Tenn.

$99,068—**Motorola Inc.**, Phoenix, for nine months' continuation of studies of automatic plot of enemy signal origin point.

$85,240—**C. F. Mayer & Co.**, Bethel Park, for construction of warheading buildings for special AAA facilities for Cincinnati Defense Area.

$67,442—**W. R. Grace & Co., Dewey & Almy Chemical Div.**, Cambridge, Mass., for a meteorological balloon.

$61,000—**Belock Instrument Corp.**, College Point, N.Y., for fabrication of engineering test models of computer-driven reticles for articulated telescope T171.

$58,443—**Union Carbide Corp., Union Carbide Chemicals Co.**, for ethylene oxic in government-furnished steel cylinders

$52,780—**General Electric Co.**, for electro tubes.

$47,959—**Belock Instrument Corp.**, for de sign, engineering and fabrication of si integrating gyro assemblies.

$45,700—**Cohu Electronics Inc., Kin Tel Div** San Diego, for a closed circuit televisio system for the White Sands Missile Rang

$40,695—**The Eagle-Picher Co.**, Cincinnat for thermal batteries.

$34,850—**Kearfott Co., Inc.**, for motor gen erators.

AIR FORCE

$33,175,558—**International Business Machin Corp.**, for transistorized support machir computers for SAGE air defense system

$11,400,000—**ITT, Federal Div.**, Clifton, N.J for duplex high-power radio amplifiers t be used in the SAGE network.

$6,859,000—**S. Patti Construction Co., Mac Donald Construction Co., C. H. Leave Co., and Scott Co.**, Kansas City, Mo., (join venture) for construction of launch an service buildings for missile launch com plex in the vicinity of Spokane, Wash.

$3,000,000—**Chrysler Corp.**, for *Jupit* ground support equipment.

$2,000,000—**Curtiss-Wright Corp., Metal Proc essing Div.**, for acquisition of machine and equipment.

$1,637,887—**Litton Industries, Electron Tub Div.**, for electron tubes.

$636,713—**Pan American World Airways, Inc** for increase in funds (for Patrick AFB

$500,000—**Ryan Aeronautical Co.**, for tech nical support of the GC-130A Dron Launcher/Director aircraft developmen program.

$249,300—**Microwave Associates, Inc.**, Bu lington, Mass., for electron tubes.

$197,365—**Radiation, Inc.**, Melbourne, Fla for development of computing-trackin group.

$167,452—**General Electric Co., Defens Electronics Div.**, for telemetric dat monitor.

$120,050—**Minneapolis-Honeywell Regulat Co., Heiland Div.**, Dayton, Ohio, fo oscillographs, visicorders, subminiatu galvanometers and manuals.

$111,153—**Hewlett-Packard Co.**, Palo Alt Calif., for signal generators.

$91,784—**Haloid Xerox, Inc.**, Rochester, N.Y for research on high-temperature com plex component development.

$78,000—**Bendix Aviation Corp., Red Ban Div.**, for electron tubes.

$73,189—**Del Mar Engineering Laboratorie** Los Angeles, for infrared-emitting aeri tow target.

$65,500—**Sperry Rand Corp., Remingto Rand Univac Div.**, for floating paint fo Univac computer modification in suppo of Project WS-133A.

$60,125—**Avien, Inc.**, Woodside, N.Y., fo product improvement on time-tempera ture integrators.

$59,357—**AVCO Manufacturing Corp., Re search and Development Div.**, for multip path photoelectric projectile detector an shadowgraph photograph system.

$58,317—**General Electric Co.**, for researc toward study of radiation damag thresholds of the elements.

$54,695—**Boston College**, for research o collection, reduction and evaluation c geomagnetic field data and electric fiel phenomena, atmospheric and terrestria

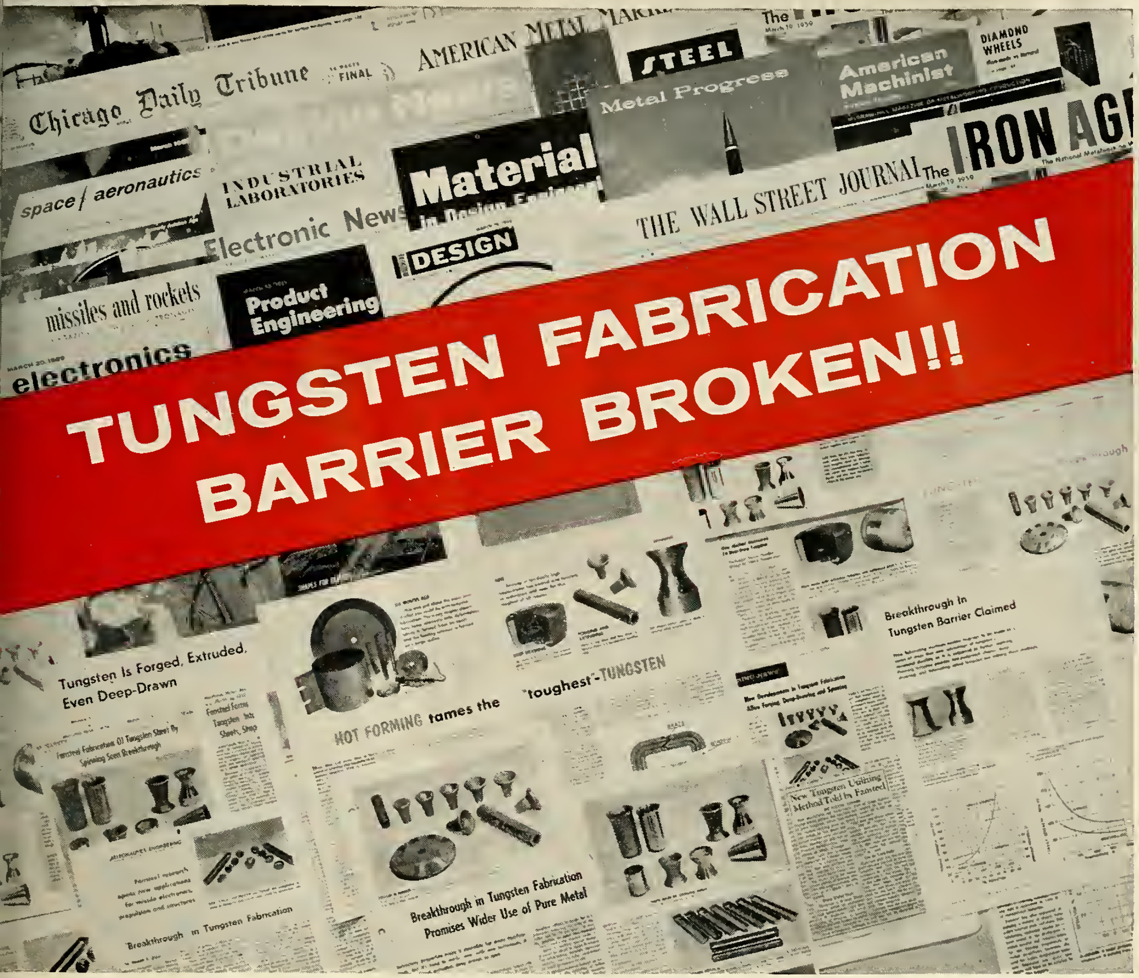
$54,177—**Republic Aviation Corp.**, for de termination of orbital motion of th Russian Satellite 1957 Beta.

$51,646—**General Electric Co., Research Lab oratory**, for research on development, tes and fabrication of sun-azimuth pointin platform.

$40,000—**Battelle Memorial Institute**, fo continuation of research on effect of ver high pressure and temperature on semi conducting and insulating materials.

$39,848—**Lightning & Transients Researc Institute**, Minneapolis, for propagatio studies using VLF impulses, to includ ground wave and ionospheric studies.

$35,000—**University of Colorado**, for study o reflection and transmisison of materia for radiation in the far ultraviolet.



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FANSTEEL

HIGH TEMPERATURE METALS

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—for greater reliability and longer life
—for even greater miniaturization
—for highest strength at extreme operating temperatures

Want to explore the possibilities of adapting tungsten to *your* product? Fansteel engineers will be glad to work with you. Just send print, part sample or call in your Fansteel representative.

Only your imagination will determine what lies ahead in the uses of tungsten.

K593

FANSTEEL METALLURGICAL CORPORATION, NORTH CHICAGO, ILLINOIS, U. S. A.

Three officials of Aerojet-General Corp. have been tapped by the National Aeronautics and Space Administration for its Research Advisory Committees. **Dr. A. L. Antonio,** vice president-Chemical Division, will serve on the Committee on Chemical Energy Processes; **Gordon Banerian,** manager, Turbo-Machinery Division, on the Committee on Mechanical Power Plant Systems, and **Lawrence L. Gilbert,** head of the Materials Department, will head the Committee on Materials.

Three new Aerojet appointments:

Dr. Adolph Oberth, 30, son of pioneer rocket expert **Hermann Oberth,** has joined the solid-propellant research and development staff to work on high-energy propellants. Oberth, who has always wanted to follow in his father's footsteps, came to the U.S. in 1946 with a PhD in chemistry from the Institute of Technology at Munich and worked for DuPont in New Jersey.

Dr. Robert F. Brodsky, who once designed the configurations for America's atomic and hydrogen bombs, will be Systems Division Manager, Engineering Services Department. Before joining Aerojet, he was chief of aerodynamics at Convair, Pomona, Calif.

Rear Adm. L. C. Baldauf, USN (Ret.), former director of Quality Control for the Navy's Bureau of Ordnance, was named technical specialist on the corporate quality control staff.

Dr. Stanley Winkler has joined the Technical Planning Staff in Advanced Systems Research at the International Business Machines Corp.'s Military Products Division. Winkler was chief, Command Control Systems of the Office of Naval Research, where he directed a study of the influence of satellites and space technology on naval operations. He also led a group which evaluated missile guidance systems and conducted an investigation of inertial navigation systems.

WINKLER

Robert H. Shatz has been named chief of technical military planning in United Aircraft Corp.'s Missiles and Space Systems division. Director for the past ten years of the Systems Research Division of Cornell Aeronautical Laboratory, he has served on Pentagon study groups involving the missile defense program.

At the same time United announced that its second George Mead Medal for Engineering Achievement went to **Thomas Richard Quermann,** chief gyro engineer of the Norden division's Ketay department. The medal and $2500 were awarded for Quermann's conception of a unique liquid-floated gyro with mechanical temperature control, and his preparation of the design for production in less than a year. A major step in development of gyros for missiles and space craft, it is now used in the *Atlas, Titan, Polaris* and *Snark* programs.

Dr. Burton H. Colvin heads the Mathematics Research Laboratory at Boeing. Colvin succeeds **Dr. Robert E. Gaskell,** who resigned to accept a post as mathematics professor at Oregon State College. Colvin joined Boeing as a mathematician in 1951 and was appointed supervisor of the mathematical analysis group in 1955.

John A. Drake, director of ASTRO, a division of Marquardt Aircraft Co., has been appointed to the Research Advisory Committee on Chemical Energy Processes of the National Aeronautics and Space Administration.

DRAKE

Appointment of **Howard E. Thompson** as supervisor of production planning and control, and promotion of **James R. Robinson** to engineering services administrator, were announced by Technical Products Division of Waste King Corp. For the past ten years Thompson was chief inspector, quality control manager and product engineer for National Seal Division, Federal-Mogul-Bower Bearings, Inc. Prior to joining Waste King, Robinson was assistant to the director of plant operations at Marquardt Aircraft Corp.

Alfred C. Harris has joined Commercial Shearing and Stamping Co., Youngstown, Ohio, as sales manager for Rotoform products, a new metal-forming service. Harris came to Commercial from the Metal Dynamics Division, Cincinnati Milling Machine Co.

HARRIS

Robert O. Briggs was recently named Chief Engineer of the Electronics Division, United ElectroDynamics, Inc. He was formerly with the missile system consulting firm, Robert Briggs Associates, Inc.

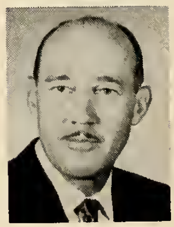
Richard S. Morse, Cambridge, Mass., newly-named Director of Army Research and Development, will succeed **Dr. William H. Martin,** effective June 1. Morse is founder and president of The National Research Corp., Cambridge. His new job carries authority equivalent to an Assistant Secretary of the Army.

Maj. Gen. T. C. Odom (USAF Ret.), IBM's new director of systems management for the Military Products Division, was until recently commander of the San Antonio Air Materiel Area.

Louis A. Payne has joined Lear, Inc., Astrionics Division, Santa Monica, Calif., as manager of its Engineering Division. For the past eight years he was senior dynamics group engineer with Convair Division of General Dynamics Corp., in charge of flight control system analysis, synthesis, lab development and flight test development.

Robert E. Rutherford and **Bernard R. Linden** have been named manager and assistant manager, respectively, of the Vacuum Tube Section of CBS Laboratories' Physics Department.

Eldon Overholtzer, corporate secretary of Tamar Electronics and Pres-To-Line Corp. of America, was appointed to the newly-created position of executive vice president for both organizations. Overholtzer was named general manager and secretary-treasurer in 1948, and assumed corporate responsibilities when Pres-To-Line acquired Tamar.



OVERHOLTZER

Dr. Robert Bromberg has been appointed director and **Arthur F. Grant** assistant director of the Propulsion Laboratory, Research and Development Division, of Space Technology Laboratories, Inc. Bromberg, who joined Space Technology Laboratories in 1958, was previously with Ramo-Wooldridge Corp.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HALLAMORE

ropulsion engineering

Hydrazine formation from ammonia now can be more clearly iderstood, thanks to University of Utah chemists who have defined e processes that occur in ammonia under high-frequency discharge. ıey also report, in the journal *Industrial & Engineering Chemistry*, e controlling factors in producing hydrazine from ammonia, and relationship between the nature of the spark and the amount of ıs decomposed by it.

Maximum hydrazine yield is about 4-6 grams/kilowatt hour. ıctors which control the yield are gas flow rate, pressure, discharge ırrent and electrode gap size. The work was done by W. Hoyt nderson, now with Aerojet-General; B. J. Zwolinski, currently at arnegie Tech; and R. B. Parlin, now with Operations Research, ıc. Understanding and possible control of the mechanism of hydra- ıne's direct synthesis from ammonia could lead to wider availability ıd drastic price reduction.

Hydrazine makes news in Germany, also, as Farbenfabriken ayer reveals a new process for recovering the material from lean ater solutions. The patented technique pulls hydrazine from solu- ons containing as little as 1% hydrazine by weight. German chemists ix the water waste with cyclohexanone, precipitating dicyclohexyli- ene hydrazine. An acid then splits off the corresponding hydrazine ılt from which hydrazine is released by action of a hydroxide. In ractice, the Germans say, the technique is simple and cheap—and l hydrazine can be recovered.

Transistors operate at 1800°F in an inert or reducing atmos- ıere, 1480°F in air, when they are made of boron phosphide. So eported Monsanto Chemical's Forrest V. Williams at the recent Amer- an Chemical Society national meeting. He also revealed a way to repare the high-purity boron phosphide by reacting boron trichlor- e, phosphorus, and hydrogen at a high temperature. Most present ansistors are germanium or silicon. Germanium works at tempera- ıres up to 160°F, silicon up to 300°F. Boron phosphide is a very ard, refractory-like material which is not attacked by most corrosive gents.

Cheaper titanium will result from a new process developed by rmour Research Foundation. The key is a cold chlorination of ower-grade ilmenite ores and crude scrap. This produces the actual arting material—potassium chlorotitanate. From this, ARF can roduce not only the metal, but also two other major products: titan- ım dioxide and titanium tetrachloride. Besides using low-grade ores nd scrap, and producing three needed items from one starting ma- erial, the process also may result in cutting other in-plant costs. This just a continuation of research that is gradually lowering the price f this corrosion-resistant metal. Titanium now sells for around 1.85/lb. A year ago it was $2.25, and five years ago it sold for 5.00.

Beryllium prices may head down, also, again thanks to a new esearch development. Sylvania-Corning Nuclear Corporation has de- eloped a continuous process for beryllium amalgam production. he process, still in the laboratory stage, is a simpler and more direct oute to the metal than techniques used at present. Sylvania's Be- nalgam is produced continuously by electrolysis. In present industry ractice, beryllium fluoride is reduced by magnesium to tiny metal alls which must be ground and then fabricated by powder metallurgy chniques. With the new process, beryllium shapes can be made irectly from the amalgam.

west coast industry

by Fred S. Hunter

The California Assembly has passed the bill which will make i possible for counties to tax machines or materials owned by th Federal Government but used by defense plants. The chances ar better than 50-50 that the Senate will concur and something like $35(million in property will go back on the tax rolls.

There are two sides to the question of exempting Federal propert in defense plants from local taxes. Take, for example, Convair-Astro nautics' plant at San Diego, for which the government supplied mos of the machinery and equipment. The City of San Diego can't ta this government property, but it was faced with finding the money t build new access roads to the plant to serve the employes.

On the other hand, any local taxes Convair-Astronautics migh have to pay on this government-owned property would be reflecte in increased costs of the *Atlas* missile. And the Air Force, conceiv ably, could tell Astronautics it would have to go someplace els where taxes are lower, to build the ICBM.

Most tax people seem to feel that once the legalities of the posses sory interest tax are spelled out in California other states will follo suit and a more-or-less uniform formula eventually will be applie throughout the country. But there is also the chance that some state may seize this as an opportunity to attract defense business to thei borders.

One Assemblyman, seeking to amend the tax bill to soften th effect, argued that the tax would drive defense industry from th state. It won't be this bad, but there's no doubt that the dollar amou is big enough for consideration in evaluating a contract price or th location of a plant. At the going rate of the defense industry in Cal fornia, the law change means a tax boost of approximately $20 mi lion a year.

Radioplane's contract from McConnell Aircraft Corp. for desig development and test of a landing system and post-landing equi ment for the man-in-space capsule, Project *Mercury,* calls for 2 units. This division of the Northrop Corp. also will provide eig landing and recovery units for the National Aeronautics & Spa Administration for early space age tests. It is interesting to note th Radioplane's approach to the problem is simple and straightforwar It has been developing recovery systems for drones for years and i engineers know the lines to follow.

Douglas Aircraft Co. makes most of the ground equipment f the *Thor* IRBM—including the shelters which roll automatically wheels mounted on tracks—at Long Beach, where it has big hanga rather than at Santa Monica, where the missile itself is assemble The shelters, which cost $286,000 each, contribute a large share the Air Force's airlift of the *Thor* to the United Kingdom. They' shipped in prefab form and weigh 100,000 pounds each.

Willis M. Hawkins, assistant general manager of Lockheed's M sile and Space Division, is another who feels it wise to keep t public informed on missile and space projects. Only in this way, says, will voters learn to appreciate the need for these projects a understand the reasons behind their huge costs.

Use of North American Aviation's Rocketdyne facilities for ba ground in a Desilu Production film prompted local speculation fo new TV series titled "I Love Liquids."

Adam Makes Comeback in *Mercury*

by Paul Means

WASHINGTON—A governmental ax-
m of long standing is that a project
jected one year may be accepted the
ext if submitted to a different govern-
ental agency in a slightly different
ay.

This certainly is the case with the
rmy's Project *Adam* man-in-space
nture, (M/R, June, 1958, p. 40)
hich was turned down cold by the
epartment of Defense last year, but
hich now forms the nucleus of the
ational Aeronautics and Space Ad-
inistration's Project *Mercury*.

Under Project *Adam*, the Army
ould have sent an astronaut 100 miles
in a ballistic missile trajectory with
Redstone, and brought him back to
rth with drogue parachutes.

Planning on *Adam* began in the
ll of 1957, but was turned down by
OD last summer because the *X-15*
cket plane would have been ready
about the same time.

Now NASA's Project *Mercury* has
corporated Project *Adam* as one of
preliminary steps.

After the *Mercury* space capsule
s been aerodynamically tested on top
the four Thiokol *Sergeant* rocket-
ustered *Little Joe* vehicles, it will
tested on top of a modified *Red-
one* with animal passengers over the
tlantic Missile Range.

The seven *Mercury* astronauts could
ke their *Redstone*-powered rides down
e Atlantic Missile Range as early as
nuary, 1960.

• **Reliable** *Redstone*—*Redstone* was
iginally picked for Project *Adam*
d subsequently selected for Project
ercury because of its proven reli-
ility.

The modified *Redstone* (*Jupiter-C*
nfiguration, minus the upper staging
rangement and Hydyne fuel) will
ve approximately a 4500 to 5000
et/sec. velocity at power cutoff when
e nose section separates.

The *Redstone* will carry its pas-
ngers to an altitude of 100 miles and
0 miles down range.

The capsule will come to a near
andstill at the apex of its ballistic tra-
ctory, gaining a speed of about 5000
et/sec. when it re-enters the atmos-
here. Two or three automatic drag
rachutes will slow the capsule down
d a parachute will be deployed at an
titude of 7000 feet. The capsule's
tro-rockets will be fired for test pur-
ses only.

Redstone will subject the astronaut
at least six minutes of combined
gative g's and complete weightless-
ss. Total flight time from launch to
return to earth will be from 10 to 12 minutes.

• **Test plans**—First *Jupiter* firings of the capsule, which is the next step in Project *Mercury* development, could come by the end of 1959. These shots are to test the aerodynamic qualities of the capsule and the reliability of the retro-rockets at velocities approaching those to which the *Atlas* vehicle will subject the capsule.

Final testing before manned flight will be with the *Atlas* launcher itself. The capsule will be sent into orbit and recovered, alone and with animals, many times before man will be sent along as its passenger.

• **Actual flight**—The manned capsule will be launched at Cape Canaveral into an orbit with an inclination of about 30 degrees north of east. (See M/R, Nov. 10, 1958, p. 14.)

The escape system, consisting of forward thrust vernial rockets and support framework, will be ejected after separation of the *Atlas* nose cone instrumentation from the booster section. Orbit will be almost completely circular with an apogee of 120 nautical miles and a perigee of 110 nautical miles.

The astronaut will be traveling forward during the accelerating phase of the flight and backward during the re-entry deceleration phase. A heavy metal shield at the passenger's back will absorb or radiate the aerodynamic heat of re-entry.

• **Controls**—Attitude (pitch and yaw) and roll jets will position the capsule for proper re-entry. They can also be operated manually by the astronaut after re-entry.

The retro-rockets will be fired at the beginning of the re-entry path, or during ascension if it is determined that the booster will not reach orbital speed.

When the capsule has decelerated to a velocity of Mach 1, a drogue parachute will be deployed to provide additional dynamic stability.

Two landing parachutes will be provided in case one should fail. The first will be deployed at an altitude high enough to allow time for the deployment of a second if necessary. Sinking speed will be 30 feet/sec. with a theoretical impact altitude of 5000 feet.

when and where

MAY

Institute of Radio Engineers, 11th National Aeronautical Electronics Conference, Dayton, Ohio, May 4-6.

Instrument Society of America, 5th National Instrumentation Flight Test Symposium, Olympic Hotel, Seattle, May 4-8.

International Scientific Radio Union, Spring Meeting, Willard Hotel, Washington, D.C., May 5-7.

1959 Electronic Components Conference, Benjamin Franklin Hotel, Philadelphia, May 6-8.

Institute of Radio Engineers, Seventh Regional Conference and Trade Show, University of New Mexico, Albuquerque, May 6-8.

Armed Forces Day, Observances scheduled throughout week of May 9-17.

Aviation Writers Association, 21st Annual Meeting and News Conference, Washington and Willard Hotels, Washington, D.C., May 10-16.

The Atomic Energy Commission, Technical Information Meeting on Test Reactors, National Reactor Testing Station, Idaho Falls, Idaho, May 13-15.

Society of Aircraft Materials and Processing Engineering-Eastern Div., Spring Meeting, Hotel Statler, New York City, May 15.

Space Medicine Electronics Symposium, Franklin Institute, Philadelphia, May 18.

Society of Aeronautical Weight Engineers, 18th Annual National Conference, Hotel Henry Grady, Atlanta, May 18-24.

American Institute of Electrical Engineers, Middle Eastern District, Satellite Tracking Session, Lord Baltimore Hotel, Baltimore, May 19-21.

The Society for Experimental Stress Analysis, 1959 National Spring Meeting, Sheraton Park Hotel, Washington, D.C., May 20-22.

Instrument Society of America, 1959 Ohio Valley Instrument and Automation Exhibit and Symposium, Cincinnati Section, Music Hall, Cincinnati, May 21-22.

Institution of Electrical Engineers, The Radio and Telecommunication Section, International Transistor Exhibition and Convention, Earl's Court, London, May 21-27.

American Rocket Society, Institute of the Aeronautical Sciences, American Institute of Electrical Engineers and the Instrument Society of America, "Investigation of Space" Conference, Brown Palace and Cosmopolitan Hotels, Denver, May 25-27.

National Missile Industry Conference, sponsored by The National Rocket Club in cooperation with Electronic Industries Association, Sheraton Park Hotel, Washington, D.C., May 25-27.

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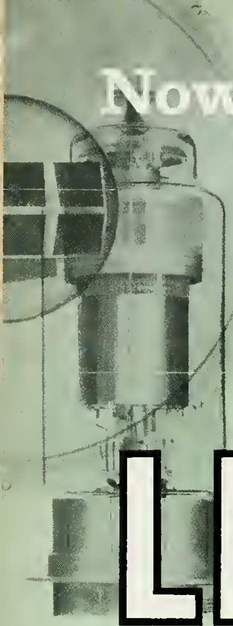

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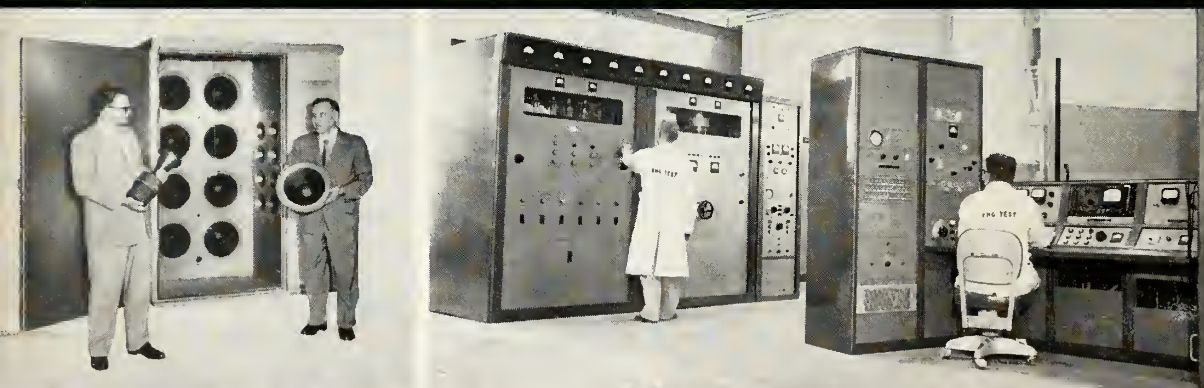

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