NOVEMBER 7, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

100 A-Subs For ASW?

- Proj. Rover Now 'Critical'
- Speed-up In Sparrow Radomes
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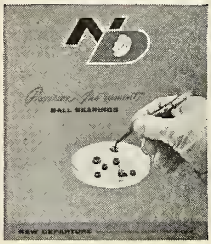

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Circle No. 1 on Subscriber Service Card.

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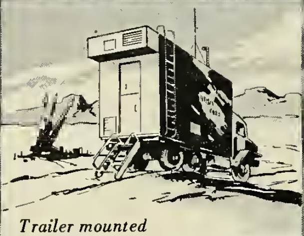
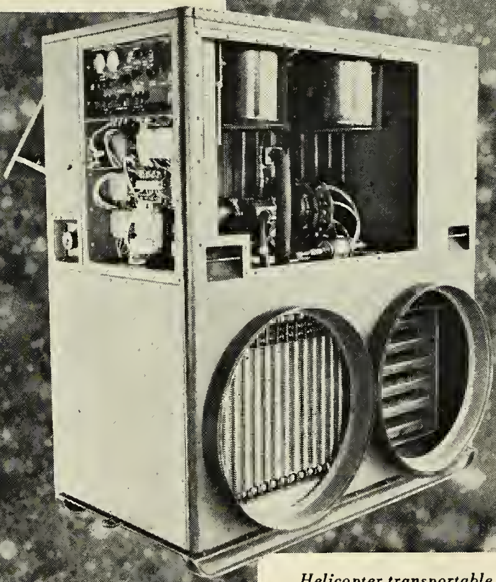
for ground support use...



Trailer mounted refrigeration unit, 5 tons capacity



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Inflatable shelter refrigeration unit, 7½ tons capacity (unit shown above)

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HE MISSILE/SPACE WEEKLY

issiles and rockets

November 7, 1960 Volume 7, No. 19

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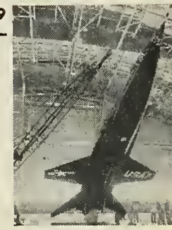
THE COVER



X-15 gets balance checks in NASA hangar at Edwards AFB, Calif., after new XLR-99 engine was installed and prior to flight tests of its operation. *See p. 38.*

NOVEMBER 7 HEADLINES

ADVANCED MATERIALS

PROPULSION ENGINEERING

SPECIAL SECTION

OPTICS

ASW ENGINEERING

ELECTRONICS

INTERNATIONAL

DEPARTMENTS

31,801 copies this issue

WASHINGTON

·using the B-70

Unless the next Administration switches signals, the B-70 Mach 3 bomber will be another "fly-before-you-buy" *Zeus*-like program. There will be probably only 12 operational prototypes produced, even with the new stepup in funding. COUNTDOWN hears, furthermore, that no work is being done to allow the B-70 to carry ALBM's —even though that was a major justification for the bomber as a weapon system. Significance: only the B-52 now will be available to launch the *Skybolt* ALBM, and B-52's are expected to become obsolescent by 1965-66—leaving no ALBM carrier.

BR Funds Sought

The Army is hoping for a large increase in the FY '62 budget to boost funding of chemical-biological-radiological warfare. If it gets the money, it will push development of large CBR warheads for existing missiles.

e'd Like to Stay

In advance of election day, NASA Administrator T. Keith Glennan was telling friends he would like to stay in Washington—working for the next administration. If elected, Sen. Kennedy presumably would put his own man in Glennan's job, while Vice President Nixon might be willing to keep Glennan on. But Glennan is willing to take some other government science job, if asked.

echnical or Political?

NASA officials are insisting the two *Mercury* shots on Nov. 7—election eve—fell on that date for "technical" reasons, not political. Some critics are charging the lofting of a final *Little Joe* prototype capsule from Wallops Island and the first *Mercury-Redstone* from the Cape were programed to boost Vice President Nixon's arguments about U.S. prestige just before the voters head for the polls.

INDUSTRY

·ore B-70 Contracting

North American Aviation says the release of $155 million to the B-70 bomber program definitely will mean the reinstatement of some subcontracts. Just how many probably will be known in another week. Contracts to IBM, Westinghouse and Motorola already have been reinstated. Where the pinch will come, however, is in areas where the state of the art already has been advanced in the year since the program was "reoriented." Several sub-contractors may be affected.

·oost for PMR

Navy has issued Federal Electric (an ITT subsidiary) a $9.4-million contract for PMR range operations over the next three years. Contract covers radio, telephone, teletype, photography, optical and radar tracking systems as well as recording and information display equipment. Included in the award are subcontracts to the Pomona Division of Marquardt and Eckerts Inc., Lompoc, Calif., for some ordnance and ground safety work.

Shades of the Past

Memory of a *Polaris* engine which tore loose and flew four miles several months ago to become the first "interplant" missile is prompting Aerojet to put destruct packages in the Project *3059* rocket for static tests. The AF *3059* is a segmented solid rocket of over 1 million lbs. thrust.

Surveyor Proposals Due

Industry proposals for NASA's Project *Surveyor* lunar soft-landing vehicle are due at Jet Propulsion Laboratory Dec. 15. Hardware contract award is expected about 60 days later.

Spread of PERT

Major weapon systems now adopting the computerized PERT (program evaluation and review technique), developed to manage the *Polaris* program, now include the Air Force's *Dyna-Soar, Skybolt* and *Minuteman* and the Army's *Nike-Zeus*. Several hundred contractors soon will be reporting progress under the system.

Modern Super Scout

NASA is planning to develop a modern propellant for the first and second stages of *Super Scout,* its solid space booster. Uprating should give the vehicle an orbital payload capacity of 250-300 lbs.

Front Office

Lockheed is intensifying its ASW capability with a new corporate-wide organization designated "Antisubmarine Warfare and Ocean Systems." Headquarters will be at Burbank . . . Douglas is setting up a new Astropower Inc. division to work on exotic propulsion systems . . . Chance Vought is dropping the "Aircraft" from its corporate name . . . Nine months earnings by Boeing ($16 million on sales of $1.2 billion) are nearly double 1959.

INTERNATIONAL

Japanese Testing MAT

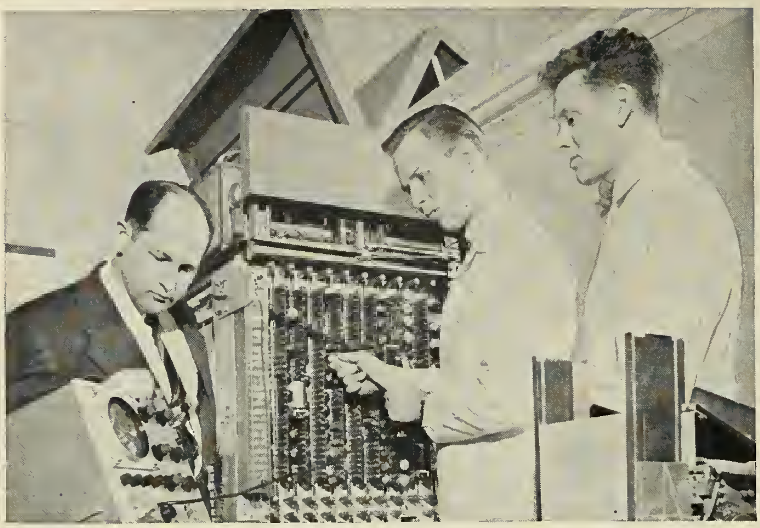
Sixth prototype of Japan's *MAT* anti-tank missile is being tested this month. U.S. military officials are attending the firing, but say it's too early yet to finally evaluate the usefulness of the weapon.

French Debate Space Program

In about a month the French Parliament will start debating legislation which includes appropriations for launching a satellite. New element in the debate will be whether to accept an invitation to join the "space club" Great Britain is trying to get together.

Tortured Thought of the Week

If the Russians refrained from trying a space spectacular during the windup of the U.S. presidential election campaign, did it have any significance? Some foreigners are wondering whether it would mean Khrushchev really favored Nixon by not adding new fuel to the Prestige Gap debate. Or whether he really favored Kennedy and thought a shot might have a reverse affect on voters and elect Nixon.



—letters—

Trudeau Interview

Secretary Brucker was pleased ind with the recognition which the Oct. M/R gave to General Trudeau and Army's Office of the Chief of Resea and Development.

On behalf of the Secretary, please cept his sincere thanks and his best p sonal wishes.

John G. Hill, Jr.
Lt. Colonel, GS
Military Assistant to
Secretary of the Ar
Washington

First for Science Fiction

Arthur C. Clarke was kind enough send me a copy of his letter to you (M/ Oct. 24, p. 9), and I thought you mig like to know that I agree with its conten I believe that space radio relays, if n earth satellites, were described in scien fiction even earlier than 1945.

J. R. Pierce
Director of Research—Co munications Principles
Bell Telephone Laboratorie
Murray Hill, N.J.

Polaris Flight Simulator

I refer to the article which appear in MISSILES AND ROCKETS (Aug. 29, 26) on the development of the Flig Simulator which helps speed the *Polar* program.

I am a careful reader of M/R— are most of my friends in the industry and felt that the article was well don quite penetrating, and illuminating— are most of those which appear in th publication. Your batting average is fa above Mickey Mantle's.

Best wishes for continued success.

Bert W. Holloway
Corporate Director
Advertising, Publicity, Promotio
Lockheed Aircraft Corp.
Burbank, Calif.

P.S. Or anybody else's batting, either.

For Defined Space Roles

(Regarding the editorial, "The Aer space Strategic Force," M/R, Sept. 5)

Now that the feasibility of large rocke boosters has been proven, the natio should alter its space vehicle plans to em phasize manned spacecraft rather tha booster systems. In recent years, apparen national policy has been to adapt spac payloads to requirements of existing o proposed booster vehicles. Couldn't w realize a significant program breakthroug by first determining our spacecraft re quirements for both military and civilia missions, and then developing on a par allel basis a suitable booster vehicle?

Use of a single manned spacecraf operating in orbital flight conditions coul

;ovide multimission capabilities, such as rveillance, communication, meteorolog-al and astronomical observation. A vari-y of present and proposed costly un-anned systems would be replaced by a ngle, maneuverable and recoverable anned system. Experience gained in or-tal and suborbital flight would provide nportant data for planetary re-entry ehicle configurations.

During the flight test phase of the acecraft development program, concur-nt captive and flight testing of necessary terplanetary booster systems could be complished. Flight testing of the "new" acecraft would be accomplished using cisting booster systems during the in-rim period.

For example, the recently announced *pollo* space ship project would have been arted before the *Saturn* C-1 and C-2 oster vehicles with suborbital flights ac-omplished by use of existing boosters. In her words, to provide a suitable and re-able manned spacecraft that would be vailable for space missions at a time co-cident with suitable booster availability, e *Apollo* vehicle is at least *three years ehind schedule* today.

There is no better time than now to re-nsider our national space objectives. We ave just two choices if we intend to con-nue space exploration: (1) Continue to lapt unmanned payloads to existing oster systems, or (2) develop manned stems and tailor booster vehicles as re-uired on a parallel basis. The relative na-onal priority of manned space flight nder the former choice is low at best. he latter choice provides the one in-redient lacking in our present program—nphasis and priority for manned systems.

It is conceivable that impetus for anned space vehicle development could aterialize if the military services and ASA were given the following roles and issions:

Army—Tactical and strategic bombardment using *all* guided and unguided missiles launched from land.

Navy—Tactical and strategic bombardment using *all* guided and unguided missiles launched at sea.

Air Force—Tactical and strategic bombardment using *all* manned aerospacecraft, and *all* space exploration.

NASA—Technical direction and development of *all* military and civilian space boosters and spacecraft to be used for space exploration.

The above plan has the advantage of oviding each service and NASA a ghly defined role within the national issile/space program. Specifically, the ir Force with its space exploration role ould provide the nation with its first non-dundant spacecraft development pro-am. Space systems developed under Air orce guidance could be used for either ilitary or civilian missions. The national ace program could be developed and ordinated by a single cabinet-level gov-nment agency, perhaps called the De-rtment of Extraterrestrial Affairs.

Robert H. Jones
Research Engineer
Lockheed Missiles and Space Div.
Santa Cruz, Calif.

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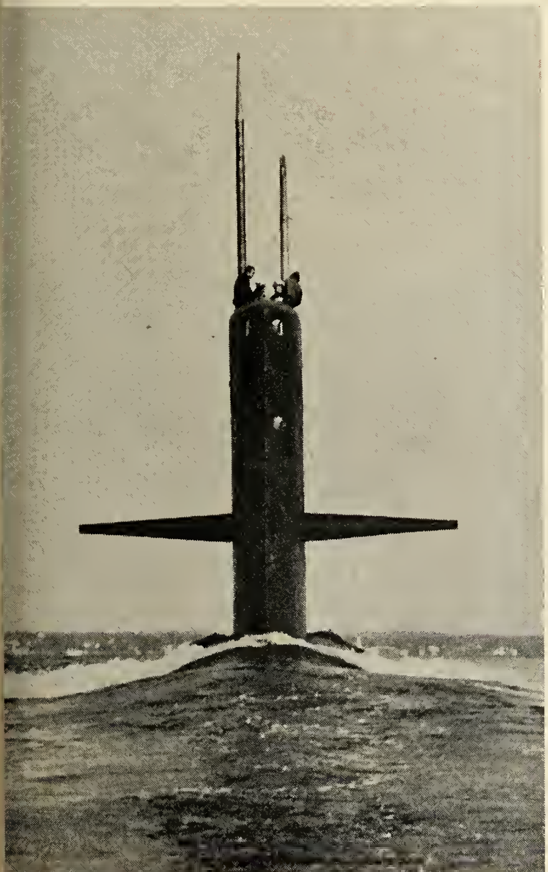
Why the Navy Suddenly Wants 100 Nuclear-Powered ASW Submarines

How much time is left to protect Polaris FBM submarines with the George Washington ready to head out on station? Are nuclear attack submarines the only answer to the threat raised by Soviet nuclear subs now a-building? These are just some of the problems bedeviling the Navy as it studies the need for creating a great underseas armada—soon. There are grave complications. Will Congress go along? What about the new Administration—when it gets a look at the $4-billion pricetag? Then there's the flattops—are they doomed?



UBMARINE MIGHT is demonstrated by the Skipjack, first f the Navy's high-speed, nuclear-powered attack submarines.

By James Baar

THE NAVY IS PRESSING for construction of a mighty ASW force of some 100 nuclear-powered attack submarines to guard the *Polaris* fleet and defend U.S. shores from underwater-launched Soviet missiles.

The time frame: By 1970. The cost: About $4 billion.

Powerful congressional support is already gathering behind the proposed program. In fact, some leading members of Congress regard the Navy's timetable as much too conservative.

For example, Chairman Clarence Cannon (D-Mo.) of the House Appropriations Committee is proposing that the Navy have 88 nuclear-powered attack submarines in commission by the end of 1968 and a total of 100 by the end of 1969.

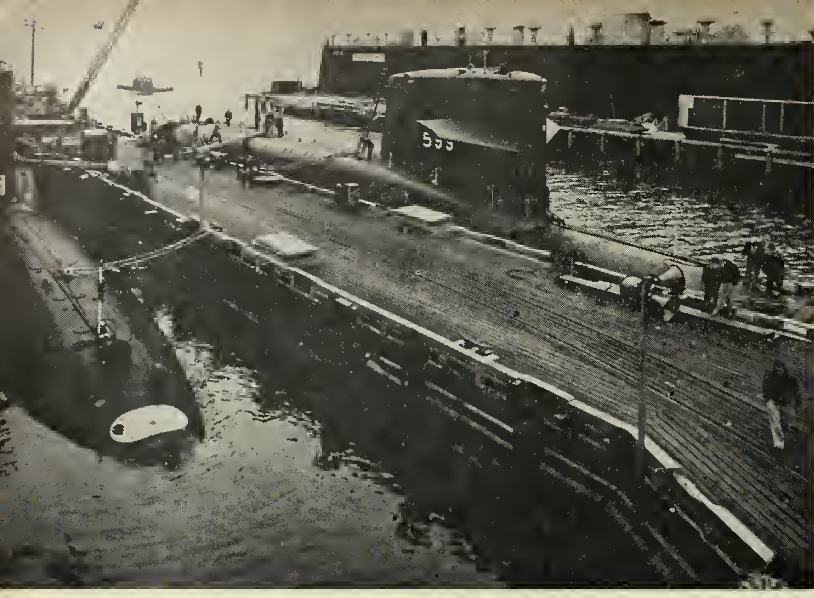
Cannon and other members of the Appropriations Committee want the Navy to have completed a fleet of 45 *Polaris* submarines by the same time or sooner. This would mean that the Navy would build nuclear attack and *Polaris* submarines at a rate of approximately two to one.

• **Big step-up would be needed**—Any such Navy program would call for a great increase in nuclear submarine construction throughout the 1960's.

At present, the Navy has commissioned, launched, under construction or authorized but still on paper a total of only 27 nuclear-powered attack submarines and 14 *Polaris* submarines.

To construct a fleet of 100 attack submarines by 1970 the Navy would have to lay a minimum of nine keels a year for the next eight years. But during the current fiscal year, the Administration has refused to authorize the Navy to lay a keel for even one.

To construct a fleet of 45 nuclear-powered *Polaris* submarines by 1970, the Navy would have to lay about



FIRST POLARIS SUBS—George Washington (left) and Patrick Henry—tied up at pier.

1960 Nuclear Submarine Strength

Type	Commissioned	Launched	Building and Authorized	Total
Polaris-launcher (SSBN)	3	2	9	14
Attack (SSN)	8	6	13	27
Picket (SSRN)	1	..	..	1
Regulus-launcher (SSGN)	1	..	..	1

four keels a year. However, many in the Navy and Congress are calling for a much faster buildup based on laying a keel a month. So far, the Administration has been building *Polaris* subs at the rate of about three a year. For Fiscal 1961, the number has jumped to five. But the increase was made at the cost of previously planned attack submarines.

Supporters of proposals for a large fleet of nuclear attack submarines feel that events will force the new Administration—regardless of who is in the White House—to support a large increase in the building program beginning next year.

The events cited are primarily two: The sailing this month of the George Washington, first of the *Polaris* fleet, and the announced development by Russia of its own nuclear-powered submarines.

The George Washington and her sister ships will operate while on station as integrated parts of the U.S. Fleet. Specifically, this means that their hiding places will be guarded by both surface and undersea warships that will be on the alert for the approach of any unfriendly forces.

These operations will be conducted over a wide area as part of the Navy's ASW activities. But nuclear-powered attack submarines also may operate as picket ships working in close cooperation with each *Polaris* submarine.

The *Polaris* submarines are fully capable of defending themselves if necessary. However, particularly when the time comes that Russia has many nuclear-powered attack submarines, some Navy planners believe a *Polaris* sub and one or more attack subs may operate as a team. This would greatly complicate an enemy's attack problem.

• **Russian threat**—The building of a Soviet nuclear-powered submarine fleet is regarded by the Navy as a threat of momentous significance.

The present Soviet diesel-powered sub fleet of 450 to 500 ships was constructed at a very rapid wartime rate. This building slackened while the Russians developed a nuclear-powered sub. Now, a great speed-up is expected.

Besides attempting to seek out *Polaris* submarines, these new Soviet nuclear subs will be capable in a few years of challenging all seaborne lines of communications. Moreover, the Russians are expected to have their own version of the *Polaris* submarine in operation by 1965 at the latest.

Soviet Premier Nikita Khrushchev only last month boasted that he already has rocket-launching nuclear-powered submarines capable of launching missiles. Informed Navy sources believ[e] that these subs are only capable o[f] launching short-range *Komets* from th[e] surface. However, longer-range *Komet[s]* capable of being launched from sub[-]merged subs are known to be unde[r] development.

• **Navy's answer**—The weapon tha[t] the Navy wants for defense against th[e] Soviet nuclear submarine menace is th[e] new Thresher Class hunter-killer sub.

The high-speed Thresher is an im[-]provement over the earlier high-spee[d] Skipjack Class—first of the tear-dro[p] Albacore hull subs capable of out[-]running any surface ship afloat.

The Thresher Class sub displaces about 3750 tons and is 274 feet long. The bow is capable of housing very-long-range sonar equipment. Its four torpedo tubes are capable of firing not only the Navy's latest torpedoes but the deadly Goodyear *Subroc* Missile.

The nuclear-tipped *Subroc* — designed to be launched underwater, fly through the air and re-enter the water to strike an enemy sub—is expected to be operational in 1961. The missile is understood to have a range of better than 20 miles.

• **Money lacking**—The current cost of a Thresher Class submarine is about $57 million. The cost of the much larger *Polaris* submarines is about $100 million each.

In these figures, both certain to increase, can be read the fiscal dilemma of the Navy.

Even at 1960 prices, the construction of a 100-ship fleet of attack submarines will cost more than $4 billion. And, in view of the continuously upward trend in the cost of equipment, this figure is most conservative.

To begin a submarine-building program of this scope could only mean a sizeable increase in the Navy's budget or the deterioration of some other part of the Navy's forces.

• **Carriers obsolete?**—The Navy contends there is no major part of its forces that can be sacrificed without a decline in needed U.S. strength. But some of the most ardent supporters of a big submarine fleet disagree. Their target is the 300-to-450-million dollar super aircraft carriers that the Navy also contends the nation must have.

"Aircraft carriers have had their day," Representative Cannon said bluntly last June. "They have won their proper place in history. However, we are only starting to exploit the nuclear submarine . . . . The Soviets see this clearly—why not we?"

In short, Cannon and others argue that the missile-launching nuclear-powered submarine—not the carrier—is the Navy's ship-of-the-line in the second half of the 20th Century.

ussians, Laborites Balk at Polaris-on-Clyde

The Navy is preparing to establish its first overseas *'olaris* supply base in Scotland's Firth of Clyde despite rotests from the Soviets and Laborite members of 'arliament.

Prime Minister Macmillan announced the advance ase would be located at Holy Loch on Scotland's rug-ed west coast within easy access of the Norwegian Sea nd the Arctic Ocean.

Under a U.S.-British agreement, the *Polaris* Tender 'roteus, a floating dock and auxiliary craft will be sta-oned in Holy Loch soon after the beginning of the ear. They will be there in time to service the George Vashington—first sub of the *Polaris* fleet. The big nu-lear-powered sub is scheduled to be on station with her 6 nuclear-tipped missiles somewhere in the Atlantic y November 15.

The Proteus will provide *Polaris* subs with food and ther supplies including spare missiles. The subs also ill use Holy Loch for changing crews.

Thirty-two Laborite MP's protested that the base ould present "grave dangers" to Britain. However, in lasgow two leading newspapers supported Macmillan nd the agreement.

-70 Bounds Back—Almost

The Eisenhower Administration's farewell FY 1962 efense budget is expected to include about $365 mil-on to $415 million for the B-70 R&D program. But e program still has money troubles.

The North American B-70 received a rejuvenating push this week with the release of $155 million by the Defense Department for resuming the program as a full weapon system project.

The extra funds—part of the more than $280 million voted for the B-70 by Congress over previous Administration objections—brought to $285 million the total funds available to the program in FY 1961.

This was a long way from the $75 million to which the Administration earlier this year sought to reduce the project. However, the total was still well below the $450 million originally sought by the Air Force.

Furthermore, informed sources in the Administration made clear the B-70 remained on trial as a program and might never be produced for deployment.

Bendix Wins Major Role in Advent

Bendix Corp is responsible for a major share of the work on the *Advent* 24-hour communications satellite under a newly announced Army Signal Corps contract.

The half-ton microwave communications satellite will be placed in a 22,300-mile orbit that will enable it to remain over one point above the earth's surface. Ground stations will be built at Ft. Dix, N.J., and Camp Roberts, Calif., for the R&D program.

Bendix will be responsible for design of the active repeater satellite, special-purpose ground and checkout equipment and communication systems engineering. No money figures were disclosed, but the entire program is expected to cost about $174 million.




Patrick Henry Nears Combat Readiness

'LARIS LAUNCHES from under the Atlantic in series four shots, day and night, simulated operational conditions. 'om left, first shot was Saturday afternoon, Oct. 15; second was Saturday evening; third was Sunday morning, Oct. 16; and fourth was early Tuesday, Oct. 18. Launches were from submarine Patrick Henry 500 miles east of Cape Canaveral.

Rover May be Put on Crash Basis

THE PROJECT ROVER nuclear rocket may become a crash program.

The National Aeronautics and Space Administration and the Atomic Energy Commission moved in that direction last week with a decision to bypass the normal paper design studies on the *Rover* nuclear engine. Instead, *Rover* will go directly into an industry research and development program.

Still hanging fire is the question of whether to build the *Rover* vehicle around the engine at the same time. Parallel vehicle development, which would make *Rover* a true crash program, presumably will be decided by the new President.

Harold B. Finger, chief of the joint NASA-AEC Nuclear Propulsion Office, last week ordered the speedup in *Rover* engine development, which could cut six months or more from the development schedule if NASA moves quickly on circulating and evaluating industry bids on the engine development. He cancelled plans to award one or more contracts for six-month paper studies of engine design.

The current NASA timetable calls for flight-testing *Rover* as an orbital stage by 1965, and completing ground tests of the engine by 1963. Finger told M/R no decision has been made on the timetable for industry participation in vehicle development. He would not rule out the possibility that it might begin within a year, an obvious indication that it conceivably might be included in the Fiscal Year '62 budget.

The *Rover* boss declared also that he wants to be in position to capitalize on any unexpected breakthroughs. This was also apparently a veiled appeal for liberal '62 funding.

• **Hopes exceeded**—Finger asserted the first three tests of the Kiwi-A experimental reactors, which ended last month, were so successful that it is now possible to make concrete plans that otherwise would have been impossible. A new series of reactor tests, the Kiwi-B series, will begin next year. "We expected a great many new problems to turn up in these tests," he said. "They didn't do so. Apparently, we were worrying needlessly."

Performance figures for the *Rover* rocket still are classified. However, it was indicated last winter that a stage weighing 40,000 lbs., generating 52,000 lbs. thrust might be built around the first *Rover*. More recently, Wernher von Braun spoke of a nuclear rocket of 80,000 lbs. thrust, possibly referring to the first-generation *Rover*.

Rover's most probable mission will be as a third stage of an advanced *Saturn* vehicle based on the 1½-million-lb.-thrust booster and the 800,000-lb.-thrust S-2 stage, which will cluster four Rocketdyne J-2 liquid hydrogen-LO engines. Presumably this first *Saturn* nuclear vehicle is to become availab in the 1966-68 time period. It migl well be the propulsion system used fc the first flight of the three-man *Apoll* space ship around the moon.

• **After Rover**—For manned lan ings on the moon, however, a singl *Saturn* booster is too small. NASA asking industry to study various phase of the question of which approac should be taken—the all-chemic *Nova,* orbital assembly and rendezvou with multiple *Saturn* launchings, or chemical-nuclear vehicle with a nuclea second stage, much larger than *Rove*

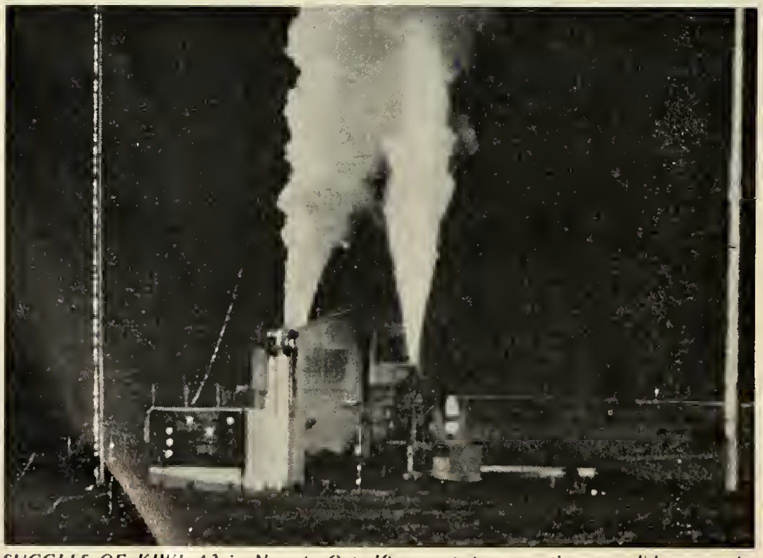
Finger envisions a post-*Rover* rock with a reactor of 10,000 to 15,00 megawatts power, which would indicat a thrust level of 500,000 to 750,000 lb This would require a chemical booste with 2½ million to 4½ million lb thrust. In the past, Finger has indicate preference for a sort of super-*Satur* liquid booster with a single F-1 1½ million-lb.-thrust engine surrounded b a circle of H-1 *Saturn* engines.

However, the NASA Office o Launch Vehicle Programs, headed b Maj. Gen. Don R. Ostrander, USAF recently has been devoting considerabl attention to very large solid booster Last month, one of a series of soli booster study contracts was assigned t look into the problems involved i building a booster weighing 1 millio lbs., with thrust of 2 to 3 times booste weight.

Even more recently, Ostrander sai in a speech that it should be possibl now to develop a solid rocket wit 500,000 lbs. thrust if desired and cluste that rocket to produce higher levels.

Finger said a nuclear stage migh be put on a solid booster as well as liquid one. He voiced concern, how ever, about the high thrust-weight rati of solids, which might put too muc acceleration strain on the delicate com ponents of a nuclear upper stage.

The nuclear upper-stage vehicle will be fired from Cape Canaveral under present plans. Although studies are in progress to verify this point, Finger declared he is certain that the test would not be a hazard to populated areas on either side of the downrange areas. He estimated that construction of a new range might cost 500 million dollars. #



SUCCESS OF KIWI A3 in Nevada Oct. 19 exceeded expectations, as did two earlier tests in series, giving new impetus to drive for nuclear space power.

Countdown for Survival

New President Pledged To Expand Defense Effort

AS THE PRESIDENTIAL CAM-AIGN went down to the wire last ek and both candidates took differ-g but definite stands on the defense d space issue, one thing became in-easingly clear:

Both candidates were committed put increased emphasis and funds o the interlocking programs which ll strengthen the nation's defense d accelerate space exploration.

Both candidates, in replies to the en letter sent them by MISSILES AND CKETS, pledged themselves to speed *Polaris* and *Minuteman* programs. r. Nixon included the B-70 project; r. Kennedy did not but is known favor it. Kennedy promised a re-est for a supplemental appropria-n in January; Nixon said he would the same if it "would usefully serve our missile program." Both were for swift accomplishment of space exploration goals.

Both candidates recognized that the U.S. is in a strategic space race with Russia and that the military must be given the mission of ensuring freedom of space—Nixon for the first time and in deviation from the present Administration's party line.

The other most significant happening in the defense/space area last week was the disclosure by the United States Information Agency that U.S. prestige has slipped badly throughout the world since *Sputnik* and that much of this is due to our lag in the space exploration race.

• **Johnson joins debate**—Senator Lyndon B. Johnson, Democratic vice presidential candidate, issued a "White Paper" pointing out—as M/R noted last week—that the present administration has gone out of its way to deny that we are in a space race and that our prestige has fallen throughout the world. The quotes, after *Sputnik I*, included:

President Eisenhower, ("does not raise my apprehensions"); DOD Secretary Charles E. Wilson ("nice scientific trick"); Sherman Adams ("we are not interested in a high score in an outer space basketball game"); Special Advisor Clarence Randall ("silly bauble"); and Jim Hagerty, ("no race").

• **Allen or prestige**—One of the fallouts from the discussions by the candidates and their followers was the prestige issue—the matter of where the United States stands *vis-à-vis* the Soviet Union in the eyes of the world. This oblique angle of defense and space caused Sen. Johnson to include in his white paper some earlier testimony of George V. Allen, director of USIA, which took the polls. Allen testified before Congress:

"The achievement of placing in orbit the first earth satellite, without great advance fanfare, increases the prestige of the Soviet Union tremendously and produces a corresponding loss of U.S. prestige, due primarily to the contrast. The Soviets were greatly exceeding world expectation in their scientific and technological capacities; we, on the other hand, were falling short of world expectation of us.

"Then came the two dramatic and successful moon shots, followed by the failure of our own. As a consequence of these events, the seesaw seems to have tipped solidly in the Soviet direction, in world opinion. Today, although we continue to see the hope expressed abroad that the United States will catch up, we also see growing doubt that this is likely during the next 5 or even 10 years.

"Probably the most significant result of the Soviet successes is a change in the overall impression of the people of the world about the Soviet Union. In public opinion parlance, we speak of this as the revised Soviet image. The change goes beyond the field of space technology. It covers all of Soviet science and technology, plus Soviet military power and general standing.

"Before *Sputnik I*, few people of the free world believed the Soviet Union was currently in a position to challenge America in the broad fields of science, technology and production. Now, the *Sputniks* and *Luniks* are taken as evidence that the Soviet Union is able to challenge America successfully in all these fields, including even production . . ." ⌘

NASA Funds to Soar, Regardless

A BIG JUMP in the NASA budget for Fiscal Year 1962 is indicated, no matter who wins the presidential election. The rise may be as much as 40 to 50% over the current level of $915 million.

The reason for the jump is a series of programs scheduled to go from study into R&D including:

Project *Apollo*, the three-man space ship, which will cost $250 million to develop over a three-year period. Probable FY '62 funding: $50-75 million.

Saturn S-II stage, a cluster of four Rocketdyne J-2, liquid hydrogen-LOX engines with total thrust of 800,000 lbs., which will cost $100 to $150 million over three years. Likely '62 funding: $35-50 million.

Rover nuclear engine, which may go into R&D before the current fiscal year ends. However, the first big appropriation will be in '62. Probably another $50 million.

Project *Prospector*, the soft-landed, remote-control, roving moon-exploring payload, which will probably cost $300 million by 1965. Likely '62 funding: $10-20 million.

Project *Mariner*, the 600-1200-lb. unmanned spacecraft for early interplanetary missions. Probable '62 funding: $10-20 million.

Besides these programs, there are a number of expensive projects making the rounds in NASA, which might come to life if the President-elect indicates he is receptive. These include:

–*Rover* vehicle development, carried out parallel to engine development. This is a question of timing. Ordinarily, a vehicle development does not begin until the engine development is well under way. If the vehicle were developed parallel to the engine, it would make the nuclear rocket a crash program, which would cost considerably more than a more leisurely pace.

–A large-scale solid booster rocket. Another development program that ordinarily would await completion of preliminary studies, but which—if speeded—might gain valuable time in the lunar race.

–A third *Saturn* launch complex at Cape Canaveral. This expensive facility might make it possible to launch big orbital payloads on a drumfire basis. ⌘

Comment Is Both Intense and Divers

THE LETTERS COMMENTING on M/R's open letter to the candidates, our nine-point proposal for survival and the replies from Mr. Kennedy and Mr. Nixon, continue to arrive. Many of them have been carried and others are in this issue.

Most of the comments were sympathetic with the significance of the nine-point proposal and its intent of providing a "working paper" by which the country could bring its defense and space program up to at least parity with the Russians.

Almost every writer agreed that we are lagging and that we must do more—although there were many different opinions as to the means.

Many also agreed that M/R had omitted two important projects from the nine-point program: one, the anti-missile missile and two, civil defense.

Senator Says We're Ahead

The nine points which you have submitted to Vice President Nixon and to Senator Kennedy are deserving of very serious consideration.

1. In regard to this question, the answer is yes, but we are doing a thoroughly competent job in keeping pace and in going ahead.

2. I feel that in regard to the timing you have suggested we will very well fill the bill.

3. There is no question but what the use of "space" must be in the pursuit of peace and that peace can only be insured through strength.

4. Yes, of course, we must always have outstanding defense potential.

5. I feel that the President's program as outlined in his various budget messages and as carried out in his activities bear all of the aims stated. He has shown complete understanding of the need for *Polaris* submarines and B-70 bombers.

6. The President has never felt inhibited by any budget ceiling when the security of this country has been at stake.

7. The National industrial effort is well keyed to the defense need. I am sure that the President in his overall capacity of Administration is not only fully aware of the situation, but utilizes the best instruments to bring about a successful outcome.

8. There is no question but what we will carry out all essential scientific objectives on the National level. We will not be panicked into crash programs which will have no long-range effect and which will weaken our domestic security. In my ranking position on the Aeronautical and Space Committee of the United States Senate, I am sure that we are doing everything within our power to achieve preeminence in the space race. I do not in any sense feel that this country has fallen behind. I feel complete assurance that we are ahead in the exploration of space and I will do my best to see to it that we maintain that position.

9. I think that we do have decision-making capability in the defense and space organization establishments of this country. I am not sure I quite understand the question, but I am sure that we have the decision-making capability for making decisions of the moment without reference to any long-winded debating society.

Styles Bridges
United States Senate
Washington

M/R's Proposal

1. Recognize as national policy that we are in a strategic space race with Russia.
2. Establish pre-eminent strategic, tactical and defensive forces with representation from all goals;
   Manned space platform—1965
   A U.S. citizen on the moon—1967-68
   Nuclear power for space exploration—1968-69
   A spacecraft which can take off from earth, travel to and in space, return and land under its own power—1968-69.
3. Recognize that "space for peaceful purposes" is possible only if "freedom of space" is ensured; hence that the U.S. military must be given a predominant role in developing and carrying out the projects necessary to guarantee freedom of space.
4. Establish pre-eminent strategic, tactical and defensive forces with representation from all services.
5. Recognize the necessity of greater defense funding to accomplish this, including a supplemental budget in January, 1961, to make it possible to:
   Speed up to a maximum degree the construction of ICBM launching bases, Polaris submarines and the Mach 3 missile-Carrying B-70.
   Provide the Army with funds to begin the immediate procurement of already-developed modern missiles, other weapons and airlift.
6. Establish further-on defense spending by need and not by budget ceiling.
7. Streamline defense regulations and procedures to make industry's role in the U.S. defense and space effort more effective.
8. Take what steps may be necessary to establish and promote national scientific objectives.
9. Re-establish decision-making in the U.S. defense and space organization.

Don't 'Splinter' Effort

You are to be congratulated for as ing for firm stands by the presidential ca didates on the vital questions of defer and space. I have read with inter Senator Kennedy's response *(Editor's No this letter was written before Mr. Nixo reply.)* and I should like to make sor comments.

1. On question 1, with regard to t space race, it is gratifying that the Senat has admitted that this race is real. T pronouncements of the present admin tration on this have been somewhat le than inspiring. In fact, some comments l Mr. Eisenhower have been absolute impervious to this vital question.

2. With regard to dates you sugge for various achievements, I would agr with Mr. Kennedy that they are elasti but the quality lacking in our prese planning is a sense of real urgenc or solid goals for these space achiev ments. I might note that the establishme of any date presupposes lead time, an this is rapidly slipping away as regar your goals. The dates suggested by you a at least five years sooner than any NAS planning and, thus, only a sharp revers in their thinking or the assignment c space missions to the military could ha our conservative approach.

3. This question on "peaceful uses c space" is a truism, but I would point o that space, military posture and peacef uses are irrevocably tied together in th present world complex. Any attempt t isolate them is artificial, even naive. Th technology of space flight has evolve from that of missiles. The technologica problems to be bridged in scientific spac exploration are the same as those for th establishment of a military posture i space.

4. On this question, as related to or ganization, I can only add that until ou space effort is organized under one head preferably with a military mission, I d not feel that we will accelerate ou progress.

5-6. These questions which relate t funding have been overworked as a topic of discussion. I can only repeat comments I have made before that those who say we must limit defense and space spending because we can't afford it are doing a severe disservice to us all. A nation which spends $7 billion on liquor in one year can surely afford to add half that to plug its defense gaps, especially if that amount is less than one percent of its gross national product.

7. Streamlining is a noble effort, but

(Continued on page 44)

(ongress Slaps Big 'Waste' I DOD, Major Probe Brews

CONGRESSIONAL COMMITTEES preparing for intensive investigas of alleged waste totaling billions dollars over the past decade in Dee Department supply management ds.

Sen. Paul H. Douglas (D-Ill.) and R. Thomas B. Curtis (R-Mo.), in a irtisan statement last week, estied that billions can be saved if D acts to consolidate common mili supply activities, standardize purses and use competitive bidding e widely.

The statement accompanied a ret of the joint economic committee , earlier this year, studied the ecoic aspects of military procurement and supply. The committee urged merging of common supply activities into a single agency at the defense secretary's level, under authority contained in the 1958 McCormack-Curtis amendment of the DOD Reorganization Act.

In another development, the Air Force warned defense manufacturers it may begin denying incentive contracts to those who continue to acquire extra profits through overstated prices rather than by improved management.

Lt. Gen. M. E. Bradley Jr., deputy chief of staff (materiel), in an address to the Aerospace Industries Assn. in San Francisco, issued the decree, apparently the strongest yet in the AF's cost-cutting and contract-improvement campaign. "We mean to insist even more vigorously that incentives are earned on the basis of improved management and engineering," he declared. "If affected companies don't take the necessary corrective action, we will simply have to stop giving them incentive contracts."

Col. A. J. Dreisezum, chief, contract administration branch, delivered the speech for Gen. Bradley.

The congressional committee recommended:

–Intensified efforts to use full competitive bid procedures.

–Aid by the Bureau of the Budget in establishing a consolidated procurement agency.

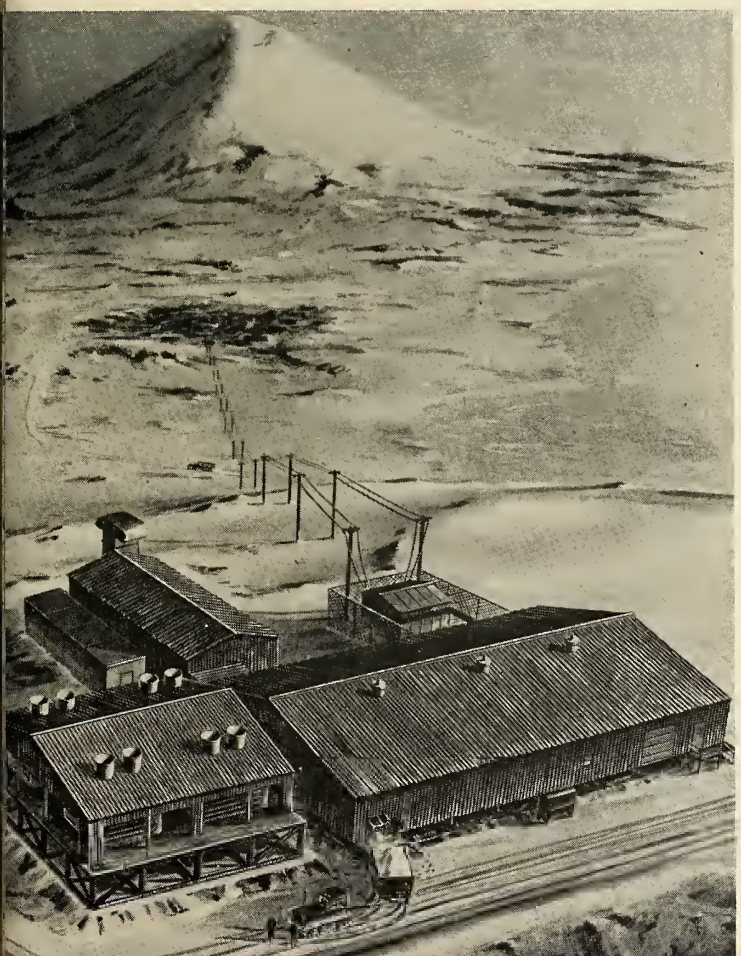
–Clarification of the role of the General Services Administration in defense procurement over the next five years.

–Granting of authority to the Commerce Department over surplus property disposal that may have an adverse effect on the economy.

–Consultation with the Commerce and Labor Departments and the Small Business Administration on procurement so as to create a more equitable distribution of the military dollar.

–Budget Bureau, DOD and GAO decision on the proper use of funds for inventory stocking and rescinding of those not justified.

–Uniform patent legislation. ⁂



First A-Power Plant for Antarctica

TIST'S DRAWING of atomic power plant to be fabricated by the Martin Co. in es of 30-ft. modules. Reactor system will be assembled by Navy Seabees within 60 s after arrival at McMurdo Sound. It will go critical 15 days later.

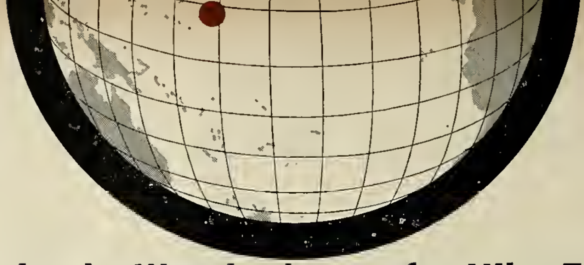
A-Test Ban Seen Keeping U.S. from Better Weapon

The nuclear test ban is holding up U.S. development of a radically new, third-generation nuclear weapon, former Atomic Energy Commissioner Thomas E. Murray charged last week.

In a letter to the two presidential candidates, Murray said the new weapon is neither a "larger and more efficient H-bomb, nor a smaller and more efficient A-bomb," but will be in a different category.

"All that may be said of it here is that it is primarily anti-personnel in destination and effect," Murray declared. "Hence it is apt for properly military uses . . . It need not create suicidal hazards for the country that employs it. Therefore, a moral argument for the use of the new weapon is possible, as it is generally not possible in the case of the immense weapons of mass destruction. Further information of a classified kind is available to you from the appropriate governmental agencies."

The Atomic Energy Commission declined comment. Murray is now a consultant to the Joint Congressional Committee on Atomic Energy.



ELECTRONICS

Research Aimed at Hi-Power Radars

Look for more money to be spent in R&D for high-power radar tubes. Manufacturers are talking about outputs in the 50-megawatt range—even though many problems remain to be solved. Chief controversy centers around crossed-field versus linear-beam tubes. More mundane problems concern cooling, "window" materials, and handling high voltages. Many questions can't be answered with equations; experimental tubes will have to be built.

Better Solar Cells Made Available

Efficiencies of solar cells are being steadily bettered. Production units of 12-14% efficiency are beginning to appear on a commercial basis. One manufacturer hints at a figure of 15% for selected units off his production line.

Wrong Emphasis on Thermionic Research

More research effort should be directed at the basics of thermionic conversion of heat to electricity, says Dr. Wayne Nottingham. Speaking at a recent IRE symposium, the MIT scientist said that more should be known about these basics before money is spent on device development.

GROUND SUPPORT EQUIPMENT

Bigger Antenna for Goldstone

A study contract for a 250-foot antenna is expected to be let within the next two months by Jet Propulsion Laboratory. The big dish will be used to augment the Lab's space-exploration facilities at Goldstone.

Seaborne Launch Pad Pushed

Navy is pushing its plans for a seaborne launching, tracking, and recovery ship. Vice Adm. W. F. Raborn, Jr., special projects chief, implied that such a vessel could be operational next year if authorization is given soon. Advantages claimed for the astronautics ship: privacy of operations, and money saved by mobility—which would make it possible to meet different launch site location requirements.

More on Solar-Storm Forecasting

"Weather forecasts" of solar activity may be possible in the future. But Dr. Joseph Friedman of NRL says they aren't feasible at the present stage of knowledge. Apparently, the *Apollo* astronauts will have to depend on shielding to protect them from blasts of solar energy.

RCA Begins Operation of "White Alice"

RCA Service Co. last week took over full operation of the Air Force "White Alice" communications network linking the Alaska Communications System, DEW Line, and BMEWS. The 33-station network uses radio (including scatter propagation), cable, and long-line installations to provide communications for civilian, military, and other government agencies in Alaska.

BMEWS Tracing Radars Being Installed

Installation of the first of the 84-ft. radars for BMEWS has started at the Thule, Greenland, site. The huge tracking radar—enclosed in a 140-ft. plastic radome—will supplement the stationary detection systems already in operation.

PROPULSION

New Sounding Rocket Tested

Rocketdyne has successfully tested its now low-cost, high-altitude, solid, weather-sounding rocket at Fort Hood, Tex. The vehicle's reinforced plastic shipping container serves as its launching tube. It can be fired from a 5-inch gun or set up and fired from the container by one person.

250-Ton-Thrust Rocket Envisioned

The next big solid rocket developed probably will have 500,000 lbs. thrust. Maj. Gen. Don R. Ostrander, NASA chief of launch vehicle programs, says it should be possible to build a ½-million-lb. solid and cluster it for larger vehicles.

20-Megawatt Space Power Considered

NASA's 1962 budget may include funds for developing a 300-kilowatt nuclear powerplant for space vehicles. NASA also is considering power levels of 1 Mw and 20 Mw.

Another Break for Storables

Small mobile ICBM's called for under SAC's SR19782 and TAC's TMX 161 proposal may have storable-liquid engines capable of 40 to 50 thousand lbs. thrust. This would be sufficient to provide ICBM range and still deliver warheads desired by the Air Force in the 1965-75 period.

ADVANCED MATERIALS

HOH as an Oxidizer

A classified propellant delivering 360-375 sec. I_{sp} is in the works at Aerojet-General. The fuel uses water as an oxidizer and can be produced easily and economically by the chemical industry.

Second Thoughts

Rocketdyne is apparently having second thoughts on publishing a manual covering the compatibility of certain liquids with specified hardware. A type of "which-valve-works-with-what-liquid" book, it could bring some unpleasant reactions from the firms involved, if published.

ASW ENGINEERING

New ASW Office at Lockheed

Lockheed Aircraft has established a new organization to direct ASW and ocean systems research and development and to coordinate corporate efforts in these areas. Thomas P. Higgins, Jr., will be technical director of the new group.

Raytheon Reduces Radome Machining

Complex shapes posed production bottleneck; solution evolved from old 'classroom' machining problem

RADOMES FOR THE Navy's *Sparrow III* air-to-air missile are being machined at the rate of one every 28 minutes by Raytheon Co. at Lowell, Mass.

Previously, the process took more than 20 hours per item, and the mere idea of producing 300 radomes a month seemed all but impossible.

What bothered Raytheon's production engineers was the fact that because of variations in the dielectric quality of the material used, each radome had to be rough-machined and given a preliminary boresight test. From this test, the machining pattern for that particular radome was developed.

This meant that each radome was unique and had to be machined differently. Since a radome is in effect a lens through which electronic signals pass and are refracted, the microwave signals must be concentrated in one place.

To facilitate this focusing, the wall must vary in thickness but be radically controlled to a tolerance of 0.0015 in.

This variation in thickness is accomplished by machining the outside diameter to an elliptical shape. In addition, the radome has an overall artillery-shaped ogive to reduce air friction.

Henry Sokolsky, of Raytheon's Missile Systems Division, says that after a considerable effort better control of the radome materials was achieved and a master pattern for exterior machining was developed.

First, the ogive shape was rough-machined on a tracer-controlled lathe, keeping the cross-section round. Elliptical contour was achieved by center offsetting and remachining in a series of small arcs the length of the radome. Finally, the arcs were blended by hand sanding.

This process was costly, tedious and required more than 20 hours per radome on special tracer lathes. Since the material of construction is laminated glass fiber cloth, carbide tools had to be used. And, to keep the radome from tearing, it was necessary to revolve it as least 90 rpm.

• No outside help—All types of tracer controls were unsuitable. The trouble was that, in turning an ellipse, the turning tool had to make two cycles, in and out, for each revolution of the radome. No available tracer could hold the required tolerances at 180 cycles per minute.

Leading machine tool manufacturers were consulted, but the ideas they provided did not prove out.

Raytheon tackled the problem first by taking the speed out of the work and putting it into the tool itself. A grinding wheel of the proper grade was tried and found to be far more satisfactory than turning.

Then Sokolsky recalled a problem thrown at him in his younger school days. He had been asked to machine a rectangular block on all its surfaces using only an engine lathe.

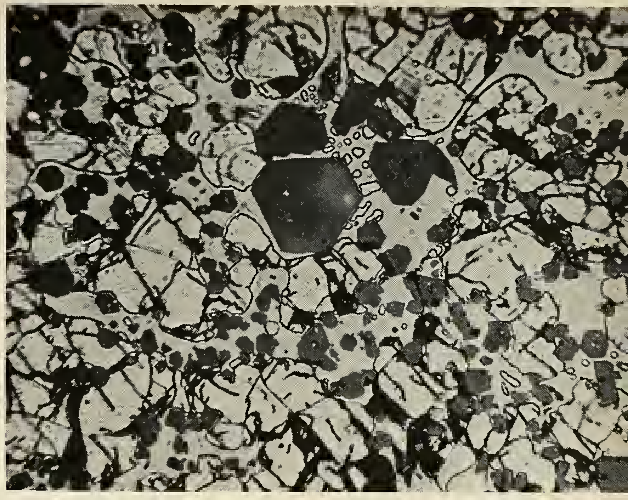
This he did longitudinally by locking the tool in the chuck and placing the work on the carriage. He then ground the work longitudinally, indexing after each stroke. When the sides were made small enough and the cuts were overlapped, a round configuration developed. Why not apply this to radomes?

Consultation with the Abrasive Grinding Co. led to the development of a horizontal grinder with a rise-and-fall head which would carry both the grinding wheel and a roll follower. The movement of the head is controlled by the roller traveling back and forth over a master radome.

The master radome drives, and revolves on a 1-to-1 ratio, the unfinished radome under the grinding wheel and automatically indexes at the end of each stroke.

With this machine, the entire operation takes only 28 minutes and produces a better finish than the hand method. ##

HORIZONTAL GRINDER with rise-and-fall head finishes the artillery-shaped ogive on a radome while imparting a close-tolerance elliptical cross-section.



REFERENTIAL ORIENTATION in AMP anisotropic graph- is illustrated on the left. Profound performance improvements result from a thin layer of this on high-density graphite. Right: nozzle section of TiC-SiC coated graphite (500X).

High Temperatures Spur Novel Graphite Developments

arbon and carbon complexes seen filling materials oid created by solid-propellant rocketry advances

by John Judge

THE "BOOM" in solid rocket tech- ology is causing a tremendous surge high-temperature materials develop- ent.

One of the fresh young leaders in e field is the Engineering Science ivision of American Metal Products ompany, Ann Arbor, Mich.

In the past two years, the Division s created, developed and placed in oduction novel processes for prepar- g high-temperature materials suitable r solid-propellant rocket engines.

A major area of interest—one that tablished AMP in the rocket field—is sign and production of structures in- lving carbon and carbon complexes.

Much research in carbon chemistry aimed at meeting the challenges and chnical advances of high-performance opellants. For this effort, AMP has en providing graphite shapes with ntrolled diffusions of a number of etal carbides.

Silicon, titanium, zirconium, tungs- n, tantalum, hafnium and niobium rbides are under investigation. In dition, mixed binary and ternary rbide systems are involved in the pro- am. AMP says long-range high- nperature applications demand better owledge of these systems.

Graphite itself has received consid- ble attention at the Engineering Sci- ce Division and various forms and combinations of this material have evolved.

Proprietary processes employed at the Division and have produced a super-density, isotropic, high-strength graphite.

Designated AHDG (American High Density Graphite), the material has a uniform structure with uniform pore volumes. It is gas-free at temperatures up to 5500°F, and has excellent thermal shock resistance. Densities range above 1.90.

Precision-dimensioned shapes and forms take the general geometries required for aft closure inserts, blast tube inserts, entrance cones, nozzle inserts, and exit cones.

In general, its mechanical and thermal properties improve with temperature up to the currently available flame temperatures of solid propellants.

Test firings indicate that the erosion rate of this graphite is around 40% that of conventional graphites.

• **Pyrolitic plumbago**—On the other end of the graphite spectrum, ESD scientists have developed an anisotropic polychrystalline material with preferential orientation in one plane. Commonly known as pyrolytic graphite, this material is characterized by being a thermal insulator in a direction normal to the surface of deposition, while being a thermal conductor in a direction parallel to the surface.

Although the AMP anisotropic product (designated AIC) generally exhibits a 100-to-1000-fold difference in thermal conductivities between the (ab) and (c) planes, certain samples have tested as high as 2000.

Test firings of AIC pyrolytic graphite backed up by AHDG graphite indicate that the erosion rate of the composite material is about 1/10 that of untreated high-density graphite and about 1/25 that of conventional graphite.

Also, AIC pyrolytic graphite in massive "free standing" form is being used in nozzles, nose cones, specialized types of heat sinks and blast tubes.

• **"Case hardened" graphite**—Another development of the Engineering Science Division is "heat-treated" graphite. This material is composed of a base of AHDG isotropic graphite with an upgraded surface of recrystallized graphite. The combination has demonstrated superior qualities in over 400 rocket engine firings.

In the rocket exhaust environment, the heat-treated surface shows excellent erosion resistance, improved oxidation resistance, and very desirable mechanical properties. Heat-treated nozzles have actually survived 10 to 15 repeated firings. The AMP process for heat-treating graphite is somewhat similar in effect to the case hardening of metals.

Developments move extremely fast. In one instance, AMP sent an experimental nozzle for firing tests. Since these specimens must wait their turn, it takes about two weeks for the nozzle to be completely tested. During this time AMP came up with an improvement that all but rendered the original nozzle obsolete, and a substitution had to be made. The second nozzle proved its superiority. ⌘

RF Plasma Torch Developed

A CHEAP, simple plasma torch reaching temperatures up to 20,000°K and generated with only 3 kw of power, has resulted from studies conducted by Dr. T. B. Reed at the Lincoln Laboratory of Massachusetts Institute of Technology.

The torch is based on inductive coupling to an ionized gas at or near thermal equilibrium. Thus the high temperatures can be achieved by using a moderate-sized power supply of the type usually associated with RF heating.

The high temperature region is of appreciable extent, not at a point focus, and therefore completely accessible for introduction or manipulation of materials to be heated.

• **Clean heat**—The main feature of the torch is that there are no contaminating combustion products and operates with any desired single gas or mixture.

According to Reed, the induction plasma torch is a quartz tube, open at one end with gas supplied at the other. An RF coil of a few turns surrounds the tube at its center and serves as the power supply.

Reed has observed that the plasma is equally stable and more easily visible when a flat, five-turn pancake coil is employed.

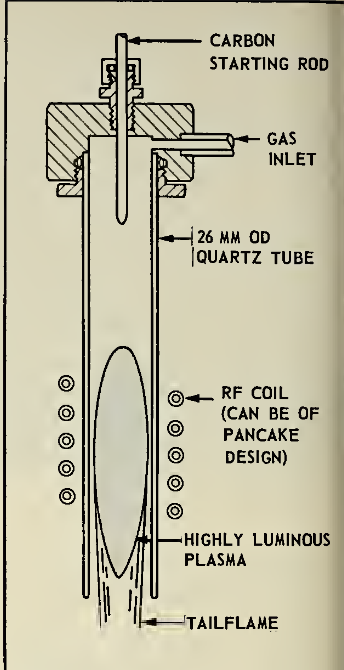
Starting is accomplished by creating a "pilot" plasma within the RF field. This lowers the breakdown potential of the gases sufficiently for the plasma to be established in the high RF field present before starting.

The coupling is initiated by heating a graphite rod or refractory wire loop inductively within the RF field, and then withdrawing it. The main plasma field then becomes the heat source for incoming gases. Tubes direct and control the gas flow in the vicinity of the electromagnetic field. The gas is ionized and a jet of high-temperature plasma projects from the open end of the tube, resembling a torch.

Temperatures approaching 100,000° without excessive power requirements appear feasible if some method can be developed to contain the plasma.

The induction plasma torch is ideally suited to crystal production by the Verneuil method because of its freedom from combustion contamination.

Lincoln Laboratory is operated by MIT with the joint support of the Army, Navy and Air Force.



PLASMA INDUCTION torch reach about 10,000°K at the edge of the plasm region. While at the heart of the regio temperatures reach up to 20,000°K.

PATC Tailored to Space Rendezvous

Two-year development by Marquardt is being used for one satellite program; has been run 4 minutes

THE MARQUARDT CORP. has ·veloped a propulsion system specially ·signed for rendezvous in space and her requirements of extremely pre-se orbital correction.

The system recently was chosen for ie military satellite project. Mar-iardt's Controls & Accessories Divi-on says it has wide application for her space missions.

Hypergolic storable liquid propel-nts are used. Most of the Marquardt ork has been done with nitrogen troxide with hydrazine and mixtures hydrazine and related fuels, depend-g on freezing-point requirements.

Total impulse is controlled on a gital basis by using a series of pulses, otained by injecting small amounts of opellant into the chamber at a time. ilses are produced at a rate estab-hed by the guidance error input gnal.

Marquardt engineers contend that act orbital correction is easier and ieaper to obtain in the satellite itself an with large, expensive thrust cor-ction systems in the booster and wer stages.

The system, called Position, Atti-de and Trajectory Control (PATC), n, as its name implies, also be used to ovide small amounts of impulse for ljustment of orientation and station.

• **How it was developed**—Mar-iardt began work on the concept two ars ago with a converted diesel en-ne operating on UDMH and RFNA. small, 2 hp reciprocating power unit as built, designed to run at 6000 rpm ith propellant injection over 30 to 40 crankshaft rotation. Thus the injec-rs opened, injected fuel and closed in to 2 milliseconds. With the equip-ent, Marquardt demonstrated feasi-lity and performance capabilities of a ilse rocket with pulse widths of 3 to) ms and with a repetition rate vary-g from single pulse to 100 cycles per cond.

Later, a vehicle attitude control sys-m was developed with the use of $_2O_4$ and hydrazine. Propellants are d by nitrogen pressure. The total iantity of propellant injected during single pulse depends on the dwell time of injectors in the position that establishes pulse width. This minimizes mechanical delays and those caused by the travel of fluid through supply lines.

The rocket chamber and nozzle are, for most requirements, uncooled structures. Radiation cooling will maintain temperature levels in long-duration operation at low duty cycles—such as 25% on and 75% off. For short duration at a high duty cycle, heat sink will be adequate.

For engines of 500 and 1000 lbs. thrust, Marquardt is experimenting with two kinds of nozzle—one of tantalum and one with a graphite throat inserted into an ablating inner surface.

Individual pulses can be as small as .001 lb.-sec., which makes the propulsion system adaptable to digital as well as analog error signals.

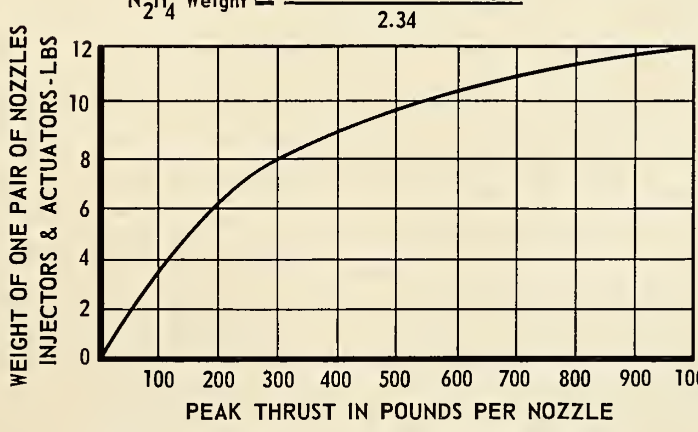
The system has been run up to four minutes duration, restarting 200 times a second. Marquardt said details of the injector used at that rate are proprietary. ⌘

Formula for Versatile PATC

1. Weight of one pair of Nozzles, Injectors and Actuators = ——— (Obtain from curve below)
2. Dry Weight of Additional System Components (Tanks, Pressurization valves, etc.) less Nozzle Assemblies and Plumbing = $\frac{I_{Total}}{1500}$ = ———
3. Weight of Plumbing (Dependent upon Installation, Use 10 to 30% of Item 2) = ———
4. Weight of Propellant = $\frac{I_{Total}}{I_{sp}}$ = ———
5. Estimated Volume (Cu. Ft.) = $\frac{I_{Total}}{17,000}$ = ———
6. Electrical Requirements:
   a. 10 watts per pair of nozzles or 775 watt seconds per lb. of propellant for pulsing power
   b. Approximately 3 lbs per pair of nozzles for electrical conversion package (Converts senser signal to desired input to injector actuators.)

TOTAL EST. WEIGHT = ———

$$N_2H_4 \text{ Weight} = \frac{\text{Total Propellant Weight}}{2.34}$$



Position, Attitude and Trajectory Control Systems

Estimate of Weight, Volume and Power Requirement

(Hypergolic Fuel Combination of N_2H_4 and N_2O_4)

NASA Prods Electric Propulsion Work

Spectacular weight advantage of ion and other units speeds plans; ion, plasma devices to be flight-tested early in 1963

by Jay Holmes

ION AND OTHER electrical propulsion, which could increase interplanetary payloads by a factor of three or four, are getting increased attention from the National Aeronautics and Space Administration.

To fulfill the elaborate plans outlined last week by NASA's Jet Propulsion Laboratory (M/R, Oct. 31, p. 15), propulsion specialists are speeding plans to develop small devices capable of reducing greatly the cost, weight and complexity of launch vehicles required for missions to Mars, Venus and beyond.

A target date of 1965 has been set for the first orbital flight of the two electrical systems that are nearest to being operational—ion and plasma units. The two may be aboard the same satellite, powered by a single 60-kilowatt SNAP-8 nuclear reactor.

Hughes Aircraft Co. is now building a laboratory model of the first ion propulsion unit, with thrust of 0.01 lb. In Fiscal Year '62, NASA hopes to award a contract for development of a flight version ion device, with total thrust of 0.1 lbs. If the Hughes approach should be chosen, the smaller unit could be scaled up, or a cluster of 10 might be used.

• **Test plans**—First flight tests are programed for early 1963. First flights will not be orbital, since the first requirement of the development program will be to demonstrate that an ion engine acts as theory predicts it will in the near-perfect vacuum of outer space. It is impossible to make the demonstration anywhere on earth for two reasons. First, it is impractical to pump a hard enough vacuum in a sufficiently large chamber. Second, any chamber will have walls that will reflect ions and electrons back into the thrust stream.

The flight tests beginning in 1963 will be a series of four sounding rocket launches. Since power will be needed only for a fairly short time, it will be provided by banks of batteries instead of the SNAP-8 nuclear reactor.

NASA officials are now studying which rocket to use for the tests. Two under consideration are *Scout* and *Argo D8*. *Scout* is attractive because, when used as a sounding rocket, it provides an hour of operating time under vacuum conditions. However, the payload would be enormously heavy. Batteries to provide 30 kw for an hour probably would weigh about 1000 lbs.

A possible compromise might be a three-stage *Scout*, which is capable of lifting 1300 lbs. to 1000 miles.

• **Completing studies**—The plasma unit will not need flight testing before the 1965 orbital shot, since it can be checked out completely on the ground. General Electric and Avco are engaged in one-year competing studies of different technical approaches for a unit of ½ lb. thrust. When the studies are completed next summer, NASA expects to choose one of the two and go into R&D.

The difference between the two types of propulsion is in specific impulse and thrust. Ion propulsion provides higher specific impulse, probably between 4000 and 6000 sec., while that for plasma propulsion is in the range of 1000 to 1500 sec. However, the plasma unit gives higher thrust at a given power level.

As a result, the ion engine is best suited for interplanetary missions, where specific impulse is an overriding factor. The plasma unit may be better for such a mission as lifting from a low orbit to a 24-hour orbit.

The first flight is programed for th *Atlas-Centaur* launch vehicle. Electric propulsion units will probably be use in *Saturn*-boosted missions too. How ever, larger engines will be necessar for optimum application to *Satur* payloads.

• **Clear advantage**—Here are som figures that indicate the advantage c ion propulsion for interplanetary mis sions. *Centaur* will have a capability o putting payloads of 8500 lbs. into 300-mile orbit or 1450 lbs. into a escape trajectory.

If the *Centaur* is programed for low orbit, a SNAP-8 powerplant an a pair of ion engines, weighing abou 3000 lbs., might be made part of th payload. At a specific impulse of 600 sec., about 450 lbs. of cesium propel lant would be consumed in boosting th spacecraft from orbital to escape veloc ity, leaving a net payload of more tha 5000 lbs.

If a hydrogen-oxygen stage wer added to the vehicle, the weight of pro pellant alone needed to generate enoug impulse to achieve escape velocit would be 7000 lbs., leaving even les payload than with a two-stage *Centau* alone.

Actually, according to Capt. Richard J. Hayes, USAF, NASA's chief o ion propulsion, there is no theoretica reason why specific impulse need b limited to 6000 sec. It might go up t 20,000 sec. or more in the near-perfec vacuum of interplanetary space. Thi would mean that much less than 45(

Electric Rockets, Performance Ranges

Thrust Device	I_{sp} (sec.)	Estimated Efficiency (%)
Arc jet (steady state, gas propellant)	1000-2000	80
MHD accelerator (steady state)	4000-8000	40
Pulsed plasma	5000-20,000	10-40
Ion	3000-100,000	75-95
Charged colloids	1000-4000	99

›s. of cesium would be needed for the ıission mentioned above.

However, it is impossible to prove ıe higher impulse figure without ex-eriments in space.

• **Other interests**—NASA is inter-sted in several other areas of electrical ropulsion. Plasmadyne is developing a -kw arc jet to be powered by the *unflower* solar collector, which will be sed for attitude and orientation con-·ol of large spacecraft.

Bids are now being evaluated, for ontract award in about a month, on ıagnetohydrodynamic engine studies. Iowever, NASA does not plan early ₹&D in that field because too little is nown in the field.

Studies also are expected to be let ı the current fiscal year on colloid ropulsion. However, the pressure of vork at NASA headquarters will prob-bly delay procurement until after the rst of the year.

The largest item in the electrical ropulsion budget is for supporting tudies. Hayes says he will be receptive o proposals on negative ion work, ion ptics, ion sources and cooling tech-iques. Some of this work will be done ı universities.

NASA's budget for electrical pro-ulsion rose from $1.3 million in FY 60 to $3.3 million in the current year. \lthough NASA spokesmen decline to iscuss the '62 budget, it is obviously oing to jump again.

Procurement is handled both by ıeadquarters and the Marshall Space Flight Center, Huntsville, Ala., where Dr. Ernst Stuhlinger has a staff of 10 ceeping track of efforts in electrical ropulsion. Contracts totaling $100,000 or more must be approved by head-uarters, where Dr. Harry Harrison is hief of space propulsion. ⁂

Two '61 Rocket 'Intervals' Scheduled by COSPAR

Two major international rocket "intervals" have been scheduled for 1961 by the Committee on Space Re-earch (COSPAR) of the International Council of Scientific Unions.

The first, Feb. 12-18, will deal primarily with the total solar eclipse expected Feb. 15, and with winter at-mospheric structure in the Northern Hemisphere. The second interval, July 16-25, will emphasize atmospheric structure during the Northern Hemi-sphere summer.

About 27 research rockets were fired as part of the U.S. contribution o the interval Sept. 16-22; twenty-two were for meteorological measurements, the rest for other geophysical investiga-ions.

SNAP's Seen Top Space Power Sources by 1970

Los Angeles—Nuclear SNAP systems currently under development will be by 1970 the predominant and most reliable source of high power available for application in space satellites.

That prediction was made by Ralph Balent, Director of the Compact Power Systems Department of Atomics International, at the Aircraft Electrical Society 1960 display here.

Balent cited the recent 1000-hour uninterrupted operational test of the SNAP experimental reactor (SER) at 50 kw thermal power and 1200°F, as evidence of the "extremely stable, predictable and satisfactory operation" of SNAP units. The SER, a 220-lb. reactor containing about 6.4 lbs. of homogeneous U_{235} fuel, produced 150,000 kwh of thermal power in its 4000 hours of tests over an eight-month period.

• **Coming systems**—Balent provided some new details of the systems currently under development at AI, a division of North American Aviation, Inc. These include SNAP 10, SNAP 2 and SNAP 8, in order of increasing electrical power output.

SNAP 10, expected to be available in 1963, has a 300-watt output and a minimum life of one to three years. SNAP 2, a 3-kilowatt system, will be available about 1964, with a minimum life of one year. Greatest power output will be from SNAP 8, totalling 35,000 watts, with a capability of producing 70,000 watts through the use of two power conversion units with the same reactor. This system is expected to be in use by 1965, with a minimum life of one year.

Operation of the SNAP systems varies with the type of power conversion utilized. A turbo-machinery system will be used in the SNAP 2 and 8 programs, while thermoelectric conversion will characterize the SNAP 10 unit.

Basic reactor types will be the same for all systems. A reactor using a homogeneous fuel of U_{235} in zirconium hydride will provide energy for system operation. For generation of one megawatt/day (thermal) in the system, one gram of fissionable fuel is consumed. In SNAP 2, one-half of one percent of the total 6.4 lbs. of fuel will be consumed in one year. In SNAP 8, this figure will be 5%.

Use of zirconium hydride, Balent said, minimizes weight in the reactor, by taking advantage of its similarity to water in hydrogen content, but avoiding the necessity for a heavy pressure vessel due to 1200°F operation. Water, with a high hydrogen-atom content, is an excellent moderator. Closest to water in hydrogen content is zirconium hydride. The reactor temperature of 1200°F, however, would prevent water from being used without a thick pressure vessel. Zirconium hydride needs no such vessel, and fills the job very well.

• **Long-lived model**—SNAP 10, the reactor which will be available first, has no moving parts and requires no active control system. Startup in orbit is accomplished by moving the two halves of the reactor together until criticality is reached, the system then being allowed to seek its own equilibrium temperature. System control is provided by a strong negative temperature coefficient of reactivity, inherent in this type of reactor.

The static nature of thermoelectric conversion is the prime reason for SNAP 10's development, and the reason for its longer minimum life. In this system, 700 thermocouples of lead telluride and germanium bismuth telluride are located about the reactor reflector in a layer 1½ in. thick.

The reactor, with a core diameter of 7 in. and a length of 10 in., is surrounded by a reflector and conduction plates of beryllium, and is equipped with radiator fins.

• **Adequate efficiency**—The 700 thermocouples each generate ½ watt of electrical power. Overall efficiency of the unit is only 2½ to 3%, although the doped lead tellurides are capable of 10 to 15% of Carnot conversion efficiencies at temperatures below 1200°F.

"We could improve the efficiency of the system," Balent said, "but it's not worth the effort to gain slight efficiency improvements, when the saving in fuel is academic."

The thermocouple hot junction is maintained by contact to the reactor surface, while the cold junction is maintained by contact with the radiator fin. The radiator, rejecting heat into space, maintains the proper temperature gradient and heat flow through the conversion material.

SNAP 2 and 8 systems will employ generally similar mechanical conversion methods, although the reactors will differ. SNAP 2 will use a reactor similar in type to SNAP 10, but will have a small mercury vapor turbine-alternator Rankine power conversion system. The liquid sodium-potassium-cooled reactor will drive only one moving part, a combined rotating shaft suspended on liquid mercury bearings and rotating to 40,000 rpm. Power conversion sub-system is under development by Ramo Wooldridge. ⁂

NOVEMBER, 196

Missiles and Rockets

ASTROLOG

A status report on U.S. missiles and rockets and all space vehicles presently in orbit

★ *Indicates change since September 12 edition*

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SPACE VEHICLES			
ADVENT (Army)	Army Signal Corps, prime, GE-Bendix prime for polar-orbiting phase	New overall name for advanced communications satellites STEER, TACKLE and 24-hour instantaneous repeater called DECREE	R&D
AEROS (NASA)	No contract announced	24-hour weather satellite to be boosted by CENTAUR or SATURN	Planning. First flights would be i 1964 or 1965
★AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout; AGENA B stop-start engine about double fuel capacity of AGENA A	Used in DISCOVERER program larger AGENA B also to be use with ATLAS and THOR
★APOLLO (NASA)	Convair, Martin, G.E.	Three-man spacecraft capable of orbiting moon or becoming space station; probably winged for lunar flights; boosted by SATURN	Six-month studies in progress; R&I prime to be chosen in FY '62
★ATLAS-ABLE (NASA)	STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion	Orbit 200-lb. vehicle around moon or send into deep space	Last attempt in 60 days
★BLUE SCOUT (Air Force)	Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion	Solid multi-stage booster similar to SCOUT	First BLUE SCOUT launching partl successful in September
CENTAUR (NASA)	Convair, prime; Pratt & Whitney/-JPL, propulsion	Pair of LOX-liquid hydrogen engines, 30,000 lbs. total thrust, atop ATLAS booster, capable of orbiting 8500 lbs. or accelerating almost 1450 lbs. to escape velocity	First test flight in 1961; first engine delivered
★COURIER (Army)	Army Signal Corps, prime; Philco, payload; Radiation, antennas; ITT, ground stations	Delayed repeater communications satellite; 51 in. diameter, 500 lbs.	COURIER IA launching failed in August because of booster blow-up. COURIER IB placed in orbit Oct. 4, successfully transmits messages and pictures
★DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA launchings of early stabilized satellites; main purpose is to test techniques for SAMOS	16 launchings; capsule recovered from orbit on No. 13 & 14. No. 15 capsule unrecovered from Pacific because of rough seas. DISCOVERER XVI failed to go into orbit because of separation failure between THOR and AGENA B. Total 35 shots
DYNA-SOAR I (Air Force)	Boeing, space craft and systems integrator; Martin, propulsion	Boost-glide orbital space craft; first space bomber; TITAN I booster; TITAN II probably to be used later	R&D; first glider flights from Edwards AFB by 1962; intensive material studies underway; R&D space flight about 1966
★ECHO (NASA)	Langley Research Center, prime	Puts 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite; next model will include internal supports	Second launching attempt successful Aug. 12; next shot next year
JUNO II (NASA)	Marshall Center/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/ JPL, prop.	Early deep space booster; small payload	Five more shots planned
MARINER (NASA)	JPL, prime	600-1200 lb. unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B	Seven shots planned beginning next year
★MERCURY (NASA)	NASA, prime; McDonnell, capsule	First manned satellite; 1 ton capsule boosted by ATLAS	Program slipping about one year. First manned capsule launching by REDSTONE down Atlantic Range slipped to early 1961. First manned orbit shot scheduled for late 1961

MIDAS (Air Force)	Lockheed, prime	Early-warning satellite; detect ICBM launchings by infrared before birds leave pad; R&D models weigh 2 tons; operational system to have 12-15 satellites	R&D; second launching May 24 partial success
★NIMBUS (NASA)	No contracts announced	2nd generation weather satellite; THOR-AGENA B booster	First launching scheduled for early 1962, but procurement delay makes date doubtful. Letting of several subsystem contracts expected soon
NOVA (NASA)	No prime announced; Rocketdyne, propulsion	Clustered 6-9 million lb. booster plus upper stages	Early R&D on 1.5 million lb. F-1 engines
★OAO (NASA)	Grumman, prime; Westinghouse, eletronic components	3500-lb. orbiting astronomical satellite observatory equipped with telescope; boosted by ATLAS-AGENA B	First flight scheduled in late 1963
★OGO (NASA)	No contract announced	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B booster	First flight scheduled in early 1963. Contracts expected soon
ORION (ARPA-Air Force)	General Atomic	Space station launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted; program shifted to Air Force alone
★OSO (NASA)	Ball Brothers, prime	350 lb. orbiting solar observatory; THOR-DELTA booster	First flight planned early in 1961
PROJECT 3059	Aerojet-General, Grand Central, propulsion	Solid motor in 1 million to 2 million lb. thrust class	Research determining feasibility; NASA contracting for complementary studies with United Technology Corp.
★PROSPECTOR (NASA)	No contract announced	Soft-landed, remote control, unmanned moon exploring spacecraft. SATURN booster	First flight planned by 1965; study contracts to be awarded in 1961
★RANGER (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. rough landed instrumented capsule on moon; ATLAS-AGENA B booster	R&D; first flight planned 1961; first lunar landing planned for 1962
REBOUND (NASA)	No contract announced	System of 12 or more passive communications satellites launched several at a time	Study
★ROVER (NASA, AEC)	No prime announced	First nuclear rocket	R&D contractor to be chosen soon
★SAINT (Air Force)	No contracts announced	Anti-satellite satellite system for both inspection and interception	Study contract awards due in November
★SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs.	R&D; stabilization already achieved in DISCOVERER series; first launch failed to put SAMOS in orbit Oct. 11; scheduled to be operational late 1962, early 1963 under new, bigger program
★SATURN (NASA)	NASA Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and midstage engines; Pratt & Whitney, topstage engines	Series of multistage vehicles based on 1.5-million-lb. clustered booster and upper stages using combinations of LOX-liquid hydrogen engines. Earliest model will orbit 20,000-lb. payload	Second series of static firings to begin in Nov.; firings of clustered booster first flight test spring of 1961; flight with live upper stages scheduled 1963
★SCOUT (NASA)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol, propulsion	Solid four-stage satellite launcher; 200 lb. payload in orbit	First four-stage flight successful in Oct.; orbital shot expected in next few months
SURVEYOR (NASA)	No contract announced; STL, McDonnell, North American, Hughes competing	Soft-landed 100-300 lb. instrumented spacecraft on moon; ATLAS-CENTAUR booster	Competing studies to be completed in November; R&D contract to be awarded 1961; first moon flights '63-'64
THOR-ABLESTAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle with orbital capability of 200 lbs. New ABLESTAR upper stage has restart engine, boosts heavier payload	THOR-ABLE phased out. THOR-ABLESTAR operational in TRANSIT and COURIER
★THOR-AGENA (Air Force)	Lockheed, prime; Bell, propulsion	Two-stage vehicle capable of orbiting more than 300 lbs. AGENA-B restartable upper stage boosts payload capacity to 1250 lbs.	Operational in DISCOVERER program. AGENA-B first used May 24 to launch MIDAS II. NASA to use extensively beginning late '61
THOR-DELTA (NASA)	STL, prime; IT&T, guidance; Rocketdyne / Aerojet-General / Allegany, prop.	Improved THOR-ABLE with 480-lb. payload capability	To be used in ECHO and TIROS programs. Used successfully in ECHO I shot
★TIROS (NASA-AF-Army-Navy-Wea. Bu.)	RCA-Army Signal Corps, prime	Meteorological satellite; TV pictures of cloud cover; next TIROS to have IR Scanner	R&D; first launching in April a success; two more scheduled; second planned before end of 1960

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
TRANSIT (Navy)	Applied Physics Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs.	TRANSIT IB R&D satellite put in orbit April 13; IIA plus piggyback satellite successfully in orbit June 22, four satellite TRANSIT systems scheduled operational 1962; next R&D launching late fall
TRIBE (ARPA)	,	Family of space launching vehicles	Planning
VOYAGER (NASA)	No contract announced	Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster	Study; first flight planned by 1965
YO YO (Navy)	No contract announced	Tactical sea-launched one-pass reconnaissance satelloid	R&D
★X-15 (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 3600 mph; flight at edge of space; on AF model each XLR-II rocket engines develop 16,000 lbs. of thrust; XLR-99 engines to develop 50,000 lbs. Three planes delivered	Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-11 engine; plane #2 undergoing flight tests with XLR-99 engine. Plane #3 undergoing repairs from June B ground test explosion
MISSILES & ROCKETS			
ALFA (Navy)	Avco, prime	ASW surface-to-underwater; 500 lb. solid; conventional; formerly called ABLE	Deployed on destroyer escorts
★ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, Sonar; Torpedo, GE; depth charge, M-H.	Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range about 8 miles; advanced ASROC (improved torpedo) under R&D	R&D; operational on Destroyers Norfolk, Adams, Dewey and Perry; plans call for deploying on 150 destroyers and cruisers
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater; rocket torpedo; nuclear	R&D
★ATLAS (Air Force)	Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	ICBM; more than 5500-to-7500 mile range; liquid; nuclear; ATLAS "E" series has inertial guidance; earlier ATLAS "D" has radio inertial	70 launchings: 45 successes, 10 partial, 15 failures; 11 scheduled sites for 13 squadrons named; operational at Vandenberg and Warren; ATLAS E tests began Oct. 11
ARM (Air Force)	No contract announced	Anti-radar missile	Studies; plan for separate missile shelved at least temporarily
BOMARC-A (Air Force)	Boeing, prime; Westinghouse, guidance; Airojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 200 m. range; Mach 2.7; nuclear	First squadron operational at McGuire AFB, N.J.
★BOMARC-B (Air Force)	Boeing, prime; Kearfott/Westinghouse, IBM guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 500 m. range; nuclear	Air Force has accepted B's for production; a B test bird intercepted simulated target 345 miles away Oct. 14
BULLPUP (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol (Reaction Motors), propulsion	Air-to-surface; 4-B mile range; conventional 250-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model under development	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; Air Force buying modified version; Marines launching BULLPUP from helicopters
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime; Daystrom, U.S. distributor	24.6-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant	Marines planning to purchase; Army considering them; already operational with West German troops
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CLAYMORE (Army)	No contract announced	Anti-personnel missile	R&D
CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
DAVY CROCKETT (Army)	In-house project at Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men	R&D; operational in FY '61; first NATO deliveries also FY '61
EAGLE (Navy)	Bendix, prime; Bendix, guidance; Aerojet, propulsion; Grumman, airframe	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow Douglas Missileers now under development; EAGLE is 15 ft. long; wt., about 2000 lbs., Mach 4; solid	R&D; Missileer production run reported to be 120 in next few years

★FABMIDS (Army)	Convair, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies	Mobile anti-missile defense system	Each of six contractors have $250,000 feasibility study contracts awarded Oct. 10
FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead	GAR-1 through GAR-4 operational; GAR-9 & 11 R&D
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D
★HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 20-mile range; solid; conventional; designed to hit low-flying planes	Operational; deployed at Panama, Okinawa; SUPER HAWK under development; Jan. 29 successfully intercepted HONEST JOHN, first known intercept of one tactical missile by another
HONEST JOHN (Army)	Douglas, prime; Hercules, propulsion	Surface-to-surface; unguided; 16.5-mile range; nuclear	Operational; deployed in Europe
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400; training fully underway
★JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear, re-entry vehicle	IRBM; liquid; nuclear	To be deployed with Italian and Turkish troops. 31 military launchings: 24 successes; 5 partials; 2 failures. Full tactical GSE used for first time in Oct. 20 shot from Cape
LACROSSE (Army)	Martin, prime; Federal Telecommunications Laboratories, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; 4 units being trained; 3 more planned for 1960; being deployed in Europe and Far East; advanced LACROSSE R&D program dropped at least temporarily
★LAW (Army)	No contracts announced	Light antitank missile to be carried in tube	R&D under AOMC
LITTLE JOHN (Army)	Emerson Electric, prime; ABL, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	Operational this year; units training with it
LOBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BALLISTA	Studies
LULU (Navy)	General Mills/Naval Ordnance Lab, prime	Small nuclear depth charge air-dropped or launched by ASROC	Operational
MACE (Air Force)	Martin, prime; AC Spark Plug, guidance; Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has 1000-m. range	Being deployed with U.S. troops in West Germany; now all mobile but hard-base version in R&D; first launched from prototype hard site in July
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650-mile range	Being turned over to West Germans; also deployed in Far East
MAULER (Army)	Convair, prime	Surface-to-air; IR guidance; highly mobile antiaircraft and antimissile missile for field use; to be on tracked vehicle; 12 missiles in each launcher	R&D; NATO may buy
★MINUTEMAN (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF rail launcher	2nd generation ICBM; solid; fixed or mobile eboard railroad trains; nuclear; 3 stages	R&D; scheduled to be operational mid-1962 at Malmstrom AFB; launching of eight tethered birds from silos successfully completed in May; first full R&D launching from Cape in Dec.; tactical rail system tests completed; first 3 squadrons at Malmstrom; Ellsworth AFB, S.D., being surveyed for more
M-55 (Army)	Norris Thermador, prime	Four-inch diameter, small, short-range poison gas rocket; to be fired from 45-tube launchers	Operational
MISSILE A (Army)	ARGMA prime	Surface-to-surface; 65-70 mile range; solid	Design studies
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Hercules Powder, propulsion	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; about 170 batteries in U.S.

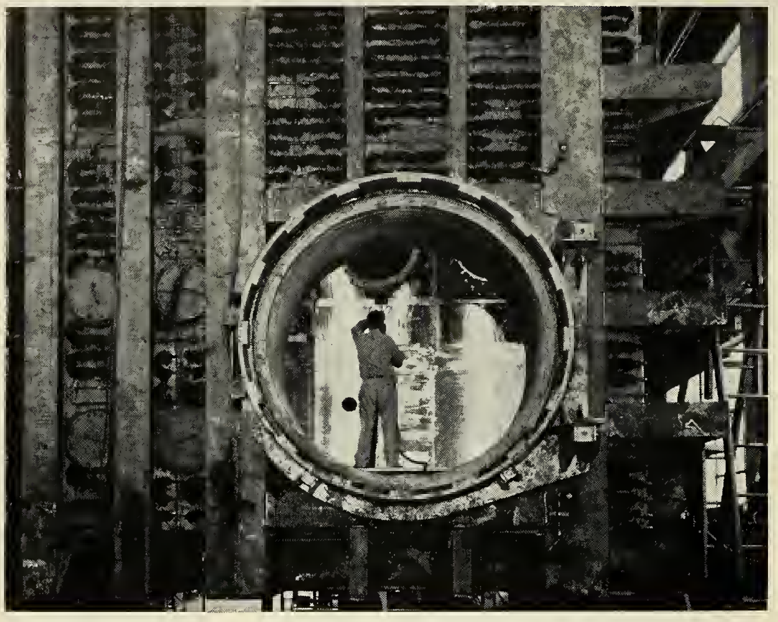
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion	Surface-to-air; 80-mile range; Mach 3+; nuclear; effective against tactical missiles as well as aircraft; mobile or fixed installation	Rapidly replacing NIKE-AJAX; more than 80 batteries deployed in U.S.; NIKE-HERCULES units on Formosa
★NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol and Grand Central, propulsion	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands. 10 R&D launchings: 6 successful, 3 partial, 1 failure. Complete system tests now scheduled for mid-'62
★PERSHING (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; two-stage solid; approx. 500-mile range; nuclear; transported on tracked FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range	R&D; to replace REDSTONE; 7 R&D launchings: 6 successes (all with dummy 2nd stage), 1 failure. Expected operational late 1962
★POLARIS (Navy)	Lockheed, prime; GE, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear; POLARIS II (1500-mile range) and SUPER POLARIS (2500 mile range) under R&D	87 launchings of test vehicles: 60 successes; 20 partial; 7 failures; (12 launched from submerged submarines —all cleared surface; 8 successful flights, 4 failures. First sub to be deployed by mid-November; No. 2 by end of year
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
REDEYE (Army)	Convair, prime; Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable	R&D; Marines also will use; NATO may buy
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe; to be replaced by Pershing
REGULUS I (Navy)	Chance Vought, prime; Stavid, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines; REGULUS II used as target drone
SERGEANT (Army)	JPL/Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	Production. To replace CORPORAL this year
SHILLELAGH (Army)	Aeronutronic, prime	Surface-to-surface; lightweight; can be vehicle-mounted	Early R&D
SIDEWINDER (Navy)	GE-Philco, prime; Avion, guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; 6-7-mile range; conventional; new I-C models to have switchable IR and radar-guided warheads	Deployed with Navy and Air Force; all-weather type under development
★SKY BOLT (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	Air-launched ballistic missile; more than 1000-mile range; solid; nuclear; to be launched from B-52, B-70 and Vulcan bombers	R&D; to be purchased by British; operational 1964-65; both U.S. and British planes to test-launch from Eglin AFB, Fla.
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear-powered ramjet; nuclear	Study-R&D
★SNARK (Air Force)	Norair, prime; Northrop, guidance; Aerojet-General, propulsion	Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear	One squadron of about 20 missiles at Presque Isle, Maine
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft; earlier SPARROW I obsolete; new contract aimed at extending range and altitude
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion	Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear	Estimated operational date: 1961. To be installed first on Thresher nuclear-powered attack submarine
SS-10 (Army)	Nord Aviation, prime	Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa
★SS-11 (Army)	Nord Aviation, prime	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional	Operational. Under evaluation by Army; decision on procurement due for some time
TALOS (Navy)	Bendix, prime; Farnsworth/Sperry, guidance; Bendix/McDonnell, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galveston
★TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Operational on Missile Destroyer Adams in Oct.
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs.; 102 in. long; 105-lb. warhead	The Navy is buying the Norwegian missiles to equip two destroyer escorts
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional	Operational with fleet

TERRIER-ADVANCED (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	About 100% performance improvement over TERRIER	Operational Advanced TERRIERS to be deployed this year
★THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases set up in England. 64 military launchings: 43 successes; 11 partial; 10 failures; 38 scientific launchings: 32 successful, 2 partial; 4 failures
★TITAN (Air Force)	Martin, prime; Bell/Western Electric, Remington Rand, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, re-entry vehicle	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range	25 launchings test vehicles: 17 successes; 3 partial; 5 failures. 9 sites for 14 squadrons named; TITAN I operational fall 1961; first Vandenberg launchings scheduled this fall; TITAN II scheduled to be operational early 1963
TYPHON (Navy)	Westinghouse, prime; Bendix propulsion	Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Early R&D; may be used on hydrofoil destroyers
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
WILLOW (Army)	Chrysler, prime	Highly-classified missile	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime	Air-to-air, air-to-surface; solid; unguided rocket; 5-mile range; conventional	Operational

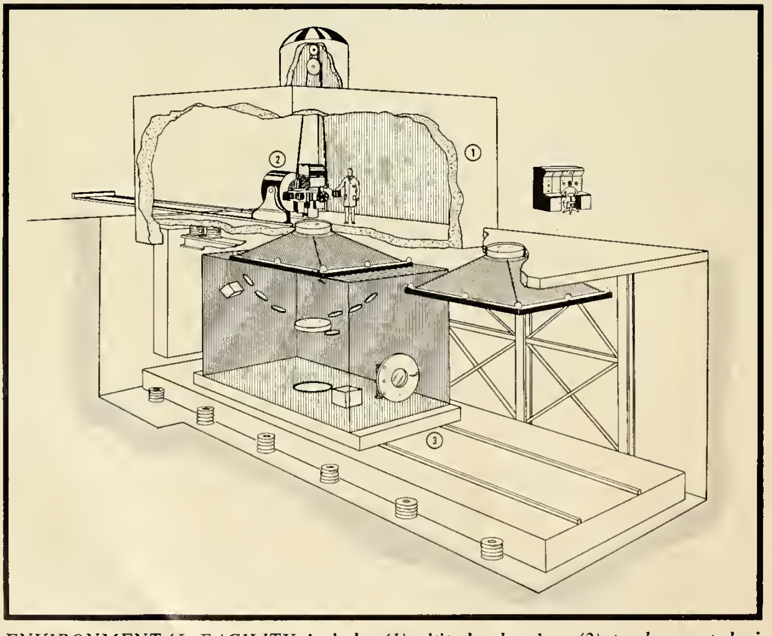
SATELLITES

SATELLITE	COUNTRY	STATUS
★EXPLORER I (30.8 lbs.)	U.S.	Launched 1/31/58, est. life 3-5 years. Orbits earth, perigee: 217 m., apogee: 1171 m., period: 108.5 min. (Discovered Van Allen Belt); not transmitting.
★VANGUARD I (3.25 lbs.)	U.S.	Launched 3/17/58, est. life 200-1000 years. Orbits earth, perigee: 408 m., apogee: 2458 mi.; period: 133.9; still transmitting.
★LUNIK I "MECHTA" (3245 lbs.)	RUSSIA	Launched 1/2/59. Believed to be in orbit around sun on 15 mo. cycle; not transmitting.
★VANGUARD II (20.7 lbs.)	U.S.	Launched 2/17/59, est. life 10 years +. Orbits earth but is "wobbling," perigee: 350 m., apogee: 2042, period: 125.3 min., inclination to equator: 32.88°; not transmitting.
PIONEER IV (13.40 lbs.)	U.S.	Launched 3/3/59. Orbits sun, and achieved primary mission, an Earth-Moon trajectory; not transmitting.
EXPLORER VI "PADDLE-WHEEL" (142 lbs.)	U.S.	Launched 8/7/59, est. life: to Aug. 1961. Orbits earth, former perigee: 156 m., former apogee: 26,357 m., former period: 12½ hours, present orbit unknown; speed: at perigee 23,031, at apogee 3126 mph., inclination to equator: 46.9°; not transmitting.
★VANGUARD III (about 100 lbs.)	U.S.	Launched 9/18/59, est. life 30-40 years. Orbits earth, perigee: 320 m., apogee: 2318 m.; period: 129.8; not transmitting.
★EXPLORER VII (91.5 lbs.)	U.S.	Launched 10/13/59, est. life 20 years, orbits earth, perigee: 344, apogee: 671; period: 101.2; transmitting.
★DISCOVERER V CAPSULE (less than 300 lbs.)	U.S.	Launched 8/13/59. Satellite burned up in atmosphere Sept. 28. Capsule also thought to have been destroyed, but it was later rediscovered and first thought to be an unidentified Soviet satellite. Est. life several months; period: 96.5; perigee: 123, apogee: 607.
★PIONEER V (94.8 lbs.)	U.S.	Launched 3/11/60, est. life: forever; orbits sun, interplanetary radio communication satellite, passed 20 million miles June 20; not transmitting.
★TIROS I (270 lbs.)	U.S.	Launched 4/1/60, perigee: 428.9 m.; apogee: 468.1; period: 99.1 Picture-taking weather satellite; still transmitting.
★TRANSIT IB (265 lbs.)	U.S.	Launched 4/13/60, est. life: 16 mos. minimum; perigee: 237.7; apogee: 433; period: 95.4. First R&D navigation satellite. Not transmitting.
★SPUTNIK IV (10,008 lbs.)	RUSSIA	Launched 5/15/60; est. life: relatively brief; original perigee: 188; apogee: 229; changed to 191/429 on May 19. Last reported—Period: 93.6; perigee: 175; apogee: 384. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed because of poor orientation of retrorocket.
★MIDAS II (5000 lbs.)	U.S.	Launched 5/24/60; est. life: 40 months; perigee: 300.1; apogee: 316; period: 94.4; Telemetry for IR scanning failed two days after launch; still transmitting.
★TRANSIT II-A (223 lbs.)	U.S.	Launched 6/22/60; est. life: 50 years; period: 101.7; perigee: 389.2; apogee: 650.5; still transmitting.
★NRLI "GREB" (40 lbs.)	U.S.	Launched 6/22/60 with TRANSIT II-A; period: 101.7; perigee: 657.8; apogee: 657.8. Solar radiation measuring satellite; still transmitting.
★DISCOVERER XIII (1700 lbs.)	U.S.	Launched 8/10/60; period: 94; perigee: 153; apogee: 267; 300-lb. capsule successfully ejected from orbit and recovered from Pacific 8/11—the first satellite to be recovered from orbit.
★ECHO I (132 lbs.)	U.S.	Launched 8/12/60; est. life: one year; period: 117.8; perigee: 781; apogee: 1192; first successful orbiting of a passive communications satellite.
★COURIER IB (500 lbs.)	U.S.	Launched 4/10/60; period: 106.9; perigee: 586; apogee: 768; first successful launching of a delayed active repeater satellite; est. life one year

Unique Environmental Center Goes up at Fairchild



VIEW OF five-foot access door leading into the 2825-cu.-ft. altitude chamber. Snake-like coils on wall can furnish up to 360 BTU/sq. ft./hr. of radiant heat.



ENVIRONMENTAL FACILITY includes (1) altitude chamber, (2) track-mounted vibration machine, and (3) track-mounted collimator-systems chamber. Optical window is in floor of (1), image splitter below it and optical mirror in floor of (3).

by William Beller

SYOSSET, NEW YORK—Early next year an advanced facility will be testing high-performance photographic systems in a simulated space environment. It is probably the only environmental facility in the world designed specifically for optics work.

Fairchild Camera and Instrument Corporation is building it in-house. Price tag is $1.7 million.

The investment is being made partly because of the space-age trend toward small total production of new and unique photographic designs, where often the prototype test is also the operational one. Consequently, final evaluation and debugging becomes a laboratory operation.

Other expected dividends will be extensive design data, improved system reliability by having such data, and near-complete performance testing under simulated flight conditions.

When it is finished, Fairchild says, the facility will be capable of resolution testing very long focal length, large relative aperture, diffraction-limited photographic sensors. It will be able to test these sensors under many environmental profiles of space vehicles. For this purpose, the controlled parameters will be pressure, temperature, humidity and vibration.

• **Moving "target"**—The test center is divided into an upper and a lower chamber. The upper (15 ft. x 13 ft. x 14 ft.) is the altitude chamber, which contains the vibration equipment and the optical unit undergoing test. The pressure can be brought down to 1.3×10^{-8} mm Hg, the temperature can range between −100°F and 200°F, the relative humidity can be varied between 5% and 95%, and the vibration machine can put out a maximum sinusoidal force of 28,000 pounds.

The lower chamber holds the collimator system. This comprises a vertical 36-in. parabolic collimator of 27-ft. focal length. The system goes 34 feet below ground level and is used with seven additional collimators and an image motion compensation system.

This system includes a simulated moving target put in by a film strip, which is expected to be extremely useful for testing the resolution of reconnaissance systems while in flight.

Equipment in the company's present environmental test facility, also located in the Syosset plant, will complement the new test center. This equipment includes walk-in temperature, humidity, rain and fungus chambers; smaller altitude chambers; salt spray equipment; an explosion chamber and a large centrifuge for G-force testing.

Sea Raises Peculiar Design Problems

Designers must keep in mind destructive effects of ocean water and sea life and varying levels of operation

by Leslie E. Alsager
Supervisory Marine Engineer
Bureau of Ships

UNIQUE TECHNICAL PROBLEMS confront the engineer who newly enters the ASW field from the aircraft or spacecraft field.

He suddenly finds himself working with a relatively dense fluid medium, where such things as temperature and salinity distributions are variable, almost capricious.

He finds other problems. The organisms that abound in the sea can score a vessel's hull or confound the craft's detection equipment. The strength of most materials decreases and human factors problems increase.

Submarines are designed to operate while on the surface, at periscope or snorkel depth, and in a fully submerged condition. Therefore, in developing the parametric studies of design, engineers must consider each of these three conditions of operation in order to provide an adequate vessel.

Surface operation of a submarine lends itself to a design similar to that of a surface ship. Since submarines generally are configured as a body of revolution with no large dominant keels or stabilizers, surface operation is the least attractive with respect to crew comfort. In addition, heavy rolling and pitching in a seaway make machinery and equipment design difficult.

Roll and pitch specifications for surface operation may require 60° roll at low power and 30° roll at high power. These degrees are measured from the vertical and are assigned a complete roll cycle (from one extreme to the other and back) of about 8 seconds. Pitching of the ship in the surface conditions may be assigned values of 10° from the horizontal plane with a complete pitch cycle of about 6 seconds.

Unfortunately, no ship operating in a seaway can be expected to have a pure rolling motion or a pure pitching motion. Thus the designer must provide an installation that will perform under combinations of these inclinations.

> **Third in Series**
>
> *This is the third in a special series of articles intended to acquaint readers with the nature of the submarine threat, the ASW engineering problems involved, and the means or lack of means for solving them. Written by authorities in the ASW field, future articles will deal with sonar, hydrodynamics, oceanography and ASW weapon systems.*

• **Underwater criteria**—Periscope or snorkel depth is a sub-surface operation. This depth does not permit full exposure of the submarine. However, it does permit ship operators to make visual examination of the sea surface and celestial observations by the periscope.

The snorkel can provide replenishment of air within the ship or an air supply for fuel-burning equipment such as a diesel engine. Here, again, the ship is subject to dynamic forces resulting from surface sea conditions. However, masts, superstructures and other protuberances provide resistance to rolling motions; hence the roll condition can be expected to decrease. Since any of these cycles can be expected to vary with the particular ship, engineering judgment in assigning design numbers must prevail.

Submerged depth is often defined as "way deep" in the sea. From a designer's standpoint, submerged operation denotes the condition where the submarine is a self-contained operating body and where no contact can be made with the surface through either periscope or snorkel. A submerged submarine generally can be considered a stable platform, reasonably unaffected by surface sea conditions. However, owing to maneuvering conditions and low speeds where currents are involved, the designer must establish conditions of dive angles, roll angles and other hydrodynamic parameters. Again, these are ship-design-dependent. For early design consideration, this set of conditions could be used:

(1) A roll 30° from the perpendicular with a complete roll-cycle period of 12 seconds, and a pitch of 10° with a complete pitch-cycle period of 60 seconds.

(2) A so-called trim on the ship can be calculated and would be dependent on the apportionment of weights throughout the ship. A satisfactory trim is defined as a trim obtained after submerging and with the ship on an even keel where this even keel can be maintained at the desired depth and at all speeds with minimum use of the ship's planes. In a rise or dive attude, however, this trim could result in design angles of 30°; and angles as great as 40° have been observed.

Submersible-weapon designers when selecting materials must recognize the (1) Corrosion-erosion effects of sea water; (2) Galvanic effect of sea water; (3) Effect of biological organisms on the hull and equipment; (4) Effect of sea water on the strength of materials.

• **Corrosion-erosion effects**—Corrosion of hull, piping, or machinery can lead to failure. Some confusion always exists as to whether the failure can be attributed to corrosion or erosion or to both.

Generally, the effects can be ameliorated for a specified life by correct control of design velocities, selection of materials, attention to system detail, and by recognizing the environment to which the equipment is used.

The Navy has conducted many investigations into corrosion-erosion effects. Paralleling the Navy work is an extensive program by the International Nickel Company in its research laboratories at Kure Beach in North Carolina. LaQue and Mason (see Bibliography)

film barriers give some protection . . .

in 1950 presented an excellent paper on 70-30 cupro-nickel alloy and its resistance to corrosion and erosion. Cupro-nickel is used extensively in the United States for sea-water systems because of its excellent corrosion and erosion-resistance for moderate flow velocities.

Stainless steels maintain an oxide film (which is self-repairing) and hence provide excellent corrosion resistance to sea water in flowing waters. Severe pitting has been reported when the material was used in stagnant waters or in equipment containing crevices in which there was no flow.

The austenitic stainless steels appear to be susceptible to stress corrosion cracking in moderate-to-high-temperature chloride water environments. Some compositions, for example AISI 304, 316, and 347, are considered to be more susceptible than others. The subjects of stress corrosion has not been explored as extensively as might be desired. However, it is believed that where the steels are subjected to wetting and drying, are at moderate-to-high temperatures, are under stress and are in the presence of oxygen, susceptibility to stress corrosion cracking is possible. This type of stress failure can be reproduced in a short period of time and must be considered when selecting materials.

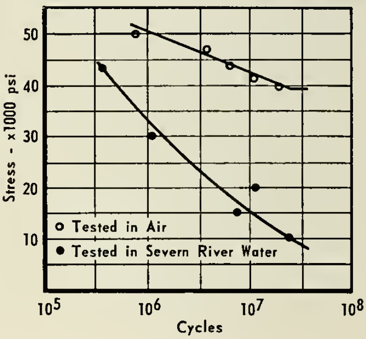
While material selection is primary, film barriers such as paints, oils, grease or some other type of coating will help to reduce the rate of corrosion provided they are properly applied and maintained.

• **Galvanic effects**—Here is an electro-chemical type of reaction where the salt water acts as an electrolyte. Where there are two dissimilar metals in contact or in close proximity in an electrolyte, a current will flow and decomposition of the less noble metal will result. Through satisfactory selection of materials, and size of materials or use of waste pieces (zincs, for example), a designer can usually combat this type of corrosion.

• **Effect of biological organisms**—Marine organisms are normally considered to be a cause of interruptions to flow. Such interruptions create turbulence in a velocity profile with consequent impingement of the fluid on the surface downstream of the organism. This impingement literally wears away the surface. Further, marine organisms assist in forming corrosion cells.

The subject of marine growth on the surface of equipment and in internal areas of piping systems such as in sea water piping must be considered. Dead-end pockets where no fluid flow is anticipated must be avoided. Film barriers such as paint with poison additives can help, but these film barriers must be properly maintained. Judicious selection of materials and flow velocities for the systems is required. No practical method of overcoming this problem is known, but the above suggestions can assist in alleviating it.

• **Strength of materials**—Generally, it is economically wise to follow industry codes for material selection and fabrication. These codes are reviewed periodically and kept up to date by interested activities. The departure from the industry codes, however, becomes necessary where the material is in intimate contact with sea water.



ALTERNATING torsion fatigue test curves.

Early information and bibliographies on fatigue and corrosion fatigue of ferrous and non-ferrous materials are given in a Gough and Sopwith paper presented in 1937 and McAdams paper presented in 1929. Some later information may be found in the LaQue and Mason paper.

It is important to realize that many materials, particularly carbon and low alloy steels, tend to have reduced fatigue strength in sea water. The accompanying figure shows a curve of endurance and corrosion-fatigue-test results from specimens subjected to cycles of completely reversed stress in alternating torsion. These tests were made with low-alloy, nickel-chrome-vanadium-molybdenum rolled steel specimens which had an average tensile strength of 140,000 psi and an average yield strength of 118,500 psi. The Severn River water mentioned is of a brackish type having a salt content of 1/6 to 1/3 (averages about ¼) that of sea water, depending on the season and the tides.

• **Ocean temperatures**—Design of the machinery plant, heating and cooling equipment and certain hull appurtenances must take into consideration sea water temperatures. The highest sea water temperatures occur generally at the sea surface in equatorial regions, roughly between 15° N. and 10° S. Temperatures here range from above 77°F to generally not more than 85°F; in the Persian Gulf, however, water temperature may exceed 90°F.

Lowest temperatures, less than 32°F and as low as 28.5°F, occur at the surface in Arctic and Antarctic waters during winter. In summer, cold water will also be present at the surface in the vicinity of pack ice. Cold water may persist at depths of 100 to 500 feet. No significant amounts of water with temperatures higher than 38°F are present at depth in these regions.

• **Testing for sea water effects**—For studying effects of the ocean environment, test laboratory scientists may have to synthesize ocean water. This is usually done on the basis of control of chemical composition and the concentration of those ions which are important to corrosion processes. The Naval Research Laboratory Report on Synthetic Ocean Water contains an excellent bibliography on this subject and recommends a formula for ion concentrations for use where spray conditions or high velocity impingement attack could occur. LaQue in his paper on corrosion and corrosion testing techniques also presents an excellent treatise and bibliography on this subject.

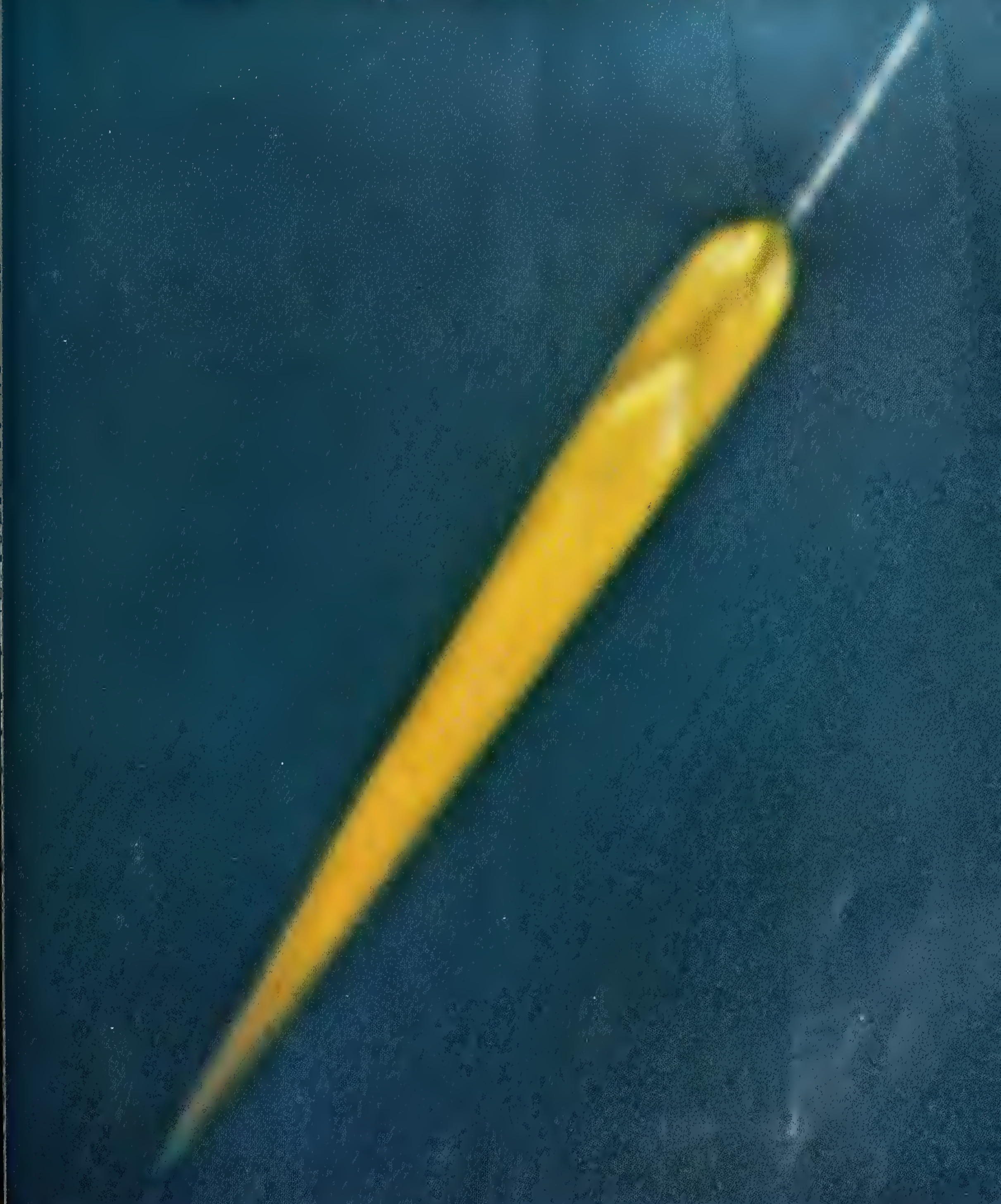
• **Internal environment**—Habitation conditions and working arrangements for the ship's forces often cause conflict between the naval architect's concept of what the ship configuration should be and what the naval engineer believes he must have in the way of equipment.

In a surface ship, it is often acceptable to use ventilating equipment which takes its air directly from the atmosphere and returns it to the atmosphere. Obviously, this technique cannot be used aboard a submerged weapon.

Where personnel are not on board, the submersible ventilation may impose a lesser problem than for a design where the personnel are on board. In the first case, the design may make effective use of the ocean as a cooling medium, conducting the heat of the heat-generating equipment to the ocean. The problem may resolve into controlling the humidity to obtain satisfactory operation of the equipment.

Where the human is to work and live abroad a submersible weapon, air-conditioning is needed. It denotes besides heating and cooling the following: (1) oxygen control, (2) removal of noxious gases, (3) dehumidification, (4) selection of equipment, (5) hull insulation, (6) recognition of the activity areas of the personnel, and (7) recog-

At 00ʰ00ᵐ01ˢ GMT, November 1, 1960, Martin logged its 724,620,000th mile of space flight



TITAN—*50 miles up: Official USAF Photo*

Air Force-Martin Titan, *giant American ICBM, has been chosen for a key role in space exploration. One of its first missions will be to launch USAF Dyna-Soar — manned aerospace craft.*

MARTIN

nition of air pressure changes on the inside of the hull of the vessel.

• **Vibration and noise**—Where personnel must eat, sleep, and work for long periods of time, airborne noise and vibration of equipment in the ship plays a significant role in the crew's combat effectiveness.

Vibration of any type has its own noise level and generally can be considered as the main source of airborne noise. Noise generated by the crew, except for specific spaces in the submarine where quietness is enforced, can usually be ignored in establishing airborne noise criteria.

Vibration occurs as a result of unbalance of equipment, frequency resonance with an associated piece of equipment or the hull, high-velocity impingements of flows causing excitations, electrical, mechanical and hydraulic circuit fluctuations and from other sources. Often the vibration with its attendant exciting forces can be corrected or alleviated through correct design or redesign, or through the use of noise traps.

There is another far-reaching consideration for combat effectiveness which transcends most other considerations and makes the military weapon more or less effective as a combat weapon. This is the noise emanating from the ship to the enemy equipment attempting to detect the weapon (radiated noise), or from the machinery to the weapon's own listening equipment (self noise).

Self noise is that noise which interferes with the listening or detection capabilities of the ship. This factor imposes upon the machinery designer the responsibility for designing his equipment around the frequency spectra of his listening or detection equipment.

From a practical standpoint the ship's machinery and detection gear designs must be integrated with certain specific frequencies eliminated from the ship's spectra and other frequencies reduced in noise level so that this detection gear is not effected. Where many different types of detection gear are installed, this restriction imposes a tough engineering problem.

Radiated noise is generated by the ship's machinery and equipment and goes into the water, permitting detection by an enemy device. Here, as with self noise, the airborne noise must be considered. Further, that noise emanating from sea-water-connected systems, from machinery foundations, from hull-connected equipment and from hydrodynamic sources plays a significant role in resolution of the ships design. Balancing equipment, streamlining hydrodynamic systems and appurtenances, and including sound traps all take part in reducing the radiated noise level.

Nothing has been said here about propulsion, electronics and fire power. These are more questions in the large sheaf of problems that confront the engineer in the ASW field. Oddly enough, even as solutions come to ASW problems, the size of the sheaf never lessens but simply changes character.

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The opinion or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Navy service at large.

Saturn Stand

Aetron Wins Contract For Second Facility

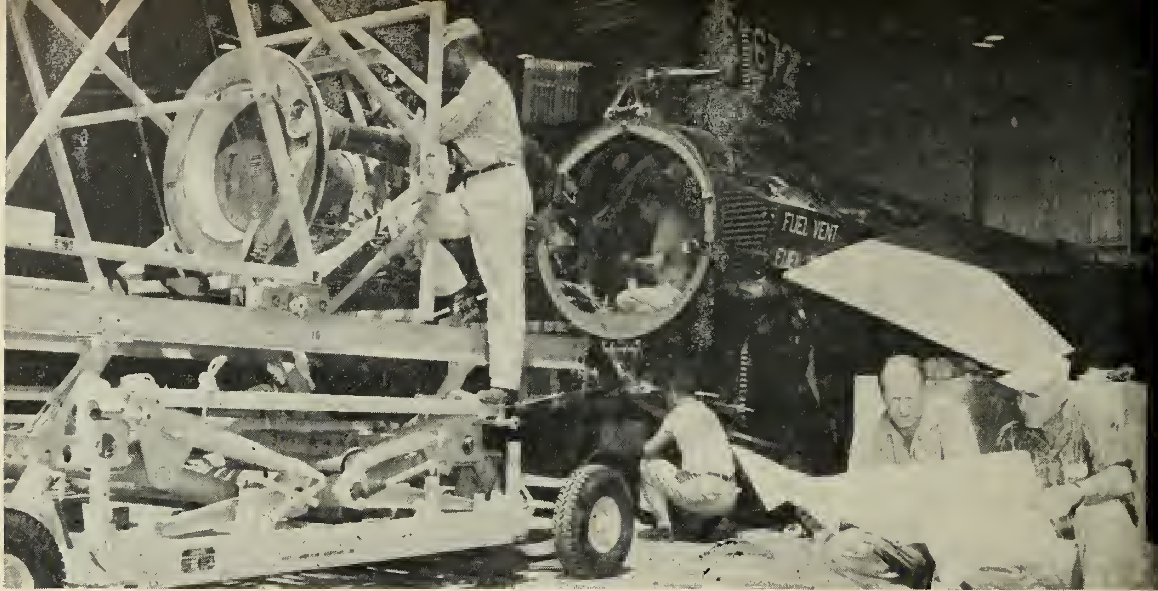
Aetron Division, Aerojet-General Corp., will engineer and design the second *Saturn* test stand to be constructed at Huntsville, Ala.

Marshall Space Flight Center, National Aeronautics and Space Administration, announced last week that Aetron was chosen from 25 architect-engineer firms bidding on the job.

The ultimate cost of the test facility will be $10.8 million. However, Aetron will perform at the beginning only the design and engineering phase of the work. Construction contracts will be awarded later.

The second facility will enable the Marshall Center to conduct two static booster firings within a short period of time. Because of the complexity of the booster and its test-recording equipment, lengthy preparation is needed for each series of tests. When *Saturn* flights reach the rate of four or five a year, the second stand will be needed to avoid delay.

The design-engineering phase of the job is expected to take seven months. After that, the Marshall Center will approve the final design and call for construction bids.



FLYING LABORATORY BEING MATED to the 50,000-lb.-thrust XLR-99 engine.

Flight Set For XLR-99 Engines

FIRST FLIGHT TESTS of the *X-15* with its new XLR-99 "man-rated" engine scheduled for last week were designed to check out stop-start operations in actual flight. No speed or altitude records were on the fire. Later tests with the new engine are expected to boost the NASA research rocket ship up to altitudes of at least 100 miles and to speeds of 4000 mph.

Three of the new engines have already been delivered to Edwards AFB. The first has exceeded its allowed 30-minute running time in ground tests and is being overhauled. The number two engine is the first scheduled for flight.

The XLR-99 is the only rocket engine designed to be directly controlled by a pilot. It can be throttled from 25,000 to 50,000 pounds thrust and is capable of up to five start-stop operations in flight. In case of a malfunction, the engine automatically shuts down. After a stop, the pilot throws a switch to purge the system, then can restart at will.

Designers of the XLR-99 foresee its use in even more advanced space missions. They say its thrust and control capabilities fit it for such flights as orbiting *Dyna-Soar* type vehicles or even soft-landing and returning a man from the moon. ⁂

X-15 Flight Record

Date	Flight*	Pilot	Max. Alt.	Max. Mach	Remarks
Mar. 10, 1959	1-C-1	Crossfield	38,000	.80	B-52-X-15 Power Loss
Apr. 1, 1959	1-A-2	Crossfield			Lack in N_2 Line
Apr. 10, 1959	1-A-3	Crossfield	45,000	.80	Both APU's Failed
May 21, 1959	1-A-4	Crossfield			APU Bearing Overtemp
June 8, 1959	1-1-5	Crossfield	37,000	0.80	Glide
July 24, 1959	2-C-1	Crossfield			Fully Fueled
Sept. 4, 1959	2-A-2	Crossfield			LOX Pressure Reg Failed
Sept. 17, 1959	2-1-3	Crossfield		2.3	1st Powered
Oct. 10, 1959	2-A-4	Crossfield			No LOX Top-Off Press
Oct. 14, 1959	2-A-5	Crossfield			LOX Press Reg & Vent Valve Failed
Oct. 17, 1959	2-2-6	Crossfield	65,000	2.3	
Oct. 22, 1959	2-A-7	Crossfield			B-52/X-15 O_2 Select Valve Seized
Oct. 31, 1959	2-A-8	Crossfield			Weather
Nov. 5, 1959	2-3-9	Crossfield			Engine Explosion, Emergency, Damage Slight
Dec. 16, 1959	1-A-6	Crossfield			Low LOX Pressure
Jan. 23, 1960	1-2-7	Crossfield	65,000	2.0	
Feb. 4, 1960	2-A-10	Crossfield			No Fuel Pressure
Feb. 11, 1960	2-4-11	Crossfield	86,000	2.15	
Feb. 17, 1960	2-5-12	Crossfield	50,000	1.6	
Mar. 17, 1960	2-6-13	Crossfield	50,000	2.1	
Mar. 18, 1960	2-A-14	Crossfield			Fuel Leak
Mar. 25, 1960	1-3-8	Walker	48,500	2.0	
Mar. 29, 1960	2-7-15	Crossfield	50,300	2.0	
Mar. 31, 1960	2-8-16	Crossfield	50,000	2.0	
Apr. 13, 1960	1-4-9	White	48,000	1.9	
Apr. 19, 1960	1-5-10	Walker	60,000	2.6	
May 5, 1960	2-A-17	Crossfield			No Start #1 APU
May 6, 1960	1-6-11	White	60,800	2.2	
May 12, 1960	1-7-12	Walker	78,000	3 +	Remote Launch
May 12, 1960	1-8-13	White	107,000	2.2	
May 26, 1960	2-9-18	Crossfield	50,000	2.0	
May 27, 1960	1-A-14	Walker			Telemetry Failure
June 3, 1960	1-A-15	Walker			#2 Hyd Press Low
June 8, 1960	1-A-16	Walker			Source Press Low
Aug. 4, 1960	1-9-17	Walker			2,196 MPH (Speed Record)
Aug. 11, 1960	1-A-18	White			Gaseous Nitrogen Loss
Aug. 12, 1960	1-10-19	White	136,500		Altitude 136,500 (Altitude Record)
Aug. 18, 1960	1-A-20	Walker			#1 APU Malfunction
Aug. 19, 1960	1-11-21	Walker			
Sept. 23, 1960	1-A-22	Peterson			Fuel Problem
Oct. 20, 1960	1-12-23	Peterson			Familiarization

*CODE FOR FLIGHT NUMBERING

First No. is Aircraft S/N.
Middle No. is number of successful flights.
Last is total.

A = Aborts.
C = Captives.

Tough Standards Set for NASA Craft

JPL calls for drastic jump in electronic performance on unmanned vehicles by 1962; stresses solar cells for auxiliary power

by William J. Coughlin

PASADENA, CALIF.—Jet Propulsion Laboratory has laid down severe per-formance requirements for instrumen-ation and other electronic and elec-rical equipment aboard NASA's un-nanned space vehicles, calling in some cases for improvements of a full order of magnitude within two years.

Walker E. Giberson, chief of the guidance and control division at JPL, which directs NASA's unmanned lunar and planetary exploration programs, has outlined for industry future guid-ance and control requirements in re-gard to sensors, actuators and power equipment, taking as a base the equip-nent for the lunar impact vehicle *Ranger,* due for its initial test launch n mid-1961. His presentation was nade at the recent NASA-industry onference here (M/R, Oct. 31, p. 5).

Severity of the NASA require-nents can be judged by a comparison f performance for *Ranger* against uture needs for the *Surveyor* and *Prospector* moon vehicles and *Mariner* nd *Voyager* interplanetary explorers. *anger* is equipped with a sun sensor ith angular deviation from line to-ard the center of the sun of 0.1°. his must be improved to 0.01° by 962 and 0.001° by 1964. A *Ranger* yroscope sensor provides a short-term eference during commanded turns of e spacecraft away from celestial eferences with an error of no more an 0.2°/hr. JPL says this must be nproved to 0.001°/hr. by 1964-65.

The dates given are those by which PL hopes to have an operating pro-type which could with minor changes ecome a production item.

In the actuator field, present gyro erformance requirements call for ass unbalance and mass stability aracteristics of 0.2°/hr./g. NASA ants this improved to 0.1 by 1962 d 0.05 by 1964. Restraint stability of 0.1 must be improved to 0.05 by 1962 and 0.01 by 1964.

• **It can be done**—Considering de-velopments of the past two years, Giberson feels fairly confident the requirements laid down for two years from now can be met. He also fore-sees other rapid advances.

"Pulse torquing of accelerometers and digital output of optical and iner-tial sensors is something that has to be pushed to get away from analog converters," he insists. "Then come digitized actuators so we can go di-rectly from the computers to the actuators. This, I think, will be a re-quirement for future spacecraft."

Extremely sensitive micro-acceler-ometers will be needed by NASA by the middle of this decade, Giberson said, citing ranges of 3 x 10^{-9}gs and a dynamic range of 10^5.

"How do you protect this delicate mechanism during high acceleration and decelcration?" he asked. "This is going to be a requirement when you start talking about electrical propul-sion systems on spacecraft. You have to be able to measure the accelera-tion."

• **Stress on solar cells**—In the power field, solar cells with a 15% efficiency, developing 6-7 watts/lb. and costing one-fifth of the present price are needed by NASA, Giberson reported. Batteries will be required with 150 stand-by life-days at 80°F and 100 watts/hr./lb. This compares to 30-60 life-days and 50-80 watts/-hr./lb. at present.

Observers attending the meeting expressed surprise at the 10-year pro-gram's emphasis on solar cells for auxiliary power, when the series of nuclear SNAP units now under de-velopment by NASA and AEC are expected to be in use beginning in 1963, with a 35-kw. unit becoming available two years later. Giberson pointed out that the "next big step beyond photovoltaic cells is the SNAP reactor, and possibly fuel cells," but

Guidance and Attitude Control Sensors

SENSOR	MEASUREMENT	RANGER	FUTURE NEED	
			PERFORMANCE	DATE
SUN	ANGULAR DEVIATION FROM LINE TOWARD CENTER OF SUN.	0.1	0.01 deg. 0.001 deg.	CY-'62 CY-'64
PLANET SENSOR ALTITUDE CONTROL	ANGULAR DEVIATION FROM CENTER OF RADIATION OF A PLANET.	0.2	0.01 deg.	CY-'62
PLANET SENSOR GUIDANCE	ANGULAR DIAMETER AND DEVIATION FROM TRUE CENTER OF A PLANET. LONG RANGE		0.01 deg. 0.001 deg.	CY-'62 CY-'64-'65
HORIZON SCANNER	ANGULAR DIAMETER AND DEVIATION FROM TRUE CENTER OF A PLANET. LONG RANGE		0.1 deg. 0.01 deg. 0.001 deg.	CY-'64 CY-'62 CY-'64-'65
STAR	ANGULAR DEVIATION FROM A STAR.		0.01 deg. 0.001 deg.	CY-'62 CY-'64-'65
GYROSCOPE	(1) SHORT-TERM REFERENCE DURING COMMANDED TURNS OF SPACECRAFT AWAY FROM CELESTIAL REFERENCES. (2) ANGULAR RATES OF TURN.	0.2/hr	0.001°/hr	CY-'64-'65

Gyro Performance Requirements

CHARACTERISTICS	REQUIRED PERFORMANCE		
	PRESENT	1962	1964
MASS UNBALANCE	.2°/hr/g	0.1	0.05
MASS STABILITY	.2°/hr/g	0.1	0.05
REACTION TORQUES	.7°/hr	0.2	0.1
REACTION STABILITY	.2°/hr	0.05	0.01
RESTRAINT TORQUES	.1°/hr/mr	0.05	0.01
RESTRAINT STABILITY	.1	0.05	0.01

indicated that solar cells would be retained until the SNAP series definitely is proven.

JPL apparently then will re-design its payloads around the SNAP units, which will provide more reliable and higher power for longer periods of time. SNAP 10, available in 1963, will weigh 300 lbs., without shielding, a big disadvantage for a system with a total payload weight of 50 lbs. *(Ranger)*, or 100 lbs. *(Surveyor)*. Future payloads of greater weight will undoubtedly use SNAP systems when their feasibility is established.

• **Big changes later**—SNAP proponents pointed out, however, that firming of payload instruments, design and power requirements now will mean extensive modification later. Payload balance, power available and scientific capability all depend on the type of system installed, they noted, and a change from solar cells to SNAP, with 10 times the power output, could drastically affect the mission.

Giberson said inverters and converters will be required, under present programing, with an output of 7-15 watts/lb. (compared to 3-7 today), an efficiency of 80-90% (compared to today's 70-85%) and regulation of 0.1-0.57% (compared to 1%).

Most critical problem for all equipment is the necessity for satisfactory unattended performance over long periods of time. To achieve this, suppliers will be expected to use present day production techniques and present day components wherever possible.

• **Breakthroughs sought**—Giberson said that while every effort will be made to maintain a step-by-step advance with proven equipment, technological breakthroughs are needed in three areas:

–A small, high-efficiency hot-gas mass expulsion system is required which will operate with high reliability.

–An attitude control system is needed which will operate in two modes—cruise mode and trim mode. Cruise control would depend on a mass expulsion system; trim control would require a precise attitude system depending on flywheels or similar devices. JPL is interested in the early availability of a reliable and simple momentum interchange device, such as a sphere, which could replace a three-flywheel system. This is desired for the 1962-64 period although it would be used earlier if developed.

–Complex computers are required which will be capable of operating throughout mission flights of 16,000 hrs. These computers will have to solve navigation equations, control sequencing and timing, operate scientific instruments and carry out data processing. Equipment of this capability will have in the neighborhood of 10,000 active components. JPL hopes for a computer with an overall 99.9% chance of surviving for the lifetime of the mission. Lacking this, individual components will be needed of 50-70,000 hrs. life. A self-healing design would offer obvious advantages.

"At the moment," Giberson said, "we have to hold down the functions of our spacecraft so we can handle them with current technology. This computer breakthrough is the one most required in terms of impact on the space program."

• **Farther on**—Giberson also outlined future guidance and control requirements for the JPL vehicles to be operational by 1970.

Ranger, boosted by an *Atlas/Agena B* combination, will be equipped with a limited-range earth sensor to direct its high gain antenna. The interplanetary *Mariner* vehicle to be used for exploration of Mars and Venus, employing an *Atlas/Centaur* launch vehicle, will require an extended-range earth seeker, probably a visual optical device similar to that of *Ranger*, which is designed around three photomultiplier tubes.

In addition, *Mariner* will require a planet seeker or tracker to direct scientific instruments to the geometric center of the planet under exploration. This is expected to be an infrared or visual optical device which will operate in the region from 300,000 km. down to 6000 km. above the planet's surface.

The Mars *Mariner*, which will follow the Venus *Mariner* in the program, will demand another major increase in capability with the addition of planetary approach guidance. For this, long-range earth sensors will be replaced by solar and star trackers. Stars such as Canopus will be used to establish a reference for roll, principally for directing the antenna.

Accurate approach guidance for the JPL interplanetary vehicles is considered a must, due to plans for near-misses and orbiting of both Mars and Venus. Some form of terminal guidance will be required so these vehicles can hit specific corridors in the vicinity of the planets. This means instruments with accuracies of 5-10 secs. of arc, says Giberson.

• **Planetary orbit**—There are no plans at the moment for an orbital *Mariner*, although this may be attempted in the later stages of the program. *Voyager*, using the *Saturn* booster, now is scheduled as the only planetary orbital vehicle. A planetary horizon seeker will be required for *Voyager* (and perhaps the advanced *Mariner*) capable of operation between 100 km. and 200 km. above the surface.

Planetary landings will require terminal phase guidance into the proper corridor, stabilization of vehicle attitude for atmospheric penetration, firing of additional retro rockets or release of parachutes as required, and possibly use of radar Doppler altimeters if an attempt is made to hit a specific landing site.

JPL also is seeking advanced guidance and control instrumentation for its moon-crawlers and planet-crawlers. ☆

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soviet affairs

By Dr. ALBERT PARRY

Space-Age metallic elements

are mentioned in the Soviet press rather infrequently, but we know they are very much on the agenda of Russian geologists sent out on surveys and of Russian scientist and engineers engaged in the processing of what they call "rare and disseminated elements." The official list of these elements, issued in 1956 by Peter Antropov, the Soviet Minister of Geological Survey, stresses beryllium, lithium, zirconium, niobium, tantalum, gallium, germanium, and indium. In his 1956 report Antropov said that these metals "are inseparably connected with technical progress" since they "possess very important properties making them indispensable in modern atomic and jet-propulsion technique, as well as in wireless engineering, automation, and telemechanics."

The complex mineralogical composition

of these metals, Antropov remarked in his report, "makes the extraction of all their valuable components the more difficult." Yet, from time to time, Moscow announces that it has scored successes with such extraction. On July 1, 1960, *Pravda* declared that cobalt "purer than gold" was achieved for the first time in history in the Soviet Arctic metal factory at Norilsk, and that a semiautomatic installation was completed there to produce such cobalt in quantity. Another accomplishment, with indium, was reported from Siberia in *Komsomolskaya Pravda,* Sept. 22, 1960. Proceeding from the premise that indium is absolutely indispensable in making semiconductors—and highly desirable in other rocket-age production, also that foreign admixtures in indium are allowable in quantities not higher than 0.0001%, Soviet scientists claim that they achieved this purity of indium some 17 months ago in the laboratories of the State Institute of Rare Metals in Moscow.

Actual production of such pure indium

was then entrusted to the Novosibirsk Tin Plant. But here came a snag: technologists of this Siberian plant declared that the indium-bearing ore at their disposal was of a character "where the Moscow laboratory experience could not be applied." The plant's chief engineer, P. P. Pul'kin, and his staff spent months evolving their own techniques of achieving pure indium. They finally succeeded in producing what is now proudly called "Five Nines Indium"—a result containing 99.999% of indium. An official Soviet statement in late September announced that "the Novosibirsk plant will shortly begin the actual production of this rare metal so needed by the nation."

An intriguing forecast

of rare-metal mining in the future was contained in *Komsomolskaya Pravda* for Oct. 4, as that paper celebrated the third anniversary of the launching of *Sputnik I.* Professor George Pokrovsky predicts "Factories on Asteroids." Pointing out that meteorites pelting our planet "consist of iron with considerable admixtures of platinum, osmium, iridium, cobalt, and nickel," the Soviet scientist suggests that such riches appear to be particularly abundant in the asteroid belt between Mars and Jupiter. "I am convinced," he writes, "that in time this belt will be the Urals of interplanetary space. In that area there will be established mines, plants, machine-shops and settlements serving rocket transport within the solar system."

Outer space is nothing but vacuum

which in time to come will be imported to earth "as a most valuable material" for man's instrument-building factories, the professor predicts, since production of vacuum on earth is so difficult and expensive. He says it is also possible that, along with rare-metal facturies on asteroids, man will erect his instrument factories in outer space to take advantage of cosmic vacuum on the spot.

Device Might Screen Out Stroke-Prone Astronauts

A radically new instrument whic measures blood pressure in the brai could be used to screen out potentia astronauts prone to strokes or t "blacking out," according to its in ventor.

Dr. Melvin Thorner, who develope the Thorner Pulsensor with the Decke Corp., cited two space applications o the instrument. First, he said, the meas urement of brain blood pressure coul be very important in the selection o astronauts. Patients with normal arn blood pressure have been found to hav high cerebral blood pressure—when disease hits. There is no present clinica method to measure brain circulation.

Dr. Thorner also suggest that th pulsensor could be incorporated into ar automatic "anti-g" system to comba blacking out under g forces. When the instrument registers a drop in blooc circulation to the brain, the pilot's sea would automatically tip over into th approved couch position.

The pulsensor, which resembles a pair of goggles, works by putting ai pressure on the eye socket until the pulse stops. Systolic pressure is then read on a gauge. Dr. Thorner said the device could be modified to fit in a space helmet, with transparent panes to allow the pilot to carry out his duties.

Doctor Drinks Recycled Waste in Six-day Test

A U.S. Navy Medical Service Corps captain has completed with no ill effects a six-day test in which the only liquid he consumed was his recycled metabolic waste.

Results verify that there are no harmful effects from the continual use of recovered water. Captain Roland A. Bosee, USNMSC, received blood analyses, including white and red cell count, and urine analyses before, during and after the test period.

The General Electric device used for recovery and purification was developed in connection with a National Aeronautics and Space Administration contract. Capt. Bosee, director of the Air Crew Equipment Laboratory of the Naval Air Materiel Center, said the device may be used in human confinement tests at the Laboratory.

The Laboratory already has run a six-day test in which subjects breathed their own purified oxygen. Eventual plans call for the combination of both tests, simulating a 14-day trip by a crew of from two to six men with only limited quantities of water and air.

Chemical and organic tests showed that water produced by the device had fewer impurities than tap water.

PHILCO CORP. will occupy a new 35-million building at its Western De-/elopment Laboratories in Palo Alto, Calif., within a year. Over 2000 em-)loyees including space communications engineers, scientists, program managers, nathematicians, systems managers, de-igners and physicists will be employed n the 250,000-sq.-ft. building.

CLAUSER TECHNOLOGY CORP. ias been formed near Los Angeles by ormer Space Technology Laboratory /P and director of research, Dr. Milton J. Clauser. The firm is located at 'orrance for the time being, pending he establishment of permanent facil-ies. Assisting in the formation of the ompany was the San Francisco venture apital firm of Draper, Gaither & Anderson.

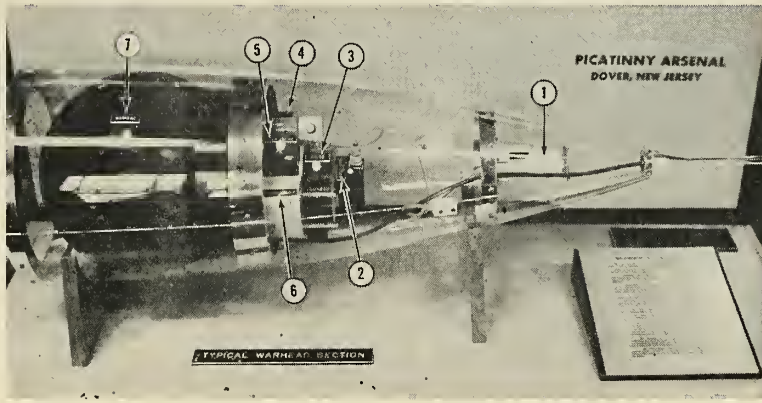
GABRIEL CO. has consolidated its ohanon and Rocket Power/Talco ivisions under the direction of Charles :. Bartley, president of Rocket Power/-'alco. Combined operation of the con-olidated divisions will be at the Rocket ower/Talco facility at Falcon Field, Aesa, Ariz.

DOUGLAS AIRCRAFT CO. is or-anizing a subsidiary corporation to onduct advanced research into exotic ropulsion systems to power space ve-icles. Donald W. Douglas Jr. and '. C. Lee, former manager of ad-anced research and rocket division of erojet-General, said that Astropower ıc. will be headed by Lee as president.

GENERAL ELECTRIC Defense ystems Department has established a pace Systems Operation in Santa arbara, Calif. The new component will e managed by Benjamin G. Walker, ɔrmerly on the technical staff of the epartment's technical Military Plan-ng Operation in Santa Barbara.

INFRARED INDUSTRIES and ramer Controls have reached a tenta-/e merger agreement whereby Cramer ould become a separate division of ıbsidiary of Infrared, retaining the ıme management. Plans call for Infra-d to issue to its stockholders addi-onal shares equal to 5% of its out-anding shares. Cramer stockholders ould then receive two shares of com-on stock of Infrared for each share of 'amer common stock.

REFLECTONE ELECTRONICS IC. will complete the first of several ants on its 10-acre site near Fort uderdale within six months. The Cnnecticut-based company just com-pted the navigational trainer for the fıt *Polaris* submarine.



Army Shows off Warhead Design

TYPICAL WARHEAD designed by Army's Picatinny N.J., Arsenal, now on display at Princeton, shows (1) fuze, (2) pressure sensor, (3) safing device, (4) power supply, (5) timer, (6) control unit, and (7) warhead itself.

financial

Northrop Corp.—Fiscal-year earnings just released show profit of $7.7 million, an increase of 5.6% over the previous year. Sales amounted to $233.7 million, a decline of 12% from the $263 million from the previous year.

Consolidated Diesel Electric Corp.—Net sales of $24.9 million for the year ending July 31 is reported, a 19% jump over the previous year. Net income in the same period rose from $40,276 to $162,465.

Texas Instruments—Third-quarter earnings rose to $54 million from $47 million the same period a year ago. Net earnings were $3,596,000, compared with $3,572,000 a year ago.

American Bosch Arma—Sales for the first nine months amounted to $93.3 million, compared with $90.1 million for the same period in 1959. Consolidated net income dropped to $981,-976, against $3 million for the same nine months in 1959.

Martin Co.—Sales rose to $164.3 million for the third quarter, compared to $129.5 million in the like period of 1959. Earnings increased to $4.5 million from $3.2 million in last year's period. Nine-months figures showed sales up 23.4% to $446.3 million and earnings 28.6% to $12.2 million.

Thiokol Chemical Corp.—Nine-months sales totaled $124.5 million with profits of $2.7 million. Sales approximated the same period last year, but net earnings fell 34% lower. Rocket Operations, which accounted for much of the loss, experienced a continuation of certain non-fee bearing contract overrun costs. Thiokol says problems causing these added costs are subsiding, Reduced sales by Chemical Operations to Rocket Operations caused a decrease of 21% in total sales of Chemical Operations.

Lockheed Aircraft Corp.—Net earnings for the three months ended Sept. 25 totaled $5.5 million, making it the most profitable quarter in nearly six years. Sales for the period were $305 million. A year ago Lockheed reported a loss of $2.8 million on sales of $324 million. Nine months totals show a loss of $49.9 million on sales of $962.3 million. The profitable quarter follows the write-off decision which gave the company a first-half loss. Backlog at the end of the third quarter stood at $1.4 billion, and Chairman Gross reports that the company already has recovered $27 million in tax carryback credits growing out of the heavy write-offs at midyear.

Chance Vought Aircraft—Sales dropped somewhat to $56.3 million during the three months ended Sept. 30 from $59.2 million the previous year. Net income of $1,191,944 was only slightly below last year's third-quarter earnings of $1,209,651. Sales for the first nine months were $169.8 million and net income was $2.8 million, compared with $191.7 million and $4.3 million in 1959.

Meteor Offers Open License Deal on Adaptable TV Drone

AN ITALIAN FIRM says it is willing to openly negotiate licensing agreements with foreign companies for the manufacture of its military drone—minus a few features such as electronic packages.

Meteor, S.p.A. feels it has a product which is adaptable to many battlefield tactics, and can meet most requirements, and thus can be unorthodox in marketing its radio-controlled television drone. The company says it is prepared to "grant its construction license to other foreign Armed Services suppliers." The surveillance drone is the *Meteor P.2,* one of two offerings by the firm—the other being a drone belonging to the more common target variety.

The TV version is 14 ft. 5 in. long, with a wingspan of 12 ft. 2 in. Its normal empty weight is roughly half the recommended maximum weight, 463 lbs. opposed to 930 lbs. With a payload area of .4 cubic yard, the drone has sufficient capacity to house a 243-lb. electronic assortment.

Standard equipment is a TV camera and a TV transmitter. The *Meteor P.2* is probably the only operational drone anywhere which is not intended for target practice. There is no boast of multimillion R&D; there is no need to give an average soldier training complicated by sophisticated scanners, recorders, developers or delayed transmissions. The *Meteor P.2,* simply enough, offers an instantaneous TV view of battle conditions to a field commander in an operating area from 60 to 100 miles through the proven, "old fashioned" television method.

Controlled from the ground and boosted during take-off by rockets or compressed gas, both drones feature fiberglass construction with blocks of expanded resin for buoyancy in water recoveries. All electronic packages are impervious to salt water.

Reports Says British Have Rocket-Armed Flying Auto

LONDON—The British Army may soon be equipped with a rocket-firing flying automobile, it is reported here.

A prototype is said to have been built at Coventry and given preliminary trials at the Army's Fighting Vehicles Research Establishment, Chobham, Surrey.

The design is reported to be a four-wheeled land vehicle capable of high speeds across country, but also able to fly for short distances. It is neither a hovercraft nor a true aircraft, these reports say, but relies on a new development of the jet engine for its lift. It would carry one or two men.

Preliminary trials are said to have been successful enough so that the Army has ordered the vehicle to be ready for full-scale flying trials before the end of the year. Seven firms—including two of the "Big Five" British automobile firms—reportedly are taking part in its development.

No details about the vehicle's rocket armament have been released. They might be 2-in. air-to-ground missiles.

METEOR P.2 "Ricognitore Televisivo Radioguidato" (TV Surveillance Drone) takes off at full RPM of 240-hp four-cylinder radial engine with rocket booster. The drone is under control of VHF 5 modulated tone carrier signal of ground transmitter.

Countdown for Survival

(Continued from page 16

being somewhat cynical, I feel that red tape and procedures are a fact of life. You can only minimize them, not eliminate them.

Your last questions on scientific objectives and decision-making are somewhat redundant. I think that one problem impeding our decision-making is the refusal of top government to face the fact that someone must run the space effort with a national goal in mind. The splintering of effort between DOD and NASA—with much of the space effort in DOD by subterfuge—is a serious block to any solid program.

George R. Arthur, President
American Astronautical Society
New York City

Must Decline to Comment

Thank you very much for sending me a copy of your open letter to Vice President Nixon and Senator Kennedy, and your nine-point proposal.

Since this open letter was directed to the presidential candidates, I do not feel that it would be appropriate for me to comment on your proposal.

Arleigh Burke
Chief of Naval Operations

I am appreciative of your invitation to comment on your nine-point proposal. However, after very careful consideration, I do not believe that it is appropriate for me to comment for publication on the proposal at this particular time. Of course, I do have my thoughts on the matter but I believe that the possible political implications might result in misinterpretation. I hope that you will understand my position in this matter.

Nonetheless, please accept my continued high regard for your fine magazine whose lucidity and complete coverage of the missile field is of such continuing great interest to those who are involved in the space age.

W. F. Raborn
Vice Admiral, USN
Director, Special Projects
Washington

I have been notified that current policy will not permit me to comment. The current position is that we in the Army must be very careful to keep ourselves disassociated from political activity, at this time in particular.

Wm. J. Ely
Brigadier General, GS
Director of Army Research

Thanks for calling my attention to your letter and its accompanying proposal. We'll certainly watch the project with interest. On the other hand, I fear it would be inappropriate for me to contribute to MISSILES AND ROCKETS' forum on the subject at tbis time.

C. V. Clifton
Brigadier General, GS
Deputy Chief of Information
U.S. Army

Thank you for the opportunity to comment on your open letter. I feel, however, that the comments in tbis area are best left to the candidates themselves. I will be most interested in seeing tbeir response.

Earl Dallam Johnson
President
General Dynamics Corp.
New York City

I was quite interested in reading your open letter and proposal, and even more interested in the public reaction.

I am, unfortunately, not in a position to give you any official comment for reasons which you can well imagine.

Peter A. Castruccio
Aerospace Division
Aeronca Manufacturing Corp.
Baltimore

As you well know, we have a very definite interest in the views requested of the candidates on the various defense issues, but this can be misconstrued as a purely selfish interest—so we don't believe we should comment for publication. We do appreciate the opportunity, and are following tbis one with extreme interest.

W. E. Van Dyke
Corporate Director, Public Relations
North American Aviation, Inc.
Los Angeles

Rallies to Kennedy

Re M. L. Carlisle's letter in the Oct. 17 issue:

Regardless of the party creating the DOD, it has been sustained by the GOP administration.

I gather from Sen. Kennedy's Proposal that a committee will "certainly study tbe feasibility and efficiency of" various commands. It does not imply that he does not know of NORAD's existence.

Carlisle's first sentence in his second paragraph sounds like a more passive blend of McCarthyism.

Was Ike aware of the U-2 flights? Belatedly, and in opposition to Mr. Nixon's stand on the absolute necessity of U-2 flights, I am venturing to say that the U-2 flights are not our primary intelligence-gathering instrument. Therefore, cancellation of such flights does not leave us void of data inputs.

Is an awareness of rare GOP achievements an acceptable criterion for selecting a President? Merely speaking of "superb advances" by the GOP is "Nixonerbage." Perhaps Carlisle could list these one or two advances.

Sen. Kennedy is to be commended for describing his programs and listing bis counsel.

People of the technological community should be aware that tbe Democratic Congress has boosted the administration's appropriations for the DOD.

Henry P. Organ
Lockheed Missiles and Space Div.
Sunnyvale, Calif.

Maybe Not So 'Modest'

No one can deny the urgency of the issue of defense and space exploration. As you quite properly point out, these two subjects are really one inextricably intertwined issue. Moreover, this issue is one upon which the two candidates ought to make their views known, at least generally.

However, I must raise the question of time and preparation. Your proposals—I suspect that they are rather ironically called "modest"—are in fact complicated, provocative, and in some instances even revolutionary. Thus, have the two candidates tbe time—the cloistered time—the information—the secret information—and the staff—the trained staff—adequate to deal with proposals which are heavily freighted with profound consequences?

Mansfield D. Sprague, Vice President
Public and Industrial Relations
American Machine & Foundry Co.
New York City

Voices from the Past

(Editor's Note: The following letter was written prior to Mr. Nixon's reply to M/R's open letter.)

In your Oct. 24 issue, you state that "tbere is no obtainable record that he (Nixon) bas said anything at all on space exploration or its part in national defense."

On Oct. 5, 1957, according to news reports, Mr. Nixon described *Sputnik I* as "a stunt, with no military or scientific value." On Oct. 15, 1957, it is alleged, he changed tbe statement to: "It would be incorrect to say that (tbe *Sputnik*) is a stunt, witb no military or scientific value."

I appreciate very much your open letter to the candidates, and your reporting on the candidates' replies (or lack thereof). It would be interesting to get the results of a survey among engineers and scientists as to their opinion of wbo is ahead in tbe missile-defense-scientific race. Wasn't it President Eisenhower who said that we aren't in a race (besides, we are abead, and also, we are gaining, so that we will catch up soon)?

It is interesting to note that Senator Saltonstall, our "senior" Senator, refuses to debate with his opponent, Mayor O'Connor. It was Saltonstall wbo said, in early 1956, "We have a stockpile of ICBM's." In 1957, he opposed statehood for Alaska on tbe grounds that "it would not be in tbe best interests of the defense of tbe United States." Senator Saltonstall also has been an advocate of, and author of bills for, "negotiated" defense contracts, as compared to competitive bidding. It would be interesting to poll the readers of M/R and determine their collective opinion on how much defense costs could be cut (with safety) and how much procurement would actually be speeded up if competitive bidding were used wherever possible.

Please keep up the good work. Obviously our founding fathers knew what they were doing when they provided for a free and independent press.

N. A. Denman, Mgr.
Basic and Experimental Physics
Engineering Services
Falmouth, Mass.

Suggestions and Goals

I am pursuing with great interest the course of debate as delineated in your proposal concerning the national path and philosophy vis-à-vis our position on defense and on our position in space exploration. I would leave, for myself, the issue of defense to the generals and admirals who, indeed, are the qualified authorities in this field. However, when we turn to the topic of space exploration and such matters as the space race with the USSR, I should like to comment.

I see much skipping about in your program and some very optimistic dates for certain accomplishments. Moreover, the omissions in your "program" for space exploration are serious and, indeed, stop short of certain major goals.

There has been great timidity in firmly specifying to the citizenry of the United States the particular goals in space, the steps by which we realize these goals, and the critical item of attaching a timetable to both the goals as specified and the steps that are necessary prerequisites to such attainment. Most persons are also deluded when they attempt to point out the authorities responsible for our failures to accomplish various space missions.

It is not our scientists, engineers and sundry program managers, but Congress whose whims regarding funding alternately starve projects or stuff them to the point of regurgitation. You cannot legislate engineers and scientists to make discoveries. They can be aided by long-time (5-10 years) funded programs for research and development backed up in turn by allowing 1% of the Gross National Product for *basic* research in *all* of the sciences.

Supporting this in turn by competitive bidding from industry for various programs and severely limit the CPFF type of contract and then the U.S. will get some results.

Oh, yes—the goals! They are three:

(1) a manned, long-lived space station;
(2) man on the moon followed by a lunar base;
(3) manned trips to, and landing on, the planets Mars and Venus.

The steps by which we accomplish this are delineated and ordered on the accompanying chart. The timetable? It could all be done by 1975, but only Congress can really put a timetable on our activity and on the items noted.

Saunders B. Kramer
Sunnyvale, Calif.

We regret that space limitations prevent reproduction of Mr. Kramer's thoughtful and interesting chart.—Ed.

Arms No Guarantee

Your open letter and Oct. 3 editorial both reflect what I believe is incorrect thinking. Your premise appears to be that in order to survive we must literally pour armament, both offensive and defensive, into what is called space. You make the point that declaring space to be "off limits" to the military will prevent us from attaining the regulation and security we now have from the "freedom of the seas" concept.

My contention is that there is no regulation of the seas and therefore no security is afforded by the seas. Actually we are extremely insecure because of the dangerous possibility (or even probability) of missile-firing submarines lurking close to our shores. Such a weapon system is capable of bombarding our country with even less warning than the present generation of ICBM's. Then is not this dangerous situation in the seas analogous to that which we would have if weapon systems were constantly over our heads in space? This is not security. This is putting our heads in a lion's mouth knowing that after a time the lion's jaws will ache so much that he must close his mouth!

Has an armament race ever ended in peace? And of the next war, will there be a victory? It is better to have Khrushchev (or even Mao Tse-Tung) pounding a desk at the United Nations, or is it better for Khrushchev or Mao Tse-Tung to pound the starting button for the next war? Strict regulation with limitation and inspection is the *only* way to survival.

R. E. Margolies
Los Angeles

contracts

AIR FORCE

$41,000,000—American Bosch Arma Corp., for *Atlas* all-inertial guidance systems and ground support equipment.

$7-8,000,000—Aetron, Azusa, Calif., for architect-engineering services.

$1,100,000—North American Aviation, Rocketdyne Div., McGregor, Tex., for producing boosters for the *Regulus* high-speed target drones.

$500,000—Curtiss-Wright Corp., Research Div., Quehanna, Pa., for research, development and production of beryllium oxide ceramic components for nuclear reactors.

$500,000—Westinghouse Electric Corp., Blairsville, Pa., for precision-finished castings of Hipernik for the *Falcon* missile.

$310,000—Blaw-Knox Equipment Div., Blaw-Knox Co., Pittsburgh, for development and fabrication of 85-ft.-diameter solar radio telescope antenna.

$250,000—Traid Corp., Encino, Calif., for airborne high-speed cameras to be used on Lockheed QF-104 drone aircraft.

$151,774—Blackinton & Decker, Inc., Denver, for AFAFC ADPS Complex (Construction of Automatic Data Processing System Facilities) Air Force Accounting and Finance Center.

$128,415—Raytheon Co., Waltham, for tube, klystron.

$100,000—Pan American World Airways, for 16 mm high-speed cameras to be used in photo instrumentation at Cape Canaveral.

$98,934—The Marquardt Corp., Van Nuys, Calif., for hardware for in House High Energy Storable Test Program (*Joshua*).

$91,335—Rocketdyne Div., North American Aviation Inc., Canoga Park, Calif., for rocket engine flame investigation.

NAVY

$20,000,000—Northern Ordnance Inc., Minneapolis, for additional production of Mk 10 *Terrier* guided missile launching systems.

$1,500,000—International Telephone & Telegraph Corp., Fort Wayne, Ind., for manufacturing of fuzing mechanisms for the *Terrier* missile.

$600,000—Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., Wyandanch, L.I., N.Y., for development of two long-range radars for tracking satellites or space capsules from Navy instrumentation ships.

$166,210—ITT Laboratories, Div. of International Telephone and Telegraph Corp., Fort Wayne, Ind., for developing, fabricating and furnishing two Doppler Receiving systems.

NASA

$6,584,624—North American Aviation, Rocketdyne Div., Canoga Park, Calif., for design of a model engine known as H-1 for use as a new powerplant in missiles. Work to be done in Calif. and at Cape Canaveral.

$6,000,000—Astronautics Div., Chance Vought, Dallas, for final assembly and launching of the *Scout* rocket.

$67,849—Aerojet-General Corp., Azusa, Calif., for development and fabrication of an optical system for *Aerobee* Zero Gravity project, to be delivered to Lewis Research Center, Cleveland.

$40,355—Veeco Vacuum Corp., New Hyde Park, L.I., N.Y., for helium mass spectrometer type leak detector, for Lewis Research Center, Cleveland.

$26,408—National Light Metals and Plastic Co., Caro, Mich., for services and materials for manufacturing 28 Fin assemblies.

ARMY

$4,673,699—Raytheon Co., Waltham, Mass., for 9 battery sets and 5 sets of field maintenance equipment.

$4,019,265—Raytheon Co., Waltham, for 234 NATO-*Hawk* missile components and subassemblies.

$3,267,396—Raytheon Co., Waltham, for engineering services for *Hawk* missile system.

$2,973,976—Raytheon Co., Waltham, for additional engineering services to be performed on the *Hawk* missile system.

$2,334,664—Pearce and Gresham, Decatur, Ala., two Contracts—(1)—$1,817,153 for missile assembly shop and (2)—$517,511 for missile assembly hangar.

$1,554,012—Chrysler Corp., Detroit, for additional funding for the *Jupiter* missile system.

$761,081—Raytheon Co., Waltham, for 27 *Hawk* missiles, 6 guidance and control packages.

$694,000—Fruin-Colnon Contracting Co., Burlingame, Calif., for guided missile assembly, technical supply facilities and Edison St., Extension, Beale AFB, Calif.

$462,048—Raytheon Co., Waltham, for *Hawk* missile system replenishment repair parts.

$99,683—LaQua Construction Co., Lawton, Okla., for re-entry vehicle facilities, Altus AFB, Altus, Okla.

$71,985—Raytheon Co., Waltham, for concurrent repair parts, *Hawk* missile system.

$37,000—U.S. Steel Corp., Consolidated Western Steel Div., Los Angeles, for rocket motors.

Generator Produces Any Wave Form

A function generator that provides ny waveform at repetition rates down) one cycle every 200 seconds is availble from General Measurements Comany, Inc.

Called the SG88 V.L.F. Function enerator, it combines accuracy with eat flexibility of operation and is esigned to fill a gap in the range of boratory instruments currently availble. It is presented as a tool for soluon of many simulation and computer design problems, for servo-system analysis, vibration testing and numerous similar applications.

The SG88 is also invaluable for practical analysis, performance testing and simulation problems on a variety of electronic, electric, electro-mechanical seismographic and medical equipment. It eliminates the need for specially shaped and wound potentiometers and complex electronic waveshaping circuits.

Circle No. 225 on Subscriber Service Card.

letal-Ceramic Terminals

The L-series line of standard sized gh voltage metalized ceramic termals, with ratings as high as 15,000 lts, and which meet JAN 1-8 and AN 1-10 specifications is available om Metalizing Industries, Inc. The series terminals consist of a glazed ramic body, metalized to permit easy ldering into the assembly, and with cessary hardware to allow terminaon of the lead. The coating will withand 450°F for 1½ minutes.

Circle No. 226 on Subscriber Service Card.

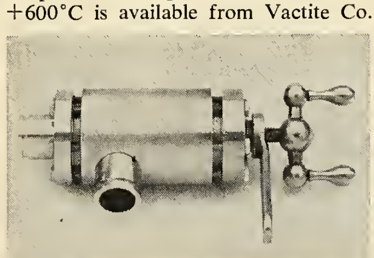
emiconductor Probe

A Thermoelectric Probe, Model E-1, is available from Electro Impulse boratory, Inc. The probe is suitable f type testing of semiconductors and etals, detection of P-N junctions in niconductors and the measurement c relative thermoelectric power of semiconductors and all metals. It consists of a sensitive galvanometer, a cold base, a hot point and a variable DC attenuator. The base can be removed and an additional cold point can be added.

Circle No. 227 on Subscriber Service Card.

Ultra High Vacuum Valve

Anultra high vacuum valve, said to achieve better than 10^{-9} mm Hg. in the temperature ranges from −200° to +600°C is available from Vactite Co.

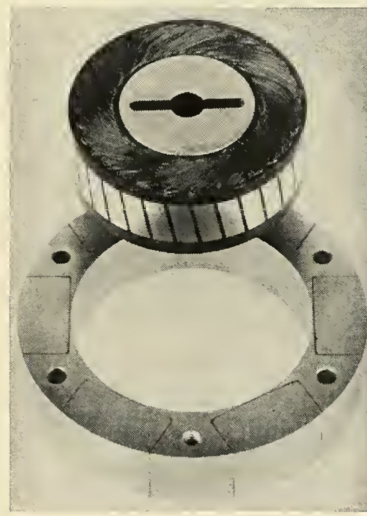


The all metal valve, including a copper seal, is designed for applications in space chambers, vacuum tube processing, particle accelerators, and other types of high vacuum systems. The valve is available in sizes from 0.5 to 4 in. I.D. and is reliable for more than 100 seals per gasket.

Circle No. 228 on Subscriber Service Card.

DC Torque Motors

A line of low-speed, high-torque, dc torque motors for use as high-performance torquers or direct-drive servo motors is being marketed by Giannini Controls Corp. The pancake-type, multi-pole, permanent-magnet torque motors feature ultra low levels of friction and ripple torque and extremely high values of torque per watt and



torque/inertia. Additional advantages include linear input current vs. torque output and the elimination of backlash problems when used in direct-drive servo applications.

Circle No. 229 on Subscriber Service Card.

Digital Comparator

A voltage comparator that operates as a high-low limit alarm over a wide input range is available from KIN TEL Division of Cohu Electronics.

The instrument, the KIN TEL model 465 Voltage Comparator, indicates whether an applied input voltage is over, between, or below preset tolerance limits. Its wide range, from ±0.0001 to ±1000.0 volts makes it applicable to many of the "go-no-go" type problems encountered in military and industrial systems.

Circle No. 230 on Subscriber Service Card.

Horizontal Motion Isolator

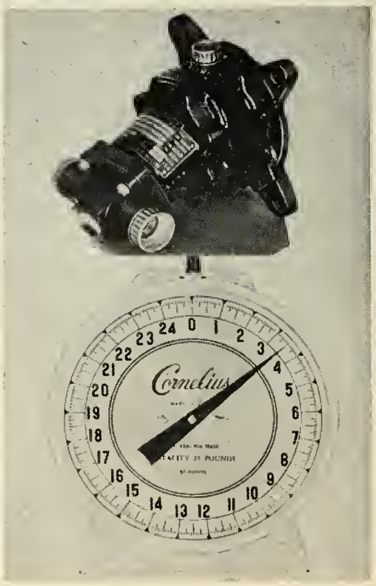
A horizontal-force mount, Series RM, designed for isolation of shock and vibration produced by machinery whose operation develops predominantly horizontal forces, is available from Barry Controls. Each mount will handle up to 4000 pounds static load.

The Series RM Horizontal-force Mount is 10-5/16 in. by 8 in. overall and 1-3/8 in. high. An attachment bolt and locknut are furnished with each mount. The RM Mount eliminates the need for special foundations or inertia blocks.

Circle No. 231 on Subscriber Service Card.

Low-Friction Motors

Hydraulic motors and fixed displacement pumps with completely new design features are being manufactured by The Cornelius Co. Both the motors (63000 Series) and the pumps (61000 Series) are rated for 3000 psi. system pressures.



Advantages of the hydraulic units are 96 to 98% volumetric efficiency, 92 to 93% overall efficiency, low operating cost, rapid response and proven performance. Inlet and outlet parts can be tailored to specific requirements.

Circle No. 232 on Subscriber Service Card.

Small Pressure Transducer

A micro-miniature, flush diaphragm Absolute Pressure Transducer, will be produced by Statham Instruments, Inc. The pressure transducer is "smaller than a dime" and was designed for airborne, missile and wind tunnel applications where small size and light weight are critical. The micro-miniature transducer features a flush diaphragm with high frequency response; ranges are 0-10 psia to 0-100 psia; and size is 0.590 inches diameter by 0.050 inches thick.

Circle No. 233 on Subscriber Service Card.

Ballistic Delay Initiator

A ballistic delay initiator is available from Chromalloy Corp.'s Propellex Chemical Division.

Fired by a gas pressure input of 400 to 500 psig, this 1.5-oz. unit generates a pressure of 2000 psig in a closed volume of 0.3 cu. in., after a delay of 0.5 second.

The special .38 caliber cartridge used in the device can be modified for various delays and/or pressure outputs, to suit a particular application.

Circle No. 234 on Subscriber Service Card.

3000 PSI Selector Valve

A miniature 3000 psi selector valve for directional flow is available from Republic Manufacturing Co.

Seals are wear-compensating, wiping the surfaces clean as they move across the ports. Line pressure aids sealing. Handle turning is easy, even at maximum pressure. Maximum panel thickness is 5/16 in. Body is forged aluminum alloy, with internal parts stainless steel.

Circle No. 235 on Subscriber Service Card.

Magnetic Relay Amplifier

Lumen Inc. has announced an addition to its line of bi-stable magnetic relay amplifiers. Model 1211 has as its input a photo-resistor with a varying resistance of 2 to 5 megohms. It functions at extremely low levels of current, reacting to signals of 10 to 25 microamps. Its output is in the nature of 10 volts at 10 mills; hence it can drive a heavy duty relay coil with far greater sensitivity than was previously feasible.

Circle No. 236 on Subscriber Service Card.

Magnesium Oxide Whiskers

Semi-Elements, Inc. has available Whiskers of Magnesium Oxide that range from 3 to 4 mm in length and from 1 to 5 mils in cross section. The research phase of the program on the semiconductor Magnesium Oxide is at a point where magnesium oxide has been doped with more than 20 different impurities.

Circle No. 237 on Subscriber Service Card.

Varactor Diodes

Two series of microminiature silicon mesa diodes, 1/8 in. in length and width, have been developed by Sylvania Electric Products Inc.

Known as microminiature "varactors" or amplifying diodes, the new microwave components (Series D-4140A to E and D-4141A to E) are hermetically sealed in Sylvania-designed cylindrical glass cases, making them especially useful in printed-circuit cavity and strip transmission lines.

Circle No. 238 on Subscriber Service Card.

Three-Inch DC Blower

VAX-3-BD vaneaxial blowers, operating from direct current to produce an optimum output of 90 cfm. at 1 in. H_2O back pressure are available from Globe Industries, Inc. At 28 v.d.c. maximum current is 1.7 amps at free air delivery and motor windings may be provided for 4 to 115 v.d.c. operation. Life exceeds 500 hours.

Circle No. 239 on Subscriber Service Card.

X-Seal Good to 1200°F

Wiggins Connectors has available an all metal seal called "Bar-X-," which withstands temperatures from –450°F to 1200°F and peak pressures of 40,000

psi. Wiggins reports that in a typical static seal application, the seal had zero leakage from room temperature to 1000°F with dry nitrogen at 1000 psi.

Circle No. 240 on Subscriber Service Card.

Strain Gage Calibration

A Strain Gage Calibration Unit providing a means of determining the gage factor of an electric resistance strain gage, resistance vs temperature curve, and creep behavior of the mounted gage is available from Cryogenic Research Co. Gages are subjected to strains (± 750 microstrain) within ± 0.3% of those calculated by displacement of a constant strength cantilever beam with a stepped block. Operating range; –452°F to +500°F.

Circle No. 241 on Subscriber Service Card.

Solenoid Valve Line

Cooler and quieter operation are features of 2 and 3-way solenoid valves manufactured by Allied Control Company, Inc. Valves can be supplied in normally open, or normally closed types, ¼ in. or 1/8 in. pipe sizes, A-C or D-C, conduit or grommet housings. Time delay, metering (bottom, 45°, side or pipe connector), free venting, and 3-way directional valves also available.

Circle No. 242 on Subscriber Service Card.

new literature

AEC ENGINEERING MATERIALS —Cooper-Trent Blueprint & Microfilm Corp., 2701 Wilson Blvd., Arlington 1, Va., has been contracted by the AEC to supply full-size blueline prints of CAPE-numbered materials or specific drawings announced in the Engineering Materials List, TID-4100 and Supplements. Queries regarding materials not in this list should be directed to AEC-OTI, P. O. Box 62, Oak Ridge, Tenn.

Circle No. 200 on Subscriber Service Card.

STRAIN GAGE SET-UP—Bulletin 360, released by the Strainsert Co., a division of Polyphase Instrument Co., describes the Model HW-1 Portable Strain Indicator. Included is a unique circuit design by which the new PIC indicator eliminates the time consuming operations normally involved in phase balancing to compensate for distributed capacity in lead wires.

Circle No. 201 on Subscriber Service Card.

MACHINE TOOL CONSTRUCTION —Information on "Building Block" design, standardized components and machine classifications is contained in a brochure from LaSalle Machine Tool Co. Descriptions and graphic illustrations are portrayed in an easily understandable manner. Also shown is a side, back and full view of a completed machine which was constructed of "Building Blocks".

Circle No. 202 on Subscriber Service Card.

TUNNEL DIODE KIT—The power of determining the purchase price while writing the specifications is available to tunnel diode users from Sperry Semiconductor Division, Sperry Rand Corp. Based upon a price and specification graph, the electronic engineer may chart an almost infinite variety of parameter combinations and simultaneously determine the various selling prices which apply to these combinations. The engineer may select the parameters he desires in a tunnel diode by marking them along the curves. Then by use of a formula he determines the selling price of the unit in quantities from 1 to 99.

Circle No. 203 on Subscriber Service Card.

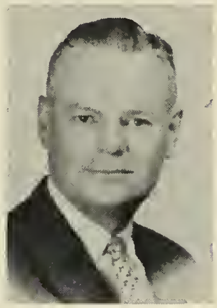
SLIDE MECHANISMS — A 16-page catalog from Jonathan Manufacturing Co., contains dimensional information, mounting patterns and descriptive information on ball-bearing slide mechanisms for electronic equipment cabinet chasis mounting. The Type II shock blocks, used to prevent damaging magnification of shock or vibration to slide-mounted electronic chassis and slide mechanisms are also described.

Circle No. 204 on Subscriber Service Card.

HIGH Q COIL—United Transformer Corp. has published their 1960-61 16-page supplement catalog. It offers complete information on electric wave filters and high Q coils. An easy reference Reactance-Frequency chart is also included. Further information is also given about UTC's other products.

Circle No. 205 on Subscriber Service Card.

McCOUBREY



JORGENSEN

DAVIS

BOCK

GELLER

Edward T. Connor: Promoted to vice president, marketing, for Instrument Development Laboratories, Inc. Prior to joining the firm in 1959 as manager, new product planning, he spent 10 years with General Electric Co. specializing in marketing and sales management.

Marvin J. Bock: Named chief engineer of the Kearfott Division of General Precision, Inc. Prior to joining the firm he was associated with Raytheon, where he completed developmental work on the AN/SP-12 system, *Lark, Sparrow III* and *Hawk I* missiles.

Carl F. Schunemann: Named to head the newly-established electronic products department of The Martin Co.-Baltimore. Prior to joining Martin, he served as chief engineer for Thompson Ramo Wooldridge Electronics.

David P. Ebaugh: Appointed chief of the Industrial Engineering Department, Automation Product Division of Nytronics, Inc. This division was formerly known as Sutton Electronic Co.

Maurice L. Smith: Named manager, advertising and sales promotion Metallurgical Products Dept., General Electric Co. Was formerly specialist-product planning and market research.

Dr. Arthur O. McCoubrey and **Dr. Joseph H. Holloway:** Named manager of research and manager, resonance physics research, respectively for Bomarc Laboratories, Inc.

Dominic L. Testa: Named advertising manager of Baldwin-Lima-Hamilton Corp.'s Industrial Equipment Division. Was formerly technical publications supervisor of the firm's Loewy-Hydropress Div.

Dr. Myer Geller: Joins the technical staff of Electro-Optical Systems, Inc., as senior scientist in the Solid State Division, where he will be responsible for materials research and spectroscopy in the field of stimulated emission optical devices. Was formerly affiliated with Hughes Products Semiconductor Division.

Col. Hohn H. Kerkering: Assumes the duties of director of the U.S. Army Engineer Research and Development Laboratories, succeeding **Col. H. J. Skidmore.**

Robert W. Jorgensen: Joins The Hallicrafters Co. as manager of market development. He previously served as management consultant with Booz, Allen & Hamilton, and vice-president, marketing, at The Richardson Co.

Robert Young: Joins Budd Electronics Inc. as president and general manager. Was formerly assistant general manager of the Electronics Division of A.C.F. Industries.

Edward R. Davis: Elected vice president, director of marketing and contract at Hydraulic Research and Manufacturing Co., a Bell Aerospace subsidiary. Was formerly West Coast marketing manager for Chance Vought Aircraft and western manager for Avien, Inc.

Harold P. Weinberg: Appointed chief materials engineer for Value Engineering Co. of Alexandria, Va. Was formerly head of materials engineering at the U.S. Naval Weapons Plant.

Dr. Kenneth M. Merz: Joins International Resistance Co., as manager of ceramic research. Was formerly engaged in ceramic research for the Cornell Aeronautical Laboratory; prior to that, was associated with Carborundum Co. and the National Lead Co.

Peter Pao, Robert Taylor and **Vincent Andreano:** Join Communication Electronics, Inc. as senior project engineer, head of the transformer development department and senior design draftsman, respectively. All were formerly with Nems-Clarke Co., a Division of Vitro Corp. of America.

Harold E. Kren: Named manager of the recently formed Monterey Laboratory of Boston-based Laboratory For Electronics, Inc. Was previously manager, Administration and Sales, for Technical Operations, Inc.

Warren Shepard: Elected national mai keting manager for shaft encoders for Li ton Systems Inc. Formerly served a project coordinator for the shaft encode and as national sales manager.

Dr. Juls Miller: Appointed head o Schaevitz Engineering's new Electromag netic Devices Dept.

Dr. Robert C. Brumfield: Named direc tor of engineering for MHD Researcl Inc. Prior to joining the firm he was d rector of operations research for the Wes ern Div. of Operations Research, Inc.

George D. Howland: Appointed cor tract manager for the aerospace group c the Hughes Aircraft Co., replacing **Wi liam Van Allen,** new materiel manage for the company's manufacturing divisio in El Segundo.

Robert G. Gallaghar: Joins the Nu clear Science and Engineering Corp. a assistant manager of the Biology an Medicine Dept.

Elmer F. Hinner and **John M. Marti** Elected vice presidents of Hercules Pov der Co. Hinner has been general manage of the company's Cellulose Products Dep since 1954 and a member of the Board c Directors since 1952. Martin has bee manager of Hercules' Explosives Dep and a member of the Board of Directo since 1953.

Roy W. Pyburn: Appointed assista to the president of Data-Control System Inc. Was previously senior product pla ning engineer for Ampex Corp.

Richard E. Love: Appointed marketir manager of The Budd Company's Instr ments Division. Was formerly with West Instruments Division of Daystrom, Inc., industrial market manager.

Fred Lucas: Named sales manager the new Magnetic Tape Division of Sark Tarzian, Inc., Bloomington, Ind. Previous served for seven years as assistant sal manager, Semiconductor Div.

NOVEMBER

Government Contracting Course, National Defense Education Institute, sponsored by National Security Industrial Association and Harbridge House, Inc., Dayton, Nov. 7-18.

American Material Handling Society, meeting in conjunction with Material Handling Institute's Central States Show, Kentucky Fair and Exposition Center, Louisville, Nov. 8-10.

First National Die Casting Exposition and Congress, Society of Die Casting Engineers, Detroit Artillery Armory, Detroit, Nov. 8-11.

Institute of Radio Engineers, Mid-America Electronics Convention, (MAECON), Hotel Muehlebach, Kansas City, Mo., Nov. 14-16.

Sixth Annual Conference on Magnetism and Magnetic Materials, American Institute of Electrical Engineers, American Institute of Physics, Office of Naval Research, Institute of Radio Engineers, American Institute of Mechanical Engineers, Hotel New Yorker, New York City, Nov. 14-17.

IRE Professional Group on Production Techniques, Fourth Annual Conference, Boston, Nov. 15.

29th Symposium on Shock, Vibration and Associated Environments, U.S. Naval Supply Center, Oakland, Nov. 15.

Engineering Applications of Probability and Random Function Theory, Purdue University, Lafayette, Ind., Nov. 15-16.

Air Force, Navy and Industry Propulsion Systems Lubricants Conference, (unclassified), co-sponsored by ARDC's Wright Air Development Division and Southwest Research Institute, Hilton Hotel, San Antonio, Nov. 15-17.

British Interplanetary Society, One-day Joint Symposium on Space Navigation, Co-sponsored by Institute of Navigation, Royal Geographical Society Lecture Hall, London, Nov. 18.

Conference on Electro-Optical and Radiation Devices, Sponsored by IRE Professional Group on Electron Devices and American Institute of Electrical Engineers, Stanford Research Institute, Menlo Park, Calif., Nov. 20-21.

American Physical Society, University of Chicago, Nov. 25-26.

American Society of Mechanical Engineers, Annual Winter Meeting, Statler Hilton, New York City, Nov. 27-Dec.2.

Government Contracting Course, National Defense Education Institute, sponsored by NSIA and Harbridge House, Los Angeles, Nov. 28-Dec. 9.

DECEMBER

IRE Professional Group on Vehicular Communications, Sheraton Hotel, Philadelphia, Dec. 1-2.

American Institute of Chemical Engineers, Statler Hotel, Washington, D.C., Dec. 4-7.

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Advertisers' Index

editorial . . .

Samos—and What Happens Then?

ONE OF THE GRAVEST problems facing this Administration in its waning days, and one which will certainly carry over to the next Administration, is how to handle the *Samos* situation.

Samos is a reconnaissance satellite, a spy in the sky. It will eject or transmit photographs of terrain and occupants with incredibly fine detail. An Air Force project, the first *Samos* launching failed last month because of mechanical difficulty. The second is due before the end of the year.

The Soviet government certainly knows what *Samos* is, what it does and why it is there (to collect reconnaissance photographs). No secret has been made of this, although the exact composition of *Samos* payloads is and probably will continue to be closely guarded.

What will the Russian reaction be? A great number of people in this administration and a great number who hope to be in the next wish they knew the answer.

The conduct of the *Samos* program and its legal or illegal status lie within the great mass of unsolved questions concerning space and space law as an extension of international law.

What precedents are there to go by? There are many, and largely they involve ancient precepts of the freedom of the seas, freedom of air and the rights of any nation to self-protection and self-defense.

Putting first things first, as did Dr. John Cobb Cooper at the 11th International Astronautical Congress at Stockholm in August, we will attempt a definition. Dr. Cooper, an American, Professor Emeritus of International Air Law at McGill University and resident of Princeton, N.J., put it thus:

"Outer space, for the purposes of this convention, is defined as the area whose upper or outer boundary is the outer limits of the solar system, and whose lower or inner boundary is the lowest altitude above the earth's surface at which an artificial satellite may be put in orbit around the earth."

Then, attempting a corollary, we might take what Dr. Cooper calls the greatest definition of freedom of the seas ever expounded—that of Mr. Justice Storey in 1826:

"Upon the ocean, then, in time of peace, all possess an entire equality. It is the common highway of all, appropriated to the use of all; and no one can vindicate to himself a superior prerogative there. Every ship sails there with the unquestionable right of pursuing her own lawful business without interruption; but whatever may be that business, *she is bound to pursue it in such a manner as not to violate the rights of others.*"

IT ALL SEEMS **SIMPLE—until** you come to that last sentence. Furthermore, several legal giants have had, in the past, strong words to say regarding the rights of states in the matters of self-protection. These include Chief Justice Marshall and Elihu Root, when he was President of the American Society of International Law.

The right of self-protection, said Mr. Root, "is a necessary corollary of independent sovereignty. It is well understood that the exercise of the right of self-protection may and frequently does extend in its effect beyond the limits of the territorial jurisdiction of the State exercising it." And later, it is "the right of every sovereign State to protect itself by preventing a condition of affairs in which it will be too late to protect itself."

That last sentence has a double hook. Is it the right of the United States, as this Administration has asserted, to protect itself from surprise attack by surreptitious reconnaissance? Or is it the right of another nation to protect itself from such reconnaissance?

We don't know. Neither do we know what Russia can and may do. This much we do know: *Samos* is about as provocative as any move we've made in our history. If we haven't a plan for every eventuality, diplomatic and military, we'd better back off and review matters.

Clarke Newlon

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We've presented a few of our many achievements to you through the leading characters of children's fairy tales. It has been fun, and we hope you've shared chuckles with us.

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