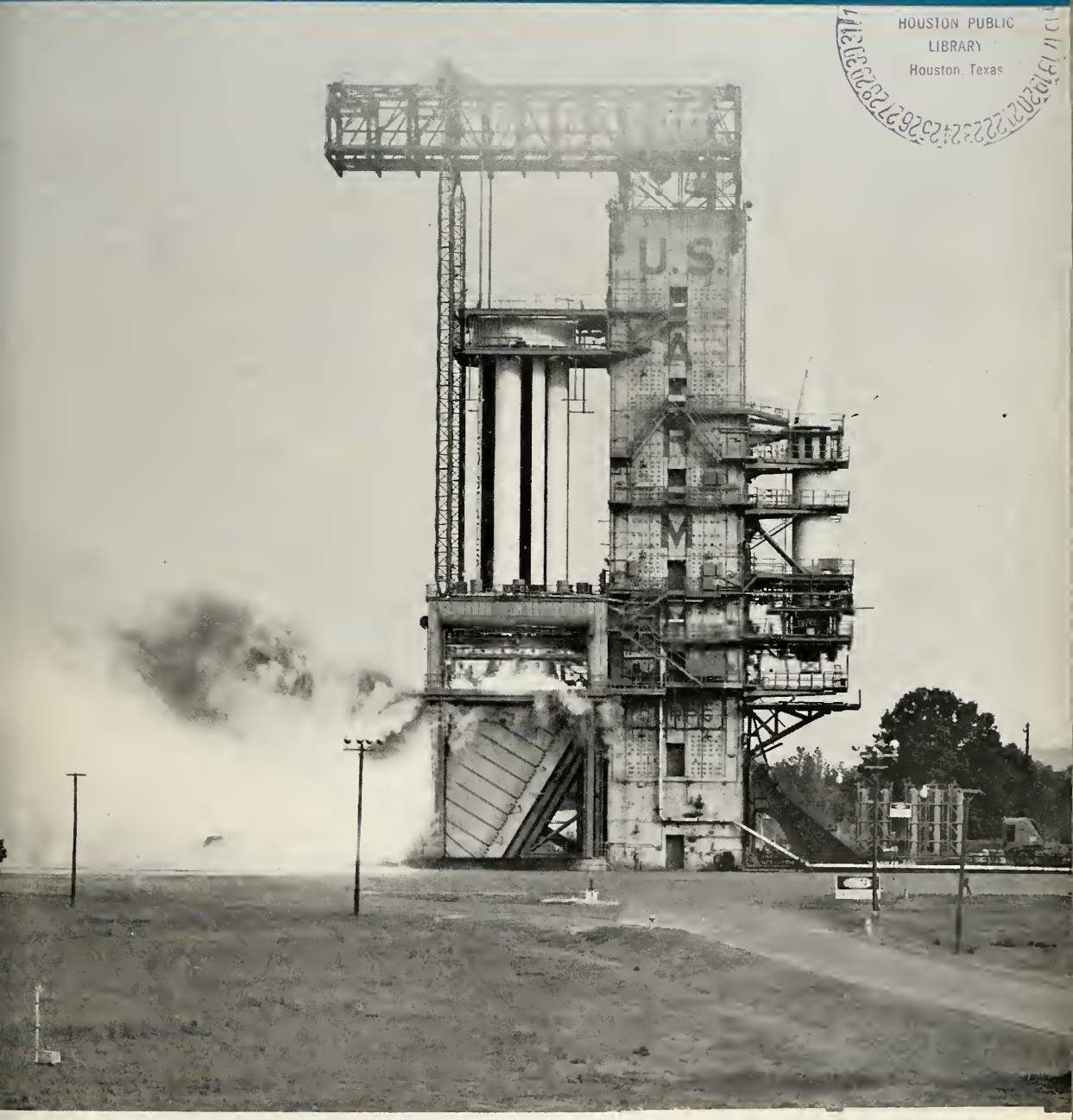
May 9, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY



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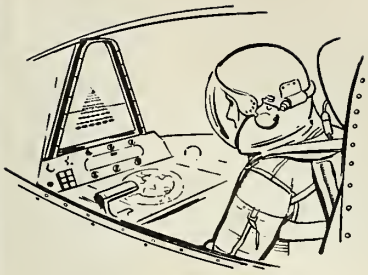

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This project evolved into ANIP (Army-Navy Instrumentation Program) with Douglas coordinating the efforts of a highly-specialized industry team.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

May 9, 1960 Volume 6, No. 19

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THE COVER

First static firing of eight-engine Saturn *cluster at Huntsville May 2 was called a "complete success," developing 1.3 million lbs. of thrust for about 10 sec. duration.*

MAY 9 HEADLINES

ASW ENGINEERING

PROPULSION ENGINEERING

ADVANCED MATERIALS

GROUND SUPPORT EQUIPMENT

ELECTRONICS

DEPARTMENTS

31,333 copies this issue

Memo from the Publisher

The 12 months lying just ahead—Fiscal 1961—should be the most vital in the short but dramatic history of the missile/space market. They will see the first launching of *Saturn* and a dozen space vehicles. *Atlas* will go into new bases, *Titan* will become operational, *Polaris* and *Minuteman* will be well on their way. The nation will have a new president and a new administration, giving us fresh vision in both peaceful and military space exploration.

During the forthcoming year, M/R will put forth its finest editorial effort: a series of special issues and special reports backing up our weekly coverage in depth of the missile/space market by the strongest group of editorial specialists ever gathered to cover this market . . . 14 editors who, in 15 months of working together under the direction of Executive Editor Clarke Newlon, have grown into a tightly knit team with solid capabilities over a very broad field.

Look for the following over the next twelve months:

June 27, 1960: Special report on drones, under the direction of Engineering Editor Bill Beller.

July 18, 1960: 4th Annual Engineering Progress Issue, featuring the Missile/Space Encyclopedia, which in turn will feature for the first time a special section on "Rocket Engines of the World," under the direction of Defense Editor Jim Baar.

Sept. 19, 1960: 3rd Annual Ground Support Equipment Issue, under the direction of M/R GSE specialists Bill Howard and Hal Gettings.

Nov. 28, 1960: 2nd Annual Advanced Materials Issue, under the direction of Materials Editor John Judge and Propulsion Editor Jay Holmes.

Feb. 27, 1961: 4th Annual Missile Electronics Issue, under the direction of M/R electronics Editor Charley LaFond.

May 29, 1961: 4th Annual Missile Market and Product Guide. (Company listings for the 1960 Guide have passed the 4,000 mark . . . a 100% increase over our first effort in 1958).

Every month: Special reports on the fascinating subject of ASW Engineering under the direction of M/R Industry Editor Don Perry.

During the past several months, with the help of expert consultants on typography and layout, we've made several changes in the traditional format of M/R. We've departmentalized it, condensed the news and industry Countdown, added the Technical Countdown, blossomed forth with a new cover and a new contents page. These improvements make M/R easier to read, easier to clip and give it better visibility.

The number of new subscriptions flowing in each week, and the marked increase in the number of renewals over the past three months, together with the gratifying number of letters of approval from all over the market, prove the acceptance of M/Rs' "new look."

And we look for your continued approval, as we continue to publish the world's most complete and comprehensive weekly report on missiles, space systems and their developing markets.

Edward D. Muhlfeld

—letters—

New ASW Section Noted

To the Editor:

My congratulations to MISSILES and ROCKETS for the new ASW Engineering section introduced in the April 11 issue. The editorial content is an excellent presentation in the field of antisubmarine warfare. The editors are to be commended for broadening the scope and content of your outstanding publication.

William B. Bergen
President
The Martin Company, Baltimore

To the Editor:

I wish to commend you and your staff for an excellent initial article (M/R, April 11) summarizing the ASW field and some of its most challenging problems. Your future success in this area will, in my opinion, depend largely upon your follow-through in isolating, and keeping readers current (within security limits) on, the problem solutions or "breakthroughs" most needed in achieving major advances in ASW capabilities. This, of course, concurrent with reporting general ASW activities and business opportunities.

I wish you success.

H. O. Hauck, Technical Director
Fairchild Astrionics Division
Wyandanch, L.I., N.Y.

U.S. Controls Warheads

To the Editor:

In regard to the article on the "Luftwaffe" in your March 7 issue, in which it is stated that the *Mace-B* missile that the Germans will receive will be atomic-tipped, I should like to raise the following questions:

Is this poor reporting? or

Has the Atomic Energy Act of 1954, which was amended by Public Law 85-479 in 1958, since been again amended to allow U.S. atomic weapons in the hands of foreign powers? or

Is there a high-level conspiracy between the executive branch of the government, the State Department, and the Defense Department working with the Atomic Energy Commission to violate, circumvent, or change the law of the land?

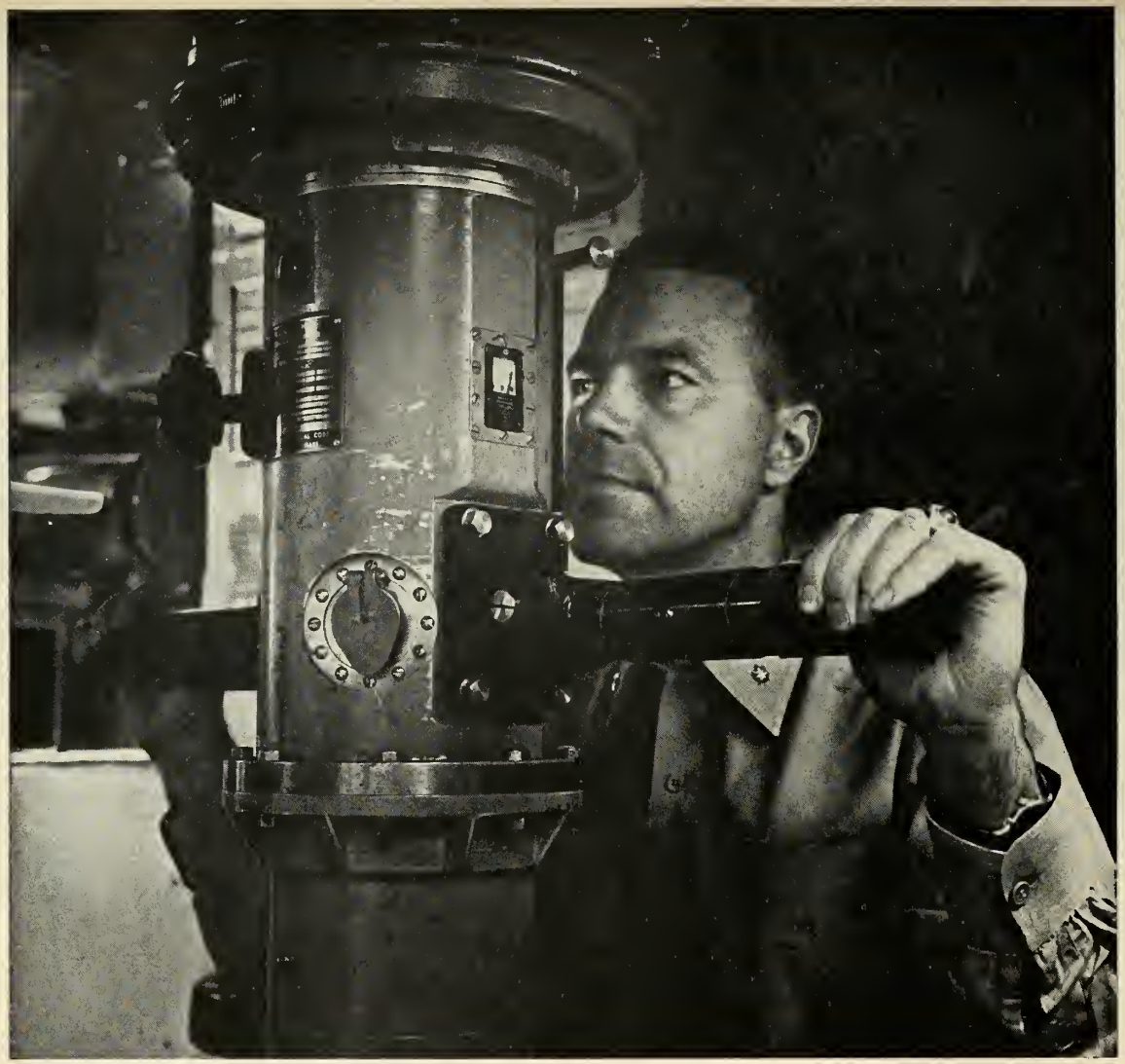
It seems that a clarification of the article in question is in order.

At the same time, can you kindly explain the "News Brief" in your March 21 issue regarding the turning over of two 15-missile squadrons of *Jupiter* IRBM's to the Italians? Presumably these missiles would be atomic-tipped and thus be covered by the atomic energy laws.

John Savas
Canton 8, Ohio

M/R did not mean to imply that the Mace-B's *which the Germans will purchase will be delivered with nuclear tips. Actually, of course, the atomic warheads will remain under U.S. control, just as are the warheads for the* Thors *in Britain and the* Jupiters *in Italy.—Ed.*

(continued on page 48)



COUNTDOWN...at full fathom five

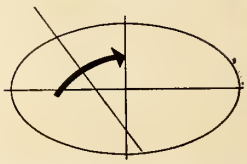
One day, a new fleet weapon system will be *on-station* beneath the ocean surface—ready to hurl retaliatory missiles toward strategic inland targets with pinpoint accuracy. This new weapon system will be part of the Navy's Polaris Fleet Ballistic Missile Program.

Though new in concept, the Polaris program makes full use of the precision Shipboard Inertial Navigation Systems (SINS) developed and produced by Autonetics for the United States Navy.

System design and components of earlier autonavigators have proved reliable in an Air Force supersonic missile, aboard the Navy's surface ship *USS Compass Island*, and on the *USS Nautilus* and *Skate*.

Advanced Autonetics' Shipboard Inertial Navigation Systems—like those to be used by the *USS George Washington*, the first Polaris-carrying submarine—will provide the critical missile alignment data to insure effective missile launching. SINS emits no tell-tale signals ... requires no receipt of external transmission at any time.

DID YOU KNOW?



The flattening of the earth at the poles can result in a navigational error of almost eleven nautical miles if not taken into account.

Inertial navigation by Autonetics

DOWNEY, CALIFORNIA

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INERTIAL NAVIGATION / ARMAMENT AND FLIGHT CONTROL / COMPUTERS AND DATA SYSTEMS

The Countdown

WASHINGTON

Subroc Scrapping Denied

Contrary to a report in COUNTDOWN (M/R April 25) the Navy says it has no intention of scrapping the Goodyear *Subroc* 25-50 mile underwater or surface-to-underwater missile. There have been no changes in the plan to put it aboard the nuclear-powered Thresher attack submarine due to be launched in a few weeks, and development is proceeding on schedule.

DOD Eyes Satellite Bomb System

Despite Eisenhower Administration statements that space has little military potential, DOD is continuing to entertain proposals for satellite bombing systems which could be released from orbit on command. Some contracts may be let once the *Discoverer* capsule recovery is perfected.

NASA Under Fire

Expect the House Space Committee to open up a full dress investigation of the *Vega-Agena* space vehicle case. Insiders are quoting officials close to the programs as saying "someone was awfully careless with the taxpayers' money" when NASA's *Vega* was dropped for the Air Force *Agena* after several million dollars had been spent on it. Another case under scrutiny is the recent award of a *Saturn* upper-stage fabrication contract to Douglas.

Ride on Underwater Jet Stream?

The Navy may deny it, but consideration is being given to sending a nuclear submarine on an underwater speed run to dramatize the advantages in sea-going missile mobility. The sub would attempt to ride the Cromwell current which flows eastward across the Pacific near the equator, at an average depth of 600 to 700 feet and speed of 3.5 m.p.h. for a distance of 3500 miles or more.

Cheyenne Bids for Missile Railhead

ICBM's apparently aren't giving Cheyenne, Wyo., the jitters, although it is now a primary target as the center of the first AF *Atlas* base. City fathers are bidding to make it a hub for deployment of railroad-launched *Minuteman,* pointing out that the city is a junction for east-west and north-south railroads.

Minuteman Guidance Limitation

Look for critics of the mobile *Minuteman* to point out that the first ones will be limited to firing from preselected sidings using pre-computed target data. Follow-on missiles after it becomes operational in 1962 will have capability of computing data to fire almost instantaneously from any position.

Hiatus Coming in NASA Shots

There will be no major NASA shots until July, when the first *Atlas-Mercury* capsule combination is fired down the Atlantic Missile Range on a re-entry test.

INDUSTRY

Secret Steel for Deeper Subs

U.S. Steel is reported to have developed a tough new steel which will increase the strength of the pressure hulls of *Polaris* submarines an average of 30%. Details are secret, but the steel is expected to be used in follow-on subs after the *Ethan Allen* class and add greatly to their operable depth.

GAO Hits Cost-Reimbursement Practice

The Government Accounting Office is urging DOD to abandon a policy under Directive 7800.6 which requires defense contractors to obtain private financing for 20% of pre-delivery costs under certain cost-reimbursement contracts. GAO contends the three-year-old directive has cost the government $8.7 million more on 26 Air Force contracts than if the military had financed the costs.

More *Regulus II* for AF

Chance Vought and the Air Force are dickering on a contract for delivery of about 10 Mach 2 *Regulus II's* for *Bomarc A* target drones. The contract has to go through Navy, which developed the missile.

New Pinch on *Bomarc B*

Negotiations for sale of the *Bomarc B* to foreign countries have been jolted by the announced cutbacks in the program. However, Marquardt Corp.'s Roy Marquardt says the company is discussing with the AF a stretchout of *Bomarc* ramjet engine production at the firm's Ogden, Utah, plant. The House Appropriations Committee has voted to kill *Bomarc B* altogether (see p. 14.)

INTERNATIONAL

Red Espionage Reported

Soviet agents are said to be causing alarm in northern Norway and Sweden where there have been reports of several arrests. The spy activity is believed connected with the protection of several Soviet IRBM launching sites in Russia just across the Finnish border.

Nord AS-30 to be Nuclear-tipped

First French missile to get a nuclear warhead probably will be the *Nord AS-30.* It will give stand-off capability to the Vautour and Mirage III bombers.

For Technical Countdown, See Page 21

To assure a new order of reliability

MICRO-MODULE

EQUIPMENT

The micro-module is a new dimension in military electronics. It offers answers to the urgent and growing need for equipment which is smaller, lighter, more reliable and easier to maintain. Large scale automatic assembly will bring down the high cost of complex, military electronic equipment. Looking into the immediate future, we see a tactical digital computer occupying a space of less than two cubic feet. It will be capable of translating range, wind velocity, target position, barometric pressure, and other data into information for surface to surface missile firings. The soldier-technician monitoring the exchange of computer data will have modularized communications with the other elements of his tactical organization. RCA is the leader contractor of this important United States Army Signal Corps program and is working in close harmony with the electronic components industry.

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CAMDEN, NEW JERSEY

Army Fears Tactical Missile Gap

Service warns it may lack firepower to stop Red swarms; praise from President gives hope of more funds

by James Baar

FT. BENNING, GA.—Army officials are warning that within the next few years the United States will face a tactical missile gap as critical as the coming missile gap involving city-busting ICBM's.

The blame is placed directly on the Administration's budget-pinching procurement policies that are preventing the Army from buying sufficient quantities of its newest tactical missiles.

Officials warn that as a result the Army will not have sufficient firepower to stop masses of missile-armed communist troops in a limited war—the kind of war the Army considers more and more likely in the 1960's.

The Red Army alone has some 175 divisions compared to the barely 20 NATO divisions that face them in Europe across the Iron Curtain. The Russians are fully equipped with a vast array of tactical missile power. On the other hand, the U.S. Army's starved 14 divisions—of which only about 10 are full and combat ready—are being equipped with relatively few of such powerful field weapons as *Pershing* and *Sergeant* missiles under present procurement plans.

Warnings of the coming tactical missile gap came this last week as the Army paraded its latest weapons before President Eisenhower and hundreds of industry, military and government officials at Project MAN —a three-day exhibition here of modern Army needs.

The exhibition included:

• First unveiling of the launching tubes of the Army's potent *Davy Crockett* system. One, constructed like a mortar on a tripod, can be carried and operated by a team of two or three men. The larger is mounted on a jeep or an armored personnel carrier. Both tubes fire a *Crockett* with a fractional-yield nuclear warhead or a conventional warhead. The secret *Crockett* itself was not displayed for security reasons.

• Disclosure of a radically modified Western Electric-Douglas *Nike-Zeus*. A wooden mock-up of the 65-ft. bird with much smaller fins and a trimmer configuration was displayed. The new version is scheduled to be fired soon. (At Los Angeles, the Army said this last week the *Zeus* could go into limited production right now because tests have been so successful.)

• Disclosure that Martin Co. and the Army are working on a follow-on *Pershing* that could have variable ranges from under the present 300 miles up to about 1000 miles. Development beyond the study depends on the scrapping of the present range limit on the Army by the Pentagon.

• Disclosure that 15% of the Red Army's munitions in the field are chemical agents. Much of the Soviet poison gas can be delivered by missiles.

• The launching of two *Honest Johns* and one *Little John* under simulated battle conditions. One of the *Honest Johns* was launched during a blazing night exercise that also included the firing of salvoes of 4.5-in. rockets. The second *Honest John* and the *Little John* were fired during a daylight attack exercise that also included the launching of *Nord SS-10's* from helicopters and salvoes of twenty-five 4.5-in. rockets from mobile multiple-tube launchers.

The *Honest John* launched during the night exercise thundered across the battlefield, trailing behind it its blazing tail. Moments later a simulated nuclear blast roared from the woods in the distance of a mushroom cloud loomed against the sky.

Tracers crisscrossed again across the field and the battle continued.

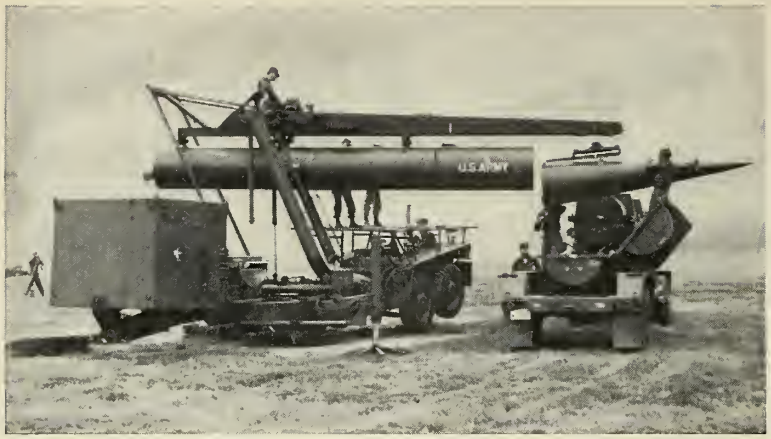
President Eisenhower said after witnessing the daytime exercise:

"A day like this makes a man quite ready to call all those people mistaken —if not worse—who say that America has become soft and is not capable of defending itself. In other words, gentlemen, I am so proud of you that I really have no words in which to express it."

ARMY UNVEILS *Davy Crockett* mortar-launched tactical missile with nuclear or HE warhead. New defense bill calls for production of more than 6000 of this new missile.

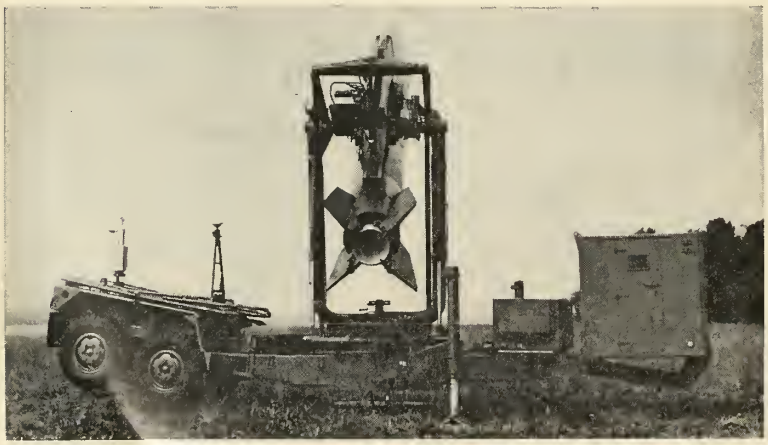
LAUNCHER FOR *Davy Crockett* can be jeeped or carried by two men.

Where money is needed . . .



NOSE SECTION of Army's new *Sergeant* missile is unloaded from its transport trailer and assembled on its erector-launcher rig at Fort Benning.

MINUTES IS ALL it takes to assemble *Sergeant* on its mobile launcher. *Sergeant* vehicles mark first use of U.S. Steel's newly developed thin sections of T-1 steel.



READY FOR FIRING, the *Sergeant*, for which Sperry Utah is prime contractor, owes much of its mobility to T-1 alloy, which cut erector launcher weight by 7000 lbs.

• **Money ills**—Army officers beamed and hoped for a loosening of funds.

The Army is looking to Congress this year to give it more money to purchase missiles and other tactical battlefield equipment.

It has told Congress it should have $180.7 million more in the 1961 budget for the purchase of missiles. This would include 50 *Sergeants*, 600 *Little Johns*, 701 *Honest Johns*, 1200 *Redeyes*, 4 *Lacrosse* battalions and 6247 *Davy Crocketts*. Funds also would be used to expedite the *Pershing* and *Hawk* programs.

Congress is expected to approve much of the extra funding. How much of it will be released by the Administration remains in doubt.

To have many of these weapons in sufficient quantities, by 1963—the beginning of what most military men agree will be a time of great peril—procurement has to begin in the next year. This is particularly true of advanced models of *Pershing* and *Sergeant*.

Lt. Gen. Arthur G. Trudeau, Army chief of Research and Development, told observers at Project MAN that his job was to provide a variety of weapons "to deter or to fight an all-out nuclear war or local aggression with non-nuclear weapons."

Project MAN showed that these weapons are being developed—but are of little use unless they are in the hands of troops in quantity.

SAC Starts Rail Tests of Mobile Minuteman in June

Strategic Air Command will begin tests this summer of the mobile *Minuteman* deployment system over civilian railroads in the Far and Midwest regions.

In cooperation with the Association of American Railroads and officials of 13 railroads, a series of six tests will be made to determine how a missile-carrying railcar could be coordinated with regular route traffic. No missile hardware will be on board during early trials.

The first test run will begin June 20 from Hill AFB, Utah, and last about a week. The special train is expected to have 14 cars, including a control and command car equipped with a single sideband radio and UHF link to Hill AFB and the SAC Command post at Offutt AFB, Neb. Other cars making up the train will be used for fuel and supplies, and Pullman cars will house the missile crew.

The AF said a mobile *Minuteman* will cost $3 million, against $1.5 million for one in a silo and $35 million for an *Atlas* in a hardened launcher.

would rely on U.S. . . .

Britain May Drop Nuclear Arms Role

Shakeup in NATO deterrent forces seen if government decides against buying Polaris and Skybolt

by G. V. E. Thompson

LONDON—Although government leaders have made no announcement of the fact and may not for some time, it is reliably said here that England will not purchase American-made *Polaris* and *Skybolt* missiles to supplant their own abandoned *Blue Streak* IRBM program.

While the final choice rests with the politicians, not the military, many competent observers think the Government have already decided against both *Polaris* and *Skybolt* and merely mention them so as to keep Britain's place in the international poker game.

Sooner or later, they believe, Britain will have to chuck its hand in, abandon its policy of having an independent nuclear deterrent, and withdraw from participation in the overall Western or NATO deterrent plan.

Such a withdrawal would bring up the question of public opinion permitting nuclear-armed U.S. fighter and bomber planes to occupy British soil.

It would also probably necessitate a realignment of NATO forces to compensate for the loss in deterrent power of the RAF V-bomber force and the British-based *Thor* missiles.

The United Kingdom in becoming non-nuclear would rely on the U.S. deterrent. Such a decision presumably would be acceptable to America. (U.S. military experts are reported to have said "it may be best for you to stop being a target, which is all you ever could be"). It is also likely to meet with approval in Britain. Support for the Campaign for Nuclear Disarmament has been growing. A crowd of over 100,000 assembled in London's Trafalgar Square on Easter Monday for a "ban-the-bomb" demonstration.

• **Target worries**—When the British government announced the cancellation of *Blue Streak*, officials stated they were considering the purchase of *Polaris* and/or *Skybolt* missiles.

Polaris is, of course, the Lockheed submarine-launched 1200-mile missile which could be launched equally well from surface ship or a land base. *Skybolt* is the Douglas "stand-off bomb," a 1000-mile or better missile to be launched from an aircraft. Both are solid-fueled.

In the ensuing discussion, however, the point repeatedly was made that these are subject to the same, or just as serious, objections as the land-based rocket. The reason given for abandoning the fixed-base *Blue Streak* was that it was too vulnerable to sudden attack by Russian missiles.

This applies equally to the airfields from which Britain's V-bombers carrying *Skybolt* would take off. It also applies to *Thor* missiles, four squadrons of which are already on station in England.

Even when the Fylingdales Moor BMEWS station is completed, there will be only three minutes warning of missiles launched from East Germany. This is not enough to get either bombers or missiles off.

To avoid having the bombers destroyed on the ground Britain would have to maintain a perpetual airborne deterrent and this would seem too expensive. It would also provoke considerable political opposition. There is no present solution to the slow reaction time of present-day missiles.

• **Lost purpose**—Britain is not interested in the use of *Polaris* as a land-based missile, and considers that surface ships carrying it would be too easily detectable. However, the U.S. is pressing for the adoption of a land-based *Polaris* by NATO. If Britain did decide to go in for *Polaris* or *Skybolt*, these might be made here under license. It is understood that the R.A.F. have already been cooperating with the USAF in the development of *Skybolt*, and Bristol-Aerojet may be working on the propulsion system.

If Britain does abandon the nuclear deterrent, it will mean that much of Britain's work in the atomic energy field will have lost its purpose. Thus the Atomic Weapons Research Establishment at Aldermaston would become superfluous and the stockpile of plutonium would be available for other purposes. Presumably, the staff engaged on weapons research would be transferred to the nuclear power programme, which would then be greatly accelerated. The plutonium would be written off and made available for power purposes at a very low cost.

Britain would not drop all work on missiles, however. Short-range rockets would still be required for "police actions" in colonial trouble spots, and for anti-aircraft defense. Work on the *Blue Steel* stand-off bomb is still continuing, though Avro is not inviting publicity about the missile, as it does not want to see it follow *Blue Streak*. As yet, *Blue Steel* has kept outside the political arena.

No decision has yet been taken on whether *Blue Streak* shall be used in a British spaceflight program. The rocket would be ready for flight tests in two or three months. More time would be required to convert it for satellite launching. Detailed cost estimates are being hurriedly prepared and it is expected that the Government will reach a final decision about the middle of May. One proposal which is being put forward is that the U.K., British Commonwealth and Europe should join together in partnership in a space research programme, initially using the *Blue Streak*.

— news briefs —

AF PUSHES SPACE ROLE—One of the strongest statements yet for a bigger role in space was given to the Aviation Writers Association meeting in Los Angeles last week by Col. Richard D. Curtin of the AFBMD. He stressed need for "comprehensive deterrence" in space.

ARMY LETS BIG CONTRACTS—A $6.3 million contract for continued *Redeye* development was awarded to Convair this past week. Army also awarded Western Electric a $4-million contract for *Nike-Zeus* R&D and a second contract for *Nike-Hercules* missiles exceeding $5.7 million.

INCENTIVE CONTRACTS HIT—Testimony before a special House Armed Services Subcommittee shows DOD has been using incentive contracts almost exclusively with manufacturers who already have the advantage of government-owned facilities. Renegotiation Board studies showed these contractors realizing profits amounting to 71.3% on total net worth allocated to renegotiable production.

Bomarc Killed in Revamped DOD Budget

A major shift in defense spending which would buy more *Polaris* submarines and kill the *Bomarc B* interceptor missile program was sent to the House this past week.

The drastically revised FY 1961 defense bill totalling $39,337,867,000 —just $2,867,000 more than President Eisenhower asked in January—included a rejuggling of programs involving nearly $3 billion.

The revisions were made by the House Appropriations Committee, which said the bill reflected its support of the mixed force concept of hardened fixed-base ICBM's, mobile *Minuteman* and *Polaris* missiles and limited development of the B-70.

The mixed force is more expensive, the committee said, adding that it urged the "numbers of weapons systems be limited by avoiding duplicating operational characteristics.

Significantly, the revised bill added $321 million to antisubmarine warfare requests, including $100 million for R&D, bringing the total Navy appropriation in this category to $1,684,400,000. It pointed out at the same time that while the Navy said it was giving highest priority to ASW, "there is no indication of dramatic or dynamic leadership in this field."

The committee recommended that the Navy immediately establish for ASW a single manager system similar to the Special Projects Office which is developing *Polaris*.

The bill wiped out all funds for the *Bomarc B* that had not been previously committed, a reduction amounting to $675,100,000. This action, if approved by Congress, is expected to have repercussions in Canada which has an agreement with the United States for two squadrons of the missile. In place of the *Bomarc B*, the committee shifted $215 million to the procurement of 50 additional F-106 fighter planes.

"The *Bomarc B* . . . is a very questionable weapon system, and therefore a majority of the committee considered it inadvisable to place any reliance at this time upon such a weapon," the report said.

The committee agreed to the Navy's post-January request for six additional *Polaris* submarines, but it revamped the funding to speed up their development. It gave full financing to five instead of three submarines and provided long-lead time authority for seven instead of nine. The number of *Polaris* subs authorized would be 21, with 14 fully funded. To accomplish this, the committee added $241 million above the $153 million extra sought by the Navy.

Concern over missile mobility was apparent in the committee's decisions, although it approved the Air Force request to add three *Atlas* missiles to the last six of 13 authorized hardened squadrons, making them 12-missile squadrons. It added $20.7 million to accelerate the development of a railroad launch system for *Minuteman*.

The committee adroitly handled the controversy over the Strategic Air Command's request for a continuous airborne alert by recommending the President be given power to incur a deficiency in DOD funds to order an alert any time he feels it is necessary. It also raised the sum for this purpose from $85 million to $200 million.

In addition, the bill increased the *Midas, Samos* and *Discoverer* satellite projects of the Air Force by $54 million to effect their acceleration.

The committee disagreed with the Navy ASW shipbuilding plans. It chopped out $293 million for a conventionally-powered aircraft carrier and then approved funds for three, instead of two, nuclear-powered attack submarines.

• **Cutting the pie**—Of the total defense appropriation, the Air Force gets $16.8 billion; the Navy $11.9 billion and the Army $9.4 billion.

Air Force missile funds were set at $2,378,400,000, a $645-million reduction accounted for largely by dropping the *Bomarc B*. Its research, development, test and evaluation funds were increased $208.6 million to $1,542,-668,000 and included $100 million for the services of Rand Corp., Mitre Corp., Space Technology Laboratories, Lincoln Laboratories, Analytic Services Inc. and others.

Navy missile and aircraft procurement, which are lumped together, was boosted $28.8 million to $2,141,800,-000. Under RDT&E the $100 million for more ASW research increased total funds to $1,268,530,000. Navy missile research is being funded for $374 million—one-third for *Polaris* and the rest divided among *Eagle, Typhon, Corvus, Subroc* and an improvement in *Sidewinder*.

Procurement of Army missiles and aircraft was placed at $1,374,000,000, an increase of $37.1 million, while RDT&E funds were cutback $510 million to $1,041,190,000. Eighty percent of the $493.8 million for missile development is earmarked for R&D of the *Nike-Zeus* and *Pershing* systems.

• **Waste cited**—To compensate for some of the increases, the committee ordered an across-the-board slash of $400 million, or 3% in procurement funds.

Noting examples of waste and mismanagement reported by the General Accounting Office, the committee said it was serving "notice on all contracting officers in the military services that hereafter they personally can expect to be called upon to explain fully their actions in administering certain suspect contracts."

Senate Hikes NASA Money Bill

The question of how much money NASA will be able to spend during FY '61 became a little more confused last week when the Senate voted to authorize the agency to spend $970 million dollars in FY 1961—$50 million more than it had asked for.

The week before, the House voted to cut NASA's FY '61 budget by $38,-985,000 on the recommendation of the House Independent Offices Subcommittee of the House Appropriations Committee. (See M/R, April 21.) The subcommittee claimed that NASA didn't really need the extra money.

The Senate Space Committee, on the other hand, claimed that NASA erred in making up the budget by thinking it could make "unspecified savings," and that therefore the extra money is needed. The full Senate agreed, by a vote of 78-0.

There thus will be an $88 million difference between the House and Senate bills. A compromise will have to be ironed out in Conference.

Space Act

Military's New Role Positive in New Bill

The House Space Committee last week reported out the space program reorganizational bill (HR 9675) designed to placate military and industry critics of the present Space Act.

Basic features of the bill include:

- The substitution for the President's National Space Council of an aeronautics and astronautics liaison board co-chaired by DOD's Director of Research and Engineering and NASA's Deputy Administrator.
- A definition of the military's role in space with language stating that "DOD shall undertake such activities in space . . . as may be necessary for the defense of the U.S."
- A mandate giving NASA power to "formulate specific national objectives" for peaceful purposes in space and carry them out.
- A provision indemnifying contractors damages resulting from "unusually hazardous risks."
- A broadening of NASA's waiver of patent rights authority so that it more closely conforms to DOD patent regulations.

The final bill failed to include a proposal by Rep. B. F. Sisk (D-Calif.) requiring NASA to submit after-the-fact data on all negotiated contracts.

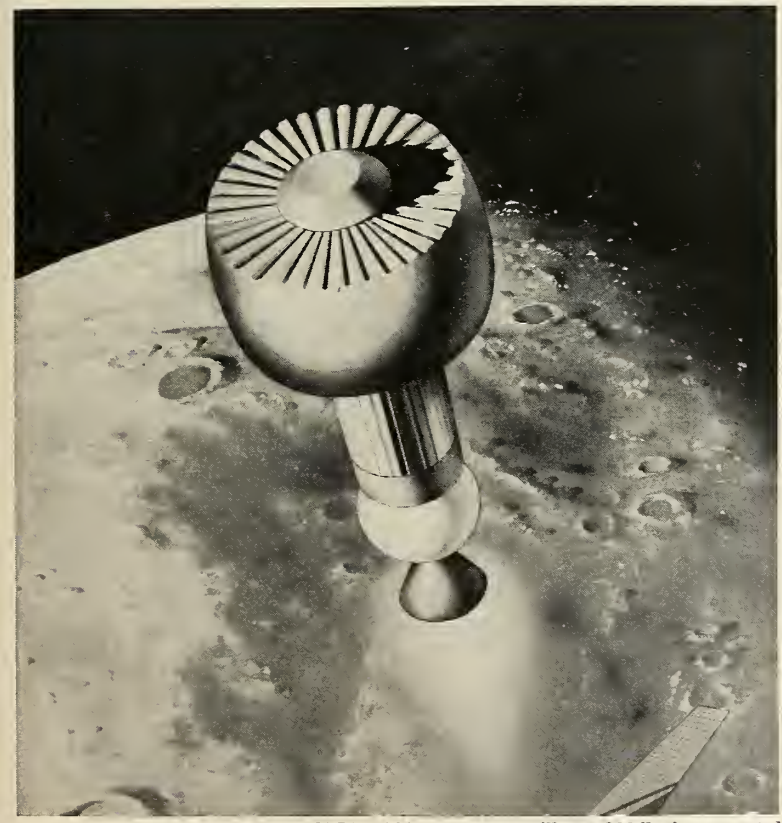
Major significance of the changes was to soften military and industry criticism that the original Space Act was detrimental to their interests.

The definition of the military's role in space was included because many military spokesmen felt that the language of the original act did not affirmatively state that the military had a role in space. The original act stated the military's role in a negative fashion, stating that "nothing in this act shall preclude" DOD from undertaking space activities.

The indemnification provision was included because industries contracting for space work have been worried about the potentially dangerous aspect of space research, and the possibility that they might have been held liable for injuries incurred.

Industry for some time has criticized the fact that NASA's patent provisions were much harsher than DOD's for the same type of research and development.

Lunar Impact Capsule



MOON LANDING attempt by NASA within two years will use 300-lb. instrumented capsule developed by Ford's Aeronautic Division. Retrorockets will lower capsule from 20 miles out. Drawing shows capsule after separation from vehicle.

Pioneer V Data Shows Threat of Solar Flare

An analysis of data obtained from *Pioneer V*—the first space vehicle to send back information from outside the earth's sphere of influence—has revealed that:

- The level of radiation from solar flares can become so intense as to produce a threat to manned space travel.
- The processes producing the outer Van Allen belt are not due directly to the injection of particles coming from the sun itself; the material caught by the earth's magnetic field is of much lower energy than most of the particles emitted by solar flares, and is accelerated by some unknown process after it is injected into the earth's field.
- Plasma caused by solar flares entering the earth's atmosphere disrupts the magnetic field so that trapped radiation is dumped into the earth's atmosphere, causing the low latitude auroras.
- The rate that plasma clouds caused by solar flares travels through the solar system can be ascertained, and it is possible that future space vehicles can give earth advanced warning of solar storms.
- The information obtained has allowed astrophysicists to divide the regions of space around the earth out to a distance of about five to seven radii.
- There is a steady field of radiation in space which may be a galactic field permeating the solar system.

These results and many others, were outlined at a NASA press conference from NASA *Pioneer V* technical reports and also from reports being made at the annual meeting of the American Geophysical Union.

The space agency also reported the possibility that Jodrell Bank may be able to command *Pioneer V's* larger 150-watt transmitter out to a distance of 100 million miles. This would mean that the sun satellite could be tracked while it speeds through over 1200 million miles of space.

NASA also reported that *Pioneer V* last week was 6.7 million miles from earth, had traveled 83 million miles through space, had been tracked for 94 hours, and that its command system has operated 227 times.

The scientists pointed out that the satellites transmitter had to be commanded regularly so that the batteries do not overcharge.

Rickover Tells Why U.S. Trails Russia

Says could not develop Nautilus today; harassment by a parade of bureaucrats hampers technical staff work

The following remarks by Vice Adm. Hyman G. Rickover, developer of the nuclear-powered submarine, were excerpted from recent testimony before the Senate Space Committee. They include a sharp analysis of what he believes to be the continuing problems facing the nation and the military in the contest with Russia—and the way to remedy them.

• **The contest**—In essence, the contest is really between two different systems of administration; between two different bureaucracies. If we place the issue on that basis, if we stop talking about a contest between democracy and totalitarianism, we can get at the root of the problem and find out why their rate of progress is greater than ours, why they are getting ahead of us.

In Russia, only the most determined and most competent people can get the best jobs. If they don't do a good job, if they botch a job, they are fired. And if they are fired, they don't have a private company to go to for a job. The Russians don't exercise too much favoritism, either.

One of Khruschev's closest friends was recently removed from the Presidium because he hadn't done a good job. He didn't even get a letter from Khruschev saying how much he regretted his leaving. He was just told to go . . .

The great mistake we make is to believe we are in competition with the Russian people. We are not in competition with the Russian people. We, the American people, are in competition with the Russian Government . . .

They have the advantage of speed in decision-making, the ability to concentrate on a few definite national objectives to which they apply the necessary energy and resources. They decide what is important technically and industrially, what is important for the political and military power of the state. These items they give national priority. They place a man in charge of a project, they hold him responsible and they let him alone.

If he fails, they get rid of him. They don't hound him day after day and literally prevent him from doing his work, which is the way we treat the men in charge of our large-scale governmental projects. This way of doing business we can no longer afford . . .

• **People, not money**—Over the last 10 years there has been a constant increase in difficulty in getting a job done in Government. In fact it has gotten to the point now where it is almost impossible to do a good job.

It isn't money. You don't get jobs done with money alone. In fact, you can slow jobs with too much money, because it takes time to spend money. Also, it takes lots of people to spend lots of money.

. . . too many fire alarms

The situation is comparable to a fire department with one fire station and many fire alarms. We have only the one fire station but we keep on adding more fire alarms, and more people are ringing alarms; the fire station can't take care of all the demands being made on it.

Similarly the few people doing the actual technical work are being overburdened by constant requests for information, justification, rejustfication, and so on . . .

For example, why don't we judge people by results? A man who is truly dedicated to a job will not want to take on work he doesn't believe in. If he doesn't believe in a job, he just won't do it.

Another thing, I have been urged numerous times to take on additional projects. I won't take them on because I don't believe they are worthwhile, or do believe they will interfere with what I am already doing.

I consider if I or somebody else has produced results, he certainly should be let alone to devote his time to his job.

There are many groups in Russia such as mine. They are not bothered. They are permitted to make some mistakes, but they are judged by results. They are not judged by the number or thickness of their reports, or by their methods.

Many things cannot be justified, in detail, particularly in research and development. Day after day people ask abstruse questions: "Why did you use this physics formula, why did you do that thing?" You can't explain those things. All you can do in scientific or technical matters, just as in politics, is to judge people and results. It is the only thing you can do. There is nothing else. In the final analysis you must judge people.

Let me recapitulate: If a man is doing a job, for God's sake, let him alone. This is not the case in our Government. That is the real issue. That is our real problem . . .

• **No Nautilus**—I don't think with the present climate, the way it has changed in the last 10 to 12 years, I could develop the Nautilus again. Now that is a statement for you to ponder.

You asked what we have gotten for the money spent in the naval program. For about $850 million we got all of our laboratories; we got five land prototypes of atomic powerplants that are now operating; we got all of the research and development over this entire period of time; and we also got the atomic powerplants for the Nautilus and the Seawolf. We got all of this for less than $1 billion . . .

• **Executive responsible**—In the broad sense it is not the legislative branch that is responsible for our shortcomings; it is the executive branch. The executive branch must see to it that the senior administrative people in the technical departments really understand the jobs they are supervising. Perhaps

the Senate should more thoroughly investigate before it confirms appointees to certain important jobs to assure that they are really qualified.

Edwin L. Weisl, committee counsel: Are there still many problems connected with nuclear propulsion plants?

Admiral Rickover: There are many problems, and we are not doing as much as we could or should. I finally got to the point of no return about two weeks ago. At 11 o'clock one night a serious technical problem arose. For the first time in my 12 years in charge of our project there were no technical people in my organization available to handle the job. The technical people were all off writing reports at 11 o'clock that night.

Now that is a fine way to use the rare technical talent we have in this country—to waste their time on nonproductive work. Whom are we fighting anyway? Are we fighting ourselves?

• **Brass parade**—A military organization is not geared to do research and development. It is an operating type of organization. Officers who have had command of ships and of fleets and have done a fine job come to Washington and are given authority over technical people. Those in line authority are frequently not competent to make the technical decisions, but they make them anyway.

Now that wouldn't be so bad if they stayed around long enough to learn their jobs. I will quote a few figures to illustrate the point.

During the time I have had my present job there have been seven Secretaries of Defense, seven Secretaries of the Navy, six Chiefs of Naval Operations, nine Directors of Atomic Energy in the Office of the Chief of Naval Operations, six Chiefs of the Bureau of Ships, four Chairmen of the Atomic Energy Commission and three Directors of the Reactor Development Division . . .

• **Schools behind**—Our children should know at least as much as those in Russia. But the educationists will say, "They will have to work too hard. It will be bad for their health."

Yet the records show that there is a smaller percentage of rejections for physical unfitness for military service in Western Europe and in Russia than there is in the United States. So that argument won't hold water.

Sen. Prescott Bush: They have a tighter discipline in the schools, do they not?

Adm. Rickover: Yes, sir.

Sen. Bush: Not only in Russia but also in Western European countries?

Admiral Rickover: Yes sir; and they go to school longer, too. For example, our children go to school 5 hours a day, 5 days a week for only 180 days a year. Their schoolday is 6 hours, with no study period, 6 days a week. In Denmark, they go to school 280 days a year. So they do in 9 years what we in 14. The average in Western Europe and in Russia is about 240 days a year . . .

• **On bureaucrats**—The Pentagon today is a big jungle, as you well know. No one could possibly control that outfit with its large number of people.

In fact, the Pentagon is the "fifth service." There are the Army, Navy, Air Force, and Marines. These are the four services. So the Pentagon has become the "fifth service . . ."

Nearly everybody in the Pentagon has the right to question me, but with no obligation and no responsibility to see that my job gets done. And every year the number of people with this right is increasing.

That is why it would help to arbitrarily reduce the number of people in the Pentagon by 20 or 30%. This could be one of the most significant steps that has ever been taken to improve efficiency. It is significant that one of the first steps Mr. Khrushchev took when he became premier was to reduce the Moscow bureaucracy by more than 100,000.

Sun Is Photographed by X-rays

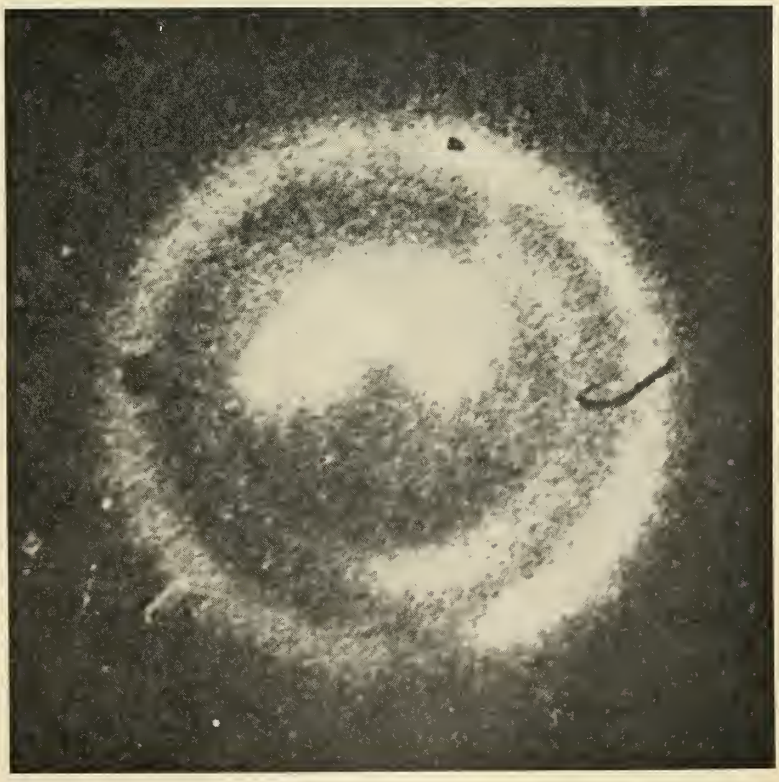
First X-ray photograph ever taken of the sun shows it rimmed by a halo and several intense spots of X-ray emission. Photo was obtained with an *Aerobee-Hi* rocket fired from White Sands April 19 to an altitude of 130 miles.

The experiment, conducted by the Naval Research Laboratory, used a simple pinhole camera mounted on a biaxial pointing control which aimed it at the sun throughout the flight.

X-rays are generated by the sun's coronal gas which reaches temperatures of millions of degrees. The gas is completely ionized at these temperatures and collisions between electrons and heavy nuclei cause the X-ray emission. Since this radiation does not penetrate the earth's atmosphere below 60 miles, photos must be taken above this altitude.

The camera used had a 0.005-inch-diameter pinhole covered by an opaque aluminum coating. The metal blocked visible light but allowed the X-rays to pass through and record their image on photographic film. The resulting photograph was one-tenth inch in diameter.

The rocket's motion caused smearing of the image but did not obliterate features of interest to the participating scientists.



AF Forms Non-Profit Unit to Replace STL

by Clarke Newlon

As M/R went to press the Air Force was ready to announce plans for the formation of a non-profit corporation to take over the job of providing administrative services, fundamental laboratory research and advanced planning for the USAF's Ballistic Missile Division from Space Technology Laboratories.

The new organization planned after a study by a committee of scientists and engineers headed by Dr. Clark Millikan, California Institute of Technology, is known informally as "Corporation A." (See M/R April 4, Page 50).

According to best available information, the new corporation is expected to take over from STL some 25% or more of its present 4900 employes. It is also expected to occupy the present complex of offices at El Segundo and Aviation Boulevards, Los Angeles, now occupied by STL. These buildings were constructed for STL by its parent company, Thompson Ramo Wooldridge.

The Ballistic Missile Division of the Air Research and Development Command will, it was said, continue to occupy its present site adjacent to STL on Arbor Vitae Avenue, Los Angeles.

BMD, under whose direction the new non-profit corporation will work as did STL, had an on-site strength March 1 of 1403. Of these 737 were officers, 206 enlisted personnel and 460 civilians.

With the Ballistic Missile Division taking over the entire STL premises for its new corporation, this would seem to indicate that either the new organization would be greatly augmented by outside hirings (since only some 25% of STL personnel would be used) or that BMD intends to increase its own strength.

• **History of controversy**—Space Technology Laboratories was formed in 1954 when the Air Force was given the green light to produce the intercontinental ballistic missile in a top priority program. Its assignment under the direction of Simon Ramo and Dean Wooldridge was to manage the systems engineering which went into the production of *Thor, Atlas, Titan,* and later *Minuteman.*

Because of the dozens of new techniques, processes and materials required, literally hundreds of companies were called upon to contribute their scientific skills. It was the job of STL to integrate and manage the work of these companies, in conjunction with BMD and the prime contractors.

The overall job done enabled the Air Force to produce the ICBM almost 18 months ahead of the forecast schedule.

STL was, however, a profit-making institution. When its management decided on entering the production of hardware field, in addition to systems management, potential competitors objected to it as a "chosen instrument." The protests eventually reached Congress which saw a conflict of interest.

In seeking a solution the Air Force apparently has decided on the non-profit corporation as the most feasible.

J. D. Wright, chairman of the board of Thompson Ramo Wooldridge, recently announced in Los Angeles that STL, the "wholly owned but separate subsidiary corporation" would be integrated into the TRW family to continue in business as a private contractor in a conventional manner. STL would, he said, "be relieved of any requirements to furnish administrative facilities, advance planning or evaluation of contracts," presumably for the Air Force.

Moss Acts to Bar Snyder Censoring

Rep. John E. Moss, chairman of the House Government Information Subcommittee, moved last week to prevent any future attempts on the part of DOD Information Boss Murray Snyder to censor the speeches, press releases and advertising of defense contractors.

As reported in M/R (May 2, Page 16), Snyder's office attempted to get approval of a proposed directive which would give him the authority to require all military contractors to submit speeches, press releases and advertising to his office for policy review.

When the proposal was publicly exposed, Snyder withdrew it. Rep. Moss last week announced that he has asked DOD what its future plans are—that is, if Snyder intends to come up with another such proposal at a later date. Rep. Moss wrote:

"News reports resulting from the disclosure of a proposed Department of Defense directive controlling advertising by defense contractors stated that, as a result of the publicity, the directive would not be put into effect at this time.

Lockheed pays dividend despite drop in earnings

Lockheed Aircraft Corp., despite reduced first-quarter earnings, has declared a two percent stock dividend. The dividend is being paid in stock rather than cash, according to board chairman Robert E. Gross, "to conserve the company's cash for expansion and product improvement."

Gross stated that first quarter earnings of approximately $2.75 million were down about a third from the same period last year. Sales and backlog are both considerably above last year's figures.

Almost 90% of Lockheed's business is in missiles, satellites, and military aircraft. Their major missile program, the *Polaris,* is progressing well, Gross reported, and on schedule. Based on a long-term goal of 45 *Polaris* submarines, each carrying 16 missiles, the company anticipates a production run approximating "those we used to have for military aircraft." The Lockheed report also cited NASA's plans to buy 16 *Agena* satellite vehicles at a cost of $50 million.

United Consolidates Two Groups to Add Capability

United Aircraft Corporation's Missiles and Space division has been consolidated with its Hamilton Standard Division at Windsor Locks, Conn.

Hamilton Standard, already engaged in electronics, ground support equipment and Space Age activities, will provide the missiles operation with the facilities lacking in the previous setup, the company says.

Wright A. Parkins, United's vice president for engineering, will relinquish his additional assignment as general manager of the missiles and space division. Charles M. Kearns, Jr., general manager of Hamilton Standard, will direct the operation.

Two current military study contracts recently awarded the missiles and space division will be continued under Hamilton Standard. Two earlier hardware contracts will be transferred to United's Sikorsky Aircraft, where the work is being performed.

He built the strongest roof in the world

This AMF engineer knows what it takes to shrug off megaton forces. He *had* to know because he designed the prototype atomic bomb shelter at Frenchman Flats, the only building that stood up under the force of the atomic bombs exploded there. Well, not altogether—a flange on the door *was* bent.

In order to design the shelter, he had to calculate the effect of the explosion on materials and structures. He had to know how the shock was transmitted through the earth's crust and what effect it would have on the shelter—from beneath as well as from above. And, after the dust of calculating had settled, he had the very practical problem of expressing the results in steel and concrete. He did so, successfully.

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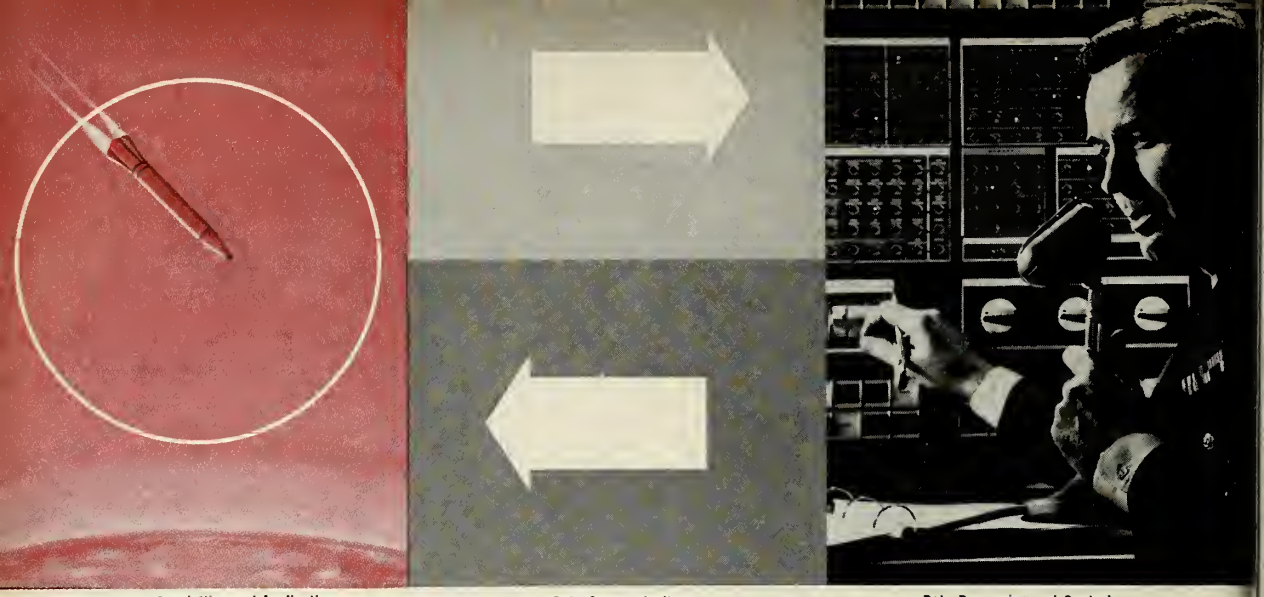

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Technical Countdown

PROPULSION

Nozzles Solid Stumbling Block

Big solid rockets will never be used for space missions, says Dr. W. J. Harris, executive secretary of the Materials Advisory Board, because the nozzles will never be developed in time to keep up with liquid rocket development. Lead time for a big solid nozzle is much too long, Harris says.

N_2O_4 Switch Seen for *Agena-B*

The Lockheed long-burning, restartable upper stage, *Agena-B,* will switch oxidizers in later versions—from inhibited red fuming nitric acid (IRFNA) to nitrogen tetroxide. The change will package higher energy in the hypergolic combination with UDMH. Farther down the road: a fluorine-hydrazine combination.

AF Buying *Scouts*

AFBMD and Chance Vought will sign a contract in the neighborhood of $2 million for several copies of the Air Force version of the NASA solid-propelled *Scout* satellite launcher. AF may put a new name on its version.

GCR-Marquardt Fire 32 Hybrid Motors

Grand Central and Marquardt have fired 32 hybrid motors in their joint, company-funded program. Grand Central makes the fuel grains; Marquardt provides the pressure-fed liquid oxidizer system. GCR says the hypergolic propellants are storable from –60° to 160°F. Thrust can be modulated between 0 and 100% by oxidizer flow controls.

Reliable Valve Introduced

A more reliable primary fuel valve has been developed by Clary Dynamics for the Lockheed *Discoverer* program. Duel squibs and dual wire leads insure that one functions even if the other fails.

ASW ENGINEERING

Killer Boat Launched

Killer submarine Tullibee launched last week at Electric Boat Co. has torpedo tubes amidship rather than in bow—devoted to sonar gear. Navy says she'll be the quietest running nuclear boat in the fleet. House Appropriations Committee is calling for four other attack-type subs.

'Task Force' Proposed

One leading oceanographer says it is possible to detect submarines by sampling disturbance of marine organisms. He calls for a research group composed of a marine biologist, a biochemist, a physiologist and a physicist.

New Market Opens for Small Business

Less than a dozen companies provided instrumentation for the Navy's bathyscaph Trieste. Now that improvements and advanced models are in the works, oceanic experts says the field was never better for small companies that can come up with improved lighting, TV, sonobuoys and instruments for measuring currents, salinity, etc.

GROUND SUPPORT EQUIPMENT

Bases in the Hole—Wired

Titan power house and control center "igloos" at Lowry AFB will be reinforced against thermonuclear blasts with up to 25 layers of prestressing steel wire—about 1600 miles of wire under tension of 150,000 psi for the 12 buildings.

Zeus Cell Passes First Test

Underground launching cell for *Nike-Zeus* underwent first successful test firing April 28 at White Sands, N.M. Thiokol's 450,000-lb.-thrust booster carried dummy sustainer and warhead. Underground cell for *Zeus* is an economy measure that reduces costs of temperature control and simplifies maintenance—rather than truly "harden" the base.

ELECTRONICS

SAGE Extends to Sea

Flying electronic detection stations will extend SAGE defense network over the sea. Lockheed Aircraft Service has received $3.5 million contract to assemble, install and flight-test the electronic systems in two RC-121 aircraft.

High-Temp Transistor Developed

The first gallium arsenide transistor—capable of withstanding the high temperatures in missiles and space vehicles—has been demonstrated by RCA. It is reported able to operate above 480°F. It is a diffused junction drift-field type.

Decoy Uncovering Sought

The best practical method of detecting ballistic missiles among decoys is sought by Raytheon under a $1.8 million ARPA study.

ADVANCED MATERIALS

Space Experiments Due

Capability of the earthbound environmental test chamber has about been reached, NASA materials specialists say. Now experiments must be held in space—to test the combined effect of vacuum, radiation and micrometeorite erosion. Most tests will be aboard *Scout* satellites.

Problem Solved

All nozzle and nozzle insert problems would be solved if just one material were developed, engineers reported at the Cincinnati materials symposium. What is needed is a rubbery refractory.

New Cryogenic Line Reported

AiResearch Manufacturing Co., a Garrett Corp. subsidiary, reports it has applied for patent on a method of transporting cryogenics such as liquid nitrogen in ordinary transfer lines, without vacuum jacketing, for more than 25 feet. Exterior remains frost-free. Flexible plastic lines can be used. AiResearch gave no hint as to how it is done.

Future of Ocean Research Is Vast

Lockheed tells Congress official estimate of time needed to double effort is 'conservative'; sub threat stressed

by Donald E. Perry

Lockheed Aircraft Corp. last week gave the House Science and Astronautics Committee an illuminating picture of the role American industry can perform in oceanic research if government draws on industry for critically needed scientists and engineers and provides the same kind of funding and priorities that have been given the nation's space program.

The corporation's presentation was made by Dr. James E. Lipp, Director of Development Planning, and undoubtedly represents Lockheed's advanced thinking toward opening new markets. Lipp spoke at the end of a session of hearings on oceanic research.

Lipp had been preceded by Dr. Harris S. Brown, noted professor of geochemistry at California Institute of Technology, who warned that "no matter how hard we might make a missile base on land, it is difficult to create it in such a way that people in neighboring communities are not going to be killed should there be an enemy attack."

Brown emphasized that "we are being pushed into the oceans" for a major answer to the problem of creating hardness in our missile bases, and said in another decade or so "warfare is going to be conducted primarily in the ocean." He pleaded that if we are going to fight a war there we must get more knowledge of the ocean—the victor in such a war will be the nation which knows the most about the sea.

Brown termed the long-range nuclear-powered missile-carrying submarine "the most serious military threat that the United States faces," and said learning how to find such submarines is perhaps the most serious and difficult technical problem which the nation faces in the military field.

On one point Lipp took issue with Brown, who is chairman of the National Academy of Sciences Committee on Oceanography. Lipp said the committee's estimate that the research effort can double in 10 years and reach a level about one-tenth of our present space effort "is very conservative." He said the estimate was based on the rate of training of new oceanographers, but he reminded the committee that the nation's space program in a few short years exploded from essentially no effort into a major profession simply by drawing on industry for scientists and engineers.

Lipp urged an accelerated basic research program as a foundation for future progress in the sea, but said that in addition the engineer and the scientist must become familiar with the new environment and thereby learn how to exploit it and behave in it.

He slid lightly over the Naval weapons aspects in the open hearing session, but said many developments indicate that the Navy is moving toward operation in the full depth of the ocean.

His emphasis was on the many peacetime commercial and industrial activities which will gain impetus from the Navy program. They included:

• **Devices for undersea research.** Lipp advocated a mid-depth type of vehicle, a "mesocaph," to operate at depths of 15 to 18,000 feet, which would have good maneuverability and a substantial payload. He said about a dozen of such craft are desirable, since roughly half the geographic area of the world will fall within their capabilities. He said also the Navy's bathyscaph Trieste should be improved as to payload and maneuverability, and that three or four such craft will be necessary within the next several years.

• **Cargo submarines.** Lipp said advances in structural materials, submarine hull design and power plants are steadily bringing closer an "economical" cargo submarine. Chief advantages would be low drag of a submerged hull and relative immunity to heavy weather or destruction by enemy submarines. Such a development would also give rise to new kinds of shore facilities for efficient loading and unloading. Lockheed recently acquired the Puget Sound Bridge and Dry Dock Co., Seattle, but neither it nor any other firm has a cargo submarine development project.

• **Undersea pipelines.** Lipp said a study is being made in Europe of a gas pipeline from North Africa to southeastern Spain, and the project is undoubtedly the forerunner of a network across narrow seas and straits all over the world.

• **Underwater communications.** He sees only uses on a modest scale and in special situations—for example, across the Arctic where the nuclear-powered submarine has the technical capability to lay a cable under the ice in a geographical area where magnetic disturbances seriously affect most other forms of communications.

• **Fresh water conversion.** Lipp believes areas of development are tremendous; the chief problem is to reduce operating costs of distillation plants to a level competitive with natural sources of fresh water.

• **Mining and chemical extraction of minerals.** Oil exploitation will continue on the upswing, with a next big step being recovery of manganese and cobalt from ocean deposits.

• **10-year program**—In separate testimony, James H. Wakelin, Jr., assistant secretary of the Navy for Research and Development and Chairman of the Interagency Committee on Oceanography of the Federal Council for Science and Technology, said his committee has estimated that total cost of oceanic research will approximate $1 billion in a planned 10-year program, if a goal to double present capability is realized.

Total funding of the nation's oceanic research requested in FY 1961 totals about $56 million, an increase of almost 50% over FY 1960's level of $37 million (M/R, May 2, p. 41). This does not include approximately $14 million for military surveys and about $10 million for military research programs mainly funded by ONR.

The Interagency Committee, with representation from DOD, Commerce, Interior, Health, Education and Welfare, the National Science Foundation, and the AEC, gives these estimated major cost elements of the 10-year program:

Oceanographic research and ship operations . . .	$490 million
Ocean surveys and ship operations	$144 million
Construction of 78 new ships and facilities . .	$405 million

The U.S. now operates about 52 ships, mostly of small size for oceanographic research and surveys. About 30 will be replaced during the next 10 years because of overage.

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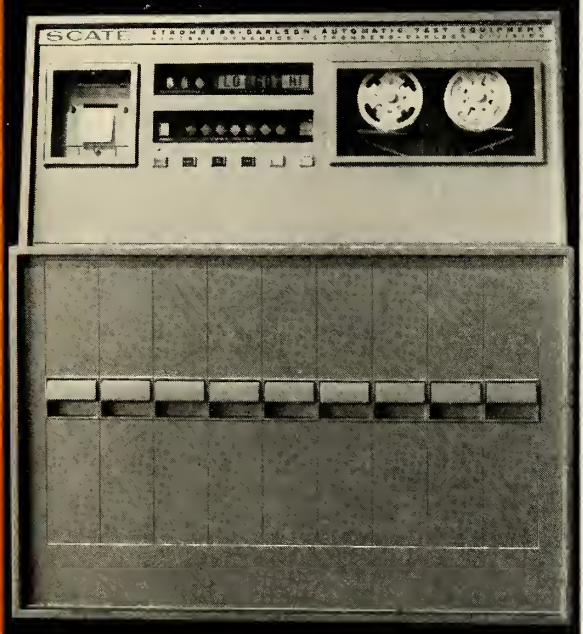

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GCR Boosts Segmented Solid Rockets

Company spokesmen claim big segmented birds will be feasible and reliable, countering arguments by advocates of on-site loading

by Frank G. McGuire

REDLANDS, CALIF.—A segmented very large solid-propellant rocket will be reliable, easily tested and capable of tremendous growth, Grand Central Rocket Co. officials declare.

Grand Central is one of six bidders on the Air Force's Project 3059, for developing a solid rocket of 100 million pound-seconds total impulse. The bidders are divided on how to go about building such a rocket. Thiokol and Rocketdyne favor a single unit loaded at the launch site. Grand Central, Aerojet-General and United Technology Corp. are following the "tootsie-roll" approach. Hercules Powder Corp. is not publicly committed.

In interviews last week, GCR officials pointedly countered the arguments put forth by Thiokol's Bryce Wilhite, technical director of the Utah Rocket Operations Center (M/R, May 2, p. 37). And they outlined what they contend are additional advantages of segmented construction.

Principal areas of differing opinion were reliability, testing capability, and growth potential. Other voices have been heard, questioning the risk of "disastrous results" occurring if combustion were to succeed in getting between the segments and causing end-burning of the grain. Some on-site loading proponents have maintained that a foolproof sealing and inspecting of these seams will be necessary.

• **Reliability and testing**—"When people refer to a 95% reliability factor in a rocket, they are talking about liquid propellant rockets, not solids," said Larry Thackwell, senior vice president-advanced concepts. "This approach will give us a reliability factor of .9999 for each segment—or a system reliability of .99," he said, pointing out that the *Mercury* escape rocket being produced by GCR has a reliability factor of .999.

The approach being followed by GCR is aimed at producing the "simplest rocket ever built," according to Thackwell, who pointed out that the company conducted thorough studies into both methods of building huge boosters, and has the capability of following either route now under consideration by industry.

The preparation of propellant grains in short sections that are open for inspection at both ends allows X-ray and other quality control methods to thoroughly check each segment. The grain can be inspected through the web thickness, as well as on the port surface.

Economic advantages exist if flaws are found in the grain of a segmented booster, contrasted with the single-grain booster. A flaw will cause only the affected segment to be replaced, compared with the required scrapping of the entire motor in event a fault is found in a single grain booster.

Additionally, dividing the booster motor into separate sections permits transverse expansion joints in the propellant grain, allowing grain freedom to expand or contract in the axial direction. This freedom from constraint greatly minimizes the tendency for the grain to crack in the hoop direction under conditions of suppressed hoop tension arising from grain shrinkage during cooling after curing, from low temperature conditioning, and from expansion of the case wall under internal pressure during motor firing.

"As for hydro-testing," said G. R. Makepeace, vice president-research and engineering, "we can hydro-test each casing segment before loading propellant, then use pressurized inert gas to accomplish the same purpose after the assembly is completed and ready to fire."

The quality control and testing capabilities presented by the segmented motor approach provide a level of quality in the final product that is far superior to any quality control possible with one huge motor, GCR feels.

• **Growth potential**—One Grand Central official termed the comment on "lack of growth potential" in segmented solid boosters as ". . . a remarkable statement." The very concept of using building blocks as a basis for constructing large boosters has "growth potential" written all over it, he said.

By use of standard segments, boosters may be built to a wide range of total impulse values and thus be used for any combination of upper stage and payload weights for a variety of end uses.

The thrust and corresponding burning time values can be varied to suit any particular trajectory by adjusting the combustion pressure and/or utilizing propellants with the desired burning rate.

The method of adding segments to attain greater total impulse has a limitation, based on the geometry of the motor. In the present design being proposed by GCR, this limitation is five segments, which would fulfill the thrust requirements laid down in the present competition.

In boosters requiring more thrust, a change in core design and nozzle configuration would probably be sufficient, but this solution is good only to a point.

When extremely large boosters are required, clusters of segmented motors will unquestionably be the only answer, in view of the overwhelming disadvantages—economic, technical and reliability-wise—faced by huge one-grain motors. Many of the arguments presented in favor of segmented boosters gain strength as the size of the proposed vehicle increases.

The segmented method, with its ready-made attach points at the juncture of each section, merely continues its building block concept.

• **Inert parts**—The increase in weight due to inert parts required by the segmented approach, in the form of bolts and flanges, has been calculated to be almost negligible. G. Daniel Brewer, assistant vice president-project management and marketing, said this increase in weight has been calculated to equal nine parts in 1000, ". . . an insignificant penalty to pay for all the advantages of the system."

Propellant mass fraction (ratio of propellant weight divided by motor

gross weight) is apparently almost unaffected by the slight additional weight, and will not affect performance appreciably.

• **Propellant geometry**—Considered by some to be the biggest drawback to the segmented approach, end-grain burning is all but ignored by Grand Central. The company says it has a foolproof solution to the situation, and doesn't even consider it a problem.

The grain, measuring ten feet in diameter by 13 feet, has a perfectly cylindrical hole down the center axis. The geometry of the case segments is such that when the exposed surfaces of the propellant are ignited, they will burn at an even rate. The amount of surface exposed to combustion at any instant is essentially constant.

Segments are joined, end-to-end, by a conventionally-designed bolted flange and sealed with an O-ring. A single case segment joined to an appropriate nozzle will provide the propulsive power equivalent to a *Thor* IRBM. Two case segments, forming a motor approximately 26 feet long, will provide the propulsive energy of an *Atlas* ICBM.

Five of the presently-conceived GCR segments incorporated into one motor would be capable of boosting the second and third stages of *Saturn* to a velocity of over 3100 ft./sec. Company spokesmen point out that thrust termination in the solid propellant motors now being produced is such that no vernier correction whatsoever is required for final velocity trimming.

Alleviation of the slump problem faced by propellant grains placed in long-term storage has been accomplished through the use of the short-section grain. The visco-elastic flow which takes place in the grain is a gravity effect that is accentuated by grain size. A short-length segment will slump much less than a full-length motor when stored in a vertical position.

Also, segmentation enables use of dummy cores, removable just before assembly, which would be centered from the girth joint flange at each end of the segment. These would completely eliminate grain slump during horizontal storage.

• **Other advantages**—GCR points out that numerous fringe benefits are to be found in the building block approach to large multi-million-pound boosters. One of these would enable the booster scheduled for a mission to be disassembled and returned to storage, in event the mission is cancelled or postponed. This is not as easily done when oversize vehicles are involved.

Every part of the big booster can be transported by truck, aircraft or ships. This includes the propellant sections (which would be open at both ends and present no propulsive problem in event of fire), the separate nozzles, head closures and igniters.

Combine Dust Reactor, Thermionic Converter?

A Martin Co. engineer has proposed the combination of a dust-fueled nuclear reactor and a shell of thermionic converters to generate from 100 kilowatts to 10 megawatts of electric power in space. Such a device could be developed by 1980, he said.

W. R. Corliss of Martin's Nuclear Division made the suggestion in a paper at last week's Symposium on Space Stations in Los Angeles.

The dust-fueled reactor, Corliss said, is a concept originated by the Armour Research Foundation. In it, the nuclear fuel is in the form of uranium carbide or plutonium carbide dust, so that the heat-transfer liquids or gases can be eliminated with the use of a flowing solid. Thus the possibility of leaks would be reduced.

The dust fuel would be pumped around a racetrack-shaped path, with its flow controlled electrostatically. Nuclear fission would occur only when the dust passes through a region surrounded by a neutron moderator. In other parts of the path, the heated dust would cool by radiation.

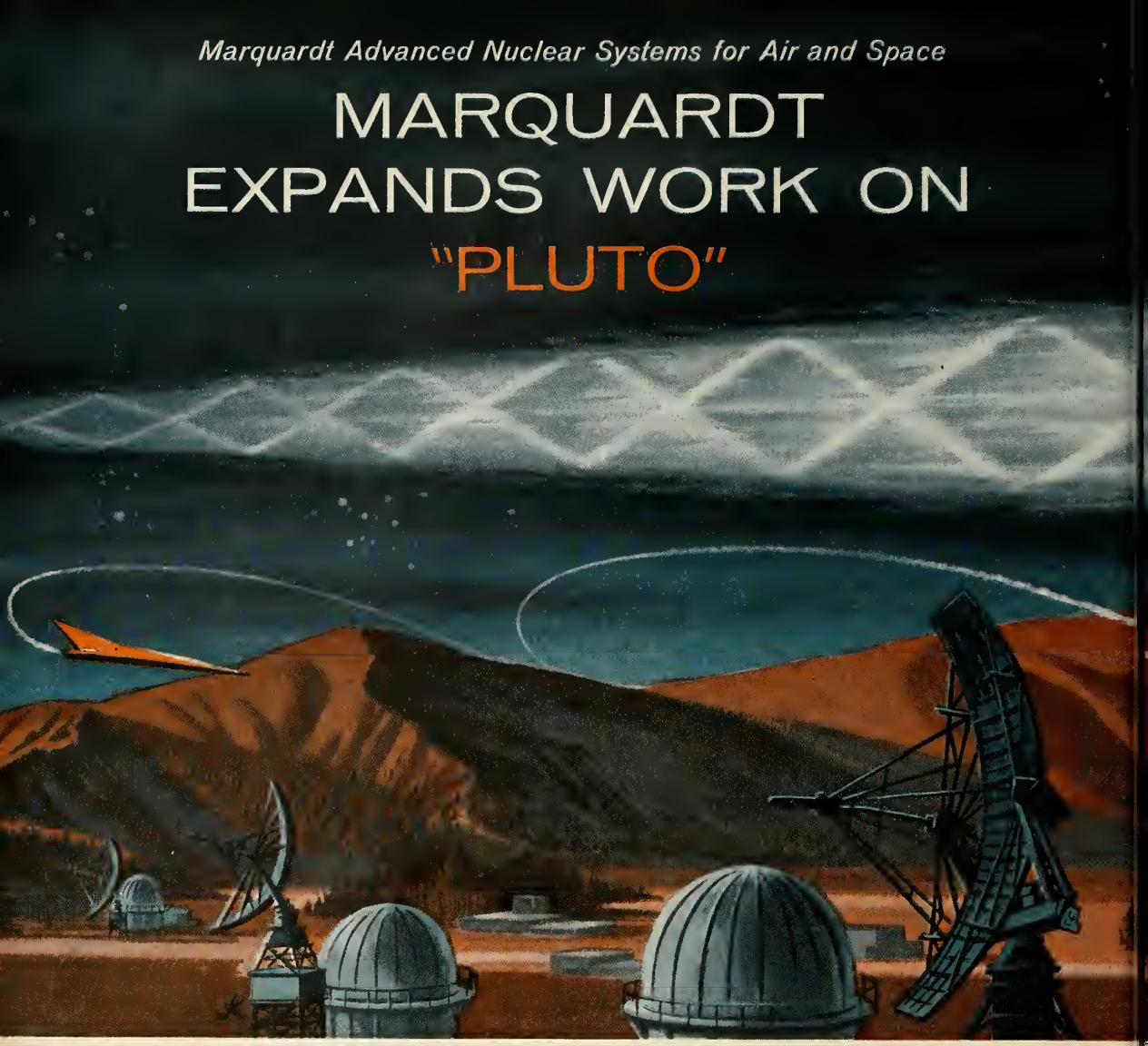
Most of the energy created by the fission would be converted to electricity by a shell of thermionic converters, walls of the ducts. The remainder would be re-radiated into space.

Record-Setting Rocket Run . . .

ATLAS VERNIER engines generate 1000 lbs. thrust for 1930 seconds at Rocketdyne's Propulsion Laboratory, Canoga Park, Calif., in the longest run ever made by a rocket engine. Hydromatics Inc., Livingston, N.J., manufactures Flo Ball valves, which control LOX and fuel flow. Hydromatics says its valves are used on all major liquid rocket projects, including *Thor, Titan, Jupiter, X-15, Nova* and *Centaur*.

Marquardt Advanced Nuclear Systems for Air and Space

MARQUARDT EXPANDS WORK ON "PLUTO"



Broadened team effort with University of California's Lawrence Radiation Laboratory aims toward early feasibility demonstration of a nuclear ramjet reactor (Project PLUTO).

A supersonic, low-altitude missile capable of weaving, feinting and dodging unobserved by conventional radar while seeking out selected targets — this is to be the mission of the Air Force's proposed nuclear ramjet-powered vehicle of virtually infinite range.

As an integral part of the team which is contributing to this country's all-out race for supremacy in weapons, Marquardt is working with the University of California's Lawrence Radiation Laboratory on the nuclear ramjet program, known as Project PLUTO.

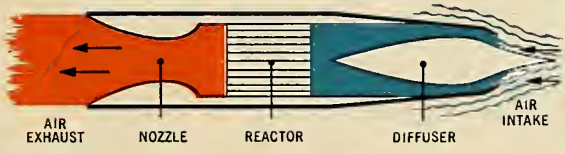
Marquardt's basic PLUTO effort concerns preliminary design of the nuclear ramjet and development of airborne reactor controls and other components for severe temperature and radiation environments. The multi-million dollar program supports a multi-phase corporate effort headed by the Nuclear Systems Division.

Other aspects of Marquardt's PLUTO effort include: support of LRL's feasibility tests on the non-flyable Tory IIA reactor; design and fabrication of significant portions of the reactor's control system, air ducts, flow instrumentation and remotely operated disconnects; fabrication and test of reactor core structural components; architect-engineering on the test air supply system; participation in a supporting program of environmental tests; and preliminary design of test facilities for full-scale power-plant development.

Highlights of the Corporation's other current nuclear programs include: exploration of both military and non-military applications for transportable reactors of advanced design, including their use for space power; development of the engine control system for the G-E nuclear turbojet; research studies of advanced space propulsion devices utilizing nuclear concepts; materials and processes work with molybdenum, other refractory metals and ceramics; and development of original nuclear instrumentation.

For a copy of Marquardt's new "Nuclear Systems" brochure, write to Mr. Aikman Armstrong, Chief Applications Engineer-Nuclear Systems, The Marquardt Corporation, Van Nuys, California.

THE NUCLEAR RAMJET



Nuclear Systems Division of The Marquardt Corporation is engaged in a continuing search for engineers and scientists capable of contributing advances in nucleonics state-of-the-art. Current expansion within this division creates challenging opportunities for: REACTOR PHYSICISTS • CERAMICISTS • NUCLEAR ENGINEERS • METALLURGISTS.

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Variable Thrusts in Solids Achieved at Rocketdyne Div.

Variation in thrust levels in solid-propellant rockets—from 700 to 1200 lbs. thrust—has been achieved by Rocketdyne Division, North American Aviation, at its Solid Propulsion Operations in McGregor, Tex.

The variation was accomplished by the use of a mechanical device consisting of movable mild steel nozzle segments covered with pure molybdenum in high-temperature areas, such as the pintle. Thrust is controlled by changing the throat area.

The first results were attained with the use of ammonium nitrate oxidizer, burning the binder at a temperature of 2700°F. Rocketdyne feels it is feasible to adapt the variable-throat principle to the higher-performance ammonium perchlorate propellants, since it has developed nozzles that have successfully withstood temperatures of 5500°F. The use of such propellants would increase pressure sensitivity, and thus the controllability.

Four tests have been conducted in the program, which began in October. The most recent test took place about two weeks ago. Rocketdyne has used the principle in proposals given to the military, and hopes to get a contract based on it. So far, all work has been company-funded.

"The variable thrust nozzle, when combined with our experience in long-duration firings with new high performance propellants, would have specific applications in battlefield missiles, sled boosters, aerial target drones and air-to-ground missiles," said T. E. Myers, vice president of Solid Propulsion Operations.

Radiosonde Measurements Used in Saturn Safety Work

Army weather specialists are taking daily radiosonde measurements throughout the *Saturn* booster development program at Redstone Arsenal so as to predict what the sound intensity from static firings will be at any given location.

The weather data will help insure that firings of the clustered rocket at 1½ million lbs. thrust can be conducted with complete safety of people and property in neighboring Huntsville, Ala.

The Army Ballistic Missile Agency is developing *Saturn* for the National Aeronautics and Space Administration. On July 1, the ABMA Development Operations Division will become the George C. Marshall Space Flight Center, an integral part of NASA.

The radiosonde measurements are typical of support services provided for ABMA by the Army Rocket and Guided Missile Agency. Both are elements of the Army Ordnance Missile Command, headquartered at Redstone Arsenal. ARGMA will continue to provide this type of technical support as required after July 1.

The weather data is taken by sending small radio transmitters aloft in helium-filled balloons with instruments for measuring atmospheric pressure, temperature and humidity. On the ground, a radar-type tracking unit and a meteorological recorder transcribe the messages sent by a radiosonde transmitter-modulator. The balloon bursts at an average height of 90,000 ft. and a small parachute carries the radiosonde to earth.

Daily radiosonde measurements during the *Saturn* program will enable the weather specialists to build up a complete area weather history and make it possible to predict the most favorable firing times.

Slow-Burning Solid Fuel Developed for APU Use

A solid-propellant grain with the slow burning rate of about 0.042 in./sec. (1000 psi, 60°F) has been developed for use as an auxiliary power fuel source.

AiResearch Manufacturing Division of Garrett Corp., which developed the grain in cooperation with Amoco Chemical Corp., said the slowest-burning propellant previously in existence had a rate of 0.059 in./sec.

The propellant was used to operate a 30 KVA turbo alternator in a 32-minute hot gas run. AiResearch said this demonstrated that duration is no longer a particular limitation on the use of solids for auxiliary power.

The company said a former problem—degradation of turbine performance because of hot gas contamination—did not appear.

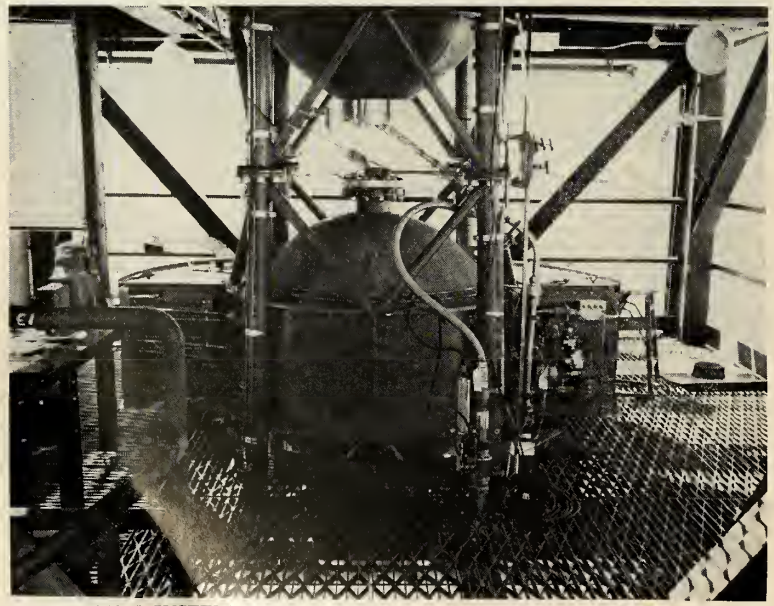
AEC Tentatively OK's Martin Reactor Facility

The Atomic Energy Commission plans to issue a permit to The Martin Co. to build and operate a fluidized bed critical reactor facility near Middle River, Md.

The AEC last week gave notice of intent to allow Martin, under an AEC contract, to test the criticality of slightly enriched uranium oxide fuel pellets. The facility, to be constructed by mid-1960, will operate at maximum power of about 10 watts.

The permit will be issued unless a request for a hearing is received by May 12, the commission said.

Storable Propellant



PROPULSION SYSTEM tanks installed in static test stand at Edwards AFB, Calif. The 6K system utilizes the same high-performance storable nitrogen-tetroxide and hydrazine planned for *Titan*. Tanks were made by Standard Steel Corp.

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High Temperature R&D Money-Starved

A survey of how a fundamental field is hurting from lack of adequate funding and a shortage of glamor

"But there can be no doubt that we can maintain an effective deterrent only by making certain that no other country will ever reach the next higher technological plateau before we do . . ."
General Thomas S. Power, USAF
Commander in Chief
Strategic Air Command

by John F. Judge

PHILADELPHIA—The U.S. is spending money at the rate of about $1.5 million per year in the field of basic high-temperature research—the fundamental source of progress in rocketry.

Dr. Aristed V. Grosse, president of the Research Institute of Temple University and one of the handful of men actively engaged in broadening our fundamental understanding and handling of high temperatures, estimates that over $30 million per year would just barely meet our needs.

There is little doubt that we have almost exhausted our fund of basic knowledge in the fields most critical to the advancement of the space effort. Various leaders in government and industry have pointed this out time and time again. The National Academy of Sciences has endorsed this viewpoint (M/R, April 4, 1960, p. 28). But little is actually done.

Five years ago the late Dr. Wendell Latimer of the University of California, upon receiving the Nichols Medal, said: ". . . high-temperature thermodynamics holds the key to the important problem of U.S. leadership in nuclear energy, jet engines and guided missiles." It still does. This is because there is a direct relationship between the maximum power generated and the temperatures involved.

Expenditures in this area, says Dr. Grosse, would pay off handsomely at least in the decreasing of the rate of military obsolescence.

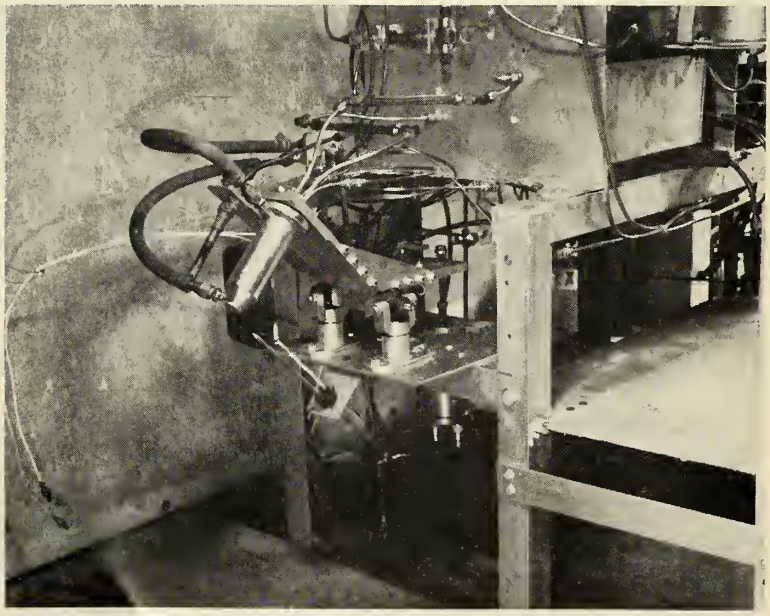
• **Glamor lacking**—The Temple scientist went on to another problem in high temperatures—manpower. This type of work is quite unromantic and lacks the glamor often attached to other aspects of the space business. Fewer and fewer young men are attracted to the field, he said. One of the most important aspects of high-temperature work, and one in which we are particularly weak in this country, is the discipline of an inorganic chemist. The reactions involved and their understanding are less likely to be achieved as quickly as in other more glamorous categories of pure science. To emphasize the manpower point, Dr. Grosse said that a single German University will turn out more PhD level men and women in inorganic chemistry in 1960 than all of the institutions in the U.S.

Under Dr. Grosse, the Institute has been specializing in high temperatures for twelve years. In terms of degrees Kelvin, the area of interest lies between 2000° and 50,000°. Regrettably, all of the current work is concentrated nearer the lower end of the scale. The primary aim of the Institute is the creation and control of high temperatures—and an understanding of their nature.

The main laboratories are located in a mansion formerly owned by Isaac D. Levy. An extension, a high temperature test site, is operated by the Institute in a small group of buildings on a farm in the vicinity of Valley Forge.

Most of the current projects are concerned with the generation of high temperatures, usually through chemical means. Fuels and oxidizers such as cyanogen, ozone, O_3F_2, O_2 and F_2 are a few of the more common ones in use. Temperatures around 5500°K have been investigated in this manner (M/R, Dec. 14, p. 17). The exhaust streams of these experimental rockets have been used to evaluate materials for nose cones and nozzles.

A major project rapidly nearing completion at the Institute is a microrocket propellant evaluator. Under development for the Army Ballistic Missile Agency, the instrument is designed to give an evaluation of labor-



PROPELLANT EVALUATOR being developed for ABMA. The microrocket is mounted on the V-shaped deflection unit and is designed to provide data on laboratory quantities of new propellants.

itory ideas in propellants wherein only a small amount of the substance is available. The device measures the thrust effects through use of a torsion type deflector attached to the motor. This is necessary because no known materials will exist in the exhaust stream long enough to give meaningful results in deflection-type measurements. Although the data obtained are limited, it provides a basis for deciding whether the test propellant holds any promise.

• **Powder metal torch**—Another interesting development is the construction of a powder metal-oxygen cutting torch. This device uses the burning of powdered aluminum and other metals to cut through construction materials such as concrete.

The Institute has built a small plasma jet to aid in the studies of the behavior of gases at high temperatures.

The field of high temperatures has been but minutely penetrated. Researchers at the Institute intend to go on in a number of divergent directions within the field. Some of the more promising areas include:

• Detonation—largely unexplored in the past. Quenching and slowing of detonation waves, and dead pressing (rendering explosives safe by reaching maximum density) are of particular interest to the Temple group.

• High energy propellants—liquids and solids.

• Plasma Jet—To be used in chemical studies as well as aerodynamic heating. The end of chemical temperatures has not yet been reached.

• Inorganic Chemistry—theoretical studies.

• Combustion of metals—the powder metal-oxygen cutting torch is an example in this area.

Dr. Grosse and his staff firmly believe that it is only through working with high temperatures that basic understanding can be achieved. For years it has been common knowledge that finely powdered aluminum and an open flame lead to disaster. The Institute has had little or no trouble in this area. Most professional scientists would be uncomfortable anywhere near ozone yet the Temple staffers work with it almost as a matter of course. There are many unknown factors yet to be discovered before the handling of high temperatures becomes practical; working with the environment instead of talking about it is the shortest route to success.

The next technological plateau in space will probably be attained through high temperatures. It is the fervent hope of Dr. Grosse and others in this field that the United States will get there first.

Ceramics Pushed

Metals being outstripped in space materials needs

Space Age materials requirements have all but exhausted the possibilities of metals and the trend is more and more toward ceramics for solutions to the high temperature problems.

John R. Townsend, Special Assistant to the Director of Defense Research and Engineering, told a recent meeting of the American Ceramic Society in Philadelphia that the Government was intensifying its effort in the field of ceramics to the point where it is considering establishing an information center on ceramic materials similar to those in existence at Battelle Memorial Institute.

In the same vein, Dr. Townsend pointed out that the usual time lag involved from discovery to application is eight years in materials research. If materials research processes cannot be speeded up, "we will be handicapped more and more in the technological race."

Looking to the future, Townsend outlined six major areas of interest in which the potential space uses of ceramics were enormous.

• Specific data on the rare earth oxides such as melting points, vapor pressures, density, ductility, thermal conductivity, thermal shock resistance and emissivity.

• Simplified processes for radomes, nose cones, insulation, coatings, adhesives and rocket nozzles.

• Effects of radiation on ceramics.

• Structural and semi-structural ceramics for use up to 3500°F.

• Bonding of ceramics to metals as coatings to withstand high temperatures, erosion and corrosion.

• An information center on ceramics with a broad familiarity of technical and patent literature.

• **Manpower**—Twice as many ceramic engineers, technologists and glass technologists are needed immediately to carry out various development programs necessary to the missile/space effort. Dr. John H. Koenig, Rutgers University, told the meeting that enrollments are not increasing despite the fact that the average ceramic graduate has as many as eight job offers on graduation. Since vehicles such as *Tiros I* carry nearly 10,000 separate ceramic components, and the new developments in nuclear and electronic fields are often tied to ceramics, a dearth of qualified men in this field will have far-reaching and disastrous effect.

Silica Radomes Survive Force of Ballistic Re-entry

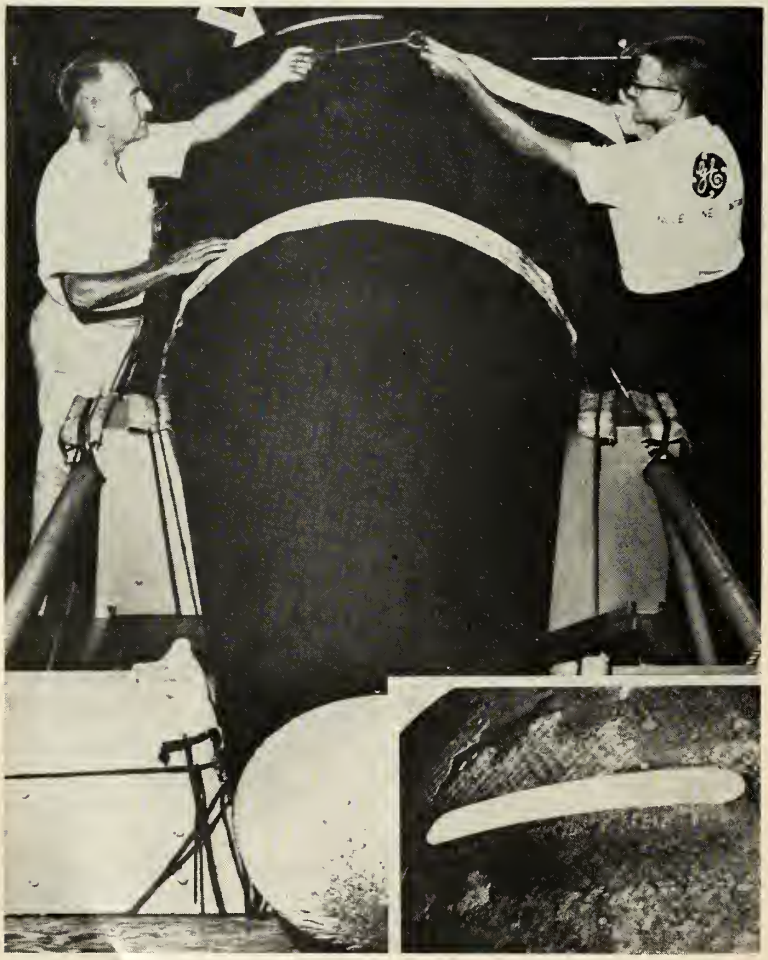
Fused silica antenna windows have survived ballistic re-entry in an experimental ablative nose cone.

The windows were in a General Electric Missile and Space Vehicle Department RVX-2 experimental nose cone flown 5500 miles down the Atlantic Missile Range on July 21, 1959, but data on these radomes was just released by the Air Force.

The windows were made by the Corning Glass Works, Corning, N.Y., from pure silica through their "Multiform" process. This method of manufacture, in which the gaseous silica is condensed into a solid slab, permits the fabrication of a wide variety of shapes—a feat not possible prior to the Corning development.

The pure silica, in its fused state, is extremely viscous at its softening point around 2880°F and tends to sublime before it can liquefy and flow. In addition, excellent thermal shock resistance (Coefficient of thermal expansion—3 x 10^{-7} per degree F), a stable dielectric constant and a low loss tangent over a broad temperature range contribute to the material's success as an ablative radome.

At a frequency of 8.6 x 10^{9} cps, the dielectric constant is 3.58 at 77°F and 3.57 at 750°F. At the same frequency, dielectric loss factor ranges from 0.00069 at 77°F to 0.00098 at 750°F.



ARROW POINTS to one of the two fused silica windows, produced by Corning Glass, that protected telemetry antennas in the experimental nose cone. The inset is a close-up view of one of the windows.

LOX Ground Transfer Lines Can Be Extended

Studies at the National Bureau of Standards indicate that the transferring of cryogenic fluids by pipelines can be done over distances much greater than are currently in vogue provided there is an awareness of the cool-down performance limitations.

The theoretical examination of such transfer problems have been completed and the Bureau is now in the process of experimentally verifying the paper conclusions.

The entire project has a twofold purpose—to determine the hardware and techniques needed; and to ascertain what losses will occur during these long-distance transfers.

The Bureau's conclusions are derived from a mathematical model based on the laws of conservation of mass, energy and momentum. These laws were used along with verified assumptions and empirical data to yield a complete model consisting of 12 equations which describe the flow characteristics of a transfer line. This flow model permits the design of a transfer system by relating all the pertinent parameters—flow rate, line length, line diameter, pumping pressure, heat leak and fluid properties.

Since economic and feasibility questions are unanswered in the equation, the Bureau computed relations involving all of the known loss factors and, together with equations for heat leak and fluid drag, included them in the total computation.

Thermocouples Measure Temperatures Up to 5000°F

Extensive investigations at Minneapolis-Honeywell's Research Center, Hopkins, Minn. have shown that two relatively new types of thermocouples have promise above 3000°F and as high as 5000°F.

Rhodium-iridium/iridium couples can be used in vacuum or inert atmospheres and in oxidizing environments up to 3600°F. This is 600° beyond the capabilities of platinum-based thermocouples.

The other thermocouple, tungsten-rhenium, is outstanding in stability and power for applications in other than oxidizing atmospheres up to 4000°F and potentially almost to 5000°F, according to John B. Moxness, Brown Instruments market manager. This is in contrast to the 2400°F limit for chrome-alumel thermocouples.

The studies were carried out by Honeywell in cooperation with the National Bureau of Standards and several other companies.

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"A Mathematical Model of an Air Defense Operation and a Method of Evaluation," a paper by SDC's staff, is available upon request. Please address inquiries to Mr. E. A. Shaw at SDC.

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NAA Cuts Costs with IBM Computers

Nation's 'largest' electronic data processing system links firm's divisions, boosts speed and accuracy

CANOGA PARK, CALIF.—Teamwork by International Business Machine Corp. and Rocketdyne Div. of North American Aviation, Inc., has paid off in a series of substantial benefits to the nation's rocket engine program, including speed, accuracy, efficiency and reduced costs.

Over 175 pieces of equipment in Rocketdyne's plants have made electronic data processing and control an indispensable aid to research, development and production of both solid and liquid propellant rockets.

What the two companies call "the largest electronic data processing complex in the nation" is due in part to a 30-mile microwave link connecting North American's two IBM 705's and two 709's at the Los Angeles Div. to the two 709's at Rocketdyne. The Autonetics and Missile Divisions of NAA soon will join the net for an even larger complex.

Developed at Rocketdyne's request by IBM and the Pacific Telephone and Telegraph Company, the network passes information back and forth at the rate of 75,000 words per minute.

Use of the link has eliminated the past problem of a peak work load at one computer installation simultaneous with a slow period at another computer installation. Work can now be distributed so that the divisions utilize the machines as a pool. Overall efficiency has increased measureably.

In addition to the main microwave link, Rocketdyne has secondary data links—leased wire cryptographic systems—connecting its operations at Neosho, Mo., McGregor, Tex., and the Santa Susana Mountains near Canoga Park. By fall, another link is expected to connect the division with the test stand for the F-1 million-and-a-half-pound-thrust rocket engine at Edwards AFB, Calif.

In addition to achieving better work distribution for its six big computers, North American also has gained the capability of programing each computer for the work it will perform most efficiently. The two 709 models at Rocketdyne are used mostly for scientific work, while the 705's at the LA division are occupied primarily with business matters.

However, even the two 709's at Rocketdyne may become tied up, and a job will be transmitted to a 709 at the LA division.

• **Typical operation**—In practice, engineers at Rocketdyne feed magnetic tapes into an IBM 9702 remote tape unit to the equipment maintained by the telephone company. The data is channeled through multiplexing gear which feeds it subsequently to the microwave transmitter.

A paraboloidal-reflector antenna atop the Canoga Park plant beams these signals at the relay station on Oat Mountain. (The dog-leg between Canoga Park and Los Angeles via Oat Mountain is made necessary by the Santa Monica Mountains, which prevent more direct line-of-sight transmission.)

At Los Angeles, the signal is reconverted to computer language and placed on tape by another 9702 unit, which feeds it to a model 760 control device. This unit examines the signals to insure that no errors have been introduced during transmission through interference. Then the tape is fed into the 709, the above procedure is reversed, and Rocketdyne gets the results.

APPLICATIONS

• **Production control**—One of the major fields in which Rocketdyne is applying its computers is mechanized production control (MPC), which is expected to yield savings of $50,000 monthly by October. Using a RAMAC 305 (random access method of accounting control) computer, MPC makes it possible to locate any part in the plant, including experimental project hardware, and determine its status within 15 minutes.

This time includes 0.6 sec. for the computer to locate the information, another second or two for the printer to display the data, and the remaining time for routing to the requester.

In full operation since January, MPC began as a study in 1958 and used a punched card system until last December, when the RAMAC was phased in. A 15% reduction in supporting labor costs has been made through use of the system. The method also has contributed to a 37% reduction in costs of *Thor* and *Atlas* engines for the Air Force.

MPC operation follows a flow pattern with few steps. An engineer's design, released for production, is assigned a seven-digit control number. This is supplemented by a code which tells management what "mix" of work (production programs, test programs and experimental programs) is currently in progress.

Information fed into the computer can be retrieved through use of many filing systems. Data can be filed according to part number, engine type, contract number, scheduled completion date, etc. Therefore, if management wants to know the status of all parts being produced under a particular contract, the RAMAC selects the information immediately.

Part numbers assigned to hardware can vary according to their interchangeability among several different engine modifications or engine types; hence the control number links all interchangeable parts.

Data regarding part number, contract number and other statistical information are entered on a color-coded production order, which is used as a basis for key-punching the programing cards to be fed into the RAMAC for future planning. (Plans are currently in the works to eliminate the need for this colored production order.)

The open order card, having been key-punched, is then fed into the RAMAC's storage discs, which whirl at 6000 rpm. The information is then available via a pickup arm that seeks out the proper disc, then extends until the proper bit of data is selected. Since the disc speed does not vary, the data must be picked up "on the fly."

As each job passes through various operations, production progress notifications (ppn) and inspection progress notifications (ipn) are filed with MPC by production control personnel. These reports are key-punched into progress cards which are fed into the RAMAC. The computer then changes all previous status information on that job,

and substitutes the latest data. If a job does not move or does not have its production status changed in any way, no card is filed.

At the end of each day, daily receival and completion reports are prepared by the RAMAC, and these are made available to every department head by 8 o'clock the next morning. The department chief is thus kept fully informed on every production order which moved in his department the previous day.

MPC personnel are currently handling approximately 500 to 600 requests for information (RFI) daily. Within a few months, Rocketdyne expects to have a series of teleprinter installations in operation about the Canoga plant which will allow remote RFI's to be handled.

In addition to the daily receival and inspection reports, a weekly analysis of all work in progress is supplied to management. About 20,000 work orders are in progress at any one time.

Company officials emphasize that the MPC system is utilized for all work in the division's Canoga Park facilities, not just for straight production. Experimental projects and test programs with numerous changes also are handled by the RAMAC system.

• **Budgetary Control**—Application of computer techniques for budget control has been initiated with the aid of a cathode ray tube and the IBM 709. The program covers cost factors affecting any given program: money spent through the prior month, commitments outstanding, adjustments in the estimated annual overhead rate, estimated price adjustments on certain purchases, and estimated charges on cancelled contracts with suppliers.

The system, designated Allocations for Budgetary Control (ABC), produces graphs on 200 projects each month to keep Rocketdyne management informed when costs and budgets don't line up. On each of the graphs are two plots: one line representing planned expenditures, and another showing actual expenditures. Precise differences are shown numerically.

ABC has thus far proved its worth in the *Atlas, Thor, Jupiter* and *Saturn* programs. Cost collection centers, the IBM 709, and a cathode ray tube setup combine to put cost graphs in the hands of top management within 10 days after the close of each month.

Budgetary responsibility for all phases of a function is assigned to the manager in charge. A production manager, for instance, is responsible for budgeting the cost of testing parts which his department turns out, even though the testing may be performed by another group. Thus action can be brought to bear on trouble spots spotlighted by the month-end graphs.

Cost details are collected and classified according to functional responsibility, then transferred to key-punch cards. At month's end, card information is transferred to magnetic tape and transmitted to the Los Angeles Division of North American, 30 miles away. This microwave link directly connects computers at the two NAA divisions.

On arrival at the LA division, data are fed into an IBM 705 computer to up-date the "balance-forward" records and these results are then transmitted by microwave back to Rocketdyne. The processed data are fed into the IBM 709, which converts them into graphic data and portrays them on a 7-inch cathode-ray tube. Photographs are then made of the presentation with a 35-mm camera. It takes less than 12 minutes to photograph the 200 monthly charts.

After processing, photos are bound into report books, and placed in the hands of management the following day.

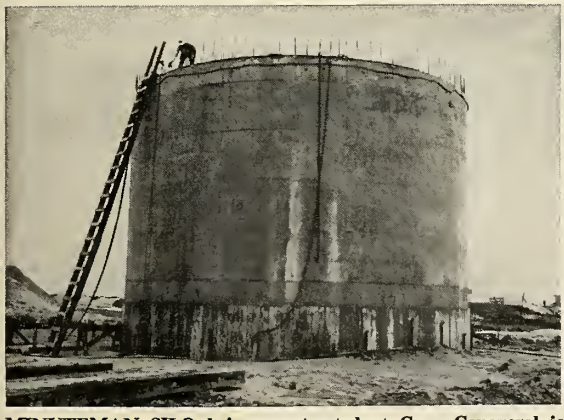
• **Model parts list**—A master list of every item needed to build a particular rocket engine is the result of pressures of time, and the available solution of a high-speed data processing system. Dubbed MPL by Rocketdyne, the model parts list shows, for each type of engine, the parts to be manufactured in-house, the raw material involved, the parts to be purchased, and the likely spare parts to be needed in the field.

Listing items on punched cards, the division files by alphabetical and numerical order. In addition to the usual identification number and part description, the cards show where the part fits, how many are used in each engine, instructions for manufacturing or purchase, a breakdown code if the component is part of an assembly, and a Federal manufacturer's code. Changes are recorded and distributed daily. New MPL's are compiled every other week, reflecting the latest modifications in an engine.

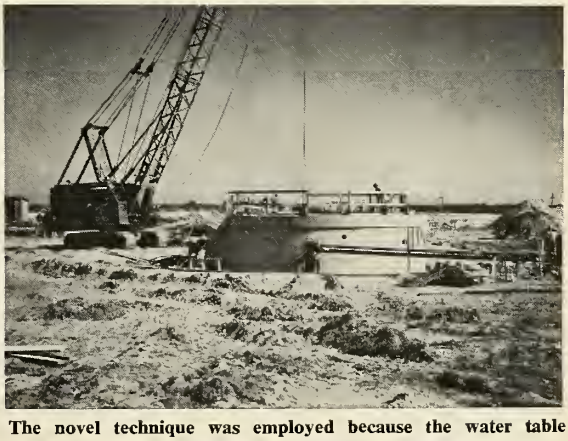
If a standard bolt should fail during an *Atlas* test, the MPL could be used with the computer (IBM 709) to indicate rapidly each engine using that bolt, so that every one can be checked for reliability.

The MPL system allowed Rocketdyne to go into production on the new MA-3 *Atlas* engine within hours after receiving the go-ahead from the Air Force. The system chose every item which was interchangeable between the old and the new engine and wrote new orders for production; the division signed contracts with suppliers for many of the remaining parts.

Sinking a Minuteman Silo



MINUTEMAN SILO being constructed at Cape Canaveral is poured in sections above ground and then sunk into the sand.



The novel technique was employed because the water table is about 5 ft. below surface, preventing hole digging.

'Hot' Bolts Best fo Impact Location

But tests by Sandia indicate that liquids with skunk-like odors may have value; fire-orange paints evaluated

by B. E. Dieruf*

Radioactive bolts, liquid odor-producing agents, and phosphorescent fire-orange paint were used in a recent missile test program to find a better method for rapid impact location.

The "hot" bolts won hands down, but some highly malodorous mercaptans were strong contenders for the honors. Their dedicated persistence—even when buried—earned a limited assignment in future recovery applications. (A mercaptan—an oil liquid similar to the alcohols or phenols, but containing sulfur—is the principal ingredient in skunk oil.)

Tests were performed by Sandia Corp. at White Sands Missile Range, N.M., to support optical tracking and to aid in identifying aboveground debris after impact. Helicopters were used to facilitate search in probable impact areas.

• **Past problems**—After an experimental flight test, the missile often must be recovered so that any test data stored in tape recorders can be analyzed and components can be examined to determine what damage, if any, occurred during the test.

It has always been difficult to locate the point of impact, particularly in the case of an air-launched missile.

If the only consideration during a flight test were to simplify recovery of the missile itself, this could be accomplished fairly easily. One would simply study the terrain and determine the best impact location with respect to camera, radar, and sound ranging stations. The launch point for each missile would be established in accord with the best impact location.

The missile recovery, however, generally is not the most important guide in determining proper launch conditions and location. The launch point frequently is chosen to insure good camera coverage during the launch phase. This results in one or more "fixed" launch points. When any significant number of flight tests have been scheduled, there will be variations in their launch parameters—planned and unplanned—and consequent variations in the flight of the missile in its range, direction, and duration of flight.

The missile may impact anywhere from a few miles to as many as 100 miles away—in a heavily instrumented area, such as the designated impact areas at WSMR, or in a lake region, mountainous area, or some other rather inaccessible location.

Participants in the flight test usually agree upon any changes in flight plan which will prevent the missile from landing in obviously unsatisfactory locations; in spite of these concessions, however, the major criterion in setting the test flight pattern is the best possible coverage in the launch region, rather than in the impact region.

• **Compromises**—In addition to these deliberately planned factors which create difficulties in locating a missile, additional problems make it hard to more than approximate the planned launch conditions.

Many factors enter into the problem for an air launch—in particular, the speed, position and direction of the aircraft at the moment of launch.

In a typical test program, both the aircraft contractor and the range personnel want a maximum number of missile rounds fired per hour by the aircraft on the range. But the missile contractor and the fuze contractor are more concerned that the actual launch conditions are as close as possible to the test plan.

Because of these conflicting desires, compromises are made. Tolerances established for the launch frequently permit a firing corridor extending two miles on each side of the flight line and 3000 feet above and below the requested altitude.

If tolerances are too narrow, aircraft and range time are wasted in efforts to conform to them; if they are too lax, desired launch parameters rarely are achieved.

There are of course many other problems. The presence of any of these conditions or any combination of them can increase considerably the dimensions of the probable impact area.

Experience indicates that a radius of five miles must be drawn about the predicted impact point to include any significant percentage of the total impacts of unguided missiles which travel 30 to 60 miles. For guided missiles, capable of extensive maneuvering, this area would have to be increased considerably.

Guided missiles often can be homed more closely to a specified impact point by placing a target—such as a radar beam or a heat source—in the impact area.

• **Radioactive bolts**—For range safety in the experiment employing radioactive bolts, it was necessary that they have a short half-life. If the unit were not recovered, a short half-life for the radioactive material would insure that the personnel hazard would dissipate rapidly; however, any delays in the test program made use of a short half-life element expensive.

Selected bolts were stainless steel, 10-32 screw thread. A hex head, 5/16-in. across flats and 5/16-in. high, contained a pellet of antimony 124. Antimony 124 has a half-life of 60 days.

At the time of procurement, each bolt had a radioactive output of 3 Roentgens/hour at one foot. This output was selected so that the bolt at the ground surface would produce a usable indication of 0.15 R—roughly five times the background level—even if the search helicopter were 100 feet away and 100 feet up. Search passes could be made every 200 feet.

Missiles used during the tests were unretarded, and they impacted at at least 400 mph. The impact generally buried the entire missile with the exception of a few fin fragments about the crater.

A bolt was installed on each fin, in the hope that one or more fins would break off at impact and remain on top of the ground. Since soil provides a good shield, strong radiation is needed to obtain a significant indication from a buried source.

Four flights were made carrying radioactive bolts. The first two were standard flights and the bolts were installed in the fins. On the first shot the bolts were of no assistance in recovering the unit when buried in soft earth.

On the second round, the missile impacted on hard ground, and the fins were scattered over a large area—up to 30 yards from the crater. The impact

* *Project engineer, Sandia Corporation, Albuquerque, N.M.*

occurred within one mile of a camera station, so a good plot of the flight was available, but the bolts would have insured recovery of the missile in any event.

The other two tests on which the bolts were used had different flight parameters. On both of these flights the missile was cut in two in flight with primacord (an explosive).

The forward section was unstable aerodynamically. It decelerated rapidly, and consequently did not bury on impact. In anticipation of this, bolts were installed in the forward section of the missiles—four on the first, and five on the second.

These rounds were not tracked to their point of impact by either camera or radar, and thus furnished a good opportunity for testing the effectiveness of the radioactive bolts. The first of these missiles landed in a cleared area and could undoubtedly have been found without the aid of the bolts, but it first was located by the scintillation counter in the helicopter. The second landed in a heavy brush area, but was located easily by the helicopter. The impact spot of this test flight was so obscured by brush that, even after the scintillation counter indicated impact location, the searchers had to hover over the area for several minutes before they located the missile visually.

During these tests with the active bolts, only two men received any appreciable exposure, and even this was well under the allowable 3 R in a three-month period. Both of these men were active in the installation and recovery of the bolts on all of the units tested.

Of the three methods attempted to facilitate missile recovery, the radioactive bolts proved most satisfactory. With a helicopter-borne scintillation counter, a large area of ground—even though extremely rough—can be covered in a short period.

If the search were extended in time, a recorder could be used with the counter to reduce operator fatigue. On level ground, radioactive bolts would help a ground research party considerably, but in rough terrain the sources would be shielded and their effectiveness reduced considerably.

Missiles which bury on impact require different techniques. It might be possible to use a much stronger source for the radiation, or to add a tail line with an attached source to the missile, or perhaps to make arrangements to have the radiation source ejected immediately before missile impact.

• **Odor producers**—On several of the flights, a very powerful odor-producing agent—one of the mercaptans—was used. Four 8-ounce bottles of the liquid were placed in the missile and arranged so that they would shatter on impact, thereby permeating the dirt in the crater and reaching the surface. The mercaptans were chosen because of their astonishingly strong odor.

A quantity of amyl mercaptan (boiling point: 126°C) was used in some preliminary tests and in two of the flight tests. In one preliminary test, an 8-ounce bottle was buried in a foot of loose dirt and shattered with a blasting cap. In another test, a bottle was shattered with dynamite, so that the liquid was completely vaporized.

The tests had similar results. In both cases, a band of very strong odor approximately 0.2 mile wide formed downwind. The terrain where the tests were conducted did not permit checking the odor at further than 2 miles, but the strength of the odor at this distance indicated that it would have been detected easily even at 3 miles.

One day after the test the odor was appreciably weaker, but still noticeable 50 yards downwind.

The first flight missile with this material in the nose landed about 50 feet from the recovery party, so the odor was not needed to locate the impact point. Excavation of the crater, needless to say, was quite unpleasant. The second round landed within a half mile of the recovery party with similar results.

The amyl mercaptan was quite expensive—about $100 a quart—and since about a quart was needed per flight a material was needed which would satisfy the requirements and still be significantly less expensive. Butyl mercaptan, with the trade name "Spotleak," was found to be much cheaper—about $1.00 a quart—and was quite similar chemically.

The only significant difference between the two materials was that butyl mercaptan had a lower boiling point (98°C). Because of this, it dissipated too rapidly in the air and left only enough odor to make the excavation of the crater unpleasant.

Only one flight test was made with this material. The flight missile landed near a camera station and was located without the assistance of the mercaptan. One hour later, the odor scarcely was noticeable 40 yds. downwind.

• **Visual locaters**—Opinions varied concerning the value of the phosphorescent-type paints in facilitating the acquisition and tracking of the missile with cameras.

In this test series, half of the missiles were painted black and white, and the other half were painted fire-orange with black markings. Tracking the fire-orange missiles was not appreciably easier; however, the fire-orange fragments around the impact point were much more visible and identifiable.

On another test flight, two 6-ounce cardboard containers of "glitter" (small, shiny pieces of silvered glass such as used on posters and signs) and two 6-ounce containers of red paint pigments were placed in the aft section of a missile.

When the "glitter" was sprinkled on the ground during a preflight test, it produced bright reflections noticeable from a considerable distance, but very little of this material was scattered on the ground by the actual impact, and the effect was unnoticeable from any distance.

Radiosonde Readied for Launch

ROCKET-BORNE radiosonde, developed by Army Signal Research and Development Laboratory and produced for the Signal Corps by Atlantic Research Corp., is loaded into nose cone of *ARCAS* rocket. It will separate 40 miles up and float down.

GE Fuel-cell Generator Now Due for Delivery to Services

One of the first practical military applications of fuel cells—devices that convert chemical energy directly to electricity—is now undergoing evaluation testing. The 30-lb. unit, a portable power supply which produces 200 watts of 24-volt direct current for 14 hours, replaces a conventional 55-lb. generator or 80 lbs. of batteries.

The fuel-cell generator is being developed by General Electric for Navy's Bureau of Ships and the Army Signal Corps to power a portable field radar. First units are scheduled to be delivered for military evaluation this month.

With added fuel, the power pack is designed to operate at full load for a minimum of 2000 hours without maintenance. GE scientists, however predict a much longer life. Experimental fuel cells have been operated continuously for more than a year.

Thermal efficiency—electrical power out vs fuel energy in—is reported to be 50% at full load and more under partial load. This compares to 35-40% efficiencies of the best internal combustion engines or turbine generators.

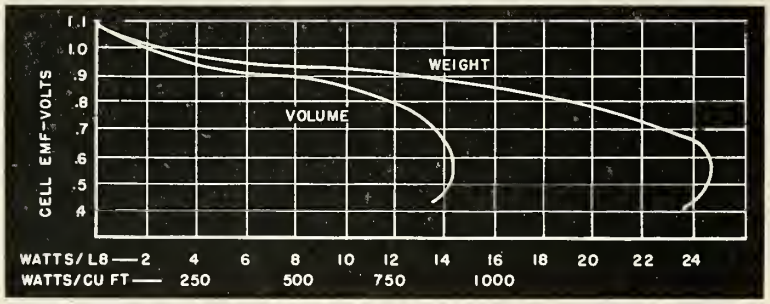
• **Simple and quiet**—Heart of the GE unit is a series of 30 ion-membrane fuel cells, each an 11-in. square assembly approximately ¼-in. thick. The hydrox cell consumes oxygen from the surrounding air and hydrogen produced by the decomposition of a metal hydride "fuel." Such a system is silent, odorless, has no moving parts, operates at negligible internal pressure and temperature, is simple to operate, and uses a solid electrolyte rather than a caustic liquid.

According to the GE announcement, the power pack can be refueled with no interruption in operation. The metal hydride is contained in reusable, hermetically sealed canisters, each containing approximately six lbs. of fuel to keep the unit going for 14 hours at full load.

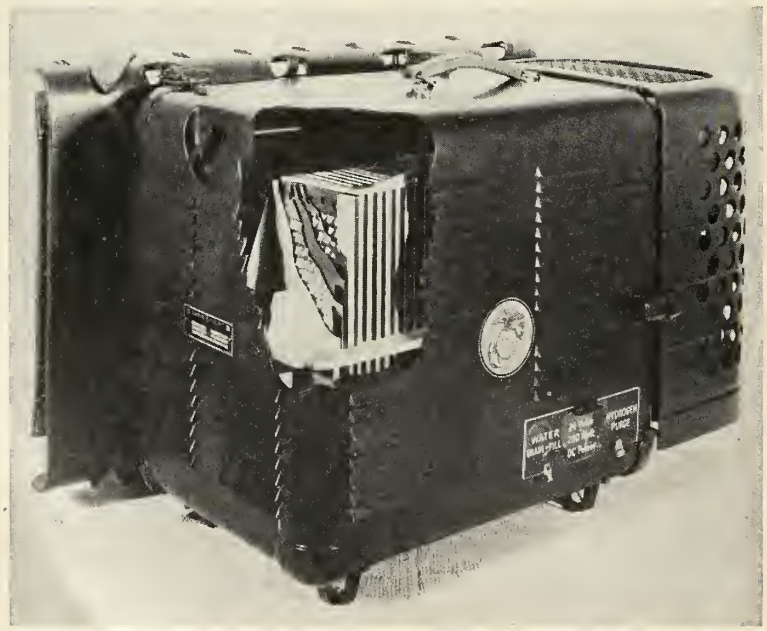
Although the principle of the fuel cell has been known for well over 100 years, only in the last year or so has there been any significant development effort. This effort has already shown some amazing results, however: less than a year ago, GE demonstrated its first working model—a tiny unit which generated only enough power to turn a toy airplane propeller. A few months after that, Allis-Chalmers produced a propane-fueled generator powerful enough to drive a farm tractor and plow.

The many merits of fuel cells—high-energy density, reliability, wide operating range, non-attended operation, and ability to operate in zero-gravity and high-shock environments—have generated intense military interest. Anticipated applications range from submarine to satellites.

Much research is being done under military contracts; probably as much or more is being done entirely by industry, with its own funds.



GRAPH OF power density (watts per pound) and power per unit volume shows significant improvement over previously published data.



CUTAWAY MOCKUP of GE fuel cell power pack shows arrangement of individual fuel cells. Perforated guard on right end protects gas generation system.

Computers Converse Among Themselves at Model Basin

Two Navy computers have been talking to each other in a common mathematical language through an electronic data processing system designed, built, and installed recently by Electronic Engineering Co. of California.

Known as the ZA-100 Computer Language Translator and located at the Navy's David Taylor Model Basin near Washington, the system permits an IBM 704 to freely exchange mathematical data or process raw scientific material with a Remington Rand Univac.

The ZA-100 can translate Univac data into IBM 704 data or vice versa, or it will translate analog or binary data from hydro-mechanical and structural tests and spectrum analysis data into either of the two computer formats. This system is capable of performing 13 electronic data translations and is the largest delivered to date by the firm.

Other "interpreters" are in use at the Systems Development Corp., Santa Monica, Calif.; The Martin Company, Denver, and North American Aviation, Inc., Missile Division, Downey, Calif.

Luskin Heads Lockheed NASA Program

Harold T. Luskin has been named program manager directing Lockheed's Missile and Space Division's production of an initial order of 16 advanced *Agena-B* satellites for the National Aeronautics and Space Administration. The *Agena-B* will be used as launch vehicles atop *Atlas* and *Thor* first-stage boosters for earth orbiting and deep space missions. Luskin, who joined LMSD in 1959 as a consulting scientist for satellite systems development, co-authored the Air Force's first major study on earth satellites for military use. Prior to joining the firm, he headed a scientific research team at Douglas working on *Zeus* and *Honest John*.


LUSKIN

Dr. Charles L. Critchfield: Former director of scientific research for Convair division of General Dynamics Corp., accepts the position of vice president-research with Telecomputing Corp.

G. W. Soderquest, R. E. Wilkinson and **H. Kilberg,** former engineering personnel with RCA at AFMTC, have formed a new missile electronics R&D firm, Astonautics, Inc. Company's field of interest will be radio interference and frequency analysis, infrared and computation systems.

Iden F. Richardson: Appointed a vice president at Hughes Aircraft Co. Will continue to serve as manager of the company's commercial products activities.

George C. Stewart: Former director of sales for Dalmo Victor Co.'s aviation radar and ground support equipment line, named vice president-customer relations and contracts for Air Logistics Corp.

Robert O. Bullard: Elected vice president and general manager of Baldwin-Lima-Hamilton Corp.'s Electronics and Instrumentation Division. Was formerly general manager of General Electric's Power Tube Department at Schenectady.


BULLARD

Seymour Winuk: Former sales manager for the Selenium Rectifier Division of Radio Receptor Co., joins Britton Electronics Corp. as vice president in charge of sales and will direct the firm's semiconductor marketing activities.

Frederick I. Scott, Jr.: Joins the engineering staff of Litton Industries' Electron Tube Division as a senior engineer. Was previously employed by Eitel-McCullough as a design and development engineer for RCA.

Donald R. Piatt: Named director of engineering at Universal Controls Inc. Was formerly vice president of research and engineering for the Underwood Corp.

Robert E. Zator: Joins American Potash & Chemical Corp.'s market research group as an analyst.

Charles F. Adams: Elected chairman of Raytheon Co., succeeded as president by Richard E. Krafve, former executive vice president.

Dr. James King, Jr.: Joins the technical staff of Electro-Optical Systems, Inc., as a senior scientist in the Energy Research Division. Was formerly a senior research engineer at Atomics International in the Solid State Physics group.

Benjamin O. Delaney: Former assistant Technical Operations manager promoted to manager succeeding **John C. Geist,** now associate director at Vitro Laboratories. **William L. Freienmuth,** assistant head of the Systems Development department will assist Delaney.


DELANEY

R. Harvey Whidden: Elected to the newly created position of executive vice president-marketing for Bulova Watch Co. Inc.

Stanley M. Smolensky: Appointed executive director of marketing at Thiokol Chemical Corp.'s Reaction Motors Division.

Hughes Aircraft Co. appoints five laboratory managers: **Dr. R. L. Roderick,** ballistic missile and ballistic missile defense systems; **J. W. Ludwig,** space systems; **Leonard Mautner,** special systems; **R. K. Ausbourne,** tactical missile systems and **Dr. L. J. Money,** tactical aircraft systems.

Fred S. Hage, Jr.: Former assistant to the president and director of advertising and public relations at Solar Aircraft Co., promoted to the newly created position of director of marketing.

Edward F. Burton: Elected vice president-engineering at Douglas Aircraft Co., succeeding **Arthur E. Raymond,** retired.

O. F. Henning: Named marketing manager for Texas Instruments Inc., Geosciences & Instrumentation division.

Wassil D. Tussusov: Elected chief of Electronics Engineering at Photronics Corp., a newly-formed scientific research and development organization. Was formerly associated with the Electronic Laboratory of Pupin Cyclotron Laboratories at Columbia University and Control Instrument Co., Inc.


TUSSUSOV

William J. Curran: Named director of market research for the Defense and Industrial Group, Packard Bell Electronics, assigned to the firm's Washington, D. C., office. Was formerly an economist with the Missile and Space Vehicle Dept. of General Electric.

Paul Petrack: Appointed general manager of the Silicon Division of Columbus Electronics Corp. Was formerly product manager for I.T.&T. Semiconductor Components Division and with the Semiconductor Division of Radio Receptor Co.

John L. Kennedy: Formerly navigation systems group leader, elected special staff engineer for Wilcox Electric Co. He will serve as a consultant to all of the firm's departments.

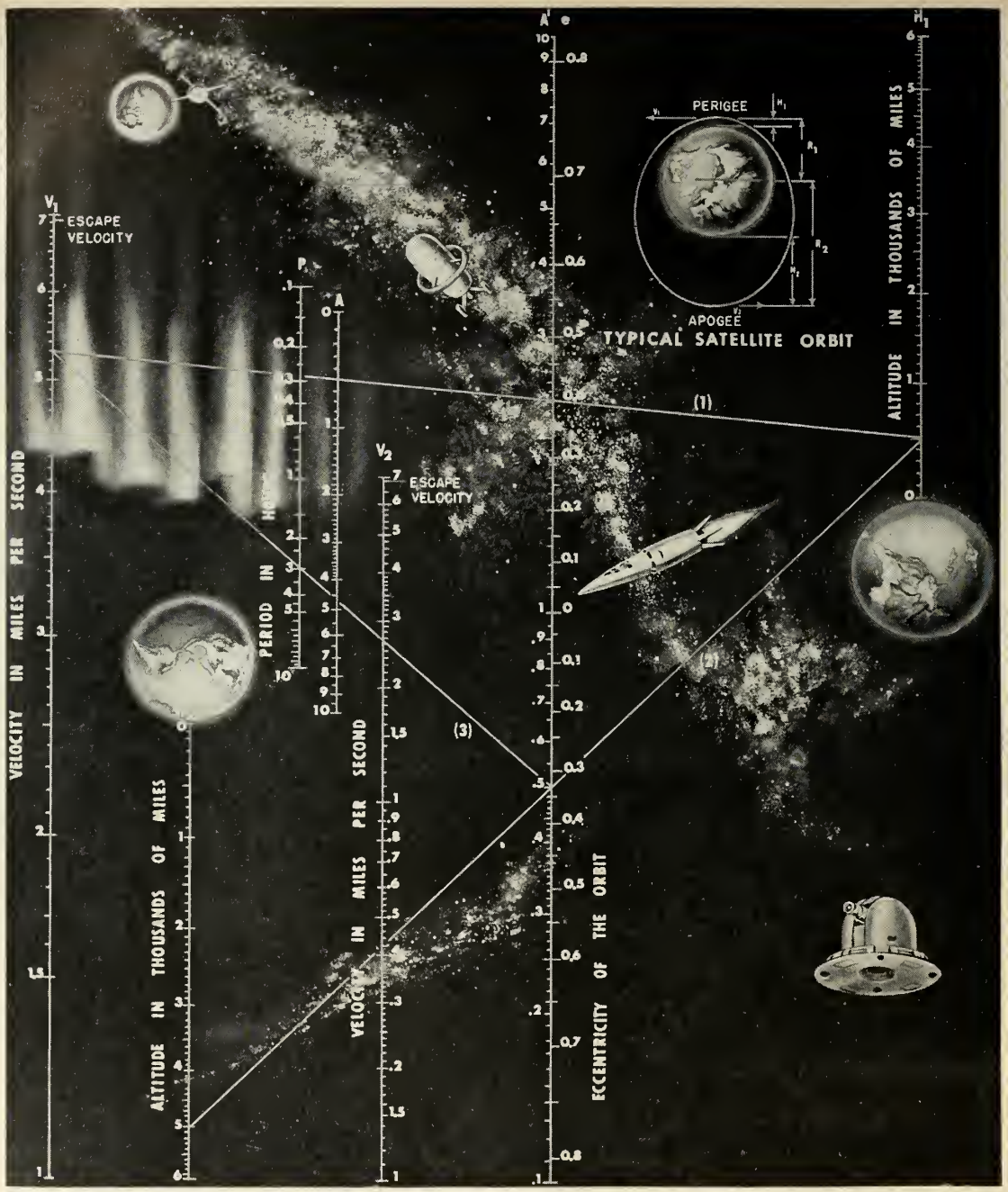
Dr. Franklin E. Lowance: Appointed president of Advanced Technology Corp., a research subsidiary of Electronic Communications, Inc. Was previously president-engineering of the Crosley Div. of Avco Corp.

Christian H. Pedersen: Former production supervisor of Superior Tube Co.'s Nuclear Products division, promoted to director of the Mechanical Development Dept.

Frederick A. Henry (USAF, ret.): Appointed manager of long-range planning for Summers Gyroscope Co. Previous posts: director of planning, Associated Missile Products Corp.; assistant to the vice president and general manager of A. O. Smith Corp., and executive contract officer for Fletcher Aviation Corp.

Bernard W. Eades: Appointed manager-Value Engineering for the Southwestern Industrial Electronics Co., a division of Dresser Industries, Inc. Previously served as manager-Value Engineering for Stromberg-Carlson; sales manager, Pressco Casting & Manufacturing Co.; sales engineer, Industrial Division of Revere Copper & Brass Co. and industrial engineer for General Motors Corp.


EADES



SATELLITE ORBIT CHART EXAMPLES—1. A satellite at an altitude of 500 miles is given a speed of 5.3 miles per second in a direction parallel to the earth's surface at that point. Find its altitude and velocity at the other end of its orbit, and find the eccentricity and period.

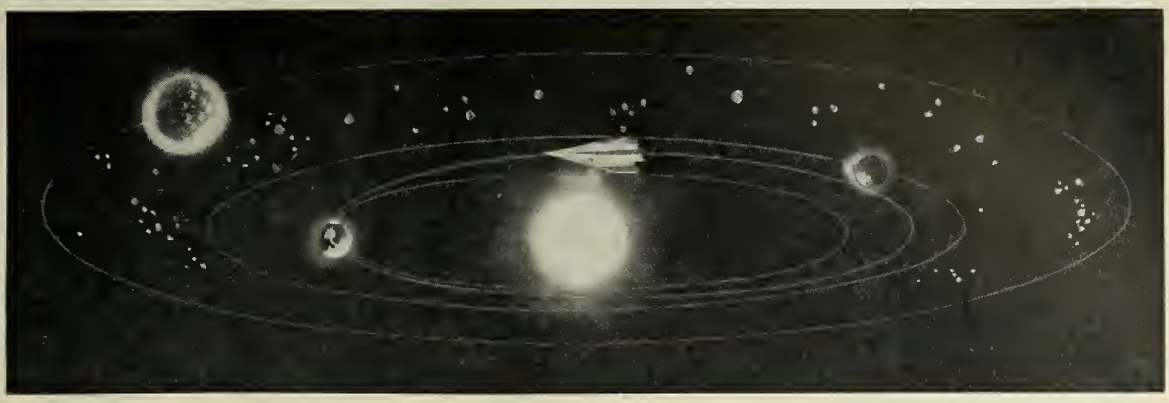
Solution: Connect 500 miles on the H_1 scale to 5.3 miles per second on the V_1 scale to 5.3 on the V_1 scale. Read the value of A = 0.5. Connect 0.5 on the A^1 scale to 5.3 on the V_1 scale. Read V_2 = 2.65 miles per second and P = 2.9 hours. Connect 500 on the H_1 scale to 0.5 on the A^1 scale, extending it to intersect H_2 at 5000 miles.

Therefore, at the far end of the orbit, the altitude is 5000 miles and the speed is 2.65 miles per second. The period is 2.9 hours, and the eccentricity is 0.33.

2. A satellite has a perigee altitude of 500 miles and an apogee altitude of 5000 miles. (a) What decrease in speed at perigee is required to produce a circular orbit? (b) What increase in speed at apogee would produce a circular orbit? (c) What would be the period?

Solution: (a) Connect 500 on the H_1 scale to 5000 on the H_2 scale. Read the value of A^1 = 0.5. Connect 500 on the H_1 scale to 0.5 on the A scale and extend this line to cut the V_1 scale at 5.3 miles per second. A line from 500 on the H scale through A = 1 meets the V scale at 4.6 miles per second. A line from 4.6 on the V_1 scale to 1 on the A^1 scale gives P = 1.5 hours. Therefore a decrease from 5.3 to 4.6 miles per second would produce a circular orbit altitude of 500 miles. The period would be 1.5 hours.

How To Plot Satellite & Planet Orbits



The history of the natural laws determining the motion of the moon about the earth and of the planets orbiting the sun is classic in the history of observation and the application of these observations to mathematics. From them Sir Isaac Newton (1642-1727) expounded his universal law of gravitation, a work for which he was later knighted.

It is interesting, indeed, that it was he who first established as fact the possibility of an artificial satellite. Scientific efforts of later years were mostly concerned with the application of Newton's basic natural laws to bodies in our solar system. Only in recent times have these laws been utilized to predetermine the paths of artificial bodies orbiting the earth and the sun.

A satellite may be caused to travel any one of an infinite variety of paths depending upon the initial direction and velocity given to it by the rocket booster.

Tiring of the computations required to determine these trajectories, at the Huntsville, Alabama, U.S. Army Rocket and Guided Missile Agency, scientists Ferdinand Mitchell and Thomas Moore prepared the graphical charts or nomographs indicated by the straight lines on the *Satellite and Planet Orbit Charts.*

These nomographs are drawn so that results of calculations may be found quickly from the relation of points upon them. By following the examples, one can quickly become skilled in the use of the nomographs for the determination of satellite orbits around the earth or for planets and asteroids orbiting the sun.

For a background, artist Hughes Michael has depicted satellites performing various tasks including the speculative one of capturing an asteroid which, perhaps is made up of nickel-iron.

Or if you prefer a simpler project and would be satisfied with traveling at an aphelion velocity of 17.9 miles per second at a distance of 94,400,000 miles from the sun by next July, you can just throw away your pencil, relax in your chair and wait knowing full well that you are rushing there on planet earth; and that both earth and pencil will faithfully obey Newton's Universal law of gravitation.

DESCRIPTION OF THE CHARTS

The charts illustrate the elliptical or circular orbits followed by planets or satellites, in terms of the heights and speeds at the ends of fthe major axis of the orbit.

The satellite orbit (at the left) applies to satellites of the earth. It contains 6 scales, not including the "A" scale. From right to left they are: (1) the altitude H_1 in the thousands of miles above the earth's surface at either perigee or apogee; (2) the eccentricity of the orbit; (3) the speed, V_2, at the end of the major axis opposite H; (4) the period of the satellite's revolution; (5) the altitude, H_2, at the end of the major axis opposite H_1; and (6) the speed V_1 at the point H_1.

The planet orbit chart (at the right) applies to satellites of the sun. Its scales are essentially the same, except that distances are measured from the sun instead of from the earth.

These charts do not attempt to take into account such effects as the slightly non-spherical shape of the earth, or the effects of the attraction of other bodies.

The eccentricity is a number, lying between zero and one, which specifies the shape of the orbit. Its value is zero for a circular orbit. The flatter the orbit, the greater the eccentricity.

HOW TO USE THE CHARTS

There are three lines to draw. Line 1 extends from the H_1 (or R_1) scale to the V_1 scale. Line 2 extends from the H_1 (or R_1) scale to the H_2 scale. Line 3 joins the V_1 scale to the e scale. These lines are drawn in whatever order is dictated by the given quantities of the problem.

The intersection of line 1 with the A scale, the intersections of line 3 with the P and V scales, and the intersections of lines 2 and 3 with the A and e scales are read. The construction should always be such that the values of A and A^1 are equal.

NOTE

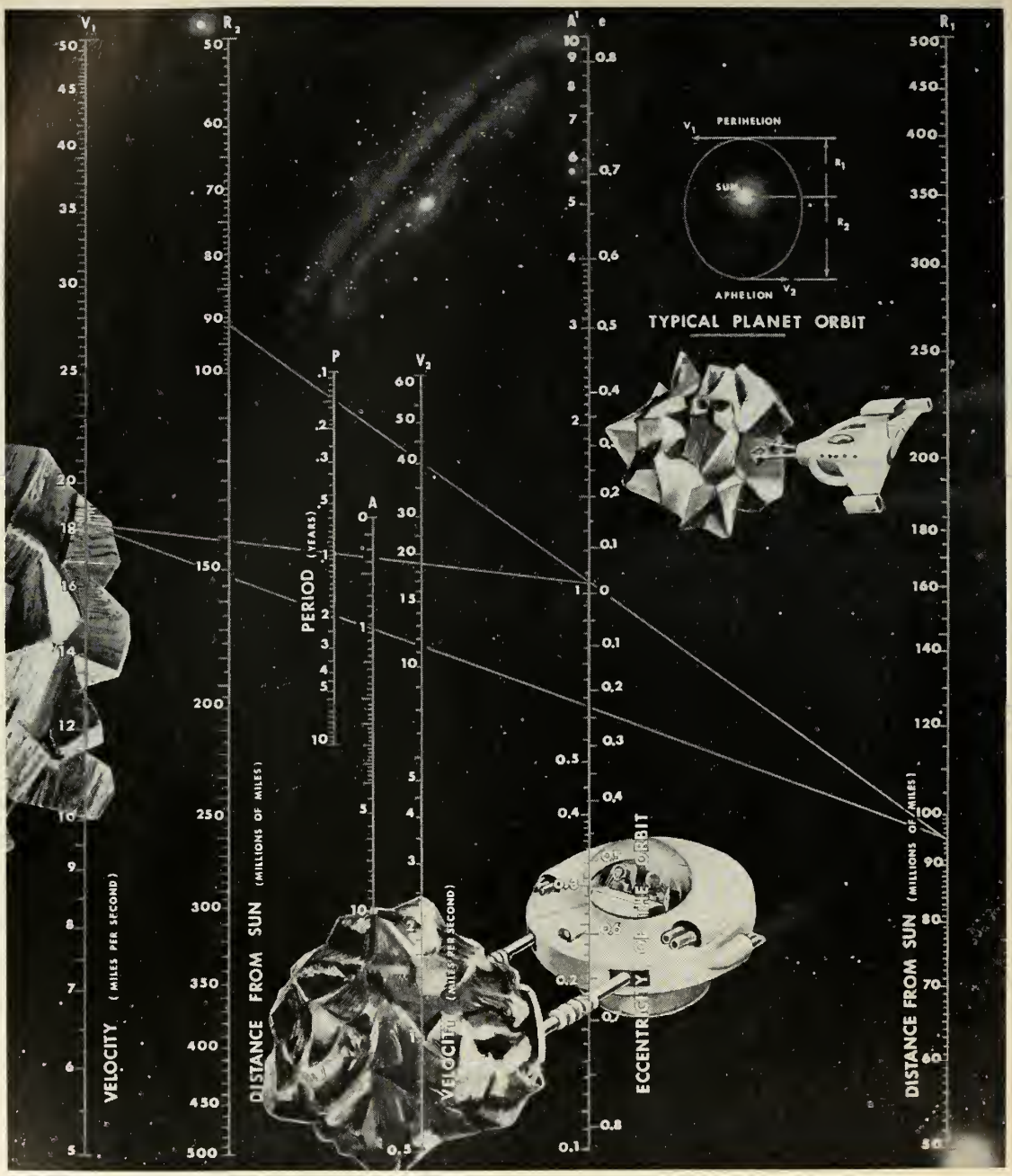
If line 1 passes through A = O, the value of V_1 is the escape velocity at that altitude. If the value of A (or A^1) is one, then V_1 is the speed required for a circular orbit at the given altitude.

(b) The speed at 5000 miles altitude is 2.65 miles per second, as shown on the V_2 scale. A line from 5000 on the H_1 scale through A = 1 cuts the V_1 scale at 3.25. Finally, a line from 3.25 on the V_1 scale to A^1 = 1 cuts P at 4.5 hours. Therefore, an increase from 2.65 to 3.25 miles per hour at apogee would produce a circular orbit at 5000 miles altitude.

(c) The period would be 4.5 hours.

3. A satellite at an altitude of 250 miles is given a horizontal speed of 4.5 miles per second. Determine its altitude at the other end of the orbit.

Solution: Connect 250 on the H_1 scale to 4.5 on the V_1 scale. Read A = 1.2, extending this line to the H_1 scale. This line cuts H_2 scale at altitude less than H_2 = 0. Hence, this satellite does not orbit, since its path intersects the earth.



PLANET ORBIT CHART EXAMPLES—1. The earth's orbit around the sun has an eccentricity of 0.017 and its period is 1 year. Find the perihelion distance and speed, and the aphelion distance and speed.

Solution: From the e scale, we note that an eccentricity of 0.017 is equivalent to $A^1 = 1.03$. A line from this point on the e scale through $P = 1$ year intersects the V_1 scale at 18.3 miles per second, and the V_2 scale at 18.9 miles per second. The line from $V_1 = .3$ through $A = 1.03$ cuts the R_1 scale at 95 million miles. The line from $R_1 = 95$ million miles through $A = 1.03$ cuts R_2 at 91 million miles.

Therefore, at perihelion the earth's distance from the sun is 91 million miles and its speed is 18.9 miles per second. At aphelion, the distance is 95 million miles and the speed is 18.3 miles per second.

2. The artificial Planet Pioneer IV was launched by the U.S. Army on March 2, 1959. Its perihelion distance is 93 million miles and its speed at perihelion is 20.8 miles per second. Determine its aphelion distance and speed, and find its period.

Solution: A line from 93 million miles on the R_1 scale to 20.8 miles per second on the V_1 scale cuts the A scale at 0.68. A line from $A^1 = 0.68$ to $V_1 = 20.8$ cuts V_2 at 14 miles per second and cuts P at 1.4 years. The line from $R_1 = 93$ million miles through $A^1 = 0.68$ intersects R_2 at 140 million.

Therefore, the aphelion distance is 140 million miles and the aphelion speed is 14 miles per second. The period is 1.4 years.

contracts

ARPA

$1,800,000—Raytheon Co., for finding the best practical method of detecting ICBM's among a flock of decoys. Program involves analysis of data collected by missile tracking radar.

NASA

$27,683—High Vacnum Eqnipment Corp., Hingham, Mass., for services and material to design, fabricate and deliver a vacuum system.

MISCELLANEOUS

$1,700,000—Lear, Inc., Santa Monica, for follow-on production of automatic flight control and stabilization systems for *Q-2C* drones. Subcontract from Ryan Aeronautical Co.

$800,000—Levinthal Electronic Products, Inc., subsidiary of Radiation, Inc., Palo Alto, Calif., for design and production of four tropospheric scatter radio power amplifiers. Subcontract from Page Communications.

NAVY

$1,870,000—Temco Aircraft Corp., Dallas, for manufacture of booster and sustainer motors for the *Terrier* missile.

$1,600,000—Temco Aircraft Corp., for flight test work and services on the *Corvus* missile.

$700,000—Giannini Controls Corp., Pasadena, for free gyros for the *Talos* missile. Subcontract from Bendix Aviation Corp.

$306,000—Midwestern Instruments, Tulsa, Okla., for production of high gravity recording oscillographs.

ARMY

Hexcel Products, Inc., Berkeley, Calif., for research and development work on high-energy propellants. Amount not disclosed.

$9,170,710—Hercules Powder Co., Wilmington, Del., for continued production of propellant and explosives plant maintenance at the Radford, Va., arsenal.

$6,300,000—Convair Division, General Dynamics Corp., for continued development of *Redeye* missile.

$5,723,807—Western Electric Co., New York City, for *Nike-Hercules* missiles.

$5,303,907—Sperry Rand Corp., Salt Lake City, for research and development on the *Sergeant* missile system.

$4,077,000—Western Electric Co., research and development on *Nike-Zeus*.

$3,457,070—Radioplane Div., Northrop Corp., Van Nuys, Calif., for *RP-76* target missile production.

$1,134,013—Chrysler Corp., Detroit, for the *Redstone* missile system. (Two contracts.)

$1,070,080—Butler Manufacturing Co., Kansas City, Mo., for 16 fuel transporters for the *Jupiter* missile.

$794,518—The Martin Co., Orlando, for *Lacrosse* research and development program.

$651,000—Western Electric Co., New York City, for *Nike* spare parts and components.

$490,275—Gilfillan Bros., Inc., Los Angeles, for *Nike* system components.

$189,426—Electro-Optical Systems, Inc., Pasadena, for research and development of techniques for obtaining massive hypervelocity particles by electronic means.

$167,894—Minneapolis Honeywell Regulator Co., Aeronautical Div., St. Petersburg, Fla,. for *Jupiter* gyroscope AB-7 GS-3.

$158,780—National Research Corp., Cambridge, Mass., for developing a basic scientific understanding of ablation.

$150,000—Radiation, Inc., Melbourne, Fla., for ground stations for *Courier* communication satellite system, satellite checkout.

$117,900—Firestone Tire & Rubber Co., Los Angeles, for repair parts for *Corporal* missile (two contracts).

$82,375—Pacific Construction Co., Fairbanks, Alaska, for additional modification to *Nike* sites Tare, Peter, Mike and Jig.

$57,772—Redstone Machine & Tool Corp., Huntsville, Ala., for *Saturn* fabrication services.

$49,567—Ford Motor Co., Newport Beach, Calif., for study of nuclear weapons effects.

$32,600—Brown Engineering Co., Huntsville, Ala., for *Pershing* engineering and fabrication services.

$32,587—The Martin Co., Orlando, for concurrent repair parts, *Lacrosse* missile.

$26,968—Northern Roofing and Sheet Metal, Anchorage, Alaska, for additional modification to *Nike* sites.

AIR FORCE

Boeing Airplane Co., Aero-Space Div., for preparing a preliminary design for a recoverable booster for spacecraft. Amount not disclosed.

The Garrett Corp.'s AiResearch Manufacturing Co., Los Angeles, for study of various infrared detectors and recommendation of cooling them in extremely high altitudes. Amount not disclosed.

Hathaway Instruments, Inc., for modification of ground support equipment in the *Titan* testing program. Subcontract from The Martin Co.-Denver. Amount not disclosed.

$6,000,000—Kellogg Switchboard and Supply Co., for intersite communications in the *Atlas* missile complex.

$3,500,000—Lockheed Aircraft Service, for installation and flight test of an airborne electronic system that will provide a seaward extension of the SAGE defense network. Subcontract from Bnrroughs Corp.

$2,900,000—IBM Corp., Federal Systems Div., Owego, N.Y., for development of prototype model bomb navigational missile guidance system.

$320,093—North American Aviation, Rocketdyne Div., for services, material and design data to conduct a program in in-service engineering analysis for the *Thor* and *Jupiter* propulsion systems and associated ground support equipment for both systems.

$310,293—North American Aviation, Rocketdyne Div., for maintaining and operating a contractor storage site for support of *Atlas* propulsion subsystem.

$105,000—Univcrsity of Chicago, for research directed toward studies of lunar properties.

$65,101—Pickard and Burns, Inc., Needham, Mass. for research and development on accurate methods of tracking and communicating with space vehicles.

$56,023—Thiokol Chemical Corp., Reaction Motor Div., Denville, N.J., for continuation of 'Research on the Influence of Ions on Rocket Combustion Processes.'

$54,406—Midwest Research Institute, Kansas City, Mo., for research on unsteady-state solid-propellant burning.

$33,500—Packard Bell Computer Corp., Los Angeles, for satellite computer.

Minuteman

by William J. Coughlin

LOS ANGELES—The Air Force has accelerated the *Minuteman* program drastically to bring the missile to operational status by the summer of 1962, rather than sometime in 1963. Maj. Gen. Osmond J. Ritland, Commander, Ballistic Missile Division, said the acceleration comes partly as a result of slashing early silo tests at Edwards AFB from 18 to eight.

Ritland told the Aviation Writers Association meeting here that *Minuteman* is "a major economic breakthrough" in the ballistic missile program.

Flight tests are due to begin at Cape Canaveral later this year. Flightweight engines of the missile have already been static-tested by the contractors, Thiokol Chemical Corp. for first stage, and Aerojet-General Corp. for second stage.

Ritland said the Air Force has found a straightforward silo configuration to be adequate, rather than a complex U- or W-shaped silo to cope with hot exhaust gases.

• **Precise environment**—Assembly of the missile after operational status is achieved will be done at centrally located production depots "where the environment is conducive to precision assembly and checkout procedures."

Hill AFB, Ogden, Utah, will be the first assembly and recycle facility. Indications are that the Air Force will not transport finished product from Boeing's plant in Seattle, but will ship subassemblies from various first-tier subcontractors to the "production depots" for final assembly.

Construction cost for each *Minuteman* squadron is expected to be $20 million for each launch site, and construction will probably extend over a period from 15 to 18 months.

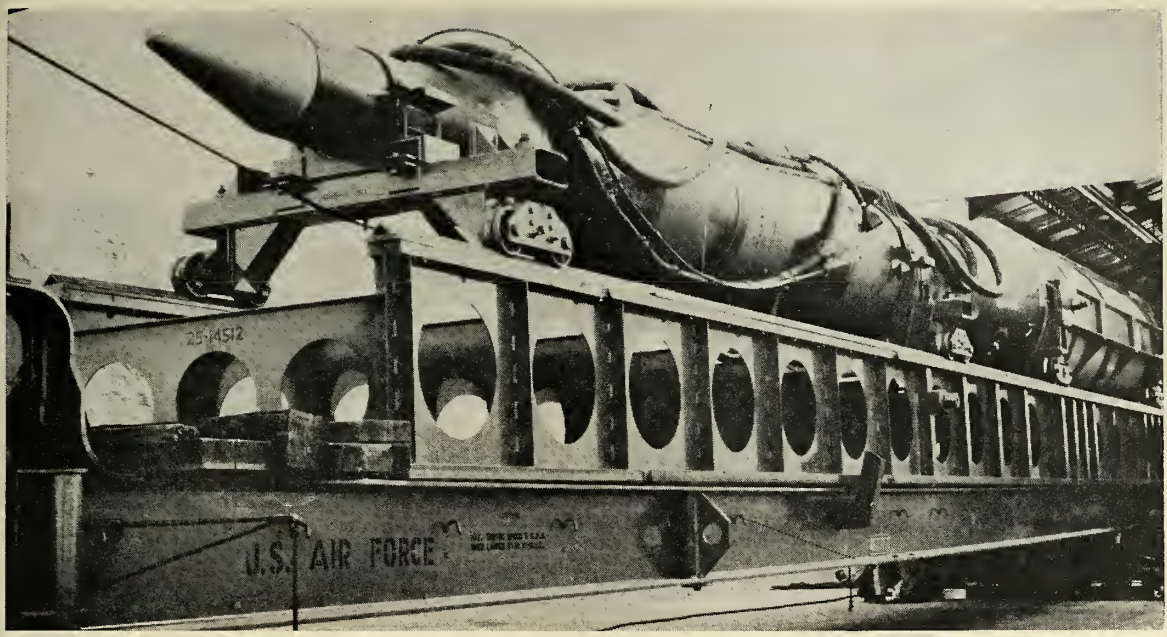
The Air Force has said the mobile trains carrying the missile initially will be on "pre-selected sidings" with missiles zeroed in on targets. Other trains will be underway around the country, each within a short distance of these sidings.

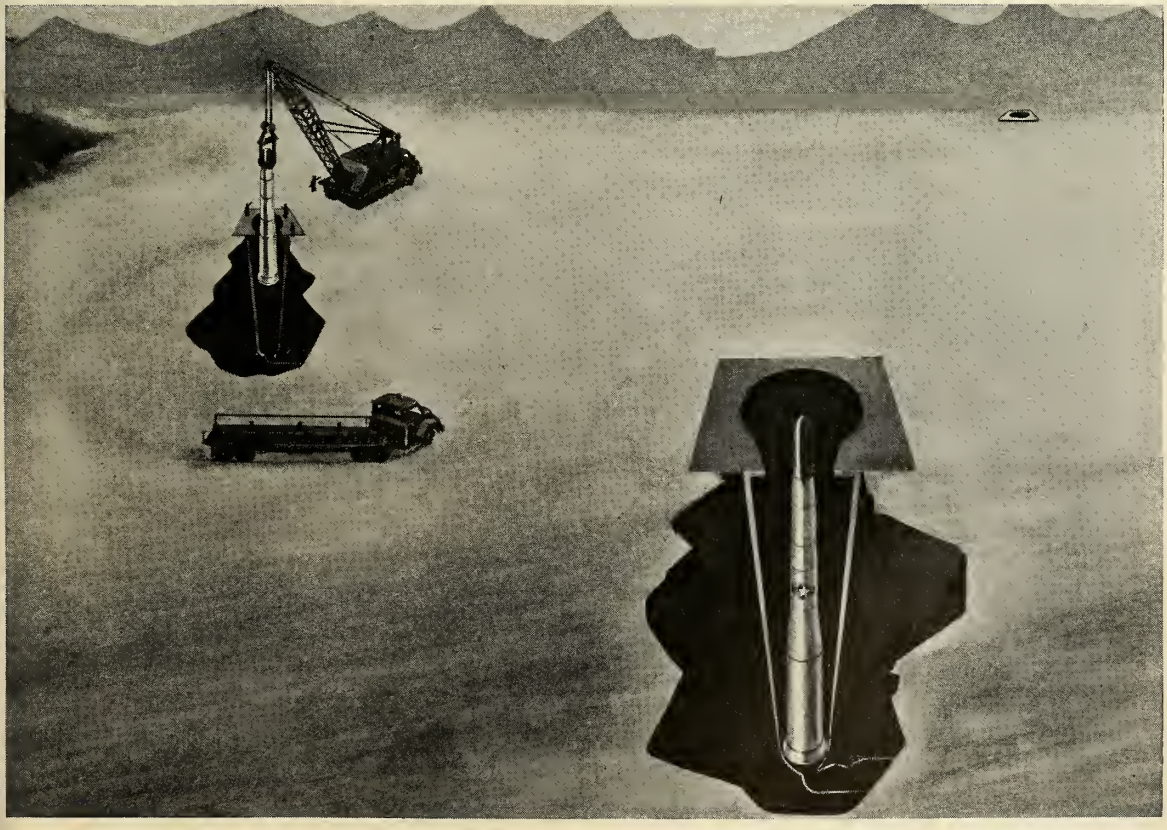
• **Trend reversed**—Ritland noted that *Minuteman* "reverses the historical trend toward progressively more complex and more costly weapons."

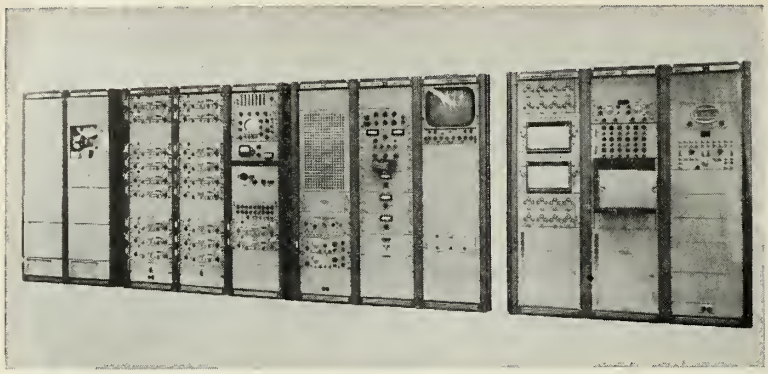
A total of 1500 tests were conducted by Air Force and Boeing before silo tests at Edwards AFB. These ranged from 1/20 to 1/3 scale.

Pictures on these pages are of the full-scale Minuteman *silo-test model which made its first successful tethered shot from a silo at Edwards AFB, Calif., on Sept. 15, 1959.*

peed-up: Operational In 2 Years







Pershing Analog Data System

The analog portion of the MADRE (Martin Automatic Data Reduction Equipment System), which will be used to process telemetry data from test missiles such as the *Pershing*, was delivered recently by Electro-Mechanical Research Inc.

The 11 racks of equipment feed telemetry data into a companion high-speed digital acquisition and computing system for handling of missile test results. All decommutation equipment is controlled from a single centralized panel. A 390-jack central patch-panel enables the operator to combine analog and digital lines in any desired combination.

EMR supplied to the Martin Co. a tape recorder/reproducer, subcarrier discriminators, tape-speed compensators, a decommutation subsystem, a high-frequency galvanometer recorder, two low-frequency pen recorders, check-out equipment, an audio amplifier and a speaker for playback of a voice channel or track.

In this portion of the MADRE system, the recorded radio telemetry signals transmitted during tests are played back, separated and demodulated, decommutated where necessary, displayed and recorded or applied to digitizing equipment.

Circle No. 225 on Subscriber Service Card.

Liquid H_2 Thermometer

Highly accurate temperature measurements of liquid hydrogen (–422.9°F) will be possible with a miniature platinum resistance thermometer announced by Trans-Sonics Inc. of Burlington, Mass.

The transducer incorporates a trimming network that permits accuracy and interchangeability to be maintained to ±0.1°F over the range –400° to –435°F. The transducer has a resistance change of 27.6 ohms over its operating range. Construction is of stainless steel.

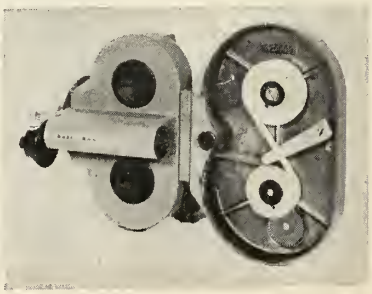
Circle No. 226 on Subscriber Service Card.

60-Second 16mm Developer

A new technique of processing movie film right in the camera within 60 seconds of exposure has been announced by Specialties Inc. The innovation lies in the development of RAPROROLL, a chemically treated paper that develops and fixes film automatically on contact.

In the magazine processor, the RAPROROLL and exposed film or photographic paper are pressed together under nominal pressure. The paper releases its liquid to the emulsion on the film. The required quantity is carefully controlled by web thickness and composition. There is no dripping; free liquids, pumps, seals and precision metering applicators are eliminated. Each area of emulsion receives a fresh application. There is no re-use with the accompanying danger of contaminative by-products remaining from previous applications.

RAPROMATIC processing is available on a production basis for 16-mm. film negative processing.



Circle No. 227 on Subscriber Service Card.

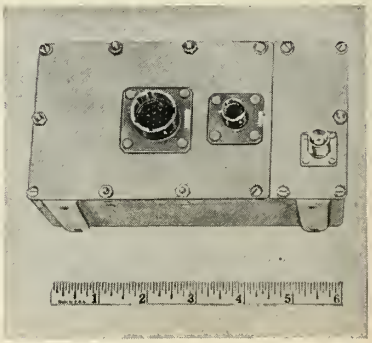
Missile Command Receiver

Development of a new command receiver for use in missiles was announced by the Crosley Division.

About the size of a kitchen matchbox, a miniaturized command receiver weighing only three pounds has been developed by the AVCO Corp. The receiver will be used in missiles as a safety device, among other things. Crosley executives explained that should a missile go awry when it is fired, an operator on the ground can push a button that sends a radio signal to the command receiver to destroy the missile in flight.

Crosley said the new receiver is a fully transistorized solid-state device that affords great reliability. Use of solid-state components helps account for the receiver's small size and light weight.

The unit is equipped with four



channels that accept four separate radio commands, and its circuitry is such that combinations of commands can be executed without the use of mechanical relays.

Circle No. 228 on Subscriber Service Card.

Machining Power Source

Maximum metal removal rate of 20 cu. in. per hour in electrical discharge machining is possible with Elox Corp.'s new ER-300 Roughing Power Supply.

The ER-300 is a completely electronic power supply having no moving parts. It is silent and can be moved about easily. When aluminum electrodes are used with the ER-300 the electrode wear ratio is between 20 and 50 to 1 end wear. In the rough machining of contour or cavity type dies for forging or metal forming, machining may be

completed at full metal removal rates to within 0.060 in. of final contour size. Finish machining is then easily accomplished by switching to any Elox NPS power supply without moving the die set-up, as all Elox Power Supplies are interchangeable.

In addition, ER-300 is applicable to rough machining through hole-type die openings that are currently rough-sawed to shape.

Circle No. 229 on Subscriber Service Card.

Leak Detector Improved

A mass spectrometer-type leak detector capable of tagging one part helium in 10,000,000 parts of air has been developed by Consolidated Electrodynamics Corp.

The CEC Type 24-210B Leak Detector operates on 105-125-volt, 60-cycle power outlets and weighs 155 pounds. Response time is less than one second for 50% full-scale deflection of the leak rate meter on the x1 scale. Six positions providing attenuations of x1, x5, x10, x100, and x1000 allow a wide range of leak rates to be tested.

The device operates in temperatures of 40 to 100°F and in any humidity up to 95%. Characteristics of drift, linearity, clean-up and noise are termed excellent by the manufacturer.

Circle No. 230 on Subscriber Service Card.

Pure Beryllium Tubing

Pure beryllium tubing in sizes from .250 to 2 in. outside diameter is available from Superior Tube Co., Norristown, Pa., which has been appointed agent in the United States for Chesterfield Tube Co., Chesterfield, England.

Because of its low neutron absorption, attractive thermal properties and high strength-to-weight ratio, beryllium tubing has wide potential application in nuclear reactors and in aircraft and missiles, Superior says.

The tubing is produced from sintered billets by the hot extrusion method. Bore-sized tubing with closer internal tolerances is produced in a limited size range. Superior will produce beryllium tubing in this country.

Circle No. 231 on Subscriber Service Card.

Pneumatic Regulator

A large pneumatic regulator, designed for use with helium by the Vision Engineering & Sales Co., has proved efficient on both fixed installations and in certain OEM applications.

The regulator's operating pressure inlet: 100 to 20,000 psi. Regulated pressure, using dome loading principle, is adjustable from 100 to 20,000 psi. Proof pressure is 40,000 psi. Flow rate is to 100 lbs. per minute helium with 6000 to 10,000 psi inlet pressure.

Circle No. 232 on Subscriber Service Card.

Gyroscopic Attitude Control

The attitude of a space vehicle can be controlled by two gyroscopes, instead of reaction jets or inertia wheels, with a device developed by the Electronics Division of Chance Vought.

Vought's Twin-Gyro Controller uses the gyros for muscle power instead of merely as a reference system as in inertial guidance. The controller consists essentially of two identical single-axis gyros gimbaled to a common frame. The frame is torqued about one axis by the controller. Thus three controllers can be used to control the attitudes of a vehicle about its roll, pitch and yaw axes.

Since rotors operate at constant speed, power requirements are low.

Circle No. 233 on Spbscriber Card.

One Part Epoxy Adhesive

A one part 100% epoxy adhesive has been announced by Metachem Resins Corp. The thixotropic paste can be applied to any surface, including vertical ones, without sagging or running. The elimination of the usual two-part concept results in quicker, less expensive applications.

Designated META-BOND 321, the adhesive has a bond strength of 3200 psi at 25°C after a short cure. The bond will remain stable up to 200°C—higher in certain circumstances.

Besides the adhesive qualities, the material has excellent dielectric insulation properties. It has a shelf life of over a year if stored below room temperatures. The company recommends its METATERGE 1405 as a cleaning agent to convert the uncured resin to a water-dispersible system to aid in the cleaning of equipment.

Circle No. 234 on Subscriber Service Card.

new literature

THIN FILM COATINGS—The properties of fluorocarbon coatings, silicones, epoxy resins and other coatings are discussed in this brochure issued by the Industrial Coatings Division of National Glaco Chemical Corp. Included in the descriptions are applications to impart chemical and corrosion resistance, wide-range temperature stability, electrical qualities, dry lubrication, and anti-stick characteristics.

Circle No. 200 on Subscriber Service Card.

ELECTRONIC CAPACITORS, FIXED, PAPER-DIELECTRIC—Complete rating and dimensional tables for a wide range of standard commercial, MIL-C-25A, and Permafil capacitors are given in a 28-page brochure published by General Electric. Bulletin GET-3032 covers such AC-DC applications as blocking and bypass service, power supply filters and other general-purpose military and commercial uses. In weight, units describe range from a few ounces to 150 lbs.

Circle No. 201 on Subscriber Service Card.

MICROWAVE COMPONENTS. Radar Design Corp.'s 16-page catalog illustrates a wide range of coaxial and waveguide attenuators and terminations—the latter available in medium power as well as low. Also described is a new Machinable Microwave Absorber—RADITE #75.

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PLASTIC PRODUCTS OF TEFLON, RAYLON AND KEL-F—A catalog describing in detail the basic shapes available from Raybestos-Manhatten. Mechanical packings, gaskets, accessories for fluid handling equipment, custom machined parts, thin-walled tubing, flexible wire-braided, rubber-covered hose, bondable Teflon and adhesives, "O" and back-up rings, bearings and teflon coatings are among the many items in the booklet of interest to the missile engineer.

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SIZE 18 VELOCITY-DAMP SERVO-MOTOR DATA—Dimensional drawings, torque-speed curves, electrical and mechanical characteristics are detailed for the Model 18 VM 460 servomotor. Published by the Helipot Division of Beckman Instruments Inc., the data sheet also contains information concerning areas of application for velocity damp units.

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SPECIFYING LAMINATED PLASTICS AND VULCANIZED FIBERS—A comprehensive guide to the ups and downs in a basic family of fast-growing materials. Published by Taylor Fibre Co., the booklet contains a quick selection chart which specifies various plastics and fibers according to properties. Common errors and mistakes prevalent in specifications concerning these materials are discussed.

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CUSTOM MOLDED INORGANIC INSULATION—The various properties of Havelex, formerly G. E. Mycalex, are described for design engineers in the missile/space industries. Issued by Haveg Industries, Inc., the bulletin aids in utilization of such properties as continuous operation at 1000°F with high dielectric strength, arc resistance and no moisture absorption. The various operations of the firm's Taunton Division, formerly G.E.'s plastics department, are included.

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letters

(continued from page 7)

No Slight Intended

To the Editor:

Thank you very much for your April 4 article on ion propulsion activities at Electro-Optical Systems, Inc. I would, however, like to point out that your continued use of the term "quick and dirty" (M/R, Feb. 1 and April 4) in reference to our construction of an ion engine for the Air Force is somewhat misleading.

This term implies a hasty and unsophisticated approach to a most important project. Such an implication is most definitely erroneous. The ion engine program presently under way at Electro-Optical Systems requires fifteen months of intense deliberation, skill, and accomplishment. The project demands the highest type of technical performance, and as a result, the finished product will be far from a "quick and dirty" device. It would be unfortunate to have this fact misunderstood.

Again, thanks for your interest in our programs. I bring up this point only to avoid any public misimpression that might arise through the use of the terms.

David T. Traitel
Manager, Information Services
Electro-Optical Systems, Inc.

M/R meant the term as praise, not blame. Under an Air Force contract, Electro-Optical Systems is building an ion propulsion device based on the present state of technology. We meant to contrast the Air Force approach with that of the National Aeronautics and Space Adminlstration, which expects to award a contract later this year for research on an ion device that will incorporate sophisticated, but untested, concepts. Research at several centers in the last year has definitely established the feasibility of an ion engine. We are pleased with the Air Force decision to build one and fly it early.—Ed.

Publicizing Industry's Role

To the Editor:

Reading your April 18 issue last evening, I was particularly impressed with your editorial "The Things We Stand For."

It is indeed encouraging that you identify the responsibilities of both Government and *private industry* in developing and putting into operation the weapons needed in the missile/space field. I am sure that the industry is cognizant of its responsibilities along the lines you have spelled out. On the other hand, I am not equally sure there is public appreciation that industry does have a role—much less that it has a responsibility—in these new weapon systems.

I think you have done a good job in pointing out the partnership which necessarily must, and in fact does, exist between Government and industry.

Roger C. Fleming
Director of Public Relations
Allison Division
General Motors Corporation
Indianapolis, Ind.

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when and where

MAY

Aerospace Medical Association, 31st Annual Scientific Meeting, Americana Hotel, Miami Beach, May 9-11.

1960 Symposium of the Institute of Radio Engineers' Professional Group on Microwave Theory and Techniques, Hotel del Coronado, San Diego, May 9-11.

Instrument Society of America, National Power Instrumentation Symposium, Drake Hotel, San Francisco, May 9-11.

National Rocket Society, Semiannual Meeting and Astronautical Exposition, Ambassador Hotel, Los Angeles, May 9-12.

Second Southwestern Metal Congress and Exposition, American Society for Metals, Sheraton Dallas Hotel, and State Fair Park, Dallas, May 9-13.

1960 Electronic Components Conference, sponsored by IRE Professional Group on Component Parts; AIEE, EIA, and Western Electronic Manufacturers Association, Hotel Washington, Washington, D.C., May 10-12.

American Institute of Chemists, Annual Meeting, Radisson Hotel, Minneapolis, May 11-13.

New York University Conference, "The Critical Million—How to Talk to the Nation's Scientists and Engineers . . ." New York City, May 17.

ASME Production Engineering Conference, Shroeder Hotel, Milwaukee, May 17-19.

Society for Experimental Stress Analysis, 1960 Spring Meeting, Hotel Severin, Indianapolis, May 18-20.

Society of American Military Engineers, National Convention, Washington, D.C., May 19-20.

National Telemetering Conference, ARS, IAS, ISA and AIEE, Miramar Hotel, Santa Monica, Calif., May 23-25.

German Society for Rocket Engineering and Space Flight Research, 12th Annual Meeting, Heidelberg, West Germany, May 23-25.

TAPPI Coating Conference, 11th Annual, Edgewater Beach Hotel, Chicago, May 23-25.

ASME Design Engineering Conference & Show, Statler Hilton Hotel, New York City, May 23-26.

American Society for Quality Control, Annual Convention, Sheraton-Palace, Hotel, San Francisco, May 24-26.

Japanese Rocket Society, Second International Symposium on Rocketry and Astronautics, University Club in Tokyo, May 24-28.

IAS Specialists Meeting, Guidance of Aerospace Vehicles, Hotel Somerset, Boston, May 25-27.

The Psychophysiological Aspects of Space Flight, sponsored by the School of Aviation Medicine, ATC, to be held at the Aerospace Medical Center, Southwest Research Institute, San Antonio, May 26-27.

Society of Naval Architects and Marine Engineers, Spring Meeting, Statler Hotel, Washington, D.C., May 26-28.

Will Britain Step Down?

Britain has been a great world power for four hundred years and more. Within the next few weeks or months she may make the decision which would leave her militarily impotent and automatically eliminate her from the summit conferences of the future.

The decision: to eliminate the nuclear bomb and missile from her arsenal of weapons. The effect would be great and far-reaching—much more so than the general public now realizes.

Britain recently abandoned her own atomic missile program—concentrated in the *Blue Streak* ICBM. It was then reported that she would buy the American *Polaris* and *Skybolt* instead.

Now, as reported by M&R's London correspondent (Page 13), Britain is very near a decision to abandon her position as a nuclear-armed power. Not only would she not buy American atomic weapons, but she would give up those she already has.

To put it baldly, England feels that in the event of a general war she would be the first target and that she would have insufficient warning to either get off her own weapons or protect herself.

England is tired of being in this position.

Any decision, of course, will come from the politicians and not the military. But British politicians reflect British public opinion more realistically, probably, than U.S. politicians reflect U.S. public opinion.

And the opinion of Britons today is that they would be sitting ducks with little chance to either fight back or survive in event of a nuclear attack.

This isn't a new thought, but it is gaining strength. And if Britain does drop her role as a great nuclear power, what will be the effect on the rest of the free world—particularly, what will be the U.S. position?

Britain would immediately relinquish certain commitments to NATO—not her role as a general participant, probably, but certainly her job in NATO's deterrent force, in which British bombers at present carry her own atomic bombs.

Part or all of this role would have to be picked up by other NATO members, either with nuclear-armed planes or missiles, probably the latter.

The United States would have to move both its nuclear-armed bombers and fighters from their bases in Britain.

The *Thor* bases would either have to be abandoned or moved to a site on the continent.

These could be the military results. From the political point of view, the result could easily be Britain's stepping down from her position as one of the great powers. It is difficult to believe that the Soviet leaders would pay much attention to an atomically neutralized Britain.

Britain's leaders will try to delay their decision as long as possible. Giving up her historically great place in the world of nations would not be easy.

But she must face up to certain geographic and economic facts. She cannot afford her own missile program. She objects to buying the *Polaris* probably because she knows American subs will have to be patrolling her waters anyway—because of the range of the sub-based *Polaris*. Close as Britain is to Russia, the airplane-based *Skybolt* would not be a complete or effective weapon unless the RAF could maintain a high degree of constant air alert—and this Britain cannot afford either.

To remove their nation from her place as Number One on the Soviet target list, British leaders would have to deny bases to American atomic weapons whether missiles or bombers, as well as give up their own.

Who takes Britain's place? France? Germany? a new NATO nuclear force under direct command of SHAPE?

If Britain does take this step, if she does give up her place as one of the great world powers, filling the vacuum which will result could give the Western World its greatest test yet—both politically and militarily. Ministers at the Istanbul NATO meeting were not unaware of this—nor will the chiefs of state be unaware of it at the May 16 meeting in Paris.

Clarke Newlon

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