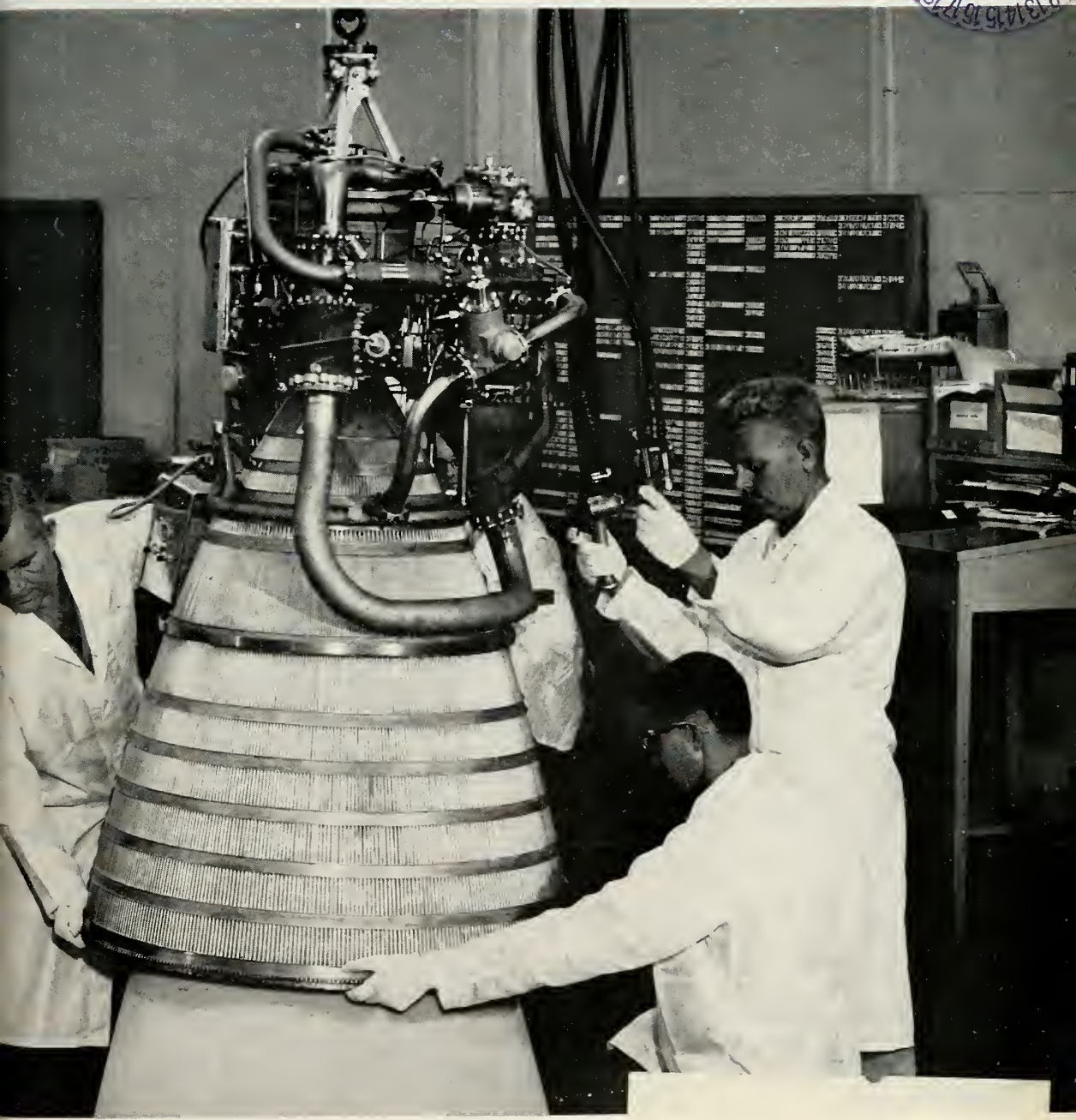
AUGUST 29, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY



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News of materials for the aerospace industry—selected from the 27,000 products of the 3M Company

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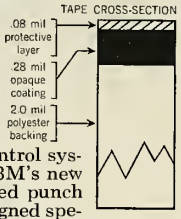
In a lather over vibration problems in your bird? Settle down, then, while we tell you the absorbing story of 3M's new vibration damping tape. Y-9052, as it's called, is an easily applied construction of self-adhering flexible foam. It stems from an entirely new basic theory on vibration control. The actual key to all this is the high internal shear action of its specially compounded foam and pressure sensitive adhesive coating. A top layer of reinforced vinyl film intensifies this damping effect. Thus, you get a structure engineered to give maximum energy absorption at minimum weight—Y-9052 weighs only ¼ lb./sq. ft.

Y-9052 is particularly effective in controlling vibration or noise due to resonance. And there's no need to emphasize how important this can be in reducing fatigue of structural materials. For maximum effectiveness, the foam should be considerably thicker than the base metal. For example, one layer of Y-9052 is at its best on sheet metal up to approximately 0.060". Of course, with an additional layer of tape, you can boost the metal thickness up to 0.125". Y-9052 brings you the added advantages of thermal insulation (0.038 Btu's/hour/°F/sq.ft./ft.), flame retardance, and excellent moisture resistance. Its high conformability to irregular surfaces and ease of cutting make application a real breeze.

If vibration problems have you jumping (and they needn't be restricted to airframes), let our INDUSTRIAL TRADES TAPE DIVISION help you.

More Brawn for Your "Brain"



Plain old paper tapes may be fine for Wall Street stock tickers—but they just won't take the beating in many of today's punch tape data control systems. Not so with 3M's new #360 polyester based punch tape stock. It's designed specifically for critical and repetitive applications of machine tool control, automatic checkout systems, guidance systems, computers, and high speed readers—to name just a few.

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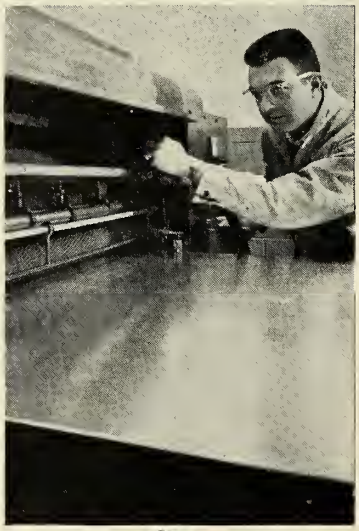
The open-textured structure of "SCOTCH-BRITE" gives you not only lightness, but also conformability to varying work geometries. To learn how it can fit into your operations, see your local COATED ABRASIVES DIVISION representative, or check the box below.



3M Company, Missile Industry Liaison—Dept. VAB-80
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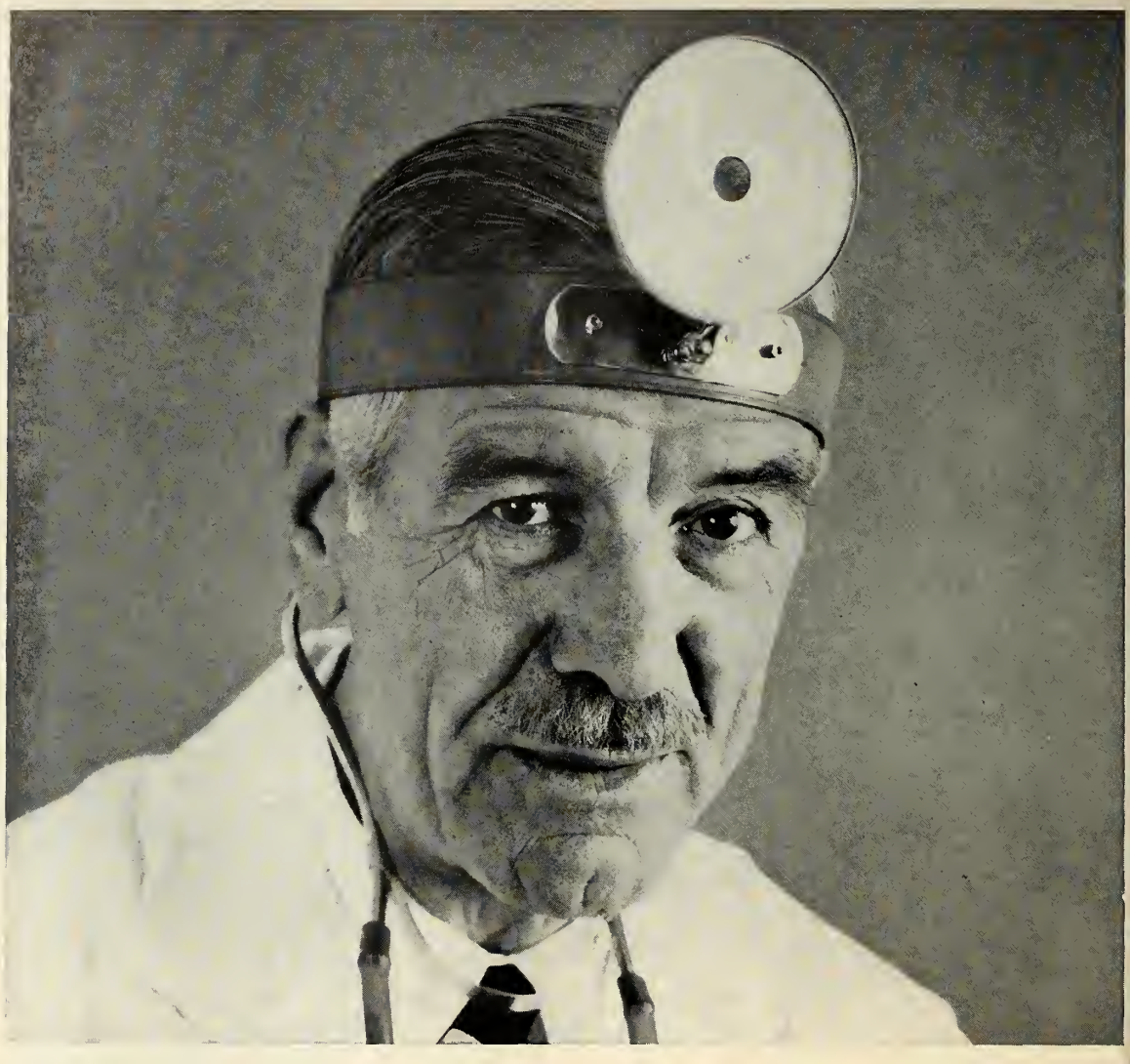

The Extreme Case of Shipmentitis

The most extreme case of Shipmentitis on record dates back to the General who lost the War because during the crucial Battle he couldn't locate the nail for his horse's shoe.

Today, Shipmentitis is a disease that afflicts many electronic component users. Its symptoms are occasional shipments arriving late, or in the wrong place, or incomplete, or with the wrong specifications. Some Companies have a slight case of Shipmentitis without realizing it. In serious cases, Shipmentitis can delay vital defense projects, cause expensive setbacks.

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Add to that key Avnet Assembly Facilities for Connector Prototype Requirements, plus immediate access to the fastest known forms of commercial transportation, plus internal Warehouse speed so highly developed that 75% of the orders received by Avnet are processed, assembled, inspected, packed, shipped, and received by customers before their confirmations reach Avnet.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

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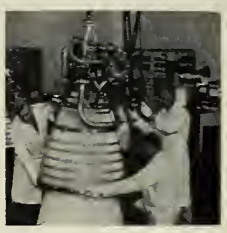

THE COVER

Nation's first liquid hydrogen rocket engine, designed to power NASA's Centaur space vehicle, has been delivered by its maker, Pratt & Whitney Aircraft.

AUGUST 29 HEADLINES

ADVANCED MATERIALS

ELECTRONICS

PROPULSION ENGINEERING

INTERNATIONAL

DEPARTMENTS

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letters

Triple Slip

To the Editor:

We have noticed in your July 18 issue (World Missile/Space Encyclopedia), under Strategic Missiles, that you have given credit to The Martin Company for the launcher systems for *Titan* missiles.

We of American Machine & Foundry Company (AMF) are doing the design, manufacture and installation of the launcher systems and would appreciate the credit, as we have a direct contract with the Air Force for this work.

R. McCardle, Acting Site Mgr.
Titan Installation & Activation Division
American Machine & Foundry Co.
Denver, Colo.

Through an oversight, M/R also erred in not crediting AMF with its role in development of the Minuteman rail car and its responsibility for Bomarc GSE. Our apologies to a major missile/space organization.—Ed.

Let's Fund Translation Now

To the Editor:

I found Paul Means' article on the efforts being made in developing a mechanical language translation program ("Auto-Translation Effort Lacks Focus," M/R, July 11, p. 22) an excellent review of the problems being faced. The article, however, did raise one or two questions in my mind.

The first is that it seems that a great deal of money and effort is being thrown into a project which is years away, while —in effect—very little money is being appropriated for solving the immediate problem: translating as much Soviet technical material as is necessary now. It seems ironical that we read every day that a lag in a critical area of as little as a year can make the difference between survival and destruction—while the authorities are content to allow at least a five-year lag in the translation program (which, while not ostensibly critical, really is).

The entire Russian translation program in the United States, which is actually producing results, at present costs less than $2 million a year. Several companies are engaged almost solely in this work; it has taken them years to build up the staffs to run out these translations and, in many cases, they do it at a loss simply because they are aware of the pressing need to maintain the program.

Moreover, when an adequate machine is provided it will be these companies whose staffs will have to provide the guidance necessary to check and recheck the accuracy of a vast amount of literature. I think that some attention should be given to these firms and to the problems they have run up against in attempting to broaden their program.

As an example, I should like to call your attention to the company called Consultants Bureau Enterprises, which not only translates more Russian scientific

journals than any other company in the world, but which also translates, publishes and sells a large number of scientific Russian books used by almost every scientist in the country.

At this time the company has six or seven Russian journals (among them are Kinetics and Catalysis and the Journal of Structural Chemistry) which desperately require translation, but for which no funds are available. It is the kind of undertaking which should have support; I believe that if in some way you could point this out you would be performing a public service.

Mark R. Feller.
Manager, Research Dept.
Kalb, Voorhis & Co.
New York City

A-bombs for Allies

To the Editor:

Your Aug. 8 editorial ("How Bold, How Imaginative?") about "Bold Imagination," or meeting unknown dangers with attack, stinks to high heaven. You and your friends in the State and Defense Departments would have the United States arm West Germany with atomic weapons to again (make the Germans) potential aggressors in what you call the defense of the freedom of the world.

Discreetly, no mention of West Germany is made in your editorial; but, to some of us who understand the underhandedness of people like yourself, the intent is clear: arm the other guy and let him do the dirty work. May I advise you that by treaty West Germany, which is a part of NATO, is not supposed to have or to develop an atomic, bacteriological, or chemical war potential?

The United States already has a diverse and widespread world nuclear striking force. Let's keep it in our own hands where it belongs. Why don't you smart fellows who editorialize and run the Pentagon ever come up with any bold and imaginative ideas to bring peace to the world? If the world was free from warmongers maybe that would be the great first step to freedom of the individual man from political and economic slavery.

John Savas
Canton, Ohio

To the Editor:

Your Aug. 8 editorial regarding arming our European allies with atomic weapons makes a point that is generally overlooked. We talk a great deal about mobility and dispersion. What better dispersion could you have than extending our real defense and attack strength to a dozen NATO allies?

And, since the spreading of nuclear weapons seems inevitable, wouldn't the very factor of its commonness make control mandatory?

Carlton Thompson
Atherton, Calif.

To the Editor:

. . . Isn't (our) holding on to our atomic secrets the very thing Russia wants most?

Peter Horn
Providence, R.I.

He built the strongest roof in the world

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

In order to design the shelter, h had to calculate the effect of the ex plosion on materials and structures He had to know how the shock wa transmitted through the earth's crust and what effect it would hav on the shelter—from beneath as wel 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.

Single Command Concept

The solution of this first-time-in-history problem is one more example of AMF's resourcefulness.

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The Countdown

WASHINGTON

B-70 Money Thaw Comes Slowly

The extra $100 million that the Administration has said it would unfreeze for the B-70 R&D program won't be flowing for awhile yet. The Defense Department, the Air Force and companies involved are trying to agree on a new program cut to the new financial pattern. The approximately $100 million would nearly double presently-planned Air Force funding of the B-70 in FY '61. But it is still far short of the original $400-million-plus program.

Super Polaris: How Soon?

Despite many words of praise, the Administration is still hedging even its announced bets on the Lockheed *Polaris* program. The Navy sought to push ahead in FY '61 with a $100-million R&D program. But the chances are that less will be made available. Also, weeks are slipping away. The apparently inevitable result will be the development of *Super Polaris* later—not sooner.

NATO MRBM Decision by Christmas

The NATO Council is expected to reach a decision by Christmas at the latest on which U.S. missile to buy to arm Western Europe with MRBM's. *Polaris* is still considered to have the lead, but the NATO countries are looking at other possibilities. (See page 16.)

Lulu Plays Double Role

The Navy's new compact nuclear—depth charge—General Mills' *Lulu*—can strike at enemy submarines two ways. It can be air-dropped from a plane or helicopter. And it—or a modification of it—can be launched by ASROC from a destroyer.

No Mourning for Space Act Changes

Few tears are being shed on Capitol Hill for the shelved Administration proposals to amend the National Space Act. The House—passed bill, which is expected to die in the Senate, is considered by a number of top congressmen to be only showcase tinkering for the most part. They prefer to try for more significant changes in the Space Act next year in the new Congress.

INDUSTRY

New Engine Readied for X-15 Flight

North American is getting ready to send its *X-15* on a flight for the first time with the new big XLR-99 engine. The date: The first week in September. This means the July 6 explosion during run-up has set back the program only about two months rather than three to six as believed in some quarters.

Advanced Sparrow Contract Expected

Some insiders expect the Navy to award a contract within the next few weeks for a new *Sparrow* propulsion system. The powerplant will be used for an advanced model of the Raytheon air-to-air missile. The big question is whether the Navy will decide on a packaged liquid or a solid propellant.

Another Buy by Litton

Litton Industries is understood to be getting ready to buy another electronics firm. Litton is reported to be negotiating for an Eastern component manufacturer—one of about 10 firms Litton would like to buy when the price is right.

Another Name for Ryan

Ryan Aeronautical is quietly considering a change in its public image. Specifically, company officials are considering a change in names. They want something that more closely reflects the company's interests in space and electronics.

Fairchild Official Switches to P.R.

Warren R. Smith, assistant to the president of Fairchild Engine & Airplane Corp., will resign Sept. 1. Smith will open a public relations and industry consultant office in Washington. He will continue to handle the Fairchild account.

INTERNATIONAL

Anglo-German Accord over Blue Water

Great Britain and Germany are understood to have agreed to produce jointly English Electric's *Blue Water*. The surface-to-surface missile may eventually be adopted as a NATO tactical weapon.

French Eye U.S. Nuclear Scorekeeper

The French Defense Ministry is considering the purchase of U.S. nuclear target scoring equipment. Interested ministry officials recently completed an inspection trip to the United States.

More Missiles at Farnborough

The Missile Park at the annual Farnborough Air Show next month in Britain will be 20% larger than last year. Among the feature attractions will be the Bristol-Siddeley Stentor engine, which powers the *Blue Steel* air-to-surface tactical missile.

British Aerospace Firms Consolidate

Three British firms—Vickers-Armstrongs (Aircraft), English Electric Aviation and Bristol Aircraft—have formed the British Aircraft Corp. The new corporation already has acquired control of Hunting Aircraft, Ltd.

The Overseas Pipeline

German firms are offering electronic systems to NASA . . . the French *Veronique* sounding rocket is carrying a 145-lb. warhead . . . the French Navy is planning to build another missile cruiser . . . reports persist that the Russians are launching big missiles from a site just north of Moscow.

New missions for the Agena

The Lockheed-built Agena satellite—used by the U.S. Air Force in its Discoverer, Midas, and Samos programs—has been chosen for another major program. The National Aeronautics and Space Administration plans to use a larger, more powerful version, the Agena B. NASA will use both Atlas and Thor boosters to launch it. Atop the Atlas, the versatile Agena B will vary from a 5000-pound earth satellite to an 800-pound space vehicle. Atop the Thor, it will be used for a new series of 1500-pound meteorological satellites. Lockheed is prime contractor and system manager for the Agena and Agena B.

LOCKHEED MISSILES & SPACE DIVISION
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Agena is America's largest satellite, weighs 1700 pounds on orbit. Agena B is larger, has doubled fuel capacity.

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B-70 Proposed as 'Booster'

System developed by North American using B-70 and intermediate booster rocket could save billions of dollars

by William J. Coughlin

Los Angeles—Development of a new intermediate stage booster rocket with a thrust of some 300,000 lbs. is proposed by North American Aviation for use in a space system in which the B-70 would serve as a recoverable first-stage booster.

The system, consisting of a B-70 and the non-recoverable intermediate booster, could be used to orbit *Dyna-Soar, Samos, Midas, Discoverer* and other space vehicles. North American estimates that using the B-70 Recoverable Booster System (RBSS) would save the nation some $2.63 billion in its space programs over a 15-year period.

Details of the system, developed under Air Force study contracts, have been disclosed for the first time. The Air Force is giving serious consideration to the proposal for RBSS launch of *Dyna-Soar*. One major advantage would be the ability to launch the manned spacecraft in a horizontal position—impossible with the planned *Titan* boosters.

• **Easy adapting**—Modifications required to adapt the B-70 to a space role as a recoverable first-stage booster are few:

–Lengthening of main gear struts by three feet.

–Provision of fairing for payload.

–Provision of an escape chute so that the pilot of a manned vehicle such as *Dyna-Soar* can eject up through the B-70.

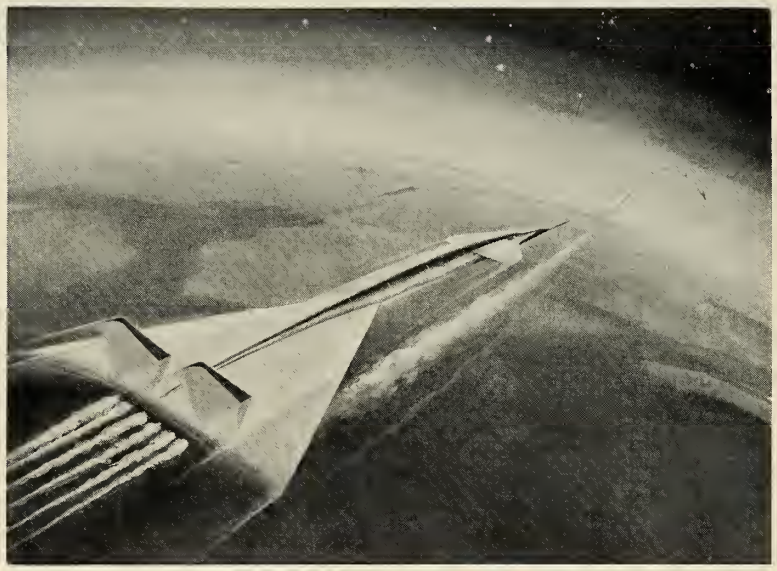
–Relocation of nose gear by moving it forward and providing for retraction into new payload fairing.

–Provision of attach and drop mechanisms.

–Elimination of unnecessary electronics and defensive armament.

The RBSS B-70 is expected to be less expensive than the military version. Cost for three of the aircraft is estimated to range between $140 million and $200 million, depending upon total B-70 procurement. No modifications are necessary to the propulsion, control or guidance systems.

The intermediate-stage booster rocket is needed because most orbital vehicles now planned will not be powered. The design proposed calls for a booster similar to a king-sized *Polaris* or *Minuteman* ballistic missile.



INTERMEDIATE BOOSTER takes off carrying space vehicle after dropping from B-70 in sketch by North American artist. Booster would drop away at about 20,000 ft.

Orbiting of *Dyna-Soar*, weighing between 10,000 and 15,000 lbs., would be accomplished by attaching the spacecraft to the top of the booster, which might be of the double, or Siamese, type to eliminate the need for lengthening B-70 main gear struts.

An orbital *Dyna-Soar* would fit snugly into the bomb bay of a modified B-70 with only its wings outside. It would rest atop the booster, which would be equipped with its own vectoring control system and faired into the bottom of the supersonic aircraft. The techniques employed would be similar to those developed by NAA for dropping of *X-15* rocket ship from a B-52.

Launch would be at Mach 3 above 70,000 ft. The Booster would drop off at about 200,000 ft. and the spacecraft's sustainer engine would take over. After burnout, *Dyna-Soar* would coast to apogee, using reserve fuel to kick into orbit after rotation into plane. Retro-rockets would be used for recovery from orbit.

One major military application of such a system is for satellite interception and inspection. The B-70 also could be used to launch a *Dyna-Soar* type vehicle as an orbital bomber.

• **Savings described**—But the role seen for the RBSS is far wider than its pure military application for vehicles of the *Dyna-Soar* type. North American has carried out a study for the Air Force based on probable national budget allocations for all types of military and civilian space programs for the period 1965-80.

This study indicated that approximately 50% of the tonnage to be placed in orbit will consist of payloads in the 5000-to-15,000-lb. weight category. For payloads above 15,000 lbs., North American assumed boosters of the *Saturn* type would be required. The B-70 was studied as a replacement for the others, such as *Atlas-Centaur*.

Use of the B-70 RBSS in these launches in place of nonrecoverable first-stage boosters was estimated to provide a net saving of some 66% in hardware alone. Financial savings per launch were estimated at $2-million—for a total of $2.63-billion.

Costs are based on the use of a

minimum of three of the RBSS aircraft, with the program envisioning eventual use by the military and National Aeronautics and Space Administration of between six and 10 of the B-70's fitted as recoverable boosters.

North American estimates that for a 10,000-lb. orbital payload, the cost/lb. in orbit will be about $125 with the RBSS. Comparable cost for a booster of the *Atlas/Titan/Saturn* type is estimated at $300/lb.

Costs are estimated on 2000 to 2500 launches for each RBSS B-70, crediting the aircraft with a service life of some 6000 hrs. The figures take into account development and use of the new intermediate booster.

• **Bigger payloads in future**—First aircraft for this use, if the B-70 program is expanded, probably would be No. 7 off the assembly line, available in 1963-64. The additional two aircraft, under present space goals, probably would not be needed before late 1967.

The B-70 is seen as easily adaptable to its role as space booster. Of its maximum gross takeoff weight of more than 550,000 lbs., some 65% is fuel. This means it could carry a payload of vehicle and intermediate booster totaling some 217,000 lbs. on the shorter-range space missions.

Employing today's cryogenic engines and fuels, the B-70 RBSS could put a 5000-lb. payload into a 300-mile orbit. As non-cryogenic systems become available, the weight penalty resulting from the requirement that several thousand pounds of fuel be carried for topping-off will be eliminated. This would up the payload to the point where 14,000 lbs. could be placed in the same orbit.

Improvement in fuels for the B-70 itself will mean an ability to exceed Mach 3 on a dash basis, since the aircraft is capable of Mach 4 for very short periods without encountering too severe thermal problems. This would provide a capability of placing 30,000 lbs. in a 300-mile orbit, increasing even further the savings possible with such a program.

The B-70, with a comfortable excess of thrust for takeoff, will be able to take large payloads through the sonic barrier if they are properly faired.

In addition to the new intermediate booster proposed by North American, studies also have been made of existing vehicles as potential space boosters. The B-70 could carry either *Polaris* or *Minuteman*. Although a single *Polaris* probably would lack the thrust to be an effective booster, a cluster of three *Polaris* missiles could be employed, according to North American designers.

• **Low drag at launch**—Major advantage of the RBSS lies in the fact that not only would Mach 3-4 energy be imparted to the payload on launching, but it would be imparted at an altitude where, with 98% of the earth's atmosphere lying below, there is very little drag.

To illustrate this advantage, the following example is cited:

From sea level, an *Atlas* booster can put about 3800 lbs. of payload into a 300-mile orbit. If this *Atlas* were hung from a balloon and fired at 80,000 ft., it would be capable of putting a 13,700 lb. payload into the same orbit. Modifying the nozzles to optimize the *Atlas* for launch at this altitude would up the payload to 18,300 lbs. If it could then be hung from a B-70 and boosted to Mach 3 before firing, it would be capable of putting 24,900 lbs. of payload into orbit.

Another way of putting it is that taking a given payload to altitude for launch makes it possible to decrease the size and cost of its booster. This could be done, in a limited sense, even with a B-52.

• **Added orbits**—It also is pointed out that use of the B-70 RBSS would add considerable flexibility to the U.S. space program now limited—by safety problems and availability of down-range facilities—to two launching sites in the continental U.S. The RBSS would offer a wide number of orbit injections where the intermediate booster would fall harmlessly into the ocean or in unpopulated areas.

Firing into an equatorial orbit also would be possible without the expense of establishing an equatorial launch base. To fly from the U.S. to a point on the equator with a maximum load of 217,000 lbs., launch its payload and return to the U.S., a B-70 would require in-flight refueling. But with lighter payloads, in-flight refueling would be unnecessary.

The Missile/Space Week

Samos to Get New Impetus

Brig. Gen. Robert E. Greer will push the high-priority *Samos* project in his new post as chief of all Ballistic Missile Division programs.

Lockheed Missiles and Space Division got formal confirmation of the $76.7-million contract it received in letter form from the Ballistic Missile Center. Work has already begun on a ground-space communications and control network for the Air Force *Discoverer, Midas* and *Samos* satellite programs.

New Nuclear Depth Charges Deployed

The Defense Department revealed that the atomic depth charge Lulu is now being carried in the fleet by antisubmarine warfare helicopters and aircraft. Lighter and smaller than the first nuclear depth charge, Betty, it was designed by the Naval Ordnance Laboratory and is produced by General Mills.

U.S. Goes Three for Four

About the same time the Soviets were launching *Strelka* and *Belka* into orbit: The U.S. Air Force shot instrument-loaded *Discoverer XIV* into a polar orbit from Vandenberg AFB, Calif. From Eglin AFB, Fla., a *Bomarc A* intercepted an "enemy" jet drone bomber heading for the Florida coast. The Navy fired another *Polaris* missile from Cape Canaveral. However, the Army's *Thor-AbleStar* launch vehicle for *Courier* communications satellite blew up 2½ minutes after launch.

The big news, though, was made the next day when an Air Force C-119 recovered the *Discoverer XIV* capsule in a spectacular mid-air snatch. Chances appeared good that *XVI* would carry the first orbiting primate.

Unstable Fuel Chemical Caused Blasts

Propellant manufactures and military installations have been warned to dispose of an unstable fuel element which caused two blasts at the Navy Propellant Plant, Indian Head, Md. The explosions, the first of which killed one workman and injured 20 others, were laid to a usually stable chemical which became unstable with heat or some other factor.

Soviet Describes Capsule Landing

Retro-rockets were used extensively to bring back the Soviet satellite carrying two dogs, according to the London *Daily Worker*. Soviet Prof. Ari Sternfeld disclosed that retros first slowed the vehicle, ejecting the capsule from orbit, then smaller retros corrected its flight toward earth, landing it within six miles of the predicted point.

Mercury slippage hit . . .

Congressmen Fear Man-in-Space Defeat

House Democratic leader concerned over military implications; Committee head sees Red manned launched this year

by James Baar

Key congressmen this last week bitingly attacked NASA for slippages in the *Mercury* program and warned that failure to put a man in space ahead of the Russians would result in a tremendous propaganda defeat for the United States.

At the same time, a number feared that the successful return of the Soviet "menagerie" satellite from orbit meant that the United States has already lost the race.

The congressional reaction came as NASA countinued to deny that *Mercury* has slipped about a year (M/R, Aug. 15) and more details of the Russians' 4.6-ton "space menagerie" were released.

NASA Chief T. Keith Glennan called the Soviet launching "a fine job," but said he did not regard it as a "major first"—only "just another step."

Others in and out of Congress regarded the launching as more significant. One top British authority—Prof. A. C. B. Lovell, director of the Jodrell Bank radio telescope—said he expected Russia to put a man into space "at any time."

• **Military implications**—The grimmest warning came from House Democratic Leader John W. McCormack of Massachusetts.

"What I'm afraid of is that now they're going to get ahead of us in putting up a military vehicle," he said. "The battleground of tomorrow is going to be outer space."

McCormack's statement hit directly at Administration policy. President Eisenhower has consistently contended that the military value of outer space is nil.

The House majority leader called for a hard-driving space program that would "coordinate the facilities and brains of the nation under strong leadership."

"We are facing an emergency and the effort should be made," he said. "The *Mercury* program has not moved as rapidly as I expected."

• **Mercury now anticlimactic?**—Chairman Overton Brooks (D-La.) of the House Space Committee said bluntly that he was "disappointed in the progress of the Project *Mercury* program," which he referred to as "a minimal experiment." He predicted that Russia will launch a manned satellite in October or "in any event before the end of the year."

"Whatever is done with Project *Mercury* after a Soviet success will be anticlimactic even if successful," he said. "This poses major, although not new, decisions for our government if we are not to suffer the kind of comparisons drawn between *Vanguard* and the early Sputniks."

Rep. James G. Fulton (R–Pa.), a top-ranking member of the House Space Committee, said "putting a man in space is worth $100 billion in foreign aid."

"You can only do it once," he said. "We should take it for its supreme value. But we're not settling down to the main event. We're spreading ourselves too thin."

Rep. B. F. Sisk (D–Calif.), another high-ranking member of the committee, said he has had "reservations about the *Mercury* program since the contract was let."

"The people running this thing have lacked the vision and foresight to anticipate the problems," he said. "They've never asked for enough money. They've continually underestimated and slipped."

Sisk also hit at the Administration's policies on man-in-space programs.

"We failed to make the broad approach," he said. "We could have gone ahead with something like *Dyna-Soar*, too, but the idea after *Sputnik* was to be somewhat economical."

• **Meadow landing**—The Soviets announced the recovery of their dog-carrying "menagerie" on Aug. 20—only one day after the Air Force successfully recovered in the air the 84-lb. capsule from *Discoverer XIV*. The *Discoverer* capsule contained no life.

The Russians said their satellite contained two dogs, some rats and mice, flies, plants, seeds and fungi. Its recovery marked the first time that living creatures had safely returned from orbit.

The satellite was launched into a nearly circular 198-mile orbit. The Russians said they observed the dogs on television during the 24 hours that the satellite was in orbit.

They reported that the satellite's retro-rockets were fired on command after the 17th circuit of the earth. A later report said the satellite and a capsule containing the animals separated after re-entering the atmosphere and landed safely in a meadow 6.2 miles from a predetermined landing area.

The two dogs—Strelka and Belka—were reported to have survived the trip "in perfect condition."

"The other biological subjects . . . also well sustained their stay in cosmic space and flight," Moscow Radio said. It added that one of the plants continues to blossom.

The Russians released photographs of the dogs taken while the satellite was in orbit and transmitted to earth. They also said they watched the orbiting dogs eat and function "physiologically" in a normal fashion.

• **Downgrading charged**—Congressmen repeatedly pointed to reports of the Soviet launching as evidence of where the United States stood in the space race.

Chairman Brooks noted that the Soviet satellite seemed to be a match for NASA's proposed *Apollo*. But he said that today *Apollo* is "only a designer's dream."

On the other hand, Brooks said that although Project *Mercury* is carefully planned with many types of safeguards, it has "some of the marginal capabilities of the kind associated with Project *Vanguard*." He said that if just a few things go wrong the project may not come off.

McCormack said the Administration has not made clear to the public "just how far behind we are, while it is evident that we are four to five years behind."

"There is no apparent appreciation of our relative position," he said.

"If the Russians didn't have anything, that balloon *(Echo)* would have been a fine thing. The Administration did the same thing with *Sputnik I*—downgrade it."

McCormack paused pointedly.

"The approach is wrong," he said. "Our policy should be not to catch up but to go ahead. That isn't our policy today."

Norstad reopens . . .

NATO Wary On Polaris; Wi

Allies are confused by lack of hard data and firm U.S. policy on competing programs; interservice struggle examined

by Donald E. Perry

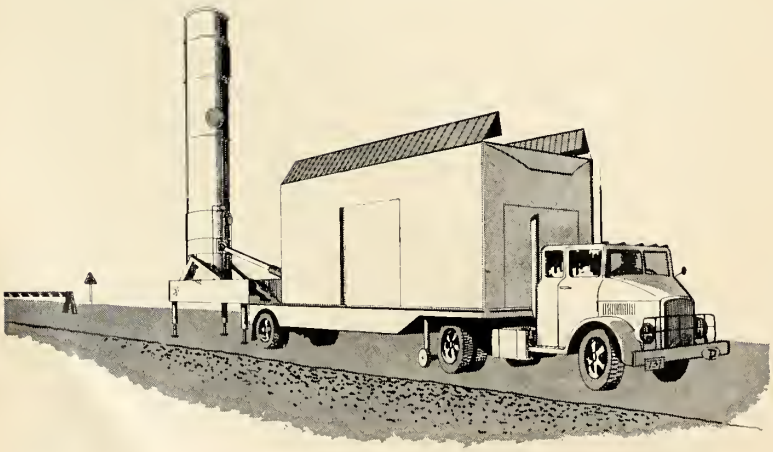
Reports from Europe indicate that America's NATO allies may want to explore the possibility of obtaining some missile other than *Polaris* to fill their need for a medium-range ballistic missile.

SHAPE Commander Gen. Lauris Norstad, M/R has learned, has asked Defense Secretary Thomas Gates whether other missiles may be made available if NATO changes its requirements.

Gates is reported to have suggested *Polaris* to the NATO defense ministers in March as the only U.S. weapon that can be adapted in the '62-early '63 period to meet their requirement for a "mobile, land-based missile system."

The Defense Secretary reportedly has promised to answer Norstad's query on or about Sept. 15, and to provide him with a detailed report on what missile systems, with what capabilities, will be available for NATO from now through 1975.

Gates' answer obviously could have a great effect on the fortunes of several U.S. missile programs—the Army's *Pershing* and the Air Force's projected TBM (tactical ballistic missile), in addition to the Navy's *Polaris*.



UNDER DEBATE: artist's conception of Polaris fired from mobile land vehicle.

Norstad's action could mean that NATO nations want to back off on range and operational dates if it would give them a more desirable system. This would be a door-opener for the Air Force—anxious to promote its TBM follow-on to the air-breathing *Mace*, and the Army—hungry for a range extension for *Pershing*.

But the prime reason—and this is conceded even by the services and manufacturers which have been pushing their individual programs—is that NATO has been given too many missile sales pitches on paper, without sufficient technical data or U.S. policy to back them up. NATO nations question touted availability dates and alleged capabilities, because DOD hasn't firmly decided what program or programs it wants.

This lack of accurate data and firm policy decisions has, many observers feel, strained the ties which bind NATO. How, they ask, can these allies agree on such things as range desired, hard or soft sites, a mobile, land-based system, use of warheads or sea and inland waterway launch capability, when the U.S. hasn't made program decisions?

• **Background**—While it is difficult to separate the chaff from the real thing, there is definitely bitter in-fighting behind closed doors. Washington observers say Norstad's query was occasioned by his own technical staff and political pressure from some NATO member nations who are not completely satisfied that the submarine environment-designed *Polaris* can be adapted in the 1962, early 1963 time period to provide a "mobile, land-based missile system."

Polaris proponents say it can. They concede some countries are not satisfied with the planned land-based *Polaris* system. However, they say these nations, perhaps deliberately, have not been given sufficient data. Nor, they say, has it been satisfactorily expounded that a mobile, land-based missile system should *not* be the only requirement. They contend that offshore ship and inland-waterway barge

ıop Around

launch capabilities, the capability of NATO nations to use their own warheads, longer range, and a system in being, should also be considered.

They are accusing the Army and Air Force of bedfellowship in a mutual effort to sink *Polaris* in NATO. While the Army and Air Force both want the weapon and the mission, *Polaris* proponents say, they are doing some trading. Norstad, they say, is being pressured by his own service to keep the NATO requirement to a land-based system in order to qualify the Air Force's TBM concept.

On the other side, TBM and *Advanced Pershing* proponents are charging the Navy with trying to ram-rod through the State Department a policy decision supporting *Polaris* as the NATO weapon. They go so far as to say Gates' firm offer of *Polaris* to NATO took the Air Force and Army completely by surprise.

This has been branded as pure poppy-cock by the *Polaris* people. Observers say the offer of *Polaris* to NATO had been before the Joint Chiefs of Staff in March. The Army and Air Force reportedly sided against the Navy, claiming that *Polaris* was not suitable for NATO's MRBM requirement.

Observers said this was why the Air Force got mad when Gates made the offer:

–The Air Force was nearing completion of a study for its own TBM, SOR-161 (Systems Operational Requirement). It had even directed Ballistic Missiles Division to start development of the TBM, or TBMX as it is known in some quarters. Some FY 1961 funds reportedly were diverted and more funds were to be asked in the FY 1962 budget if the JCS should agree on the requirement. The new, non-profit Aerospace Corp. (broken off, because of Congressional criticism, from Space Technology Laboratories), had been assigned major responsibilities for the selective 200-1500-mile range system which was being promised for the 1965-75 time period.

The Army bristled because:

–It had its own program to extend *Pershing's* range to 1000 miles up for consideration by Gates and the JCS. Availability was being promised for late 1963 or early 1964. Principal effort would be to cut down weight of 682-pound guidance system, allowing more propellant in first stage, virtually doubling thrust.

The Army felt that if NATO would wait one year it could get a better land-based system in the improved *Pershing*. Further, the limited-range *Pershing* due to go to U.S. troops in Europe in 1962 could handle more than 70% of the NATO targets in the interim, with full coverage the following year—along with added capability to disperse the system to more distant nations and launch points.

Where does this leave Gates? Among the ticklish problems which will have to be decided in his answer to Norstad are:

1. Whether to let the *Polaris* offer stand? This could open him to partisan political criticism because of his former position as Secretary of the Navy and because of political objections that *Polaris* is being touted as the missile epitome of the Administration.

2. Whether to assign the Army a tactical missile role by extending *Pershing*'s range, qualifying it as a possible NATO MRBM and opening the roles and missions struggle again between tactical Army and air power?

3. Whether to keep the Army in its Wilson-imposed range limitation but permit it to develop a longer-range *Pershing* for the Air Force and possible NATO use. The Army, some observers say, is willing to make this concession.

4. Call for a new Air Force TBM system with availability in 1965.

Many people feel that Gates could score a major political and budgetary coup by permitting Army to develop a longer-range *Pershing* for the Air Force. If both services would agree, Gates could be known as the first Secretary of Defense who got the Army and Air Force to work together.

Some observers say the technical and missions side of the Air Force has by no means convinced the money holders that there is a separate requirement for a "Cadillac-version" of the MRBM in the TBM form incorporating the latest state-of-the-art for the period 1965-75. Guidance and GSE alone for the proposed AF TBM would run some $350 million. Many, even in the Air Force, feel this would be hard to come by.

NATO nations have good reasons to be confused with the slaps and counterslaps in the programs. Here are a few:

Against Polaris:

–In the 1965-75 period it will be technically behind the state-of-the-art while the TBM will be more "advanced."

–Its 28,000-lb. weight is against it as a "mobile, land-based system." (This is ammunition for the Army, which proudly cites *Pershing's* 10,000 lbs.)

–A submarine-designed system can not meet the stringent environmental conditions—shock, propellant grain temperature, electronics environs, etc. —of a "mobile, land-based system." (Again *Pershing* is mentioned: 20G shock cited, solid-grain capability to withstand 140-plus or minus temperature variation spread using –25°F as the medium, electronics designed for the ground, etc.)

–*Polaris* can not become a land system by its touted 1962 date.

Polaris counters:

–The TBM system which also would have to be deployed on foreign soil, would cost more than $1 billion just for development. Few technological "breakthroughs" could be expected to make it worthwhile. Further, it would put an unnecessary drain on industrial facilities and manpower. It's a "paper" promise and could not meet a 1964 date. *Polaris*—assuming the 2500-mile bird is realized—has its growth factor for the 1965-75 period.

–It's a system in being and "we don't have to wait until there's a tail-fin on next year's model." (1964 for advanced *Pershing* and later for TBM).

–It has 1000-mile range now, which *Pershing* does not have, and the 200-1500 mile range for the TBM again makes it questionable whether a new development program is worthwhile.

–A new guidance system for *Pershing* could be more of a development program than a new propellant program.

–*Polaris* would permit a nation such as France to use its own, still not fully-developed heavy nuclear warhead.

–Its capability of launch from merchant ships and barges in off-shore coastal waterways can pacify those nations (Britain, for example) which would like to have them off home soil. Further, this would strengthen the U.S.'s strategic *Polaris* capability, since launching submarines could be detached from European waters.

–It can meet the 1962 NATO date with the A1P because the mobile land system would only entail putting the submarine launch tube on mobile or tracked vehicles which would settle any environment problem (They don't consider there is any problem and cite the number of launches from Cape Canaveral). The tube also could be used as a shipping container and the pop-up effect could be used either in hardened or soft sites.

Discoverer Monkey Shot May Get Higher Priority

LOS ANGELES—Just how soon a monkey is launched into orbit in the *Discoverer* program may depend on the amount of political pressure applied as a result of recent Soviet space successes.

A spokesman for the Air Force Ballistic Missile Division said here "It is not likely" now that *Discoverer XV* will carry a primate aloft. He admitted, however, this still is a possibility if the monkey shot is given a higher priority.

His statement conflicted with reports from Washington that the Air Force definitely plans to attempt recovery of a monkey from orbit with *Discovered XV*.

Discoverer XV is scheduled for launch sometime within the next two weeks.

"We may have lost a little bit due to the Soviet accomplishments," Maj. Gen. Osmond J. Ritland, BMD Commander, said. "But it means we are in very tough competition in missiles and space."

• **Assurance sought**—Sources here said it is likely that two or perhaps more shots may be attempted before the primate is launched. It is known that Col. C. L. Battle, *Discoverer* Program Director at BMD, is anxious to have a reasonable assurance of a safe return before the shot is attempted. This will depend on successful recovery of two more shots, in his opinion.

The program moved closer to the life support launch with successful mid-air recovery of the capsule from *Discoverer XIV* on Aug. 19. *Discoverer XIV* was launched from Vandenberg Air Force Base at 12:57 PM, Aug. 18. An Air Force C-119 from the 6593rd Test Squadron made a successful mid-air snatch of the re-entry capsule 27 hours later, 300 miles northwest of Hawaii.

The aircraft, piloted by Capt. Harold E. Mitchell, made two unsuccessful attempts to recover the capsule before hooking it on the third try. The chute was snagged by a trapeze-like recovery gear strung between two telescoping steel poles trailing beneath the fuselage. A grappling hook then secured the chute and its capsule. The capsule was winched aboard by nylon cable to mark completion of a 450,000-mile journey through space on 17 earth orbits. It was the first mid-air recovery.

Dyna-Soar Invitation

Invitations to bid will go out early next month, M/R has learned, for the communications-data link and primary guidance subsystems for the Dyna-Soar boost-glide vehicle.

Some 86 firms attended a pre-bidders conference Aug. 10 at Wright Air Development Division at Dayton. Forty-two out of 48 firms indicated an interest in bidding on the communications-data link; 24 of 38 firms indicated they wanted to bid on the guidance subsystems.

Each firm has been given details on requirements. A deadline for bids will be set when the invitations to bid are issued.

Red Rockets Seen Able to Down U-2

Was reconnaissance pilot Gary Powers' U-2 knocked out of the sky from an altitude of 68,000 feet? If so, what Red rocket has this capability?

Powers testified at his Moscow "show" trial that it "was at that altitude I was struck down by something—I have no idea what it was. I didn't see it."

The consensus of Western observers present was that the U.S. aviator had not been brainwashed and that his answers were given firmly and without restraint.

Many American rocket experts think the Russians have such a capability. They point specifically to the *SA-4* anti aircraft missile, which should be able to destroy aircraft at altitudes much higher than 68,000 feet.

It is also entirely possible that a Russian air-to-air missile such as the *M-100A* fired from a late-model MIG could have done the job.

U.S. intelligence experts did not believe that the U-2 had been hit by a "remarkable rocket," as Premier Khrushchev described it, because this had not been detected by U.S. radar tracking Powers. They speculated that the plane had stalled trying to change altitudes.

But Powers' testimony—and the conviction with which he apparently gave it—indicated that the view from the radar scope may have been deceptive.

• **U.S. birds could do it**—Many U.S. antiaircraft missiles could hit aircraft flying at the U-2's altitude. *Bomarc-A*'s ceiling is above 68,000 feet, *Bomarc-B*'s more than 70,000 feet.

The maximum ceiling of *Nike-Hercules* is more than 150,000 feet.

The Soviets may be having trouble with antiaircraft missile guidance. A direct hit would have destroyed the U-2 and its pilot. It seems more likely that Powers' craft was hit by shrapnel from a missile detonated by a proximity fuze.

U.S. intelligence has known about the *SA-2*, which corresponds to the *Nike-Ajax*, and the *SA-4* for some time.

Disclosure of the *SA-4* by the U-2 and other intelligence sources gave high priority to such projects as *Skybolt*, because bombers could not fly out of reach of the newer Soviet missile.

It is also known that the Russians are developing an antimissile missile designated the *SA-6*. This missile may be further along in development than the *Nike-Zeus*, and may already be in production.

It is not thought that the knowledge that Russian rocketry may have been able to knock down a U-2 will alter Air Force planning in any way. It has been known for some time that future use of bombers will be as mobile missile launchers flying out of reach of enemy antiaircraft defenses.

The U-2 as a reconnaissance tool was becoming obsolescent at the time of Powers' flight. It will be superseded in the near future by reconnaissance satellites such as *Midas* and *Samos*.

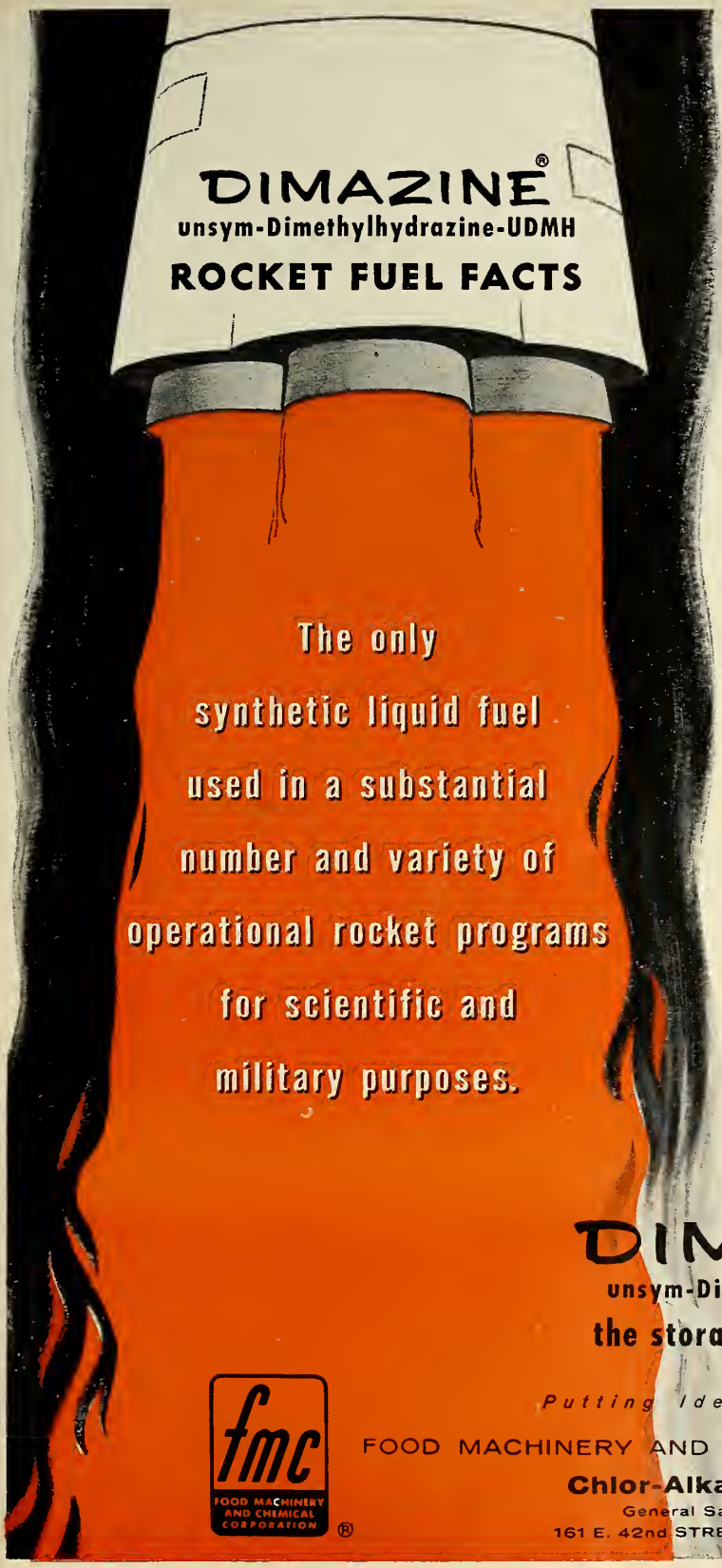
Echo's Varying 'Twinkles' Point to Irregularities

"Twinkling" of the *Echo* satellite varies so greatly that some observers feel that it must be due to irregularities in shape or variations in orbital path.

Engineers at Kollsman Instrument Corp.—using a Kollsman Astro-Tracker—have reported equivalent star magnitude changes ranging from +1.0 to −0.5 and altitude variations from 966 to 985 miles. They feel that changes of such magnitude cannot be attributed to high cloud coverage or atmospheric changes.

Observations were made during routine tests of a star tracker used in celestial navigation systems. The system automatically tracks stars to obtain precise data for navigation by aircraft, missiles, and submarines. Accuracy is reported to be within minutes of arc.

Calculations at the Smithsonian Astrophysical Observatory, Cambridge, Mass., also indicate orbital changes due to sunlight pressure. Computations show that the satellite's perigee is coming 1½ miles nearer the earth each 24 hours. This daily change is predicted to double soon, then slowly decrease and eventually change direction.



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The Countdown

ELECTRONICS

5-Ton Feed to Scan Big Dish

The 1000-ft. fixed reflector of the AF-ARPA radio telescope in Arecibo, P.R., will be scanned by a mobile line source feed rotating like a giant pendulum about its center. The unique feed—to be designed by TRG, Inc.—will weigh five tons, measure 101 ft. in length, and contain 768 radiating slots.

X-15 Guidance Works

Inertial guidance in the *X-15* rocket ship worked extremely well in the recent record-breaking 26-mile-high flight, according to reports. The Sperry system provides critical attitude, speed, altitude, and re-entry control data to the pilot and to airborne and ground-based recorders.

Hughes Transistors Yield 4 gc

Parametric mode transistors that operate at ultra-high and microwave frequencies have been developed by Hughes Aircraft. Demonstrated recently in a mixer-oscillator circuit invented at Lenkurt Electric, the Hughes transistor reportedly produced nearly 4 gc (kmc) at 10% efficiency.

Bendix Gets Advent Contract

A $2-million contract for Project *Advent* satellite communication equipment and associated ground terminal has been awarded by the Army to Bendix Systems Division. *Advent* includes several different advanced communication satellite systems.

Transistors Show Big Gain

Transistor sales for first six months of 1960 were up 67% over the same period last year. According to EIA, sales topped 60 million units; dollar volume was close to $153 million.

GROUND SUPPORT EQUIPMENT

Saturn Test Facility Begun

Construction has started on a dynamic test facility for *Saturn* at NASA's Marshall Space Flight Center. The installation will accommodate the complete three-stage space vehicle for structural, mechanical, and operational tests.

Dual Array Raises Resolution

The resolving power of radio telescopes may be increased by using two small antennas rather than one large one, according to two astronomers at England's Cavendish Laboratories. They recently reported a method of changing the position of two small antennas to cover successively the area of a large reflector. Information received is mathematically combined to produce one output.

PROPULSION

Ground-effect Problem Critical

Various configurations for flame deflectors at launch pads and silo bottoms still are being investigated. As booster thrust increases, ground-effect problems become more critical. Newest approach for high-thrust launches is a pad configuration resembling an anechoic chamber wall.

Arc Plasmajet Engine Contract Awarded

Plasmadyne Corp. has been selected by NASA to develop a one-kilowatt electric rocket for space-vehicle attitude control. Test objectives of the 12-month, $200,000 contract call for an engine with a minimum thrust level of 0.01 pound.

ASW ENGINEERING

ASROC Production Funded

Minneapolis-Honeywell has received an additional $2.9 million for production of *ASROC*. The new contract brings to $4.9 million total funds awarded to M-H for development of the antisubmarine rocket.

Porpoise Sonar Good to 5 Miles

Much-publicized porpoise studies are in earnest. The porpoise can emit "sonar" signals ranging from 450 cps to 190 kc, and possesses almost incredible ability to discriminate between objects. He can find schools of fish at ranges up to 8000 yards. ASW researchers would like to know how it's done. They are also interested in how the porpoise can adjust to extremely rapid pressure variations without ill effect.

Other Sea Inhabitants Drafted

The Navy is also studying salmon, seals, and whales, with research goals similar to those of the hydrodynamic studies of the porpoise. Marine biologists say the Russians have done much work in these areas; they complain that underfunded U.S. work is hampered by having only four oceanography vessels, against some 50 such Soviet ships.

MATERIALS

World's Strongest Wire?

Steel wire for plastic motor cases reaching tensile strengths of 575,000 psi has been developed by National Standard Co. The new wire is about twice as strong as ordinary carbon steel wire.

Refractory-Metal Ductility Improved

Electron-beam processing and critical composition control in tungsten and molybdenum has resulted in a substantial improvement in ductility. Stauffer-Temescal Co. found that in addition to easier working, the finished product shows increased shock resistance.

Bendix cermets (ceramic-metallic materials) beat the inferno-like heat of rocket launching and re-entry. Sub-scale and full-scale motor tests, using the latest types of aluminized propellants, consistently show zero erosion in the throat areas.

The new cermets result from our experience with Cerametalix®, now a widely preferred friction brake material for high-performance aircraft. Even more advanced refractory techniques are used in our cermet production. These include: flame spraying, plasma arc spraying, hydrostatic pressing, vacuum sintering, layer compounding and transpiration cooling.

True space-age materials, Bendix cermets have wide application in supersonic aircraft and space vehicles for such companents as jet vanes, jetevators, nozzle throats and linings, leading edges and nose cones. Besides resisting extreme temperatures and pressure, they effect weight savings up to 75% over comparable solid metal structures. Bendix provides complete product design, development, testing and manufacturing. For full details, write, wire or phone:

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Friction Research Grinds to Halt

Frictional behavior of metals in space environment is barely known; consistent theory of friction still undiscovered

by William Beller

WHEN TWO METALLIC surfaces rub across each other in a vacuum, surprising things begin to happen. Oddly enough, government research agencies are not bothering to find out what they are.

From early work, this much is known: the friction coefficient—the ratio of tangential force to perpendicular force—often rises precipitously. It can fall, too—in some instances becoming less than in air.

The two surfaces can conceivably become strongly welded together.

Many of the phenomena are not known. A consistent theory of friction, in air or vacuum, is still to be devised.

Aerospace applications of the friction of metals in a vacuum are countless. Wherever one surface moves across another, there is a problem. In particular, friction coefficients are needed for the design of any exposed bearing in a spacecraft. Such bearings could be on shafts that rotate antennas, that orient solar cells or mirrors, or that move control surfaces during the aerodynamic phases of flight.

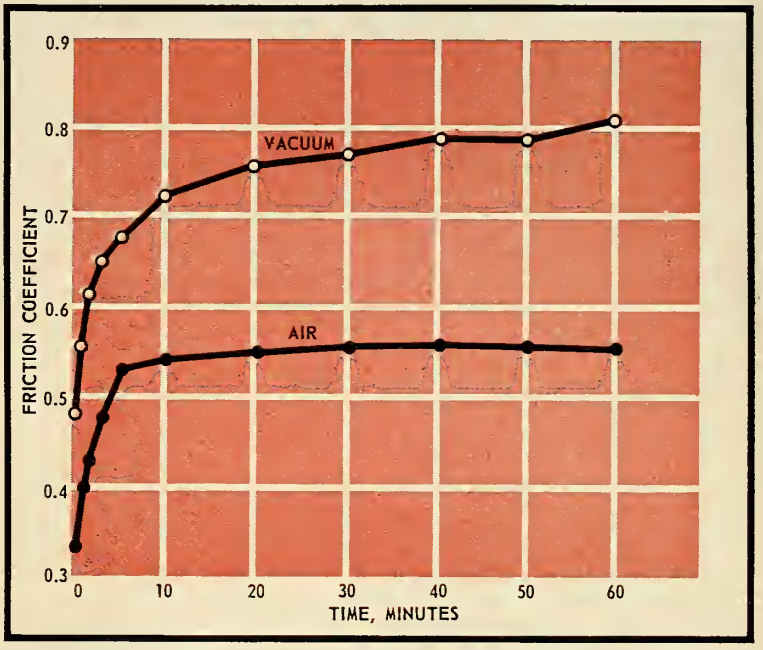
Basic research is needed to enable scientists to predict friction coefficients —with good fortune perhaps even to synthesize them.

Yet an M/R inquiry of federal agencies charged with supporting or engaging in such research disclosed that nothing is being done about the problem. The reasons given are lack of interest or lack of money—or both.

One government department-head scientist maintains that there is no point in studying high-vacuum friction, especially with space applications in mind, because any designer worthy of his name would be lubricating his surfaces. Rather, "the stress should be laid on research on films and such."

But another engineer countered forthrightly, "He's in the biplane era. The problem of sealing in the lubricants is as big as the one of friction." He added that "all the seals are able to do is delay the onset of exposure to ambient. Time will clean any surface and burst any seal."

One of the few reports that give engineering data on high-vacuum friction was written by Litton Industries' Space Research Laboratories. It was derived from work the company did under an expired Air Force Office of Scientific Research contract.



AVERAGE OF FRICTION data for 19 metal pairs. "Vacuum" data was taken as soon as pressure in the environmental chamber reached 3 x 10^{-6} mm Hg or less.

In this report, there is a listing of friction data for metal specimens exposed to a vacuum. The information was found experimentally and is shown in summary form in this article.

• **It's a poor theory**—In most problems concerning a friction force, the engineer has a fairly easy time of it. Both the load force and the resulting friction force are assumed to be uniformly distributed over the contact area.

Then, as Leonardo da Vinci pointed out in the 15th Century, "Friction produces double the amount of effort if the weight be doubled."

Although modern theory does explain some of the grosser effects of friction, it cannot do the most important job of such a scientific theory—provide a way to predict friction coefficients.

Along the same line, SRL's director of research, Siegfried Hansen, complains that we are not even able "to adjust parameters to achieve desired friction coefficients for specific engineering applications, except to the extent that tests for these specific conditions have been carried out and results tabulated."

One of the long-standing friction theories is Coulomb's. In it, prominence is given to the microscopic irregularities of presumably plane surfaces. Surface-to-surface contact of two blocks is assumed to take place at many points and with random angularity.

The friction force is taken to be that needed to cause one block to slide up the contact planes to a new interlocked or stable orientation of contact areas.

Although some authorities accept the general concept of this theory, many others reject it as being grossly inadequate.

Some recent investigators look upon

friction as a function of the forces between the molecules of two surfaces that are in range of each other's atomic fields. Again, authorities do not agree.

It is generally felt that, until the nature of molecular forces is much better known, attempts at understanding friction must be made at the microscopic rather than the molecular level.

• **Welding called friction clue**—A hypothesis that has intuitive as well as some experimental appeal, and is widely accepted at present, is the adhesion or welded-junction theory. It holds that the initial points of contact between two surfaces are extremely small and therefore loaded beyond their elastic limit. They yield, plastic flow takes place, and the contact areas increase in size and number until the load can be supported. Typically, the actual contacting area of the two surfaces may be only 0.1% of the surfaces' mating area.

Some advocates of the welded-junction theory believe that the localized temperatures at the load-bearing points of contact reach melting temperatures. Other experts say that the action is in the nature of a cold weld.

One of the most earnest workers in the field of welded-junction theory is Cambridge University's F. P. Bowden. He brings out the following points:

(1) The real area of contact A between two surfaces where the load is W is given by $A = W/p_m$, where p_m is the metal's yield pressure.

(2) Even when loads of only a few grams are applied to the surfaces, the local pressures between them may be great enough to cause metal flow. When large flat surfaces are used, it does not mean that the real pressure is much less, merely that the points of contact are more widely distributed.

(3) As a rough approximation to the friction force, we may write $F = As$, where s is the shear strength of the junctions. In addition to this factor, the surface irregularities of the harder metal may penetrate the surface of the softer one, thereby requiring work to plow tracks along one of the surfaces. If the metals are of similar hardness, there may also be some interlocking of the surface irregularities.

The adhesion theory lends understanding of the experimental fact that friction is largely independent of surface area.

The theory also provides for the fact that friction is dependent on load—since the real area of contact is dependent on load.

Further, the theory accounts for the fact that the friction coefficient of most metals is of similar value.

There are problems, though. Hansen proposes this teaser: In a plastic material such as copper, the yield stress in shear is about one-half the compressive yield stress. Weld theory indicates that the friction coefficient can never exceed 0.5. Yet experimental values of the coefficient for vacuum-cleaned surfaces rise as high as 6.

The discrepancy is clear: it is explained away by a vague statement that the area of contact must somehow increase when motion begins.

• **A surprising finding**—In their friction experiments, SRL made a unique discovery. Friction occurs in two modes.

In the first one, there is an extremely low friction coefficient. Here there is practically no wear or distortion of the metal surfaces.

On the other hand, the second mode characteristically has a very high friction coefficient and rapid destruction of the two surfaces moving with respect to one another. (In the SRL experiments, the friction model was a blunt point running over a block's surface.)

In the first or "sliding" mode, the friction coefficient is low, varying very little from 0.1. In the second, the coefficient is greater than unity.

By careful experimental work, it was possible to slide the point five to six inches in the nondestructive mode. Generally, though, the first mode held for only one or two inches and then deteriorated suddenly.

Summary of Friction Data for Metal Specimens

MATERIAL			FRICTION COEFFICIENT					
			IN AIR			IN VACUUM		
Upper Block	Lower Block	LOAD (lbs.)	Start	10 min	60 min	Start	10 min	60 min
Aluminum 99%	Aluminum 99%	7.0	0.50	0.78	0.78	1.10	1.57	1.57
Aluminum 2024T4	Aluminum 2024T4	7.0	0.52	0.54	0.57	0.50	0.50	0.35
		14.0	0.57	0.59	0.59	0.61	0.75	0.59
Beryllium Copper	Beryllium Copper	7.7	0.46	0.57	0.58	0.71	0.87	1.10
		14.7	0.44	0.89	0.70	..	.	..
Brass Com'l ½ Hd	Brass Com'l ½ Hd	7.7	0.31	0.32	..	0.43	0.50	0.71
		14.7	0.37	0.39	..	0.40	0.55	0.60
Copper 99+%	Copper 99+%	7.7	0.26	1.04	1.04	0.32	1.22	2.00
		14.7	0.40	1.14	1.15	..	.	..
Stainless Steel 304	Stainless Steel 304	14.7	0.29	0.47	0.51	0.32	0.62	0.93
Steel 52100	Steel 52100	14.7	0.13	0.66	0.70	0.25	0.41	0.45
Stainless Steel 304	Aluminum 2024T4	7.7	0.29	0.39	0.40	0.38	0.39	0.34
Aluminum 2024T4	Stainless Steel 304	7.0	0.30	0.40	0.37	0.49	0.50	0.50
Brass Com'l ½ Hd	Stainless Steel 304	7.7	0.36	0.35	0.39	.	..	..
Stainless Steel 304	Brass Com'l ½ Hd	7.7	0.21	0.32	0.39	0.32	0.67	0.84
Brass Com'l ½ Hd	Beryllium Copper	7.8	0.26	0.28	0.36	0.50	0.77	0.89
Beryllium Copper	Brass Com'l ½ Hd	7.7	0.28	0.34	0.38	0.49	0.62	0.90
Copper 99+%	Steel 52100	7.8	0.32	0.38	0.55	0.77	0.97	0.96
Steel 52100	Copper 99+%	7.8	..	..	..	0.58	0.79	0.85
Cadmium Plate	Cadmium Plate	7.7	0.26	0.44	0.39	0.43	0.43	0.31
Chrome Plate	Chrome Plate	14.7	0.33	0.59	0.85	0.11	1.30	1.30
Nickel Plate	Nickel Plate	7.7	0.33	0.33	0.30	..	..	..
		14.7	..	..	..	0.28	0.41	0.39
Silver Plate	Silver Plate	7.7	0.36	0.60	0.50	0.69	0.99	0.99

Analysis showed that the first mode exists when the surface film, whether a lubricant or an oxide, prevents the formation of adhesion bonds between the sliding point and the plane.

The second mode occurs whenever a point encounters an obstacle large enough to prevent free sliding, or possibly when the lubricant film breaks down locally and permits strong adhesion.

Thus the friction coefficient is made up of two parts: a constant sliding part equal to 0.1, plus a variable shearing part that is greater than unity.

Experimental values of 5 or 6 are explained by an increase in the area of shearing contact relative to the area of sliding contact. This increase results from the removal of surface film by chemical or physical cleaning, or by exposure to vacuum.

• **Metal behavior in a vacuum**—In SRL's vacuum work, all the specimen pairs were tested in air and in "immediate" vacuum. The term "immediate" is used to indicate that the specimens were not subjected to a long outgassing in vacuum. Rather, they were tested as soon as the vacuum reached the desired value, a period of about one hour. The test then continued for another hour, a time long enough to reach equilibrium.

The specimens were considered to

be representative of unlubricated metal parts prepared by standard machining operations in an ordinary atmospheric environment. The test procedure envisioned that these specimens would then become part of some system that is launched into space.

Behaviorial trends are brought out clearly in the curve constructed by averaging corresponding ordinates in all the individual data.

–The friction coefficient starts out at about 60% of its final value and then quickly increases as surface breakdown takes place.

–In air, a relatively stable final value is reached in about 10 minutes. In vacuum, the final value is reached more slowly, corresponding with the rate of flow of absorbed gas out of the blocks through the rubbing surfaces.

–The average coefficient values for vacuum tests are only about 50% higher than the averages for air. This is the result of the immediate vacuum technique and is not representative of thoroughly cleaned and outgassed blocks, which can give values far greater than unity.

The results reported here barely scratch the surface of the friction problem. An adequate theory of the phenomenon is needed, one that can both predict and build up friction coefficients. At the same time, data on the frictional behavior of materials in a vacuum are vital for design of long-lived satellites and space probes. What is most important is an awakened interest and sponsorship of basic research.

Norton Produces Advanced Silicon Carbide Refractory

The nozzles of fluorine-fueled rockets may contain a newly developed high-temperature refractory from Norton Co., Worcester, Mass.

The material may also be used in blast pads or test stands, where fluorine-containing exhausts usually raise merry hell.

The refractory, "Crystolon 63," represents a major advance in silicone carbide technology.

The silicon carbide refractory most often used in the United States is oxide-bonded. Its individual grains are held together by clay or glass. It presents problems in corrosion resistance and in structural applications. But it is cheap.

Present nitride-bonded silicon carbides are refractories with very desirable corrosion resistance and structural properties. But they are so expensive that they are termed "exotic" refractories, especially in massive installations.

The new carbide will do everything a nitride-bonded carbide can do, but at a price comparable to that of oxide-bonded carbides.

• **Impact on industry**—The biggest commercial application seems to be in the aluminum reduction cell. In the main, these cells have not changed substantially since about 60 years ago, when Charles M. Hall used one to extract aluminum from alumina.

Experimental use of Crystolon 63 indicates a possible 75% reduction in wall thickness and a substantial decrease in power requirements.

Other applications include melting and alloying of high-purity metals, transferring molten metals, and use as a structural ceramic for package boilers and incinerators. Company spokesmen expect nothing less than a full-production turn to this new development at Norton.

The actual effectiveness of silicon carbide refractories is determined by the bonding agent. The nitride bond is the hardest to attack. Samples of 63 have passed 28 days in an atmosphere of steam and air at 1100°C; showed no metal penetration after seven-day baths in molten aluminum, lead, zinc and cryolite; and exhibited a strength of 7000 psi at 1250°C.

Electronic applications are numerous. Norton labs are growing silicon carbide crystals with controlled impurities. Single-crystal rectifiers have been produced using this material; eventually, transistors may be developed. Use of the silicon carbide would extend the operating temperatures of such devices well above the melting point of germanium and silicon transistors.

Nitrate-bonded shapes are most likely to prove successful as microwave absorbers. Much activity in this field is aimed at absorbing or attenuating the power from a high-frequency transmitter—rather than have a signal on the air. In high-power applications, these attenuators reach red heat. Crystolon 63 is being evaluated in this area.

Hinges for Titan Silos

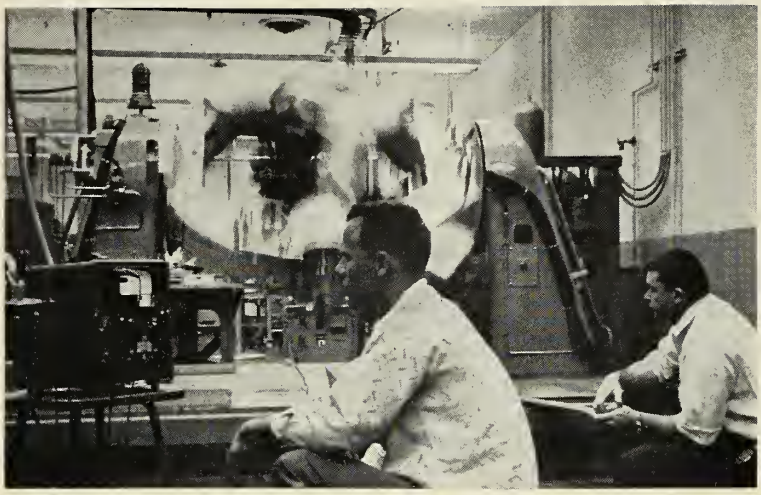
MAMMOTH 600-TON hinges will be used to open the doors of underground Titan launch silos. Nearly five feet high, this is one of a set flame-cut and machined by Lukens Steel Co. for American Machine & Foundry Co.

AF Funds 250,000 Gauss Magnet Laboratory at MIT

The Air Force will finance the building of the world's most powerful magnet at the Massachusetts Institute of Technology.

An array of generators will be able to produce a continuous magnetic field rate at 250,000 gauss (A gauss is the electromagnetic unit of magnetic induction—one maxwell per square centimeter). This rating is more than 500,000 times larger than the earth's magnetic field.

The $9.5-million contract awarded by the Air Research and Development Command is expected to considerably broaden the search for new knowledge in matter and energy.



MOTION OF THREE-AXIS flight simulator table is evident as gimbal rates are checked out by technicians at Lockheed's Missile and Space Division.

Flight Simulator Credited With Speeding Up Polaris

A three-axis flight simulator made a major contribution to the *Polaris* IRBM abbreviated time table, says Lockheed's Missile and Space Division.

It was used to checkout guidance and flight control systems of the Navy's most advanced missile at its Sunnyvale, Calif., plant. Company engineers feel the simulator also saved dollars by minimizing required test flights.

The simulator is used in conjunction with an analog computer especially designed for angular position and motion testing of the guidance package. The system employs direct hydraulic drive to obtain its tremendous power and wide range.

Basically, the flight simulator consists of a hydraulic supply, accumulator, console and flight table. It operates in a closed loop, using the analog computer and flight control system hardware.

• **3-axis simulation**—Simulation of position and angular motion is achieved by means of three independently controlled gimbals whose axes can be related to pitch, yaw, and roll motions.

Each gimbal uses a vane type hydraulic actuator controlled by a pressure feed-back hydraulic valve. The actuators are designed to provide fluid cushioning to prevent damage to the gimbal when rapidly operated over its complete excursion range. In addition, each gimbal has fixed rubber stop pads.

A removable fixture provides a bridge between the roll gimbal mounting tracks and the cart used to transport the guidance package.

There are servo amplifiers for each gimbal. Although the basic design of all three are the same, different plug-in compensation networks are used in each. The servo amplifier is dc drift stabilized. It converts the sum of the dc input signal and error signal from the feedback potentiometer into dc current which actuates the control spool on the gimbal servo valve.

There are two types of feedback information given to the servo amplifier. Position feedback is provided by a linear potentiometer with an accuracy of within 0.015% and a feedback sensitivity (200v across 350°) of 1.75°/v. The feedback potentiometer is on the actuator end and is the one nearest the gimbal. These potentiometers are always connected to the console plus or minus 100 vdc.

Acceleration feedback is provided by an accelerometer mounted on the gimbal. The signal is amplified by an ac amplifier and then fed to the servo amplifier. The accumulator smoothes out surges in the hydraulic line due to varying load and supplies reserve power for peak demand.

The analog computer is connected to all servo amplifier inputs by the control panel. A two-bay rack console houses all the electronics (except for the associated computer) for the system. The computer serves as the nerve center and control spot for the simulator and all information is fed into the computer. Results are recorded in the computer room.

High Accuracy Obtained By Atlas Gyro Check Stands

Rotational accuracies within ±2.5 seconds of arc are being achieved with the sidereal rate stands used to check *Atlas* ICBM gyros.

Such complex test devices have been employed by Arma Division of American Bosch-Arma Corp. to counteract the effect of the earth's rotation. This is the only effective means of providing a standard for checking performance of precision gyroscopes around which the Arma inertial guidance system is built.

The stands were developed and built by Vinco Corporation in Detroit, Michigan. Mounted equatorially, each inertial system is sidereally driven by the test table. Sanborn "150" oscillographic recording systems collect test results.

• **Two million-to-one gear ratio**—The gyroscope and tooling are mounted on a 24-inch diameter face plate, which is attached to the north end of the main or polar axis spindle. Embodied in the gear box is a differential drive to obtain an over-all gear reduction ratio of 2,154,101.8625:1.

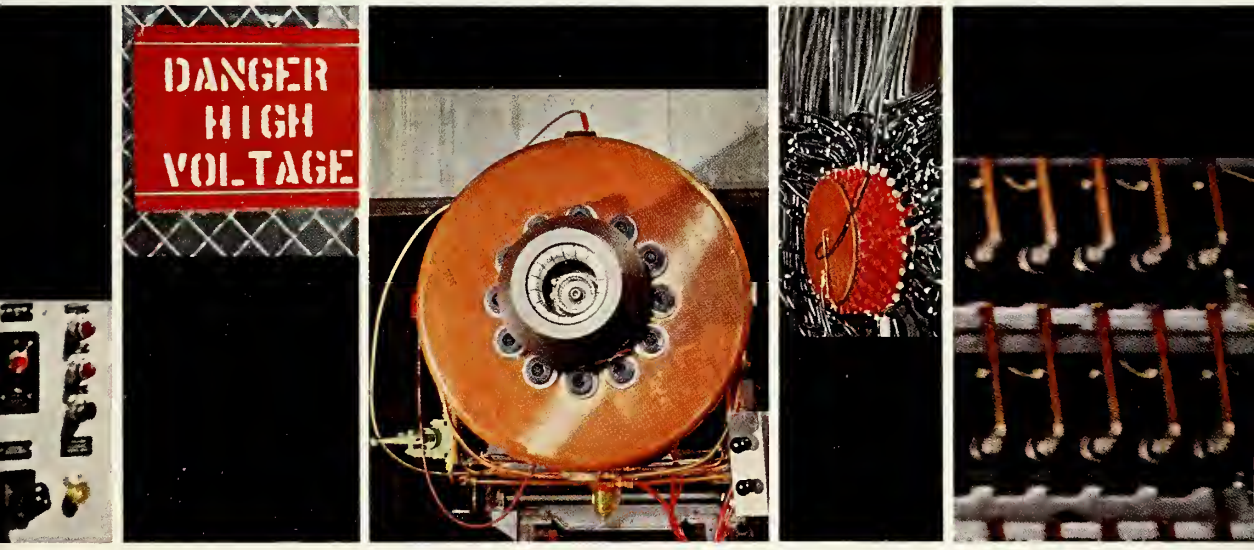
The last reduction in the gear train is a hardened and precisely ground gear (19.6875 in. pitch dia.) and worm set, having a zero backlash adjustment. Rotational accuracy between any two positions of the face plate is guaranteed to 5 sec. of arc. A series of multiple output speeds is provided by means of change gears.

Azimuth and elevation adjustments in the base of the stand provide for final alignment of the equipment after being placed in permanent position. A precision level provides for monitoring the alignment periodically after making final adjustments.

A 1500-rpm synchronous motor drives the main spindle through a change gear box and a final precision worm and gear reduction. The controlled frequency input (50 cycles, 115v) to the motor is derived from a 100-kc oscillator, frequency dividers and a power amplifier. A precision electronic counter continuously monitors the frequency.

The oscillator and dividers are designed to produce a stable output signal throughout a wide temperature range, according to Vinco.

HOTSHOT

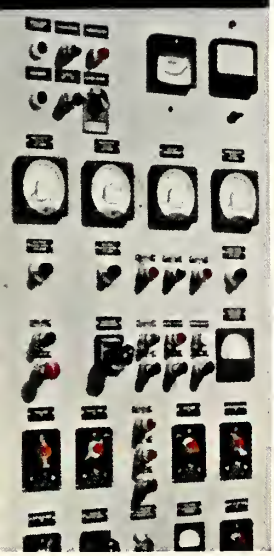


Westinghouse Capacitive Storage System for McDonnell's new Hotshot Wind Tunnel Delivers 7,000,000 Joules in 3 Milliseconds with a Peak Current of 4,000,000 Amperes

See following pages ▶

1

The Trigger: Operator's control panel by Westinghouse activates tremendous flow of energy for new hypervelocity impulse wind tunnel.

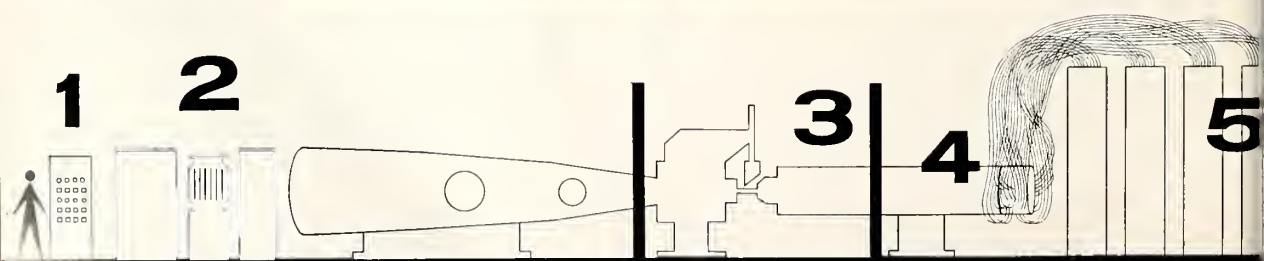


2

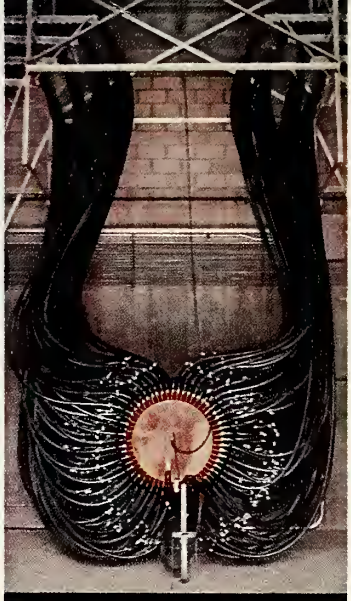
The Hot Stuff: High-Voltage equipment is tucked away in this enclosed area. Westinghouse transformer-rectifier—combined with a bi-stable amplifier regulator—charges capacitor bank to predetermined level.

3

The Cannon: Uniquely designed coaxial conductor delivers arc energy to compressed air, raising pressures and temperatures several orders of magni-

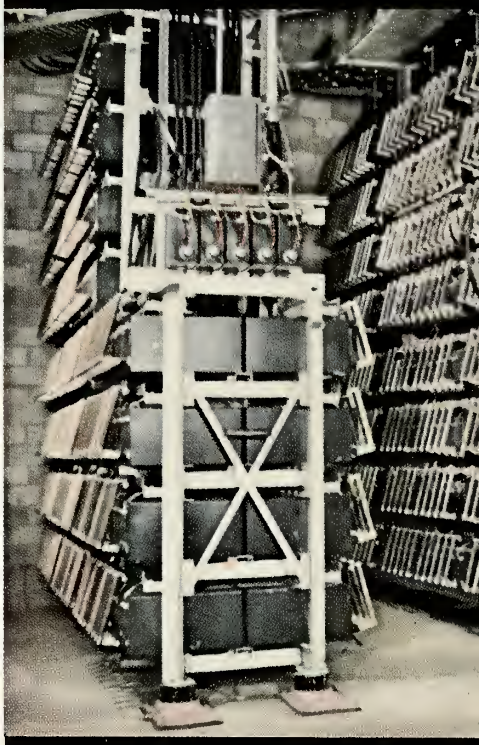


tude. Air explodes into the tunnel simulating hypersonic re-entry speeds of aircraft and missiles at altitudes above 100,000 feet.



The Supply Lines: 230 spaghetti-like cables converge in rear of cannon to deliver peak currents to 4,000,000 amps.

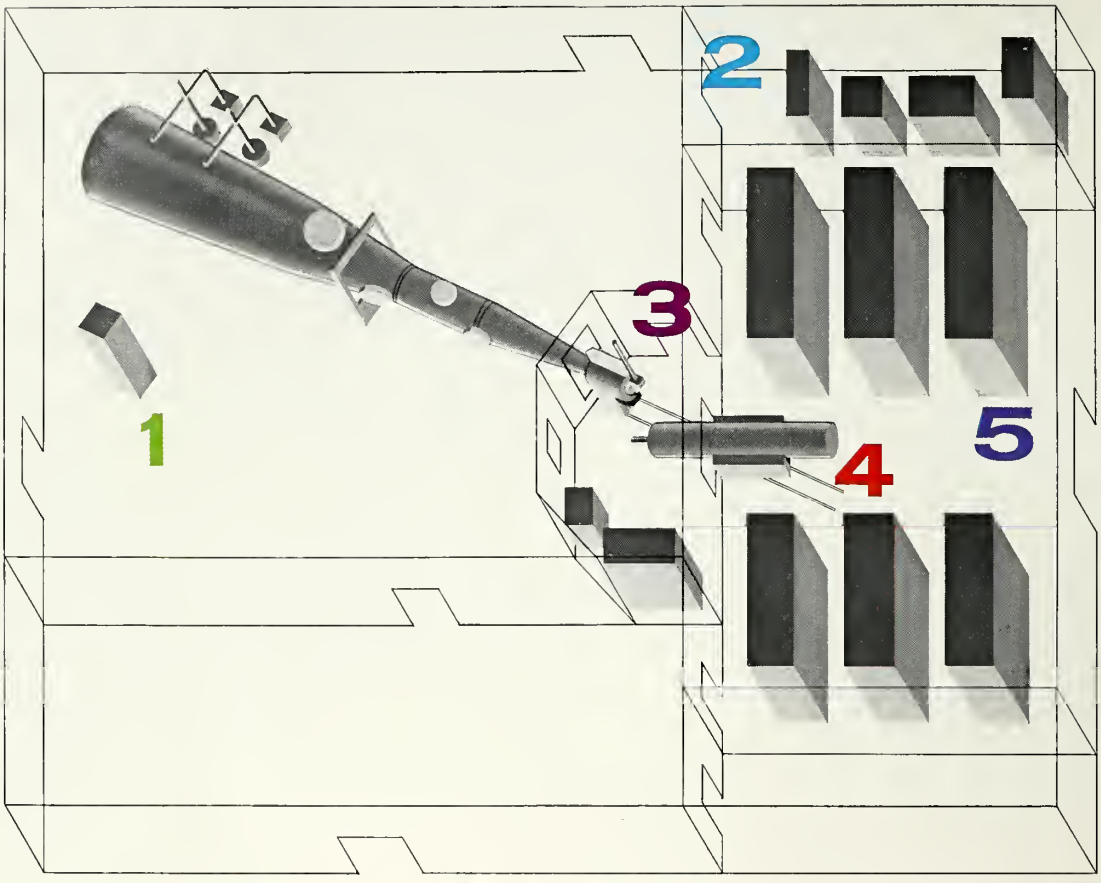
4



The Arsenal: Twenty-nine Westinghouse custom-built racks, each containing 80 fused capacitors, are bussed together in groups of ten, and connected by coaxial cables to the collector.

5

Within six months after receipt of contract Westinghouse delivered and installed this capacitive energy storage system for McDonnell Aircraft Corporation's new "Hotshot" wind tunnel at St. Louis. This facility is now providing vital data at a small fraction of the cost of actual flight testing. This same capability for quickly providing reliable equipment can help you solve your aerospace R & D problems. Contact your Westinghouse sales engineer. Or write: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.



1. Creating outer space environment on earth starts with this control station for McDonnell Aircraft Corporation's new hypervelocity impulse wind tunnel. Operator can automatically or manually control the entire facility from this Westinghouse cabinet.

2. High-voltage equipment charges the capacitors (Figure 5) to a predetermined level up to 12 kv, with ±1% accuracy in 30 seconds. At 12,000 volts, seven megajoules of energy stored in this bank is delivered to the arc chamber in just 3 milliseconds.

3. In actual test, arc chamber is filled with compressed air and the tunnel is evacuated. Then, electric energy surges into the heavy walled arc chamber. Pressure increases to 100,000 psi. Temperature to 14,000°F. Heat vaporizes diaphragm separating arc chamber from the tunnel. High pressure air races through a converging-diverging tungsten throat to produce hypersonic velocities in test section.

4. The collector-cannon — main artery of the energy storage system — is composed of coaxially oriented conductors connected to the arc chamber. Carriage mounting permits axial motion of the conductors and simple connectors allow disconnection from the arc chamber. A lateral 45° swing allows connection to a second tunnel. Such flexibility permits operation of either tunnel with only one power pack, one capacitor bank, and one collector.

5. Twenty-nine racks of capacitors, sprouting 230 coaxial cables, enable this system to discharge electrical energy at an average of 2⅓ million kilowatts. That's more than the combined impulse power of Grand Coulee and Hoover Dams. Built-in expandability allows for a growth capability to 10,000,000 joules.

Westinghouse

JI-92506

Subcontractors to Westinghouse:
The Calvert Company, Rocky River, Ohio for the cannon.
The Phelps Dodge Copper Products Corporation, New York for the coaxial cables.

Explosion Forms Saturn Manifolds

Unique method developed at NASA's Marshall Center uses explosive charges in plastic bags filled with water

HUNTSVILLE, ALA. — An unusual method of explosive forming is used in the manufacture of LOX manifolds for the big *Saturn* booster.

Usually, explosive forming takes place with both the explosive charge and the object to be formed under water. *Saturn* manifolds, however, are formed by an explosion in a water-filled plastic bag.

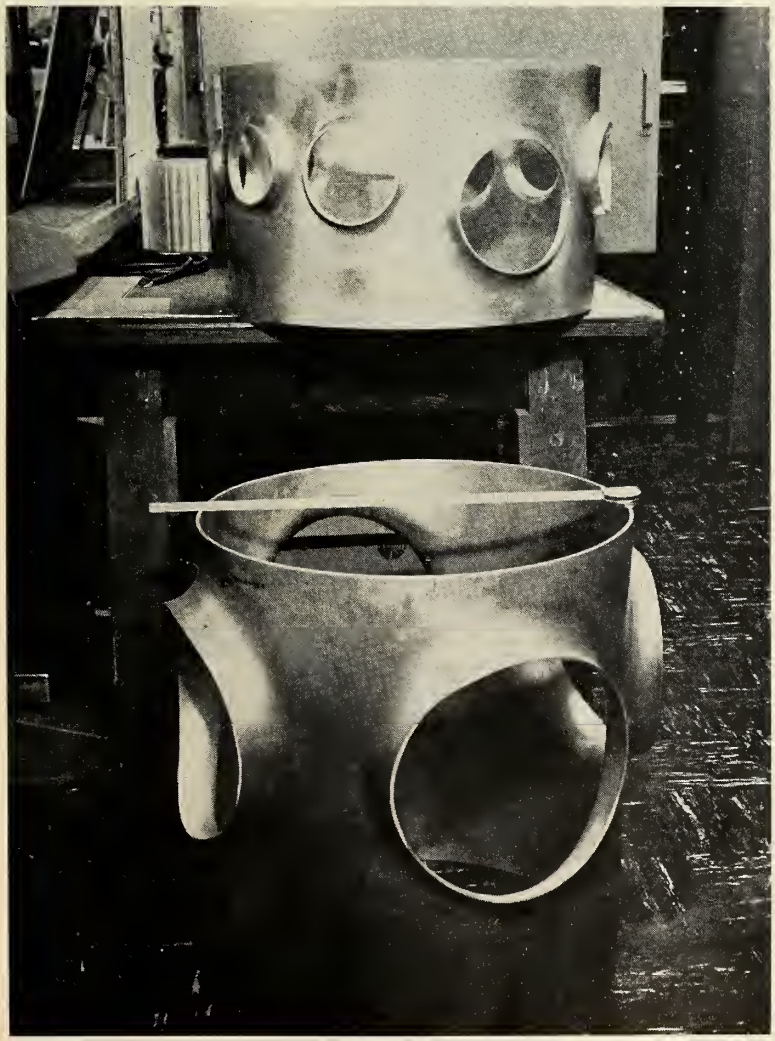
The manifolds, like all parts of the *Saturn* booster, are manufactured by the Marshall Space Flight Center, transferred last month from the Army to the National Aeronautics and Space Administration.

The cylindrical manifold blanks are put together from four drop-forged pieces of 5052H32 aluminum alloy. The pieces are welded together at Redstone Arsenal. Then the cylinder is sent to Olin Mathieson at East Alton, Ill., for explosive flaring of the outlet holes.

Olin Mathieson cuts the holes—for instance, four 12-in. holes in the 22-in.-diameter rear manifold. Then a big plastic bag of water, containing the explosive charge at the center, is put inside and set off. This first explosion improves the circular shape.

Next, smaller bags, with smaller charges, are set off in each of the four holes. Two charges are exploded in each hole.

The process was developed by Earl A. Hasemeyer, aeronautical structural material research engineer in the Fabrication Laboratory of the Marshall Center.



SATURN LOX manifolds shown after explosive flaring of outlet holes by Olin Mathieson in a process invented by research engineer Earl A. Hasemeyer.

Titan II Fuel

Olin Mathieson Wins Contract for Hydrazine

Olin Mathieson Chemical Corp. has won a $25-million Air Force contract to deliver hydrazine for the *Titan II* program. The contract calls for deliveries to begin in 1961 and continue for three years.

Stanley de J. Osborne, president, said a major part of the supply will be produced at a new plant in Saltville, Va., which Olin Mathieson is building for the Air Force at a cost of $14 million.

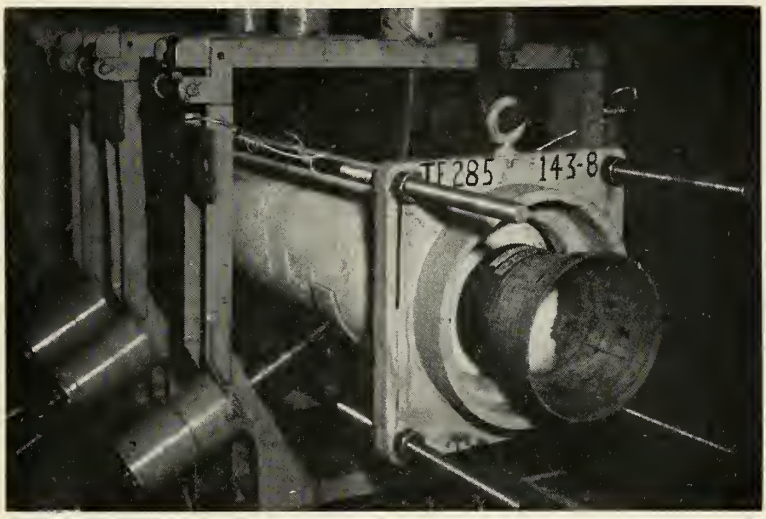
Titan II fuel will be a 50-50 mixture of anhydrous hydrazine and unsymmetrical dimethyl hydrazine (UDMH). Olin Mathieson, which says it is the nation's only manufacturer of anhydrous hydrazine, will supply all of that type. Nitrogen tetroxide is the oxidizer for the storable *Titan II* propellant combination.

Anhydrous hydrazine is made from ammonia, caustic soda and chlorine, all of which are manufactured by Olin Mathieson. Olin Mathieson began research on hydrazine in 1946 and started commercial production at Lake Charles, La., in 1953. The company now produces about 4,000,000 lbs. a year, partly for such uses as regulating plant growth, inhibiting rust and combatting poultry disease.

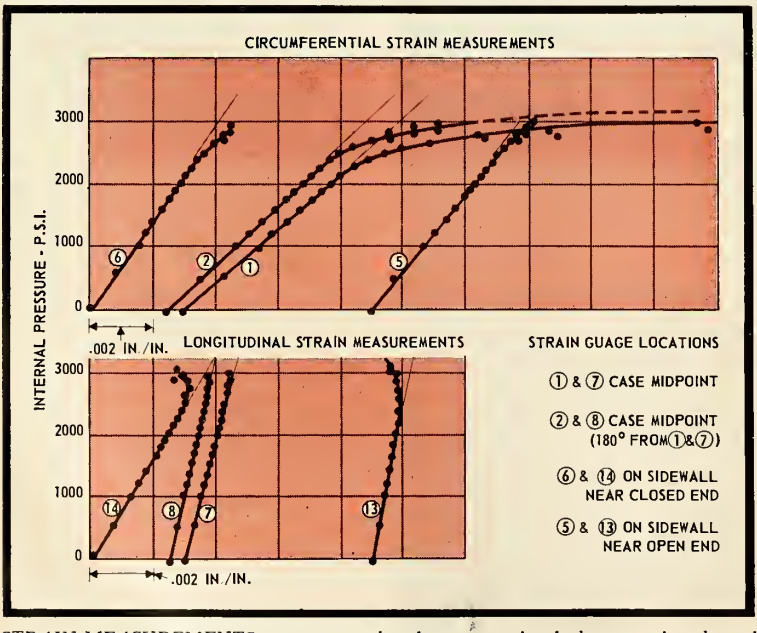
Construction has already begun on the Saltville plant, announced in April. Operations are to start March 1, 1961.

Aluminum Gains as Motor Case Material

Test firings show high performance and promise of big savings; Alcoa researches to raise size limits set by welding



ALUMINUM ROCKET engine chilled to –65°F prior to firing. The one-piece 7178-T6 alloy cases were successfully tested at ambient and elevated temperatures.



STRAIN MEASUREMENTS on case tested to burst occurring in hoop tension through sidewall. Note reversal in longitudinal strain near failure. This is believed to be caused by a decrease in length as the hoop stress increased the diameter.

by John F. Judge

COMMERCIAL high-strength aluminum proved itself a serious contender in the solid-motor case field in a series of recent test firings.

The cases were fabricated from high-strength 7178-T6 aluminum alloy by the Aluminum Company of America through a combination of forging, extruding, sizing, and machining operations.

The first set of firings involved monolithic aluminum cases. The second set utilized one-piece aluminum liners wrapped with cold-drawn steel wire, a development of Precision Structures, Inc., of Berwyn, Pa.

One of the wire-wrapped cases performed successfully even though all of the conditions were exceeded because of a misfire. As a direct result, serious damage to the test stand was avoided.

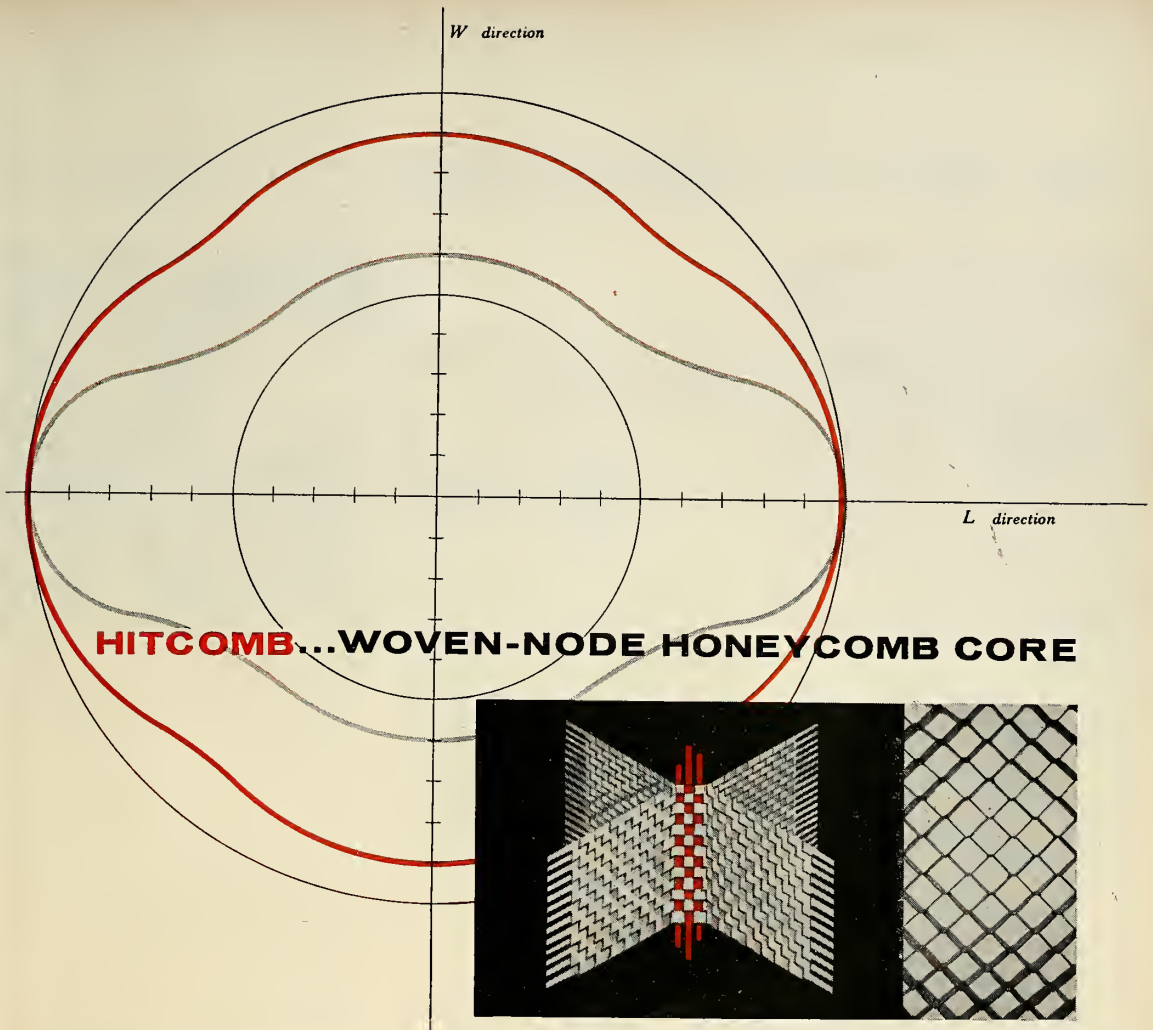
• **Welding problems**—Aluminum's strength-to-weight characteristics make it an ideal material for motor case construction. The main limitation is in the metal's welding properties—the high-strength alloys are extremely difficult to weld and even when this is accomplished, the weld does not develop a high percentage of the parent metal strength.

Thus there is a size limitation; one-piece construction is required to attain maximum efficiency.

An intensive program at Alcoa directed at larger monolithic cases produced the chambers fired in the first set of tests. These chambers do not represent the absolute ultimate size in monolithic construction, but the large ICBM-type motors are still out of reach without some sort of joining procedure.

The monolithic chambers are 12 in. in diameter and 45 in. long, with wall thicknesses of 0.210 in. The design yield internal pressure of 2575 psi was successfully met. Burst tests, with failure in hoop tension through the sidewall, reached 3160 psi. This is a steel equivalent stress of 246,000 psi.

Based on a minimum wall thickness of 0.196 in., one case developed a bursting stress of 94,000 psi and exhibited a strength-to-weight ratio of 935,000 in. In steel equivalents, using



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Write for Technical Products Bulletin PB6-2

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Data Acquisition and Application Subsystems—IBM has proven capabilities to provide real-time man-to-machine and machine-to-machine elements of weapon guidance systems. In addition to the Bombing-Navigation system with its visual displays in the B-52, IBM also provides interface devices to apply this system to air-launched missile guidance. Federal Systems Division experience in air-based and ground-based guidance systems is proven in operation.

Data Communications Subsystems—The SAGE data processing system, heart of America's air defense network, embodies advanced communications devices and techniques required to filter and direct an enormous flow of data. Designed and built by the Federal Systems Division, the AN/FSQ-7, an advanced system in operation, embodies processing and communications power to direct defense operations as well as to guide missiles from remote sites.

Data Processing and Control Subsystems—Now in development, the Advanced Bombing-Navigation and Missile Guidance system is another example of IBM's "closed-loop" system capability. This system satisfies the operating requirements of high-speed, long-range weapon systems. Compact, reliable equipment such as this and Federal Systems Division's computer for the Titan missile guidance system are the result of IBM's vast background in data processing and control.

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IBM's experience in data processing and data communications, supplemented by an extensive background in data acquisition, adds up to a three-way capability for developing, producing and integrating total automated systems. This capability is being advanced through continuing research in miniature high-speed devices for high-reliability guidance systems of the future.

Federal Systems Division, 326 East Montgomery Avenue, Rockville, Maryland IBM

a density of 0.283 for the ferrous metal, this burst pressure is 264,000 psi.

According to Alcoa, one of the most significant aspects of the development program is that no failures under biaxial loading in pressure vessels have occurred at stresses below the guaranteed minimum mechanical property level for 7178-T6—the highest strength commercially available aluminum alloy.

• **Wire wound**—Precision Structures was responsible for the structural design of the wire-wrapped cases. A set of aluminum liners with all thicknesses cut to less than 0.095 in. was delivered by Alcoa; Precision enveloped them in cold-drawn steel wire.

The wire-wrapped Alcoa cases attained a strength-to-weight ratio in excess of 1,000,000 in. at burst. The cases have been proof-tested to a steel equivalent of 248,000 psi without distortion or permanent set.

L. C. Becher of Precision says the wire wrapping technique can attain a weight reduction of approximately 25% over plain aluminum or steel. In strength-to-weight ratio comparisons, wire wrapping will surpass monolithic steel cases at half the cost—and almost meet beta titanium at 1/15 the cost.

To overcome aluminum's size limitations, Alcoa is developing methods and design approaches in high-strength aluminum welds.

Alcoa is also hard at work in experimental high-strength aluminum alloys which may show efficiency increases as high as 15% over the current 7178-T6 member of the Al-Zn-Cu-Mg family.

Space Cabin Atmosphere Generated Through Algae

A duplication of the natural life process may provide oxygen for manned space stations.

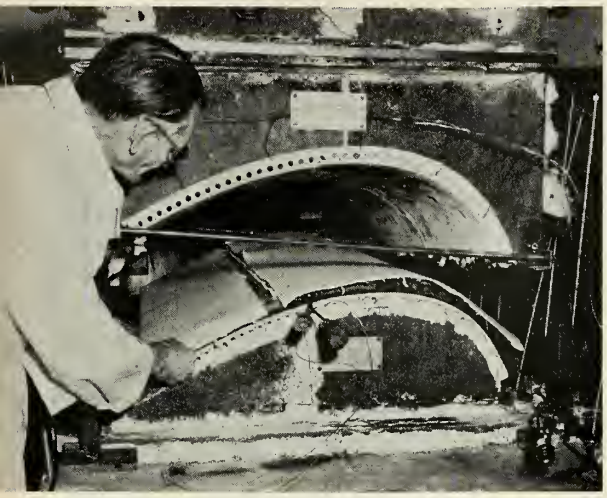
Scientists at Tapco Group, Thompson Ramo Wooldridge Inc., have succeeded in producing oxygen from carbon dioxide.

In the TRW gas exchange system, algae in aqueous media is pumped from a central reservoir through an irradiating light system. After irradiation, the algae is cooled to remove the excess heat produced in the light system.

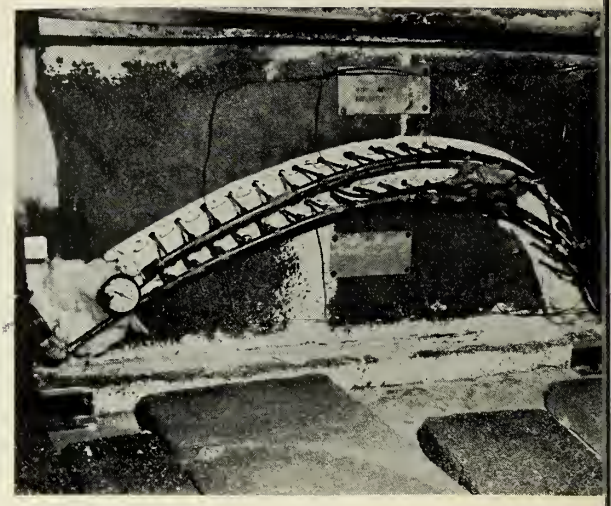
The algae is mixed with filtered CO_2 enriched air from the cabin through an air injector. The gas-algae mixture is admitted to a gas-liquid separator where oxygen enriched gas is separated from the culture. The culture moves back to the central reservoir and the oxygen-enriched gas is circulated to the cabin. This is breathed by the crew who, in turn, exhale carbon dioxide; the cycle starts again.

The culture produces oxygen through photosynthesis.

Avco Process Cuts Cost of Brazing



HONEYCOMB CORE sandwich arrangement is placed between the ceramic platens. Holes in the platen are for heating and cooling purposes.



AVCORAMIC BRAZING PROCESS in operation. Nichrome calrod heating units bring the system up to temperature. Thermocouple controls are used in maintaining the correct heat period for the B-70 structural section.

ALMOST ANY SHAPE and size of stainless steel honeycomb can be brazed with a significant reduction in cost from present techniques through a new process developed by the Nashville Division of Avco Corp.

The method is currently being used to manufacture sections of the aft fuselage and some of the bulkheads for the B-70 bomber. The six-figure contract with North American Aviation extends over the next several months.

• **Avcoramic brazing**—The essence of the new process is a ceramic material with excellent thermal shock properties. The ceramic can be cast with tolerances of 0.003 in. yet it is easily worked into any required shape.

The ceramic is used to make brazing platens. Holes are put through the material for heating and cooling purposes. The surface of the platen acts as a contour form for brazing the stainless honeycomb.

The steel sandwich material is enclosed in a steel envelope which is then placed between matched ceramic platens.

The ceramic is heated electrically to the proper brazing temperature and held for a short, controlled time period. Cooling is rapid since the medium can be forced through the same holes which contain the heating elements. It is possible to reach sub-zero temperatures if necessary.

To assure close contact of the parts to be brazed, a vacuum is maintained in the envelope and pressure is applied to the ceramic platens.

Maximum strength is achieved through ageing at elevated temperatures.

A representative configuration using precipitation hardened steel requires about 14 hours from start to finished heat treated product.

Avco is currently studying other applications for the Avcoramic process. The method is suitable for other structural metals including titanium.

Investigations into the problems of re-entry led to the development of a number of ceramic finishes and compounds at Avco's Research and Advanced Development Division. The brazing process at Nashville is one unrelated area in which this research paid off.

Re-entry Brake Materials Studied

The Air Force is sponsoring $250,000 worth of research aimed at developing a flexible, high-temperature material for use in advanced space vehicle re-entry deceleration devices.

Two Massachusetts firms—Arthur D. Little, Inc., Cambridge, and Fabric Research Laboratories Inc., Dedham—are handling the project which calls for the development and evaluation of sample cloths.

Possible candidates are those materials which can stand the extreme environments and yet be made in fiber form so as to be applicable to expanded brakes. These substances do not possess many of the desirable properties of the textiles usually used in parachutes.

Completed studies at ADL investigated the external conditions which might be encountered during re-entry and the fibrous materials which might be applicable.

FRL evaluated the re-entry environment in terms specific to a novel chemical reaction process in a similar study. Details of this process were not disclosed. Both firms will use these studies as background for the current contract.

A further complication is a re-

quirement for air permeability much lower than that of conventional parachutes—eliminating one contender, conventional wire cloths.

Another current obstacle in "exotic" fibers is their cost—over $2000 per pound.

About two thirds of the current program is being done at FRL. Another phase at FRL has to do with the development and evaluation of 2000°F resistant drag chute materials made of quartz fibers and high temperature finishes.

The practicality of a quartz fiber chute is not certain but some evidence exists in its favor. According to FRL, successful completion of the quartz program may cut a year or more from the lead time of an operational reentry drag device.

Both firms will work closely together in considering the most promising materials—high temperature alloys, refractory metals, ceramics, graphite, and organic fibers—in addition to the chemical reaction approach.

New Sealing Method Adds To IR Receiving Range

A new technique for sealing germanium windows to infrared detectors will result in extending the receiving range beyond 25 microns, says Philco Corp.

Developed by its Lansdale, Pa., division, the method is based on painting a glass frit/amyl acetate mixture on the surface of a germanium disc and then fusing it to glass having a comparable thermal coefficient of expansion.

This results in a vacuum-tight seal that is mechanically and thermally stable, according to division special products manager Dr. C. H. Sutcliffe.

Detectors using the more conventional silicon or sapphire windows limit IR radiation reception to 9 or 6 microns, respectively. In using the new method to extend ranges to the longer wavelengths, the germanium window can be coated to peak in this range, he said.

G.E. Group to Study Army Missile Vulnerability

A mathematical model will be developed by the Special Programs Section of General Electric's Defense Systems Department in a study of the vulnerability of various Army missile systems.

Missile systems will be examined under peacetime, limited and general warfare conditions. The environmental and operational hazards in each phase will be in the form of equations derived from basic data.

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GUIDANCE AND CONTROL DEVELOPMENT: Requires outstanding educational background in EE or Physics and experience in servo theory and dynamics, for mathematical analysis and synthesis of orbital guidance and control systems. Requirements also exist in the development and test of guidance and control components.

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Exhibits Overflow at WESCON Show

LOS ANGELES—Some $12-million worth of advanced Space Age electronics gear was on display here last week for 35,000 engineers and technicians gathered for the annual Western Electronics Show and Convention (WESCON).

The four-day meeting, combined with technical sessions and marketing discussions, was the Largest yet held. An all-time record of 987 exhibits overflowed the Los Angeles Sports Arena and officials said another 300 qualified exhibitors had to be refused due to lack of space.

The theme of the show, appropriately enough, was "Rush Hour in Space."

One of the largest missile and space exhibits was that of Texas Instruments, Inc. TI displayed a nose cone programer for *Minuteman* designed to insure safe ejection of the test data capsule before impact, as well as the digital flight programer which sequences launch and flight functions in the *Titan* ICBM. This was a transistorized 6.4-lb. package. Also shown by TI was an FM/FM telemetry system for Moon and planet probes. Another exhibit was a TI airborne PCM telemetry package which packed 64 analog channels, plus a serial digital data channel and five 8-bit parallel digital data channels, into a 25-lb. ½-cu. ft. unit.

Lockheed Missiles and Space Division put its emphasis on the *Agena-B* and Hughes Aircraft displayed five new welders for the electronics industry.

• **Instant algebra**—Autonetics Div. of North American Aviation, Inc., set up a Recomp computer at tbe show to solve time-consuming algebraic equations on the spot. This was a demonstration of Autonetics' new RAFT (Recomp Algebraic Formula Translator) programing tecbnique. The object was to show that advanced computer or programing backgrounds are not necessary when RAFT is used with Recomp, an Autonetics product. Key Recomp features include a compact magnetic memory disk with a 4096-word, 8000-instruction capacity, built-in floating point arithmetic and simplified programing.

DoAll Co., Des Plaines, Ill., showed for the first time a machine that slices ingots of rare metal such as germanium into wafers one-hundredth of an inch thick in production of transistors and other electronic components. According to the company, the tool will increase productivity up to 50% in cutting rare and expensive metals.

• **Cost - cutting semiconductor**—Transistron Electronic Corp., Wakefield, Mass., displayed a major new semiconductor device which it termed a fundamental contribution to the industry. Called a Binistor, it permits a significant reduction of peripheral components in switching circuitry. Transistron expects the device to form the heart of many digital systems. It says the Benistor is compatible with present circuitry and does not require major systems design changes. It is said to achieve significant savings in cost, space, weight and solder connections.

Hoffman Electronics introduced for the first time a new family of rugged, high-conductance silicon diodes developed by its Semiconductor Div. These are designed for applications requiring an extremely small, ligbtweight rectifying device capable of withstanding severe environmental conditions. A feature of the new diodes is their encasement in a 400-milliwatt package.

• **Many new lines**—Synthane Corp. of Oaks, Pa., announced a new flame-retardant, industrial laminated plastic for printed circuit and other electronic applications. Micro Gee Products, Inc., Culver City, Calif., unveiled a new angular oscillating table for subjecting gyros, accelerometers and guidance systems to extremely smooth sinusoidal motion for precise frequency response tests.

Automation Development Corp., Culver City, introduced a newly developed line of low-cost digital servo components for automatic control applications. This pulse-operated series of transistorized step-servo motors and companion controllers, a new pulse generator and a new dc/power supply line were being shown for the first time.

Also in the power line, Raytheon's Power Supply and Voltage Regulator Operations announced a new series of heavy-duty, regulated dc power supplies ranging in output from 3 to 1000 volts and from 50 to 3000 watts.

Computer Control Co., Framingham, Mass., displayed a new series of plug-in, high-speed digital modules priced at less than $20 per flip-flop.

Astromics, a division of Mitchell Camera Corp., showed a compact latching relay which it said can be battered with a hammer without damage.

• **Radical depositing method**—Athom Electronics, Sun Valley, Calif., described a new technique for depositing numerous alloys and other materials onto virtually any substrate material, including ceramic, glass, bakelite, Teflon, mylar, fiberglass, quartz and mica. This "plasmionic mono-crystalline film deposition" process was said to be a radical departure from the "sputtering" of alloys onto a substrate material. It is accomplished in a high vacuum of alloys onto a substrate material. It is accomplished in a high vacuum.

Nuclear-Electrical Conversion Cell

The direct conversion of nuclear energy to electrical energy by a thermionic converter has been announced by General Atomic Div., General Dynamics Corp.

The cell's operation depends on the "Edison effect." Electrons are boiled out of a hot plate, or emitter, by the heat from the fissioning of uranium. The resulting electron stream, the electrical current, is collected on an adjacent cold plate called a collector.

Cesium vapor is used in the gap between the emitter and collector to enhance the rate of power production.

The cell's heat source came from a nuclear fuel element made of uranium carbide and zirconium carbide. Highest power run in the tests produced 90 watts electrical output at a power density of 21 watts/cm² delivered into an external load.

Efficiency of converting fission heat to electrical energy went as high as 10%, the operating temperature being about 3500°F.

A metal vapor, such as cesium, is used to (1) step up the rate at which the electrons boil out of the emitter; (2) reduce the energy loss at the collector; and (3) become an ionized gas, or plasma, which causes the current to pass readily through the region between the emitter and collector.

The tests were part of General Atomic's program of research and development in direct conversion, which is being carried out with support from the Rocky Mountain-Pacific Nuclear Research Group.

mergers

MINNEAPOLIS-HONEYWELL Regulator Co. has formed a new Special Systems Division for complex integrated control systems for industrial and military applications. John W. Morrison has been picked to be general manager for the new division, at Pottstown, Pa.

ELECTRO-OPTICAL SYSTEMS has organized Micro-systems, Inc., a wholly-owned subsidiary to be engaged in manufacture and sale of microminiaturized electronic components and devices utilizing solid-state and advanced semiconductor technology.

APPLIED ELECTRONICS CORP. has purchased Flight Electronics Corp., West Chester, N.Y. No changes in personnel or operations are anticipated other than an increase in the research and development end of the business.

ATLANTIC RESEARCH CORP., through its U. F. Flare Division, has established a new technical service and liaison facility to serve the U.S. Naval Ordnance Test Station, China Lake, Calif. Located adjacent to the Naval Station in the City of Ridgecrest, the new facility is served by company airplane from Division headquarters at Saugus, Calif., near Los Angeles.

LABORATORY FOR ELECTRONICS, INC. has acquired an interest in Segnalemento Marittimo ed Aero, Sp.p.A (SMA), Florence, Italy. SMA is producer of marine navigation radar and microwave, infrared, lighting and signalling equipment.

ANTENNA SYSTEMS, INC. opened a new Engineering Laboratory adjacent to its present manufacturing facility in the Hingham Industrial Center. The 3500-sq.-ft. building will centralize all engineering activity for the firm, including mechanical structural and electrical design.

Aereo, Sp.p.A (SMA), Florence, Italy.

GENERAL MOTORS CORP. Defense Systems Div. has bought a 104-acre facility for extensive research in underwater instrumentation. The ocean-view site was formerly held by the Aerophysics Development Div., Studebaker-Packard Corp., and later taken over by Curtiss-Wright Corp.

TRANSVAL ELECTRONICS enters the space propulsion field with the acquisition of an ion engine which has been under development in West Germany for the past 10 years.

McGRAW-EDISON CO. sold its Edison storage battery business to The Electric Storage Battery Company. The division, now known as the Nickel Alkaline Battery Division, continues to manufacture the nickel-iron battery invented by Thomas A. Edison.

PACIFIC SEMICONDUCTORS, INC. is moving its administrative offices to a newly-completed module of a $10-million Diode and Rectifier Facility in Lawndale, Calif. The Thompson Ramo Wooldridge subsidiary will retain its Culver City buildings, with about 350 employees in several departments. The new 193,000 sq. ft. facility will house 1700 employees.

ELECTRO-TEC CORP. has contracted to buy a 10-acre site in West Caldwell, N.J. for construction of a 23,000-sq.-ft. plant. The proposed facility will house the company's executive, marketing and fiscal offices, engineering and R&D groups, and a prototype manufacturing department. Research activities of Precimet Labs. will be quartered in the building.

financial

Consolidated Electronics—Net sales for first six months totaled $46.5 million, with consolidated net income amounting to $2 million. No comparison was was made with the previous year's figures because of changes in corporate structures.

Motorola, Inc.—Net sales for six months were $143.5 million and profits were $6.5 million—both new records for Motorola. Last year's totals, previous records, were $128.9 million and $5.9 million. Second quarter sales and earnings were also record makers—sales up to $73.2 million from $65.2 million and profits improving to $3.5 million from $3.3 million.

Jack & Heintz—Net income of $771,000 for the first half of 1960 jumped considerably over the sum of $97,000 for the same period in 1959. (Company lost nine weeks of production time in the second quarter last year because of an employee strike.)

Garrett Corp.—Preliminary fourth quarter sales figures reached $57.8 million and preliminary net earnings totaled $1.7 million. Unaudited figures disclosed year sales to be $224.4 million and earnings $5.6 million.

Air Reduction Co.—First six months sales were record breaking at $104.9 million, compared with $101.8 million in 1959. First half income was $7.9 million, topping 1959's first half total of $7.8 million.

Textron, Inc. During the first half of 1960, Textron had sales of $164.3 million with earnings of $6.3 million. Same period in 1959 brought sales of $146 million with earnings of $8.5 million, before non-recurring income of $2.5 million. Second quarter sales this year were $81.8 million with earnings of $2.9 million.

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IAF Congress Finds No Agreement on Space Control

STOCKHOLM—Space Law and the problem of when is a spy not a spy got a lot of attention at the International Astronautical Congress here, particularly at the panel set up by America's Andrew G. Haley, IAF General Counsel and Past President.

As was expected, nothing was solved and it seemed apparent to most observers this was a problem which would wind up inevitably with the United Nations. Russia declined to participate and even declined to comment on the subject, saying it had no experts present.

The Powers trial and the RB-47 incident were obviously close to the minds of all participants.

Introducing the Stockholm colloquium, C. Wilfred Jenks, a lawyer from the International Labor Office in Geneva, observed that international control of space is part of a far-reaching disarmament program. The farther nations went toward disarmament the greater are the chances of agreement being reached on space control, he observed.

Professor John Cobb Cooper of McGill University, Montreal, Canada, an acknowledged expert on air law, pointed out that before any plan for international control of outer space can be adopted three preliminary problems must be settled: what is meant by "outer space," the present rights of sovereign states in outer space, and that international control of outer space is not inconsistent with provisions of the Chicago Convention of 1944.

Professor Cooper's views were supported by Belgium's Dr. J. G. Verplaetse, who stressed that it would be wrong to set up an entirely new set of rules for outer space control when air law is already well defined. He suggested that air law might be modified to take into account spacecraft. He warned that outer space is still largely an unknown and as such cannot yet be regulated.

• **Sedov re-elected**—At the end of the meeting, Russia's Professor Leonid Sedov was re-elected as IAF President. Elected vice presidents were Dr. H. Seifert, U.S.; Dr. L. Shepherd. Great Britain; Professor R. Pesek, Czechoslovakia; Professor J. Peres, France; and F. Staats, West Germany.

J. Stemmer of Switzerland continues as Secretary, and Haley as General Counsel.

The next IAF Congress will take place in New York City in October, 1961. The precise dates will be fixed later. The New York meeting will be organized by the American Rocket Society. The 1962 meeting probably will take place in either Bulgaria or Yugoslavia.

The IAF admitted to membership West Germany's Deutsche Astrinautische Gesellschaft and the Italian Rocket Society. Due to the continuing dispute between the two Portuguese rocket societies, it was not possible to admit either to IAF membership.

Two new scientific committees were established by IAF here—one on satellite tracking and the other on space medicine. A working group was set up to discuss a new constitution for the organization. A publishing committee for the proceedings of the IAF was also created.

Report Finds Few Faults in DOD Procurement Policies

Department of Defense procurement problems can and should be solved administratively rather than by legislating a "requirement that good judgment be used."

This was the gist of the *Report on Procurement* just issued by the Congressional Committee on Armed Services. Nothing much was found wrong with present policies that couldn't be cured by a little better management.

Taking an especially hard look at negotiated procurements—the subject of much recent criticism—the committee took note of the limitations and "indispensable prerequisites" to formal advertising for procurement. They concluded that much modern military buying doesn't fit within this concept and, therefore, some contracts must be negotiated. And, they found, negotiation does not necessarily mean no competition.

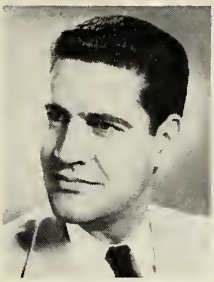
The Committee decided that all of the major contract types now in use have their place and can be good or bad, depending on how they are used and administered. They also concluded that procurement authority cannot be unduly centralized and some authority must be delegated.

Several amendments and revisions to procurement regulations were recommended. These were generally mild and suggested changes in degree rather than drastic legislation. Chiefly, the proposed amendments would encourage more procurement by formal advertising whenever practicable.

Sen. Leverett Saltonstall (R-Mass.) voiced the hope that the suggested amendments might help small business.

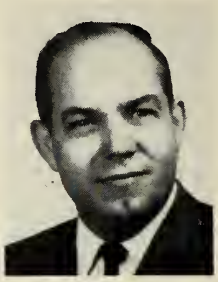
names in the news

DANIELSON



WILKINSON

TRIBERT



TEASDALE

SCHWARTZAPFEL

August A. Danielson: Named vice president to head up GB Electronics, Inc. He joined the organization in 1926, became chief engineer in 1937, and most recently was vice president in charge of the General Bronze Brach Division.

D. A. Wilkinson: Elected manager of the newly formed Product Planning and Market Research sub-section at General Electric's Light Military Electronics Dept. He will continue as manager-*Sidewinder* marketing for the department until a successor is named.

Claude Tribert: Former operations manager, promoted to operations vice president at Portland Industries Corp. He was responsible for the firm's *Bomarc* missile program, and will continue in this capacity.

A. R. Teasdale, Jr.: "An authority in missile guidance control" joins The Martin Co.-Baltimore corporate engineering staff, where he will head a corporate group of consultants. Was formerly manager of the Electronics Division of Temco Electronics and Missiles Co., and prior to that an electronic controls specialist with the Convair Division of General Dynamics Corp.

Wilbert Schwartzapfel: Former project director with Booz, Allen Applied Research, Inc., in charge of technical and scientific consulting on military systems research and development, joins General Electric Co.'s Special Programs Section as manager of Missile Systems Engineering.

Dr. John L. Schwab: Special assistant to the U.S. Army Director of Research and Development, joins General Motors, Sept. 1, as head of the Advanced Planning Department for the Defense Systems Division.

Dr. David van Tijn: Former senior staff scientist for Applied Science, Inc., promoted to Director of Research.

Lawrence John Schlimgen, Theodore W. Steele and **Richard Morrell Zehr:** Join the technical staff of The Oxford Corp. All were formerly with Bell Aerosystems Corp.

Carl G. Gottlieb: Appointed manager of the Armament Division of Universal Match Corp. **Max E. Norman,** former avionics systems engineering manager, succeeds Gottlieb as head of what will now be called the Avionics and Electronics Dept. **Earl E. Biermann** will head the newly formed Heavy Military Equipment Dept., which is a result of combining the Heavy Equipment Engineering Dept. and the Armament Fabrication Dept.

Winston O. Faith: Elected director of development of the Microcircuitry Laboratory for Varo Mfg. Co., Inc. Prior to joining the firm in 1958, he was senior system design engineer with Chance Vought Aircraft, and then group engineer with the Automatic Controls Group, Temco Aircraft.

J. W. Hinchliffe: Former director of Subcontract Marketing, named to head Northrop Corp.'s newly-established Commercial Products Marketing Section of the Norair Division. **Lee H. Smith,** director of customer service, is now director of Ground Environment and Subcontract Marketing.

Dr. Nicholas Yaru: Head of Hughes Aircraft Co.'s radar laboratory's microwave department, elected associate laboratory manager, research and development. Also, **Samuel Langberg** and **William R. Welty** named associate laboratory manager, product engineering, and chief scientist, respectively.

Howard Gleason: Former assistant to the president, Southwestern Industrial Electronics, appointed vice president for manufacturing.

Ralph T. Dosher, Jr.: Appointed manager of the Automation Products Dept. for Texas Instruments Inc. Geosciences & Instrumentation group, with responsibility for engineering, manufacturing and marketing of electronic component reliability testing systems, semiconductor test equipment and special contract products.

Richard W. Powell: Joins Telecomputing Corp. as vice president and manager of its Electronic Systems division, succeeding **Berne N. Fisher,** now President and general manager of the firm's Value Engineered Products, Inc. subsidiary. Powell was previously division manager of Aerojet-General Corp.'s Avionics Div., chief development engineer at G. M. Giannini & Co., Inc., and prior to that research engineer for Lockheed.

William E. Vogel: Named chief engineer-Manufacturing Research and Development at Dana Corp. Was formerly with Atlas Drop Forge Company, a Dana subsidiary.

James M. McCarty: Former chief engineer and marketing manager of Chicago Aerial Industries, named vice president-engineering of J. A. Maurer, Inc. He succeeds **J. F. G. Miller.**

Ted C. Combs: Vice president-engineering, Zero Manufacturing Co., appointed chairman of the Container Design Section, Packaging & Handling Division, American Ordnance Association.

Richard W. Cook and **Joseph P. D'Arezzo:** Elected vice president of American Machine & Foundry Co. Both were formerly divisional vice presidents.

James E. Borendame: Former director of marketing services for Acme Steel Co., joins Fanstell Metallurgical Corp. as director of marketing and public relations.

Carlos C. Wood: Joins United Aircraft Corp.'s Sikorsky Aircraft division as engineering manager, succeeding **Michael E. Gluhareff,** who is retiring as of October 1. Mr. Wood resigned as director of advanced engineering planning for the Douglas Aircraft Co., Inc., after 23 years engineering service.

Bruce R. McFadden: Appointed engineering manager for the Packaged Electronics Division of Amphenol-Borg Electronics Corp. Formerly supervised electromechanical design in Sylvania Electric Products, Inc.'s Data Systems.

John Spitzer: Joints the Semiconductor Division of Sylvania Electric Products Inc., as supervisor of advertising and sales promotion. He was formerly product promotion supervisor for the Univac Division of Sperry Rand Corp.

Sixth Sense for Republic's F-105

Republic's F-105 Thunderchief, the Air Force's new Mach 2 tactical fighter, is able to nail targets on the head, night or day, cloudy or clear—even if the targets are hidden deep in rugged mountains.

This remarkable capability stems from NASARR—the F-105's monopulse radar system—developed and manufactured by Autonetics for the AN/ASG-19 armament control system. Lightweight, compact NASARR provides radar functions for both low-level and high-level missions . . . air search, automatic tracking, air-to-ground ranging, ground mapping and terrain avoidance.

For more than a decade Autonetics has pioneered the way with monopulse radar systems like NASARR to provide America's pilots with a sixth sense.

Autonetics

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contracts

NASA

Hercules Powder Co., Wilmington, Del., for flight configurations of a retro-rocket motor. Subcontract from Ford Motor Co.'s Aeronutronic Division. Amount not disclosed.

Ryan Aeronautical Co., Ryan Electronics Division, San Diego, for an altimeter for use with the *Ranger* program. Subcontract from Ford Motor Co.'s Aeronutronic Division. Amount not disclosed.

$154,000—Reynolds Electrical and Engineering Co., Inc., Freeport, Tex., for continuous check-out and periodic maintenance and/or modification of electrical equipment at NASA-Marshall Center.

ARPA

$250,000—TRG, Inc.'s Antenna & Microwave Dept., Somerville, Mass., for design and construction of a mobile line source feed for the 1000-ft. spherical reflector antenna for the Arecibo Radio Observatory in Puerto Rico. Subcontract from Cornell University.

NAVY

General Electric Co., Santa Barbara, Calif., for investigating systems for the defense of the continental U.S. against attack by missile launching submarines. Amount not disclosed.

Datex Corp., Monrovia, Calif., for building two angle-measuring data handling systems for use at the Pacific Missile Range.

$3,200,000—Sylvania Electric Products, Inc., New York City, for electronic data processing equipment.

$1,247,000—General Electric Co., for prototype fabrication of new *Polaris* inertial guidance system for an advanced design.

$850,000—Manson Laboratories, Inc., Stamford, Conn., for research and development of high-frequency synthesization and advanced high-frequency communications.

$250,000—Aeronautics Division, Chance Vought, Dallas, for testing a new type of sonobuoy designed for detecting the movements of enemy subs.

$208,497—Computer Systems, Inc., Monmouth Junction, N.J., for design and fabrication of two of the largest plotting boards ever produced for missile range use.

$79,050—Consolidated Electrodynamics Corp., Arlington, Va., for tape recorder-reproducer systems and associated components.

$45,000—Hughes Aircraft Co., Microwave Tube Division, Los Angeles, for high power traveling wave tube.

AIR FORCE

Kidde Aero-Space Division of Walter Kidde & Co., Inc., Belleville, N.J., for study and feasibility testing of an integrated, cryogenic fueled power system incorporating secondary power, reaction control and environmental control systems. Amount not disclosed.

Bell Aerosystems Co., Buffalo, for miniature accelerometers for the GAM-87A *Skybolt*. Subcontract from Nortronics Division of Northrop Corp. Amount not disclosed.

$78,000,000—Lockheed Missiles and Space Division, Inglewood, Calif., for developing ground-space and communications and control systems for the *Discoverer*, *Samos* and *Midas* satellite programs.

$2,014,865—Tung-Sol Electric, Inc., Newark, N.J., for electron tubes.

$1,000,000—International Resistance Co., Philadelphia, for producing new high-stability, high-reliability resistor for the *Minuteman*. Subcontract from North American Aviation, Inc.'s Autonetics Division.

$525,000—The Siegler Corp.'s Hallamore Electronics Division, for design, fabrication and installation of instrumentation for the cold flow test facility used in the static testing of the *Titan II*.

$97,543—Ford Motor Co.'s Aeronutronic Division, Newport Beach, Calif., for a high-speed scanning device.

ARMY

$8,486,025—Republic Aviation Corp., Farmingdale, N.Y., for AN/USD-4 short-range surveillance drone system.

$5,300,000—International Telephone & Telegraph's Federal Division, Clifton, N.J., for electronic "brains" for the *Lacrosse* missile. Subcontract from The Martin Co.-Orlando.

$4,000,000—Western Electric Co., New York City, for furthering work on the *Nike Zeus* antimissile missile. (Three contracts.)

$667,920—Western Electric Co., Inc., New York City, for *Nike* replenishment spare parts. (Five contracts.)

$200,000—Douglas Aircraft Co., Inc., Santa Monica, for research and development of *Honest John* rocket system.

$170,093—The Martin Co., Orlando, for replenishment spare parts for the *Lacrosse*.

$134,485—Namron Construction Corp., Oceanside, L.I., N.Y., for conversion to *Hercules, Nike* Battery 48.

$117,600—James Farina Corp., Newton, Mass., for conversion to *Hercules, Nike* Battery 05.

$27,000—Brown Engineering Co., Inc., Huntsville, for engineering services for *Pershing* weapon system.

reviews

DYNAMICS OF CONDUCTING GASES, edited by Ali Bulent Cambel and John B. Fenn, Northwestern University Press, Evanston, Illinois, 212 pp.

Since 1955, the American Rocket Society and Northwestern University have been having biennial symposia on specialized topics in gas dynamics. The present volume contains the papers and lecturers presented last year at the Third Gas Dynamics Symposium.

To the merit of the volume is that the material is topical and specialized. To the demerit, for those readers looking for a readable text, is that this is a book for experts and those familiar with mathematical physics.

The book is divided into four parts. Part One: Elementary processes and properties in ionized gases. Part Two: Theoretical considerations on the interaction of magnetic fields and flow of ionized gases. Part Three: Laboratory experience with flow of ionized gases. Part Four: Applications of magneto-gasdynamic effects.

U.S. ARMY RESEARCH AND DEVELOPMENT PROBLEMS GUIDE, Distributed to qualified private organizations through Ordnance District Offices which deal with U.S. industry.

A guide book for industry that spells out problem areas in the development of Army weapons, ammunition, guided missiles and rockets, combat and support vehicles has been published by the Ordnance Corps.

Companies possessing a secret clearance who have qualified to participate in the Ordnance Corps Qualitative Development Requirements Information Program may obtain copies of the Guide through the District Offices or directly from a Commodity Command or Arsenal with which they have signed a policy agreement.

Any civilian organization having an interest in such activity which is not participating in the QDRI program, may also qualify to receive the guide.

Don't expect packaged space to come in a glass jar. But simulated environments are available from Vitro which can duplicate conditions millions of miles away. Using its proprietary high-intensity arc, Vitro is designing a solar radiation simulator for the Department of Defense. USAF scientists will use it to expose coatings slated for space vehicle application. The arc accurately represents the solar spectrum and energy distribution—importantly, from a single source. To date, this is Vitro's proven record of accomplishment: 11 major projects in which the simulation of unusual environment was vital.

Vitro

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SS-11 Gets One-man Portable Control

by Bernard Poirier

France's Nord-Aviation has developed the first man-portable fire control system for use with lethal antitank missiles.

The Waist Belt Fire Control System is designed for Nord's *SS-10* and *SS-11* missiles. A particularly significant feature, say Nord spokesmen, is that it brings to the *SS-11* the high mobility already associated with the *SS-10*. The *SS-11* has a top range of 11,500 ft., twice that of its predecessor.

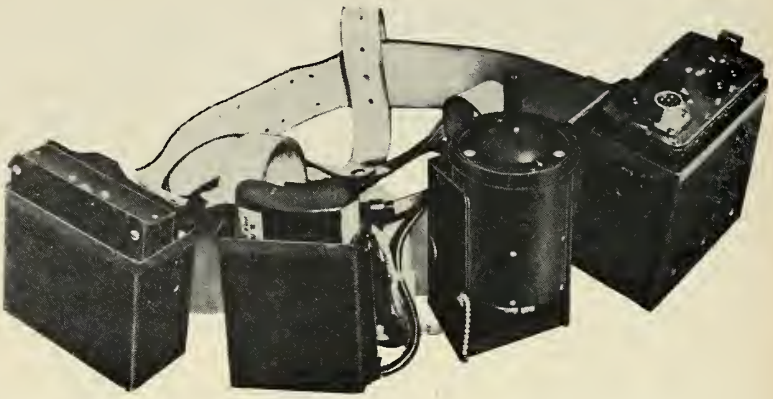
The equipment may be manufactured in the U.S. by General Electric under the same license agreement worked out with the French firm at the time the *SS-11* IR optical guidance was reported (M/R, May 2, 1960). Terms of this agreement are still under Pentagon scrutiny, reliable sources say.

Miniaturization of the 11½-lb. FCE (fire control equipment) was achieved with transistors in the command and signal circuits. The four FCE components include a small manual Joystick Unit (2 lbs.), a battery pack (1 lb. 2 oz.), a Control Unit (1 lb. 4 oz.) and an Electronic Generator (2 lbs. 4 oz.).

• **Visual pre-flight check**—The integrated Control Unit is 4 in. x 3½ in. by 6 in. and has a pre-fire check-out procedure which enables the gunner to check responses of the elevation and direction controls prior to the missile's ignition. Roger Fleury, head of Nord's New Products Division, and Mr. Dupuy, Head of the Electronics Group, have described the checkout as a system of small, briefly flashing lights on the Control Unit's face plate.

When the gunner tests the controls, the small "blink lights" flash to indicate satisfactory servo responses through the command and signal circuits between the Control Unit and the T 10 Electronic Generator to the missile.

The effective range of the Waist Belt FCE is believed to be more than triple the range possible with IR optical guidance, although both figures are kept classified. Also classified are the aerodynamic-type corrections featured in the *SS-11*.



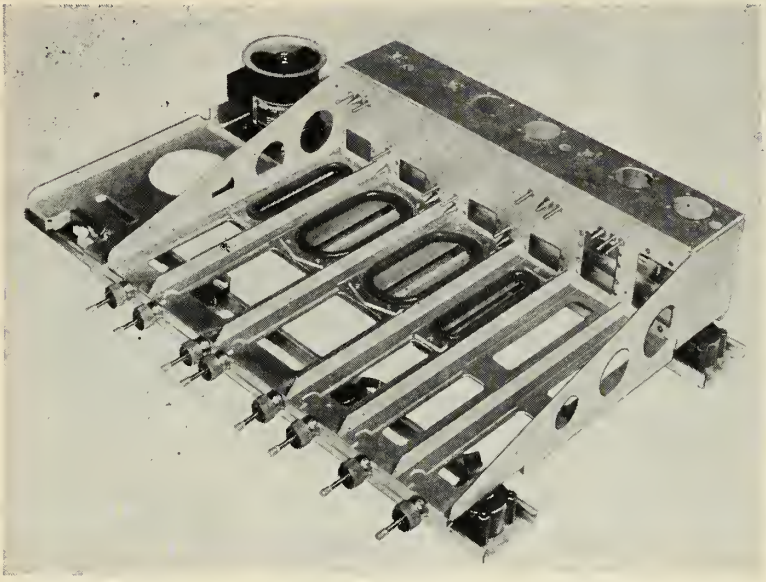
LEFT TO RIGHT: T 10 electronic generator; battery pack; joystick unit, and control unit of Nord's miniaturized Waist Belt Fire Control System.

• **Tests revealed by** COUNTDOWN—The Waist Belt FCE was evaluated during secret missile tests reported by M/R on July 25. Five missiles, three with active warheads, were fired on May 11th in the Dauphine Alps near the town of Alpe d'Huez. Selected Alpine Troops carried *SS-11* missiles in shoulder packs while one trooper carried three warheads in a shoulder harness.

The Waist Belt apparatus was tested by Nord Personnel and by Alpine troopers. The actual launchings took place at a site 8692 ft. high. The lowest target was at 5904 ft. and the highest at 9348.

ONE TROOPER carries three live warheads; his comrade carries a single missile in a pack.

FOUR MEN carry a total of three missiles and three warheads. Eleven enlisted men were the total needed in the Alpine tests.



Vibration Damping Mounts

Elastomeric mounting systems are being produced by Lord Manufacturing Company to meet requirements of an aerospace design trend calling for integration of "black boxes" and protective structures. Elastomeric members are Lord BTR(r) (Broad Temperature Range) Mountings which provide all-attitude control of high-frequency vibration plus attenuation of shock and structure-borne noise from −65° to +300°F.

Lord BL-1909 base weighs 11 lbs., supports 51.7 lbs. of equipment including four ¼ ATR units, two 3/8 ATR units, computer, and blower. The system incorporates eight BTR elastomeric mountings for all-attitude shock/-vibration protection over the −65° to +300°F temperature range.

The base meets the shock and vibration requirements of MIL-E-5272C plus sustained accelerations of ±6.2 g vertically, ±1.9 g horizontally, ±2.4 g longitudinally.

Circle No. 225 on Subscriber Service Card

Vapor Dipole Indicator

A device for detecting and measuring vapor or gases which exhibit an electric dipole moment is being marketed by Conrad-Carson, Inc.

The Humistor can be tailored to individual application requirements in both read-out and automatic control circuitry.

Circle No. 226 on Subscriber Service Card

Time Delay Relay

A highly flexible, transistorized, printed circuit time delay relay for timing operations and other functions in undersea, air or space craft is available from Controls Division of the Leach Corp.

The relay is capable of either horizontal or vertical mounting within its package and, optionally, of outside timing adjustment.

The relay output is operated by a transistorized gate which is energized from an RC (resistor-capacitor) timing network. Accuracy is guaranteed by regulated power applied to the timing unit.

Circle No. 227 on Subscriber Service Card

Swift Digital Computer

Packard Bell Computer Corporation has produced an ultra-fast, general-purpose, digital computer. Designated the PB 250, it can be applied to an extremely broad range of scientific, industrial and military problems.

The PB 250 combines a large, expandable memory and a versatile command structure with computing speed in the microsecond range.

Specifications of the PB 250 qualify the computer for either on-line or off-line applications. It is a serial, binary, single-address computer with an internally stored program. A few of the features include: Microsecond Speed . . . Add/subtract—12 usec., multiply—276 usec., divide/square root—252 usec.

Circle No. 228 on Subscriber Service Card

Plastic Properties Tester

A "Plastechon" Universal Tester is being marketed by the Plas-Tech Equipment Corp.

The tester is capable of measuring tensile, flexural, and compressive properties of all types of materials at rates of loading ranging from 0.2 in./minute to 8000 in./minute. Stress-strain curves are obtained automatically via oscilloscope-camera techniques.

Circle No. 229 on Subscriber Service Card

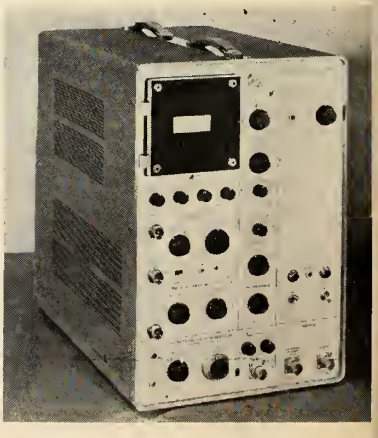
Two-Part Control Box

One control box in two multifaced parts is being marketed by Barber-Colman Co. The box has two special qualities—form-fitting design to match the space limitations inherent in missile applications and close operating tolerance. The box occupies less space than a four inch cube and controls temperature to less than ±0.03°F.

Circle No. 230 on Subscriber Service Card

Wide Band Oscilloscope

A calibrated, high-speed, laboratory oscilloscope designed for observation, measurement, and photographic recording of wide-band phenomena is being marketed by Tektronix, Inc. A 2 x 6 cm viewing area, coupled with 24 kv accelerating potential affords bright displays with excellent definition.



Performance features include: passband from dc to beyond 1000 mc, rise-time of 0.35 nsec, sensitivity of 10 v/cm, linear sweeps to 2 nsec./cm, and sweep delay to 35 nsec. All features (including a sensitive trigger system) are fully compatible with the signal bandwidth capabilities of the instrument.

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new literature

DECADE COUNTER TUBES—A counter tube handbook describing the construction, operating principles and applications of a wide variety of decade counter tubes used in computers and tabulating machines, radiation-measuring instruments, frequency dividers, and other electronic equipment, has been made available by Sylvania Electric Products Inc. The 12-page handbook contains illustrated sections on design procedures, specifications, and circuit information. In addition, new drive circuits for medium-speed and high-speed (100 kc) types are included.

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- **Prototype System Development**
- **Advanced System Concepts and Design**
- **System Cost Analysis**
- **Operational Evaluation**

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MITRE, formed under the sponsorship of the Massachusetts Institute of Technology, is a system engineering organization engaged in the design, development and evaluation of large scale command and control systems. Its convenient location in suburban Boston offers excellent opportunities for advanced study under MITRE's liberal educational assistance program.

editorial . . .

Wanted: Optical Engineers

A NUMBER OF little-known facts about what is actually a little-known industry were revealed in a special report on optics in MISSILES AND ROCKETS' Aug. 22 issue.

The manufacture of precision optics had grown into a significant industry in this country after World War I, when we first discovered that Americans could build optics which were just as good as those built by the Germans and the Swiss, who theretofore had monopolized the field.

M/R's report revealed that the optics share of the missile/space industry will reach $75-85 million next year and is likely to double in the three to five years following; that the American industry is no longer dependent on European techniques; that the optics industry is getting more sophisticated, more competitive—and much larger.

The report also revealed that there is an acute and shocking shortage of trained optical engineers and of optical and photographic scientists in the United States.

There is an almost complete (one industrialist called it "shameful") lack of interest on the part of engineering schools in establishing good courses in optics. Moreover, the few good physicists in the field are not interested in everyday optical engineering.

Thus, just at the time when the Missile/Space Age is levying greater demands on an expanding industry, that expansion is almost certain to be held back and limited by the lack of people trained in optics.

Why? Blessed with 20/20 hindsight, we can easily spot the answer: almost complete lack of foresight and preparedness on the part of both educators and the industry.

For education is, of course, the solution. To educate, however, you must first have teachers. Then you must have students supplied with adequate courses and laboratories.

It seems apparent that the optics industry itself will have to provide these essentials if it is to have the trained people it needs. This can be done in part by financial support to the universities to set up and staff facilities. By means of scholarships promising students can be aimed in the right direction. Cooperative programs, which cost participating companies little, could produce relatively soon the beginning of the needed stream of competent personnel.

The textile industry in the South has followed such programs for years—with scholarships, school facilities and equipment—to provide the bright young men and women to meet the challenge of synthetics. Without the new ideas in manufacturing, industrial management and engineering contributed by these trained new minds, our natural-fiber textile industry probably would not exist at all today.

But this is still not enough. In the case of optics, education must go a step further. Pre-education is necessary, as well as advanced training. The industry must make our high school and early college students aware of the opportunities that exist in optics. The general public, too, should be educated to the importance of optics, its challenges and rewards.

A PARTIAL remedy for the present might be a higher development of computer techniques for optical design. Already finding limited use, computers can solve difficult lens problems and probably can be used for more complex design configurations. The immediate effect of this would be to free optics specialists from routine tasks, and permit them more time for advanced problems.

Optics is not the only industry which should take heed of the manpower shortage. Almost every other business in this Missile/Space Era of leap-frogging technological advancement would do well to look to its own house. Many have already found that lack of skilled technicians is their greatest problem. Obviously, this situation will spread in the future—if individual industries don't start to do something about it now.

Clarke Newlon

Several new contracts for research and development of computer and guidance components for the Polaris Missile have recently been awarded to the Hughes Engineering Division. As a result, a variety of openings have been created for graduate engineers and scientists who have a minimum of three years experience specifically related to:

- Inertial Components and Platforms
- Systems Design and Physical Design of Inertial Devices
- Digital Computers
- Servomechanisms
- Controls Systems Analysis
- Magnetic Drum and Magnetic Core Circuit Design
- Transistor Switching and Circuit Design

Polaris Guidance is but one of the many R&D programs which reflect the growing emphasis on space oriented projects at Hughes. The Engineering Division is also responsible for such projects as: Space Ferry Systems, Anti-ICBM Detection Systems, Infrared Search Systems, and Communications Satellites.

For immediate consideration, please write, wire or call: **Mr. R. A. Martin**
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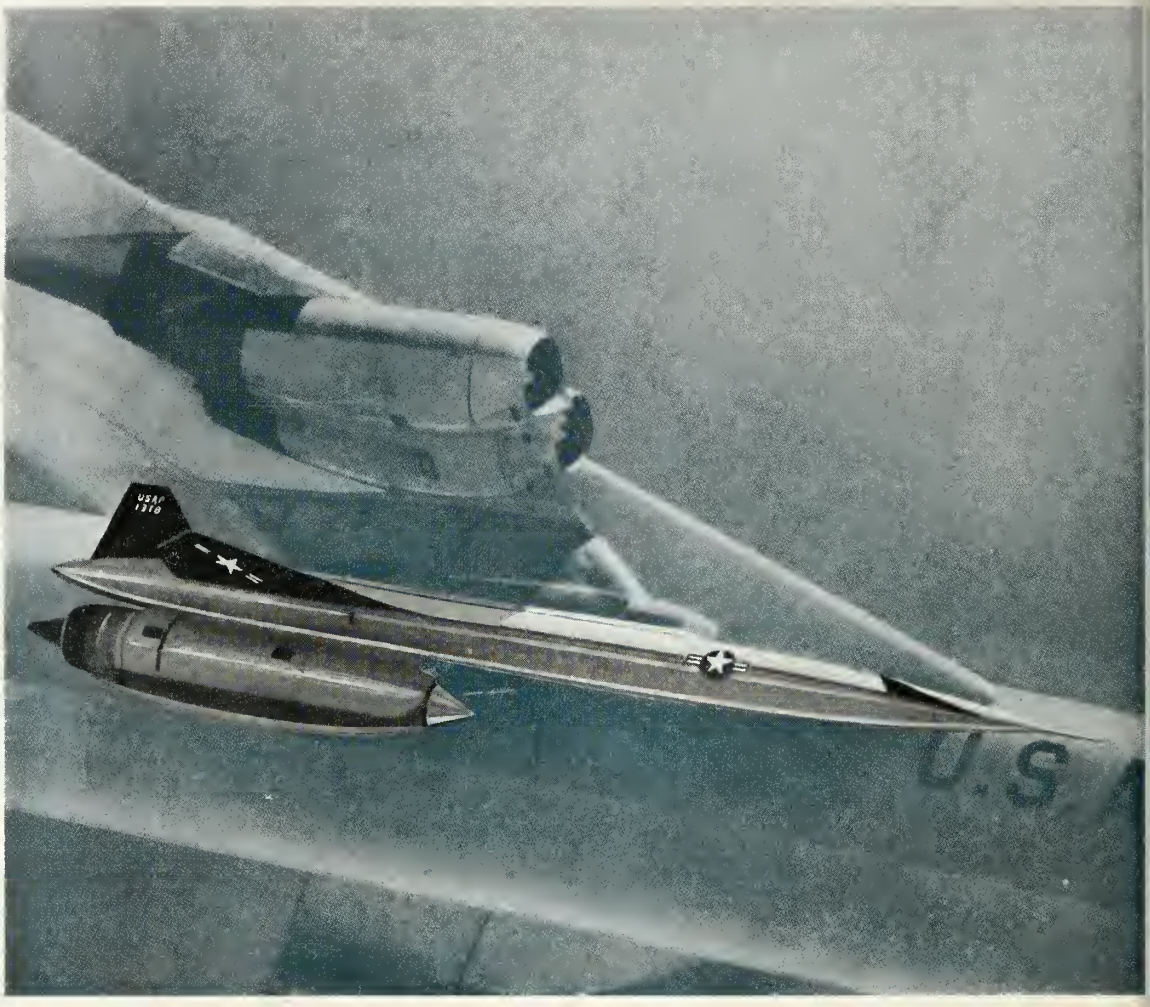

Leashing and Unleashing the Hound Dog . . .

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Here's a missile safe-arm and release mechanism that must never fail . . . used by the Missile Division, North American Aviation, Inc., to safety-lock and release its *nuclear-armed* Hound Dog GAM-77 missile – potent weapon on the B-52. Rocket Power custom-designed this device to securely lock the missile to the aircraft during flight and unlock and ready the missile for launching with its built-in ballistic-actuated launch system . . . instantly starting the Hound Dog towards its target. Simple electro-mechanical design assures complete safety over friendly territory . . . allows the pilot to easily and safely arm and disarm the release actuator at will. ♦ This highly critical device typifies Rocket Power/Talco products in such solid propellant and ballistic system areas as sounding vehicles, sled rockets, escape and recovery systems for aircraft or missiles, cartridge actuated devices and a variety of rocket motors. ♦ For complete information on Rocket Power's propellant and component capabilities, write to Rocket Power/Talco, Falcon Field, Mesa, Arizona.

CAREER OPPORTUNITIES are available for qualified engineers and scientists. Write for complete information.

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