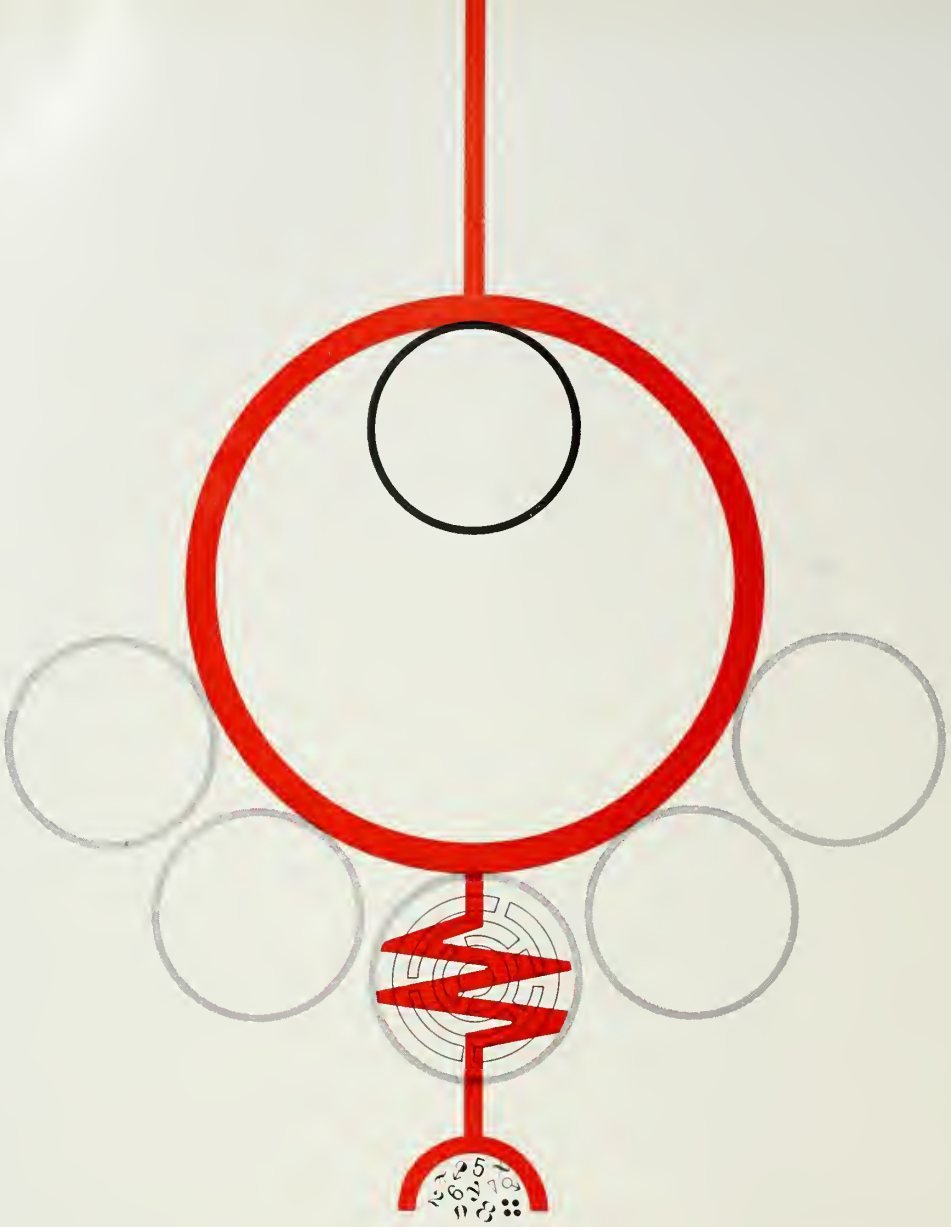
NOVEMBER 2, 1959

EXPLORER VII LAUNCHED

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION



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Propulsion .....MICHAEL LORENZO
Industry .....JAMES J. HAGGERTY, JR.
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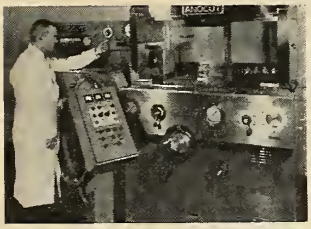
COVER: Army's *Juno II* rocket carrying NASA's *Explorer VII* satellite into orbit rises from Cape Canaveral Oct. 13. The successful shot followed a failure with another *Juno II* on July 16.

GENIE WAITS on Douglas trailer for attachment to Northrop F-89J jet during recent William Tell II World Wide Weapons Meet at Tyndall AFB. Fla. See a report on the meet, pp. 14-16.

MISSILES are heated, quenched in water during simulation tests at one of the facilities of the Naval Weapons Laboratory at Dahlgren, Va. A report on NWL starts on p. 20.



ELECTROLYTIC cavity-sinking machine developed by Anocut. Work space is at right, drivehead mechanism at left. This advance is reported in machining story, p. 29.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

31,900 copies of this issue printed

NOVEMBER 2 HEADLINES

ASTRIONICS

MISSILE SUPPORT

U.S. Reg. Pdg.

ASTRONAUTICS ENGINEERING

U.S. Reg. Pdg.

THE MISSILE WEEK

U.S. Reg. Pdg.

DEPARTMENTS

Washington Countdown

IN THE PENTAGON

An indefinite stretch out . . .
of the **Douglas** ALBM study program is underway apparently because of Air Force money shortages. **Douglas** originally was expected to have come up with a prototype model by November.

• • •

A possible substitute . . .
for the deceased **North American** F-108 in the "master plan" for U.S. air defense may be an advanced **Boeing** *Bomarc B*. Or, it may be modification of the **Boeing** *Minuteman*. (See this issue, page 16.)

• • •

Heating problems . . .
are believed to have caused the repeated failures in attempts to recover *Discoverer* capsules from orbit. Re-entry caused the capsules to become hotter than expected, creating an environment that their equipment was not designed to withstand.

• • •

New anti-radar missile . . .
called *Cobra* is being designed for the Navy. The missile will home on shipboard radiation.

• • •

The Air Force anti-radar missile . . .
program—known only as ARM—is now in the early study stage. The Air Force budget for FY 1960 includes more than $20 million for the project.

• • •

Fire control testing . . .
is being conducted aboard Air Force jets by launching missiles that never leave the plane. The job is understood to be done by a **Hughes** *Falcon*-shaped evaluation missile carrying equipment that automatically simulates the entire firing cycle from plane to target.

AT NASA

The NASA launching program . . .
for the remainder of the year includes:

. . . Two *Little Joes* carrying *Mercury* capsules.
. . . One *Atlas-Able* carrying a moon-orbiting satellite.
. . . One *Thor-Able* carrying a sun-orbiting satellite.
. . . One *Redstone* carrying a *Mercury* capsule down the Atlantic Missile Range.

The most dramatic shot scheduled for the early months of 1960 will be a repeat of the *Redstone-Mercury* launching only this time the capsule will be manned.

• • •

A billion-dollar budget . . .
or more has suddenly become a possible target for NASA for FY 1961 with the acquisition of the Army Ballistic Missile Agency all but assured. Previously, NASA had been expected to shoot for around $650 million.

• • •

Some of the reports . . .
heard around the nation's capital:

. . . Russian scientists are showing an increasing interest in Mars.
. . . The next class of U.S. astronauts will include a married couple.

AROUND TOWN

The new boss of ARPA . . .
is expected to be chosen within the next two weeks. The Administration is reported to be looking both inside and outside the government for Roy Johnson's successor.

• • •

Sweden's STRILL-60 . . .
The Swedish Air Force's new semi-automatic operations control system for launching *Sidewinders*, appears to be a compromise between the U.S. SAGE and Sweden's outdated radar-human observation system. STRILL-60 is development of **Marconi's Wireless & Telegraph Co.** in England under an initial $4.25 million program. It will be used for surface-to-air as well as air-to-air missiles.

Industry Countdown

MANUFACTURING

Even if NASA funding . . .
increases substantially with the acquisition of ABMA, don't expect the space agency to hand out more R&D contracts. Reason: NASA soon will have a staff numbering more than 16,000 and a tremendous in-house capability. It will take a lot of work to keep them all busy.

• • •

Look for decision . . .
by Air Force on a contractor for *SLAM* (supersonic low-altitude missile) in February or March. **Convair, North American** and **Chance Vought** are competing for the airframe. All have study contracts.

• • •

Major opportunity . . .
may await manufacturer who comes up soon with VTOL aircraft capable of firing anti-submarine missiles. Navy reportedly is considering arming merchant ships with such a system to cope with the Russian undersea threat—which now numbers 450 subs.

• • •

Sea trials begin this week . . .
for the first *Polaris* FBM sub George Washington. Built by the **Electric Boat Division** of **General Dynamics Corp.**, the G-W is expected to attempt some pop-up tests of dummy missiles in the trials and to make its first live *Polaris* shot early next year.

• • •

New explosive forming . . .
process by **Ryan Aeronautical** can produce precise and intricate structures with little or no machining required for finishing. At the moment the shape, size, placement and type of explosive are a closely held company secret.

• • •

Expect the French . . .
to abandon their shipboard surface-to-air *Masurca* missile program, say U.S. officials. They will wind up either buying—or being given—*Terriers*. As in the IRBM field, the French want to make their own missiles. However, the experts believe the *Masurca* can't come close to the *Terrier*, and eventually they will have to drop it.

PROPULSION

Cesium supply problem . . .
as source for ion propulsion systems may be solved with the discovery of an extensive deposit of high-grade pellucite—an aluminum-cesium silicate—in Southern Rhodesia. **Bikita Minerals Ltd.** made the find.

• • •

Fluorine is now being . . .
researched as an additive to solid fuels. In solid state most of the nasty handling characteristics of liquid fluorine are eliminated.

• • •

Decision is in the works . . .
on the vehicle which will use a new liquid rocket engine being tested at NASA's Lewis Research Center. **Solar Aircraft** is fabricating thrust chamber and injector of brazed stainless steel. Regeneratively-cooled chamber is formed of 120 U-shaped AM-350 channels .008 inches thick, spot-welded, wrapped with .008 stainless steel ribbon and then brazed with copper.

ASTRIONICS

Moon-mapping . . .
capability is seen for high-resolution, three-dimensional radar being developed by **Goodyear Aircraft** on the **Martin** *Dyna-Soar* team. Big problem is still satellite power output inadequacies and antenna gains.

• • •

Thin-film research . . .
in microelectronics at **Motorola**'s Phoenix, Ariz., facility is aimed at eliminating three out of four connections within the next five years.

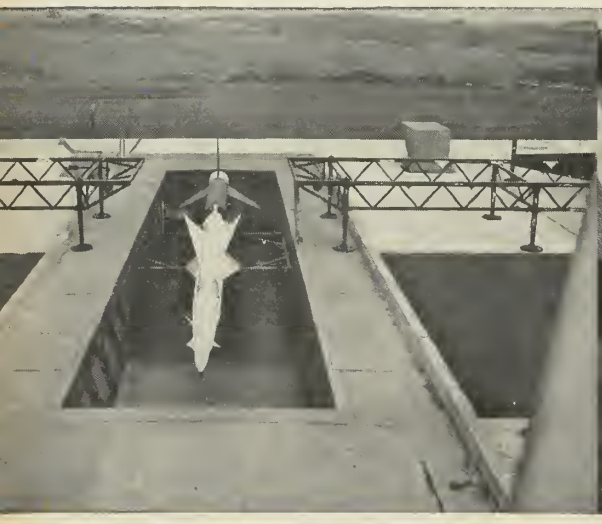
WE HEAR THAT—

NASA may allow big sell . . .
of its *Scout* space probe vehicle to foreign nations starting this spring. The current price-tag is $500,000, but it could be obtained for less in volume orders . . . WADC has awarded **B. F. Goodrich** a development contract for a "unique, higher-thrust" solid rocket fuel . . . An underground R&D laboratory is being built at Anaheim, Calif., by **Nortronics** for advanced engineering studies of passive counter-measures rockets . . . **Temco** is estimating 1959 sales will be 40% from Space Age production compared to 26% in 1958 and 12% the year before.

More About the Missile Week on Page 40.

About the earthly side of the Nike Ajax.

The U. S. Army's Nike Ajax is a strange but potent bird. Graceful, tough, packed with delicate instruments. He will fly only once in his lifetime—only in the event of an enemy attack. To launch him with split-second timing and accuracy, the Army puts most of its manpower and most of its materials into ground equipment. And virtually all the material required other than electronic equipment can be purchased from one firm—United States Steel. Whether you're talking about carbon steel, high-strength low-alloy, or ultra high-strength alloy steels, Stainless Steel, steel fence,



The Nike Ajax spends his days in a concrete and steel nest like this one. ICBM's will also live this way, but in nests that will take *thousands* of tons of concrete and steel. U.S. Steel specialists work continually with designers and construction engineers to find ways to use steel to its full advantage on such projects to build stronger with less materials . . . to build them faster.

It takes miles of wire and cable to rig a Nike nest. It will take *hundreds* of miles when bigger birds are put to roost. The Army uses many types of steel and steel products in a Nike nest. U.S. Steel conducts research and knows how to cut costs for any steel product used in ground support equipment.

electrical cable, cement or wire rope, United States Steel maintains the technical services to provide the proper assistance to cope with any problem on materials for ground equipment. When a ground support program goes to the drawing board, consult with

United States Steel

USS is a registered trademark

How light can you make a steel boom for any missile system without sacrificing strength? The proper selection of USS High-Strength Steels or Constructional Alloy Steels has cut the weight of similar equipment as much as ⅓—and *increased* the strength and service life.

Saturn Switch Takes DOD Out of Lunar Space Effort

Transfer of big rocket to NASA may commit the United States to becoming second-class military space power

WASHINGTON—The date of the transfer of the *Saturn* program from the Pentagon to NASA may go down in history as the point when the United States firmly committed itself to being a second-class military space power.

As of that date—probably early March—the Armed Forces will have no going program leading toward the conduct of military operations much beyond the edge of space.

It also will mark the end of the frustrating saga of a Pentagon attempt to make the United States a first-class military space power despite the hobbling restrictions placed on it by the Administration.

Saturn—the 1.5-million-pound-thrust clustered booster plus two upper stages—would be capable of placing 15-to-20-ton manned space stations into orbit and putting sizeable payloads on the moon. It is America's only foreseeable chance to overtake Russia's para-military space program in the early 1960's.

NASA conceivably could save the day by putting the *Saturn* program on a crash basis and planning for construction of dozens of the giant rockets for itself and the Air Force. However, unless there is a violent reversal of Administration policy, the chances of this happening appear thin indeed.

The current ARPA program for development of *Saturn* by the Army Ballistic Missile Agency has $70 million to support its operations in FY 1960. ARPA is expected to include about twice as much for *Saturn* in its new budget for FY 1961—a normal increase in line with the current development program. The same funding schedule would call for about $300 million for FY 1962.

Here are the past and estimated planned appropriations for the Saturn program under the current middle-of-the-road schedule and a crash schedule:

	CURRENT	CRASH
FY 1959	$ 34 million	$ 34 million
FY 1960	$ 70 million	$130 million
FY 1961	$140 million	$250 million
FY 1962	$300 million	$650 million

Under this program, a prototype of the three-stage *Saturn* vehicle would be ready for its first test flight in late 1963 at the earliest—nearly two years behind the original schedule. However, the funding rate of this program represents only a middle-of-the-road approach.

Officials generally agree that more than a year could be shaved from the program. To do it, the Administration would have to pump another $50 or 60 million into the program for FY 1960, about $250 million more in FY 1961—and follow that up with correspondingly bigger outlays in the next half-decade. The total cost could easily run to more than $1 billion.

Such a program would provide at least 30 to 40 *Saturn* vehicles—all of which must be planned for in the near future if they are to be available in the 1963-66 period. The first dozen or two probably would cost about $20 million each, the later models about $15 million.

The program also would include construction of a number of multimillion-dollar launching pads and static test stands for the giant rockets. The present program calls for construction of only one of each. This provides a built-in schedule of a maximum of about six launchings a year—and the built-in risk that if a vehicle explodes on the launching pad operations would be halted for months.

How far along this road NASA would be willing to fight its way is open to serious question.

NASA officials are extremely enthusiastic about the possibilities that have been opened up to their civilian space exploration programs by the transfer of ABMA and the *Saturn* program to their jurisdiction. They feel that *Saturn* will give them the capability to conduct major experiments on the moon and planets and deep space as well as to launched manned laboratory satellites.

However, it remains to be seen how far the Administration will go in allowing NASA to ask Congress for the big additional appropriations that would be needed to accelerate the *Saturn* program significantly. And NASA would develop and plan to build the *Saturn* vehicles that the Air Force would need for extensive military space operations only when the Air Force was able to begin funding the necessary extension of the *Saturn* program.

The Air Force has no money for such large-scale new funding now, and its chances of finding it in its large but pinched budget in the next year or so do not appear good.

Moreover, the Air Force has no assigned major mission at present to justify a big *Saturn* program because of the Administration's arbitrary division of space at 600 miles up.

Administration policy decrees that no military missions exist beyond that point. From 600 miles out, space belongs to NASA and the Russians.

It is to this 600-mile ban that the transfer of *Saturn* to NASA can be directly traced to a very large degree.

Because of the ban, ARPA has been justifying the *Saturn* program to the Budget Bureau since the program's inception in 1958 on the grounds that it would be used to boost large communications satellites into orbit about 1964 or 1965—not on the grounds that the military needed it to prevent Russia from dominating the moon and most of cislunar space.

In turn, the program has been transferred from the Pentagon on grounds that the Air Force can get no extra funds to support *Saturn* as a communications satellite booster—and can get no extra funds to support it as anything else.

Without question, the acrid smell in Pentagon corridors these days is caused by the smoke from the burning of the military bridge to the moon and space.

Red Photo Bears Out M/R Prediction

Lunik III photo released by Tass gives Arabic numerals to features on far side of moon newly named by Soviet astronomers: 1—Moscow Sea; 2—Astronauts' Bay of Moscow Sea; 3—Continuation of South Sea; 4—Tsiolkovsky Crater; 5—Lomonosov Hill; 6—Joliot-Curie Crater; 7—Soviet Mountains, and 8—Dream Sea. Roman numerals on visible side of moon denote: I—Humboldt's Sea; II—Sea of Crises; III—Marginal Sea; IV—Sea of Waves; V—Smyth's Sea; VI—Sea of Fertility, and VII—Southern Sea.

The Russian photo shows basically what was predicted in M/R Feb. 16, in an article written by Contributing Editor Dr. I. M. Levitt, director of Fels Planetarium. Dr. Levitt said a "statistical look at the moon's other face showed that it would be wholly unlike the side we see from earth.

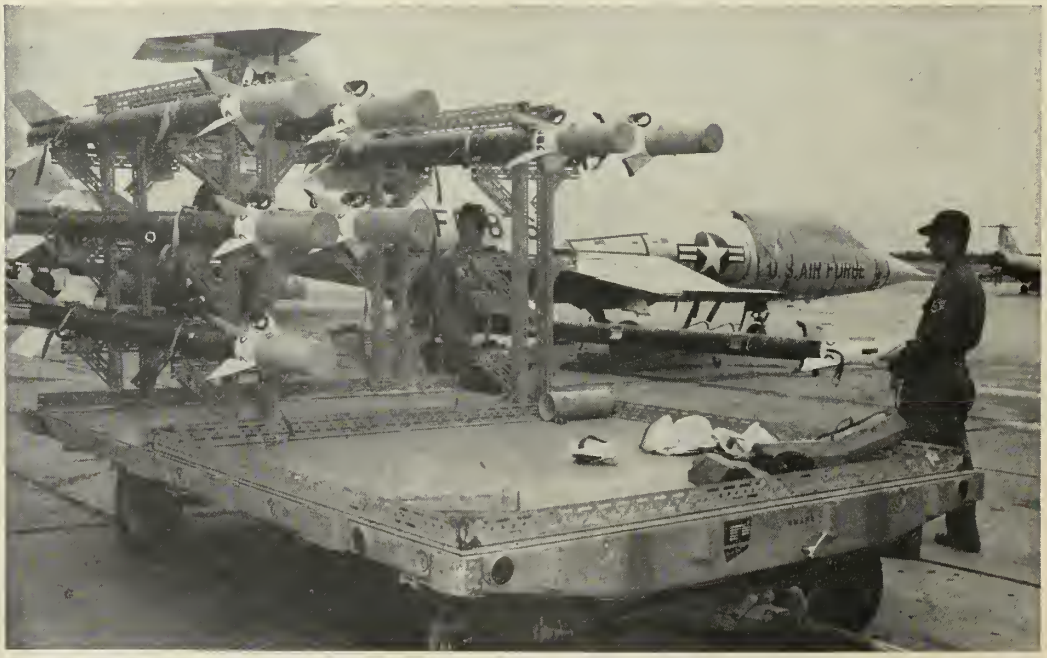
He assumed that there could be no large "sea" area—comparable to the visible Mare Imbrium—on the dark side, and that the other side therefore must be one of a few small "seas" and almost twice as many craters as on the visible side. This prediction was apparently well substantiated.

The craters don't show in the poor resolution of the photo, however, and what appears to be a smooth, drab plain is more likely to be pitted with craters, according to Dr. Levitt. Only the seas are prominent and the lack of detail fails to indicate the actual roughness of the far side.

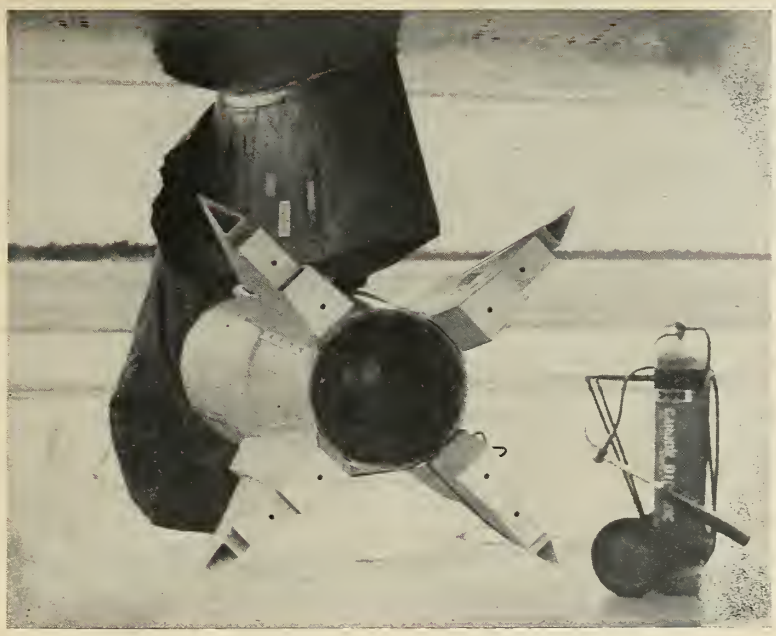
"THE ENEMY
Ryan Q-2A drone
fished from the Gul
Mexico after safely d
ping there by paracl

THE DEFENDER
Douglas nuclear-
head-packing *Genie*
ready for action u
wing of near-sonic N
rop F-89J.

Missile Meet Tests Air Defense



LOADING GE-Philco *Sidewinders* from racks transported to jet interceptors on a Convair flatbed carrier trailer.



Near-combat conditions show value of weapon mix

The 10-day William Tell II World Wide Weapons Meet that ended Oct. 23 gave observers a detailed picture of the missile-striking power of the Air Defense Command. Here is a synthesis of that picture.

by James Baar

TYNDALL AFB, FLA.—You are at Ground Control Intercept at the William Tell II World Wide Weapons Meet.

This is a test under near-combat conditions of the ability of missile-packing Air Force interceptors to break up a bomber attack.

The GCI director waits patiently before his radar scope in the instrument-crowded room. Some 50 miles away out over the shimmering blue Gulf of Mexico a **Douglas** B-26 is dropping a near-sonic **Ryan** Q-2A drone. Suddenly the drone appears as a new blip on the GCI director's radar and he orders two supersonic F-102's into the air.

Minutes after the scramble, he and the pilots begin a staccato exhange:

Gold One, this is Rip Rap. How do you read?

Rip Rap, Gold One reads you five square.

GCI now is in complete control. He is the master tactician. The two **Convair** Delta Daggers, the **Hughes** *Falcon* missiles clutched in their bellies, the jet pilots are pieces on a board that he must move in a deadly game with the target. And so he begins.

Gold One, vector one five zero, climb angels thirty-five, go buster.

Gold One, roger one five zero, angels thirty-five, buster.

The Delta Daggers adjust their course and roar heavenward to 35,000 feet at full throttle. Meantime, the Q-2A *Firebee* drone enters on the hot leg of a racetrack-shaped course that will take it eight minutes to traverse.

The jets must make their pass and launch their *Falcons* during the eight minutes. This will be done toward the drone's tail in order to give the *GAR-2* heat-seekers a target. In combat, this would be the bomber's exhaust. In the meet, this is a flare attached to each of the drone's wing tips in order to conserve drones.

Gold One, target is measured thirty-two angles, tracking two five seven degrees, ground speed four-hundred knots.

The angle of attack depends on the missile. The IR heat-seekers—the *Falcon GAR-2* and the **GE-Philco** *Sidewinder*—must be launched so they can see the blast from the target's tailpipes.

On the other hand, the *Falcon GAR-1D* radar-seeker is launched toward the target's side. This provides a larger surface from which the interceptor can bounce the radar beam that the missile rides.

Finally, the **Douglas** nuclear-tipped *Genie* can be launched successfully at the target from any direction. The *Genie* is purely ballistic and—thanks to its nuclear warhead—doesn't even have to come very close.

In the meet, the **Northrop** F-89J's that carried *Genies* always launched them head on to keep targets from escaping. But this was done because the *F-89J* is only near-sonic. The Mach 2 **Convair** F-106 and the supersonic **McDonnell** F-101B which will be equipped to carry *Genies* will be able to launch them from any direction.

Gold One, target three o'clock position, range forty miles. You'll be turning shortly to your attack vector.

The decision as to which air-to-air missile probably will prove most effective at a particular time depends to a great extent on the weather and what countermeasures the enemy is able to employ successfully.

The Delta Daggers now speeding to their target will use *GAR-2* heat-seekers; the sky is clear and the *GAR-2's* can "see". If the weather were soupy, the *GAR-1D* radar-seekers would be used instead. This is why the load of six *Falcons* carried by the Delta Daggers is mixed.

Even so, both the heat-seekers and radar-seekers can be thrown off by countermeasures. But not the *Genie*: once launched, it is unstoppable.

Gold Flight, set speed Gate Two.

The Delta Daggers now cut in their after-burners and leap forward through the thin air with everything they have. In a matter of moments they will be in contact with the target with their own radars.

The 17-foot *Firebee* is only one-fifteenth the size of a Soviet Bison bomber. However, it is carrying radar reflectors that will make it appear on the jets' radar screens as almost a full-scale target.

Once the lead jet's radar is locked on the *Firebee*, the role of the GCI director in the attack is completed. The pilot and his fire control system will take charge.

Gold One, starboard turn to two four zero. Have you measured five

hundred feet low of target. When steady on two four zero you'll have your target at twelve o'clock, fifteen miles.

Gold One roger, I have a contact.

• **No countermeasures**—Up to this point the operation is running fairly close to the way it would under combat conditions. The only major difference would be the substitution wherever possible of the GCI director by SAGE—the semi-automatic electronic system still under construction in many areas.

However, the GCI director and the jets are not having to contend with the countermeasures that they most certainly would have to contend with in combat.

All enemy bombers would carry ECM equipment that among other things would present the GCI director and the jets with a variety of targets only one of which would be the real thing. It would attempt to jam the GCI and jet radars, fouling their ability to track and fire accurately. And it would fire flares that would tend to deflect the heat-seeking *Falcons* and *Sidewinders*. All of this would be more or less effective against the various air-to-air missiles in the Air Defense Command's arsenal.

One way to reduce the effectiveness of countermeasures that are proving successful is to launch missiles visually instead of relying on the jet's computer. However, there is no question that the use of countermeasures still would cut down on the more than 80% kill scores made in the meet. Because of this, the next William Tell interceptor competition, scheduled for 1961, probably will have countermeasures equipment installed in the drones.

Two other factors not taken account of in the meet were the higher number of kills that are made possible by the firing of full loads of missiles rather than only one, and the loss of aircraft from enemy fire.

The danger of enemy fire was recognized in the approach maneuvers employed by the interceptors. However, the scoring system does not record whether the interceptor flies accidentally into the cone-shaped path of the enemy bomber's tailguns.

During the meet, scoring was recorded automatically by the **Parsons Co.** PARAMI system—a device for measuring the distance between the missile and the drone by monitoring the transmission of electronic pulses between them.

The new **Cubic Corp.** MATTS scoring system also was scheduled to be used, but technical difficulties prevented it from being put into operation. MATTS records the vector of the miss as well as the distance.

Gold One, we have you measured with target.

Gold One locked on at nine miles.

Roger, Gold One. Understand you locked on. Your target is measured two hundred feet high.

Gold One roger. I have a judy.

The pilot has now taken complete command of the interception. He does all the talking; GCI the listening. But even the pilot is mainly acting as a monitor and director.

Unless the pilot falls back on visual launching, he will not see the target when he looses his missiles on the enemy. His fire control system's computer will decide on the right moment and automatically pull the trigger. Then the pilot immediately will begin his escape manuever. This is particularly important in the launching of nuclear warhead-tipped *Genies*.

The meet provided a demonstration of the capabilities of all but two of the Air Defense Command's principal weapons—the **Convair** F-106 and the **Boeing** surface-to-air *Bomarcs*.

• **No substitute**—Both are able to deliver a nuclear punch and, since the sudden demise of the **North American** F-108 program, they share the role of the ADC's shortened front line of defense. So far, no plans have been announced as to what—if anything—will replace the F-108 and its advanced *Falcon GAR-9* missiles.

One possibility is that the Mach 3 North American B-70 will be given the dual role of interceptor and bomber. Another is that the range of the *Bomarc-B* may be extended to the 1000-mile reach that the F-108 would have had—or the *Bomarc* bases may be moved farther north into the Canadian Arctic.

Gold One fifteen seconds.

The pilot's voice is tenser. This is the payoff: Hundreds of thousands of man hours put into R&D, millions of taxpayers' dollars, years of training, it all comes down to this moment. He's roaring high over the Gulf of Mexico, but it could just as well be Hudson Bay.

The jet shrugs slightly as the missiles rip free and flash toward the target two miles away.

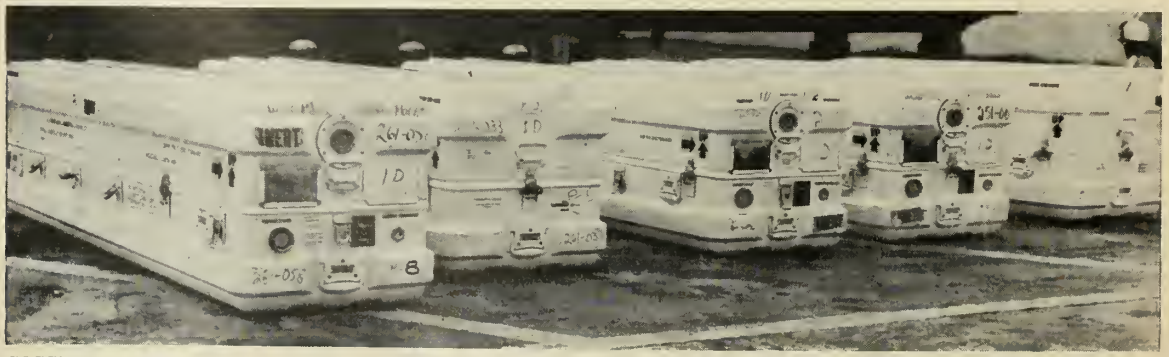
Gold One splash.

The voice is full of triumph. Death delivered by missile at 35 angels is his business.

TYNDALL AFB—*The 10-day William Tell II Weapons Meet generally received a big hand as a demonstration of U.S. missile-airpower—except from two fun-loving Vermont mayors.*

Mayor Dan Healy of Rutland and Mayor James Fitzpatrick of Burlington gave an unscheduled dash of bitters to the proceedings after a 24-hour run on the base, the officers club and nearby Panama City.

"Terrible waste," they complained as they checked their clinking suitcases on a plane for New Orleans.



COFFIN-SHAPED environmental containers made by Hughes are used for shipping each Hughes *Falcon* air-to-air missile from the factory to the airfield.

Are Batteries Always Superior? Missile APU Manufacturer Says No!

Editor's note: The August 31 issue of M/R contained an article outlining a report made to the Air Force Ballistic Missile Division by Frank R. Cook Co. of Denver, concerning the relative merits of batteries as opposed to hot-gas units for missile auxiliary power. Sundstrand Turbo Division contends that some of the facts in the article based on the Cook report failed to give a complete picture and hence presented an unfair comparison of the two systems. M/R takes no stand in the controversy but here presents Sundstrand's rebuttal.

WASHINGTON—The controversial **Cook Co.** report is believed by some to have been a contributing factor in the Air Force cancellation of hot-gas auxiliary power systems for the *Atlas* and *Titan* ICBM's—a cancellation which affected **Sundstrand's** Turbo Division and **Aerojet-General.**

The report said use of a battery APU system would provide significant gains in reliability, and reduction in weight, costs, maintenance, personnel training, activation and checkout time, and spares and depot requirements.

Sundstrand takes exception to some of these claims.

The Sundstrand rebuttal is based, first, on the premise that the Cook report "compares apples and oranges" —the battery alone vs. the complete gas APU system. Sundstrand says that APU choice must be made for individual applications—no firm line can be drawn as to superiority of one over the other. It contends that for certain applications batteries would be the logical first choice; for others the gas unit is definitely best. Some of the parameters to be considered include power levels, space and weight requirements, operation duration, and type of desired outputs.

Sundstrand makes these points:

1) Requirements for an early operational ICBM dictated a design freeze on the *Atlas* which resulted in the choice of the battery power unit developed on a parallel program. Hot-gas APU development was on schedule with respect to reliability goals and BMD felt goals could be met. Lack of progress was not responsible for contract termination.

Design called for more than twice the energy capability of battery units now being used. Capability can be extended even beyond this point with only modification of tankage. Battery system beef-up requires design of entirely new components.

2) The Cook Co report was not responsible for switchover decision. It was compiled in July, 1959, some six months after decision was made.

(The report seen by M/R carried the date July 31, 1959. The report actually had been completed and presented to BMD in the last quarter of 1958.)

3) Development cost comparisons are unreasonable since the *Atlas* unit was designed on a crash basis—with consequent high costs. Battery development has been under way for 50 years.

4) Reliability of the gas-turbine APU has been proven. Considering complete systems, both are capable of meeting approximately 98% reliability requirement.

5) Sundstrand is now building for the Air Force an APU capable of producing power at extremely high efficiency for periods of up to several hours. Batteries to do the same job would be much too heavy to even warrant consideration. This program uses directly the technology gained in the *Atlas* development.

6) Reliability, weight, costs, and operational comparisons made in the Cook report are unrealistic, since only the battery is considered against total gas APU system—and necessary battery accessories (inverters, motors, pumps, etc.) ignored. On the basis of the total system the *Atlas* battery system weighs over 100 pounds more. The *Titan* battery unit is even heavier.

7) Gas-turbine APU's can be used in prelaunch checkout to check both the system itself and powered units. Use of batteries requires replacement and, hence, an unchecked unit in the fly-away missile. Replacement of batteries is costly and can drive system cost to several times that of gas systems.

8) Costs for training crews for APU maintenance were approximately $320,000 rather than the $1.5 million stated in the report.

9) Sundstrand furnished support equipment and services for *Atlas* maintenance. The prime contractor assumed responsibility for equipment and services required for battery unit. No comparison, therefore, can be made on this basis.

10) Comparison of activation times is unrealistic. Figures cited for the battery did not include the entire system. Activation time for the gas APU was less than AF specifications.

Sundstrand additionally makes the point that the change from bi- to monopropellant was a decision of BMD based on the AF effort to make *Titan* and *Atlas* units interchangeable. Both types performed satisfactorily in field tests.

Sundstrand also claims to now have an APU which meets almost identically the *Atlas* requirements and weighs under 50 pounds total—less than 20% of the current operational battery system.

Fuel Cells Deliver 15-kw Electric Power

MILWAUKEE—The first practical application of fuel cells to produce large amounts of electric power has been demonstrated here by **Allis-Chalmers Mfg. Co.** The propane-oxygen cells powered a 20-hp electric motor which drove a farm tractor, developing a 3000-pound pull. Total electrical output was 15 kilowatts.

Although still in the research stage, the unit is comparable in size and weight to an equivalent gasoline engine. Company officials feel that the size could be easily halved now and reduced still further in the future.

It offers a great possibility for space vehicle auxiliary power. Energy conversion in the cells produces no heat and efficiencies of up to 90% are possible (conventional steam turbines and diesel engines are about 40% efficient).

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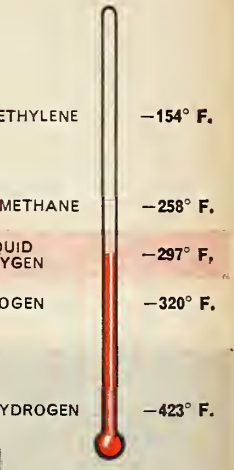
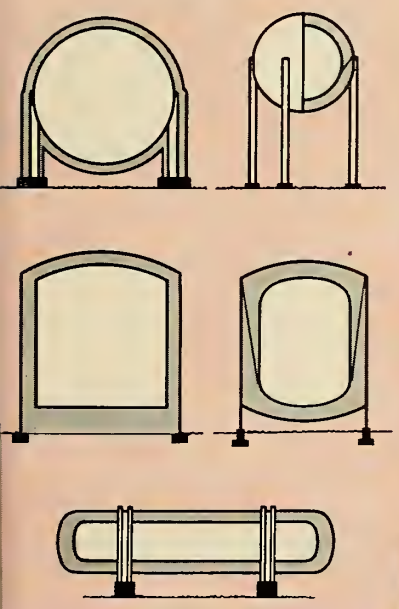


LOW TEMPERATURE STORAGE VESSELS



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Navy Saves Money on Missile Tests

Weapons Laboratory's short-cuts in testing and evaluation programs yield economies of millions of dollars and months of time in development

by Hal Gettings

DAHLGREN, VA.—Bargains are rare in the missile business. But the Navy says its Naval Weapons Laboratory here is saving the U.S. missile program several million dollars each year—and it backs the claim with hard facts and figures.

Work at the Laboratory covers a wide range of missile projects. Current are nose cone and re-entry research, capsule recovery, space surveillance, missile system management, missile safety, electromagnetic radiation hazards, warhead development, and rocket motor testing.

• **Nose cones and re-entry**—One of the principal money-saving projects at NWL was in the test of nose cone fuzes. As originally planned, the tests were to be conducted with a series of rocket-sled runs. By reversing the usual procedure and firing "targets" at the fuzed nose cones, a saving of approximately $2.5 million was realized on the *Atlas* program alone.

Using the world's largest gun—a 24-incher—total costs for eight shots ran less than $325,000 as compared to $2.8 million originally alloted. Much time also was saved.

• **Capsule recovery**—Approximately $300,000 was saved in a program to study recovery of data capsules from re-entry vehicles. The capsules, roughly the size of basketballs, contain recorders to log various aspects of performance such as acceleration, temperatures, pressures, and stress during re-entry. In actual firings of *Thor* and *Atlas* missiles, the capsule is separated from the nose cone and plummeted into the ocean; recoveries are few and very little information on design deficiencies is obtainable.

NWL engineers devised a method of firing the capsules down an instrumented track through a frangible plastic port into a water tank. Within minutes after firing, angle of impact and the condition of capsule equipment was available. An estimated 100 air drops would have been required to provide the same information. The program was completed in two months as against a year originally contemplated.

As a result of work done at the Lab, successful capsule recoveries have now become routine.

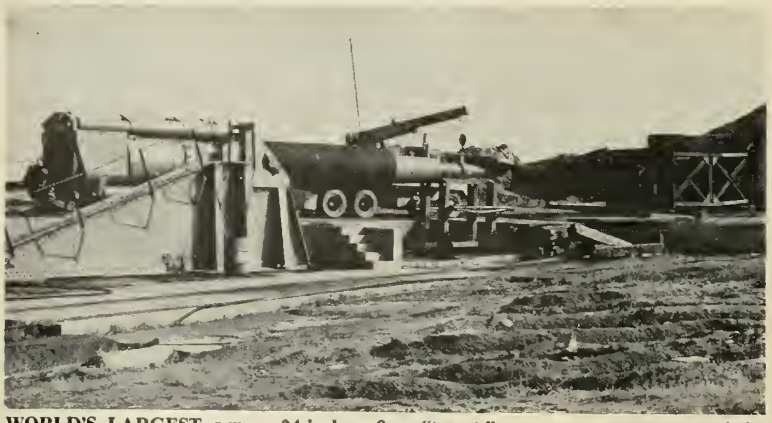
• **Warhead development**—Currently, NWL has major tasks in the development of warheads for five missiles, either in service or planned for service use in the near future. The Lab provides facilities for managing the program—from concept through fabrication of experimental models in its own shops to procurement and detonation of full-scale prototypes.

The first warhead development work assigned to NWL, just two years ago, was in connection with the *Bullpup* air-to-surface missile. As a result of its successful completion of the *Bullpup* warhead design, NWL in recent months has been assigned responsibility for developing warheads for *Talos, Tartar* and *Corvus*.

A primary aspect of warhead development is determination of fragmentation patterns. These tests utilize a "fragmentation arena" which measures patterns (space distribution), velocities, and forces of exploded warhead fragments. Facilities include both static and in-flight chambers and arenas where explosive charges of up to 600 pounds can be tested.

• **Missile safety**—NWL has had overall direction of the Navy's missile safety program for two years. A sizable group is developing safe handling and firing practices for *Terrier, Tartar* and *Talos* missiles. Facilities for test and evaluation include all manner of ignition, environmental, and test equipment. Missiles are dropped, heated, quenched and generally shaken up to establish safe procedures for shipboard handling.

• **Electromagnetic radiation hazards**—The Navy's program to define and eliminate hazards arising from exposure



WORLD'S LARGEST gun, a 24-incher, fires "targets" at nose cones to test missile fuzing and arming components. The Dahlgren base was founded 41 years ago.

ONE-FIFTH scale model is used for *Polaris* launch ejection tests, part of a unique managerial control system.

of missile ordnance to electromagnetic radiation has also been an NWL responsibility for two years. This work, carried on under Project *HERO,* has already produced significant results (M/R, Oct. 19).

• **Cartridge-activated devices**—Design and development of power cartridges for a multitude of aircraft and missile applications is a continuing program at Dahlgren. These miniature explosive power-packs serve such functions as stage and nose cone separation devices, valve and control operators, and self-destruct mechanisms.

• **Space surveillance**—The Navy's Space Surveillance Operation Center was located at Dahlgren earlier this year. It is responsible for detecting all satellites, transmitting or silent, which pass over the Navy's electronic fence extending from Georgia to California.

The heart of this system is the Naval Ordnance Research Calculator, better known as NORC. This computer, put in operation in 1955, is still recognized as the world's leading "electronic brain." It operates at a capacity of 15,000 operations per second. An operation may include addition, subtraction, multiplication or division, of 13 decimal digit numbers. Its high inherent speed and its 13-digit word length have enabled NORC to attack space satellite calculations with a speed rated at eight times faster than its nearest commercial counterpart.

• *Polaris* **program**—The Weapons Laboratory has played a significant role in development of the Navy's *Polaris* missile, scheduled to be operational next year. NORC was assigned major data processing responsibilities to help control highly diversified component production for *Polaris*. This program represents a unique managerial control of a large missile development program, with its hundreds of sub- and sub-sub-programs influencing one another in subtle and complicated ways. Its contribution enabled *Polaris* managers to exercise vastly improved comprehension and control of this hierarchy of events, allowing for modifications or alterations in plans as work situations developed, and applying additional effort just when and where needed.

Another important use of NORC has been in preparation of firing tables for *Polaris* missiles.

Until this summer, NWL was known as the Naval Proving Ground. Founded in 1918 on an isolated point on the Potomac 50 miles south of Washington, its function was to develop and test naval guns and projectiles. The advent of the missile age made the big guns pretty well obsolete, and the Proving Ground found itself without a need for its services in the new era. But, operating on the premise that missile and space vehicle performance is but an extension of the ballistic problems encountered in large-caliber shipboard projectiles, the Navy converted its extensive facilities at Dahlgren to work on these problems. Today they have a going concern involved in many aspects of missile research and development.

Present workload totals are more than $15.5 million, divided about equally among three major labs: computation and analysis, weapons development and evaluation, and warhead and terminal ballistics. This figure represents approximately a one-third increase over the previous fiscal year.

• **Facilities**—In addition to the facilities already mentioned, NWL has extensive laboratories, firing and launching ranges, test and measurement equipment, computation and data processing systems, and missile assembly and storage facilities.

Several completely equipped firing batteries provide a wide selection of experimental conditions for firing guns, launching rockets and small missiles, reduced-impulse launching of larger missiles, and static tests of large missile boosters and sustainers. There are also emplacements for mounting launchers for flight testing small missiles and rockets; static firing stands for testing rocket motors, JATO units, and missile motors up to 300,000-lb. thrust; and a wide variety of altitude and temperature conditioning chambers for static test of igniters and actuators.

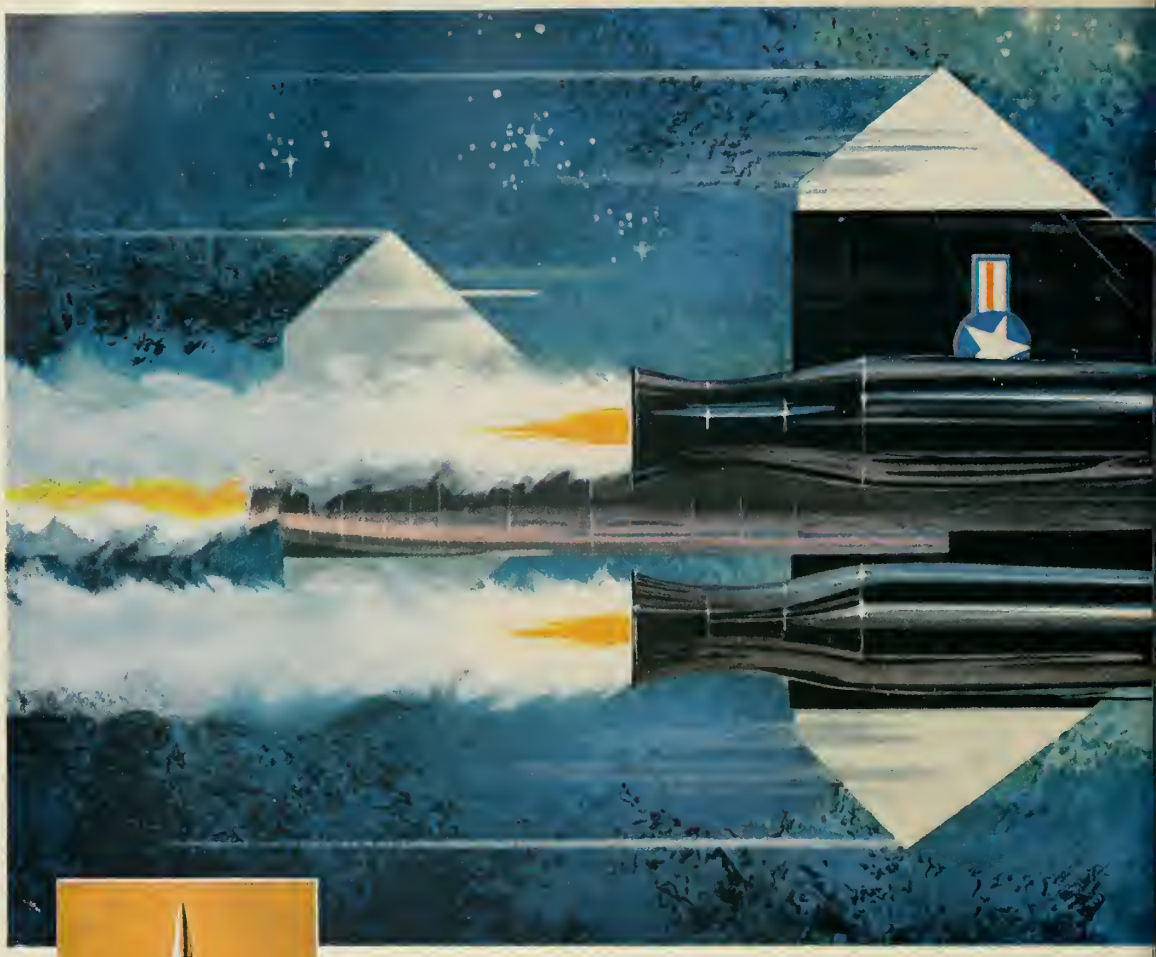
Specialized smoothbore guns are available with bore diameters up to 24″ for firing non-spinning test missiles. The 24″ gun is capable of firing modified bombs and guided missile warheads up to 5000 lbs. weight and at velocities up to 1300 ft./sec. Velocities up to 3500 ft./sec. can be obtained with objects weighing up to 1000 lbs.

Other facilities provide for all types of hazard classification tests of explosive ordnance, including rapid heating by flame throwers, controlled heating to attain cook-off temperatures, 40 ft. free fall drop, detonation of pelletized explosives and warhead impact sensitivity.

Several missile firing tracks—one 2500 feet long—with recovery tanks provide for the recovery of undeformed experimental projectiles and missiles for study of firing effects.

The value of the 5000-acre Dahlgren complex is estimated at close to $40 million. It is staffed by over 1400 military and civilian personnel—a large number of them mathematicians, physicists, and electronics scientists and technicians. This dedicated group feels that it is making a sizable contribution to the Navy's missile program—and saving a lot of money in the process.

SIMULATED shipboard missile magazine is used for damage evaluation tests of bulkheads, venting, sprinkler and drainage systems and for stowage safety tests.



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Solid-Fuel Technology Progresses

Reliable propellants in operation give I_{sp} ranging from 240 to 250 sec.; new gains occur steadily; ARPA expects 20-30 sec. quantum jump from Project Principia

by Jay Holmes

WASHINGTON—Whatever the status of other phases of the race for space, solid propellant chemistry is one area where America need not take a back seat.

The science has taken huge strides in the last five years—to the point where we soon will be powering our longest-range weapons with solids. Furthermore, we now hear serious proposals for building solid-propelled booster rockets of a million pounds or more of thrust for space exploration.

Reliable propellants in operational use today provide specific impulse between 240 and 250 seconds. We are testing and soon will be using several with more than 250 impulse. The 260 mark does not seem too hard to attain. Present lines of marginal development and improvement may even reach 270 without sacrifice of other desirable properties.

But in addition to this a quantum jump is expected from research in progress under Defense Department sponsorship. The department's Advanced Research Projects Agency expects impulse to rise 20 to 30 seconds in the next year or two as a result of studies under its Project *Principia*.

If the Soviet solid-propellant program has this much vitality, it has been an extremely well-kept secret.

The rapid progress in American technology has been a purely indigenous phenomenon. Most of the German scientists brought here after World War II confined themselves on liquid propulsion.

A major breakthrough shortly after World War II made possible the present state of the craft. Before that time, the size of solid propellant grains was rigidly limited. It was impossible to make a large propellant grain that would not collapse of its own weight.

But in 1946, a group at the **Jet Propulsion Laboratory,** California Institute of Technology, found a way to beat this limitation by bonding—or glueing—the propellant to the metal case. Before then solid propellant grains were inserted in the case after manufacture. Now it became possible to mold the grain in the case.

• **Rubber to rockets**—The JPL method made use of a class of organic compounds called the polysulfides, which had been used in the manufacture of synthetic rubber. These are long chains of atomic groups each containing a pair of sulfur atoms. A typical link in a polysulfide chain is shown in the accompanying diagram.

The polysulfide serves two purposes in the solid propellant grain. First, it acts as fuel. Second, its rubbery consistency holds the material together and makes it possible to bond the grain to the case.

It has one drawback, though. Sulfur, with atomic number 16, is a relatively heavy element. Its atomic weight is 32 times that of hydrogen. The two sulfur atoms in the polysulfide linkage add appreciably to the average molecular weight of the exhaust gases. This in turn reduces the average velocity of the gas molecules and thus the specific impulse.

For this reason, there was a continual quest after fuels without sulfur that have physical properties as good as the polysulfides. The solution was found in the early 1950's in the polyurethane family. Polyurethanes are composed of carbon, hydrogen, oxygen and nitrogen—all among the first eight elements of the periodic table. The accompanying diagrams show the two basic types of polyurethane links, the polyester and the polyether. Each is made up of combinations involving the basic urethane unit, which consists of two carbon atoms and one each of hydrogen, nitrogen and oxygen, also shown in diagram.

• **Argument on details**—Propellants containing the polyurethane fuels have specific impulse several seconds higher than those with polysulfide fuels. Although there is still some argument about details, it is generally agreed that polyurethanes can be developed with physical properties virtually as good as the polysulfides.

Meanwhile, development continued on another type of solid propellant, based on the nitroglycerin and nitrocellulose used in gunpowder and dynamite. Because of their relatively high impulse, these so-called double-base propellants were used in many small missiles.

About a year and a half ago, the Allegheny Ballistics Laboratory, operated for the Navy by **Hercules Powder Co.,** succeeded in case-bonding double-based propellants. This removed the rigid size limit.

At about the same time, a fourth type of case-bondable propellant entered the picture: the polyhydrocarbon. This is another class of rubbery fuel used with a crystalline oxidizer. A typical polyhydrocarbon linkage might be made by a reaction between an epoxide group, a combination of two carbons, three hydrogens and an oxygen as shown in the diagram, and a carboxyl group consisting of a carbon, two oxygens and a hydrogen.

Among the major solid propellant companies, **Aerojet-General** is usually considered a polyurethane producer and Hercules is commonly identified with double-base formulation. **Thiokol Chemical Co.** has a long history of working with the polysulfides but in the last few years has branched out into polyhydrocarbons and polyurethanes.

• **Hotter flames**—It was established several years ago that the addition of aluminum powder improves the performance of all solid propellants. Although aluminum increases the average weight of the exhaust gases by introducing aluminum oxide, (Al_2O_3) the flame temperature is increased even more. Since specific impulse varies with the square root of the flame temperature divided by the average molecular weight of the product gases, the over-

all performance is improved.

In the last year or two, all of these systems have been coming closer together. The double-base propellants have become composite propellants with the addition of oxidizer. Polyurethanes have been developed that are closer to the polyhydrocarbons. Polyhydrocarbons are being developed that are closer to the polyurethanes.

"All systems seem to be following converging lines of research," says Ernest S. Sutton, chief of research at Thiokol's Elkton plant. "The three we are working on are converging on polymers containing mostly carbon and hydrogen."

Aerojet sees the next big step in attaining higher specific impulse values and improved physical properties in the use of nitro compounds, an extension of the polyurethane family.

In nitro compounds, the nitrogen is bonded directly to an oxygen atom. In the normal urethane unit, nitrogen is bonded to carbon and hydrogen atoms. Aerojet's R. H. Hartman says specific impulse values in excess of 250 are expected from the nitro polymers.

What are the advantages and disadvantages of the competing systems in existence today? First, compare double-base with composite formulations of oxidizer and plastic fuel.

• **Unstable gases**—Hercules says it obtains a higher specific impulse with double-base propellants than has been done to date with composites. Thiokol's Sutton replies that double-base compounds are far less stable at high temperature than binder materials, the limiting link in the composites. They may ignite spontaneously when stored at high temperature. They may detonate during processing and during combustion. Sutton says this never happens with composites.

The Thiokol researcher emphasized, however, that double-base propellants are still valuable for many applications.

Among composites, there is a similar distinction in specific impulse between polysulfides on the one hand and the newer polyurethanes and polyhydrocarbons on the other. Thiokol says the difference is from two to five seconds. Aerojet says it is greater.

Why stay with polysulfides if there is a difference in impulse, however small? Sutton says there are three reasons: easier curing of the fuel, greater experience in dealing with them and better low-temperature properties. On the latter, he says the services customarily set requirements down to —75°F, at which polyurethanes tend to convert from a rubber-like to a brittle state. This in turn causes a solid-propellant grain to fragment and crack. More burning surface is exposed and, when it is ignited, the grain burns much more rapidly. The whole engine can explode in such a case.

Aerojet disputes all these points. Hartman says curing and handling of polyurethanes is quite simple. On production motors, he reports, Aerojet has produced polyurethane grains that operate satisfactorily at as low a temperature as —65°F. Furthermore, the Aerojet spokesman says polyurethanes have such advantages as lower cost, low viscosity and non-toxicity. He says polyurethanes are especially adaptable for large solid rocket motors because they do not engage in an exothermic reaction during cure. Hartman reports that aging characteristics of the polyurethanes are improving constantly. Today's propellants have ballistic and physical properties considerably improved over those produced two or three years ago, he added.

• **Secondary advantages**—What about the polyhydrocarbons? Sutton says thermodynamic calculations indicate they have exactly the same impulse as the polyurethanes. Polyurethanes have wider range of burning rates, he says, but polyhydrocarbons are superior in low-temperature and long-term aging properties. These secondary properties may be decisive when the range of burning rates is not a factor, he says.

In contrast with the disputes that swirl about the fuel binder in composite systems, there is little argument over the predominance of ammonium perchlorate as an oxidizer. Potassium perchlorate and the potassium and ammonium nitrates still are used but the industry is gradually dropping them. Ammonium perchlorate is cheap, light and the most effective oxidizer available. **American Potash & Chemical,** which produces virtually all of the ammonium perchlorate used in the industry, recently cut its price from 34 to 29 cents a pound.

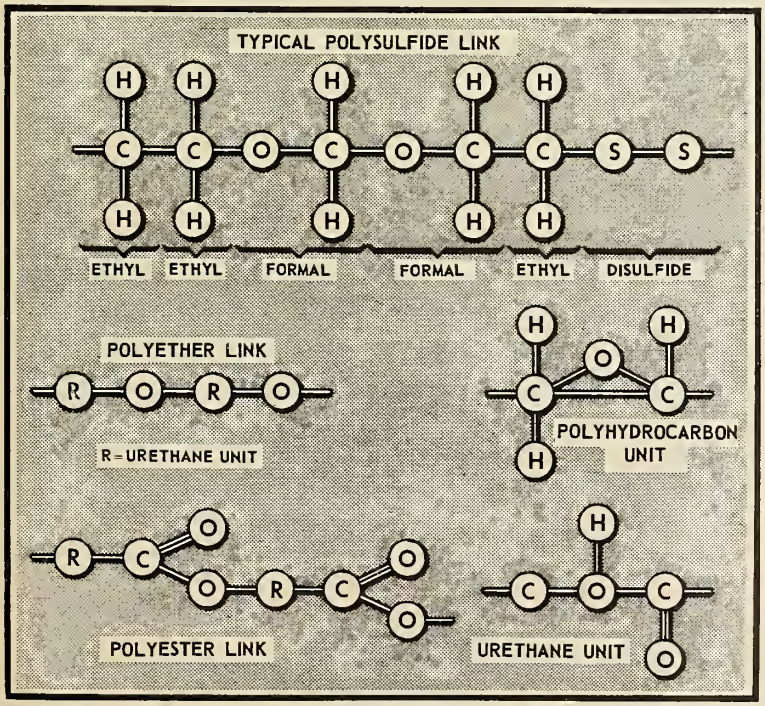
For the propellants of the future, researchers supported by ARPA are trying to synthesize materials that do not now exist. "Potentially," says ARPA's Dr. Walter May, "materials that one can put down on paper are capable of producing a huge jump in specific impulse. Twenty seconds is the barest minimum. Much higher figures are stated in our documents with contractors."

The research is following many lines, he continued. There is a quest for better fuels, better oxidizers and better binders in the thermodynamic sense.

• **Lighter atoms**—Fuels can be improved, he said, by reducing atomic weights. This means getting more hydrogen into the system. Also, there must be continual efforts to reduce the number of relatively heavy elements.

How can oxidizers be improved? The chlorine in ammonium perchlorate has an atomic weight of 35.5. Fluorine,

(continued on page 43)



HERE ARE SOME common atomic groupings that appear in the organic polymers used as solid-propellant binders.

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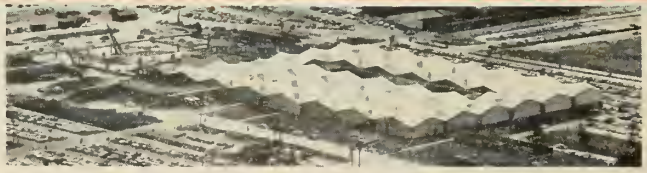

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electrical characteristics at 25°C ambient

(unless otherwise noted)

	PARAMETERS	TEST CONDITIONS		min.	max.	unit
I_{CBO}	Collector Reverse Current	V_{CB} = 30v	I_E = 0	—	1.0	μa
	at 150°C	V_{CB} = 30v	I_E = 0	—	100	μa
BV_{CBO}	Collector-Base Breakdown Voltage	I_{CBO} = 100μa	I_E = 0	60	—	v
BV_{CER}	Collector-Emitter Breakdown Voltage	I_{CER} = 100ma	R_{BE} = 10 ohms	40	—	v
BV_{EBO}	Emitter-Base Breakdown Voltage	I_{EBO} = 100μa	I_C = 0	5	—	v
h_{FE}*	D-C Forward Current Transfer Ratio	I_C = 150ma	V_{CE} = 10 v (2N696)	20	60	—
			(2N697)	40	120	—
$V_{BE\,(sat)}$*	Base-Emitter Saturation Voltage	I_C = 150ma	I_B = 15ma	—	1.3	v
$V_{CE\,(sat)}$*	Collector-Emitter Saturation Voltage	I_C = 150ma	I_B = 15ma	—	1.5	v
h_{fe}	A-C Common Emitter Forward Current Transfer Ratio	I_C = 50ma	V_C = 10v f = 20mc	2.5	—	—
C_{ob}	Collector Capacitance	I_E = 0ma	V_C = 10v	—	35	μμf

*Pulse conditions: length = 300μs; duty cycle < 2%.

maximum ratings at 25°C ambient

Collector-Base Voltage	60v
Collector-Emitter Voltage (R_{BE} = 10 Ω)	40v
Emitter-Base Voltage	5v
Total Device Dissipation	0.6w
Total Device Dissipation at case temperature 25°C	2w
Storage Temperature Range	−65°C to +175°C

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ARE YOU GETTING ALL THESE BENEFITS WITH YOUR MAGNESIUM CASTINGS?

Dow magnesium foundry offers experience, production capacity for sand and permanent mold castings of all sizes and shapes.

The unique capabilities of Dow's Bay City, Michigan, foundry help users of magnesium sand and permanent mold castings. Activities at this facility—largest and best equipped of its kind—run the gamut from large volume production jobs to one-shot "specials".

Huge or tiny castings. The foundry is capable of producing castings weighing in excess of 3,000 lbs. down to ounces—in all degrees of complexity. Experienced pattern engineers ensure that the best use of casting processes is made. This can result in either lower costs, improved quality, better deliveries, or a combination of all three.

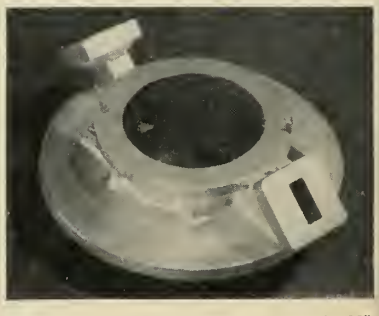
Newest techniques. Many milestones in magnesium casting have been reached at this Dow foundry. In fact, Bay City has men permanently assigned to developmental work, keeping the foundry in the forefront of technological advances at all times.

Results of their work include special processes for cast-in inserts and tubeless passages, and improved melting techniques. Casting methods have been developed for many of the newer magnesium alloys, such as the elevated temperature group and the new high damping capacity alloy, K1A.

Quality control. A full time quality control team exhaustively checks all work, from alloy composition to the shipping dock. A direct-reading spectrometer makes rapid alloy composition analyses. Its speed is particularly valuable when alloying elements that are hard to hold in the molten state, such as thorium, are present. Chemical analysis is also frequently employed.

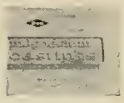
Testing facilities. Molding and sand cores are analyzed as a regular part of casting quality control. Radiography, fluorescent penetrant inspection and other testing facilities are used to check properties and specifications.

Experienced magnesium team. The foundry often draws upon the broad range of specialized experience available throughout the company. To Bay City customers, this means assurance of high quality work, done with utmost efficiency and economy. If your requirements involve magnesium castings, Dow can help you arrive at optimum casting design and reliably supply your production requirements.



THIS SAND CAST WAVE GUIDE was held to ±.005" on possogeway dimensions. Surface smoothness requirements are 63 RMS. The foundry has government approval for any phases of its operations where such approvals are applicable.

THIS BRAKE CARRIER is sectioned to show how the hydraulic lines were integrated by use of tubeless possogeway costing techniques.



WRITE TODAY for this illustrated brochure discussing Dow foundry services. THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Soles Dept. 1303CL11-2.

THE DOW METAL PRODUCTS COMPANY, Midland, Michigan

DIVISION OF THE DOW CHEMICAL COMPANY

Revolution in Electrolytic Machining

Anocut engineers develop cavity sink device to meet metalworking challenge of Space Age—a report on this and other recent advances

by John F. Judge

WASHINGTON—A great deal of the debris littering the path to outer space consists of broken or worn-out drills, dies and cutting tools.

Since the Industrial Revolution, the task of machining and forming the products of the eternal quest for newer, stronger metals has been as much of a problem as their discovery—and very often. a serious limitation on the use of the metal.

A major contribution in this area is the recent development of a new electrolytic cavity sinking machine by the **Anocut Engineering Company**

Intended for use first in machining the high-strength metals used in missiles and jet engines, the machine can sink cavities of any shape into metals which resist ordinary cutting methods.

In operation, material is removed from the workpiece by passing a direct current continuously through a harmless, water-base electrolyte solution between the workpiece and the electrode.

Although Anocut electrolytic machining is widely used in industry, this device differs in that the electrode does not rotate but plunges linearly into the work material.

Roughly described as an electroplating process in reverse, the removal method does not involve high temperature and there is no metallurgical heat damage to the material. Since there are no sparks or arcs as in the electrodischarge process, there is no wear or erosion of the electrodes or tools. The removal method imparts a highly polished surface to many of the new high-temperature alloys and its accuracy is comparable to conventional drilling and cutting operations.

Total volumetric removal with the Anocut machine is dependent upon the capacity of the power supply used. Ordinarily, the total removal potential may be concentrated in a small area. Thus it is normally easy to remove 0.100 cubic inches per minute over an area of one square inch.

Several pieces may be machined simultaneously by multiple electrodes as long as the power capacity is not exceeded. Neither the thickness nor the length of the electrode affects the penetrating rate.

Other recent developments in missile metalworking extend from electronic tool guiding to extrusion processes. A brief survey of the field reveals this rapid growth, characteristic of industry's progress in meeting the ever-increasing technological problems of the space era.

• **Automation**—Ten years ago a series of experiments were performed by engineers at the Massachusetts Institute of Technology on a Hydrotel milling machine. These efforts led to development of numerical control, a form of machine tooling automation.

The Cincinnati Milling Machine Company has applied this concept to many of their systems in the past decade, from the drawing boards to the finished product.

In all numerical controls, the basic bits of information that are fed into the control are really dimensions that define the location of points on the workpiece. These points are the essence of a positioning control—tool movement from point to point is relatively unimportant.

But where the points are used to define curves, the tool must be guided in the path it takes between points to produce the proper smooth curve in the workpiece.

Cincinnati's method of parabolic interpolation fits one curve with others in their system of contouring control. Such a control interpolates segments of parabolas between points on a curve. therefore requiring far fewer points,

ANOCUT'S electrolytic cavity-sinking machine forming a narrow slot with a knife-type electrode. Note that low heat permits operator to keep fingers on workpiece.

and drastically reduces time consumed in plotting input information.

• **Form fabrication**—The MetaDynamics Division of Cincinnati Milling has concentrated on metalworking machines that employ controlled force rather than a grinding wheel or cutting edge to produce finished material.

Three of the Division's "chipless machining" methods utilizing controlled force are Cincinnati's Intraform, Hydrospin and Hydroform machines.

• The Intraform is the newest method for forming internal profiles. Hollow cylindrical stock is placed over a mandrel and kneaded by rapidly pulsating, rotating dies. The process results in high finishes and close dimensional tolerances. The metallurgical characteristics of the worked metal—such as hardness, tensile strength and fatigue failure resistance—are improved, largely through formation of continuous "flow lines" in the profile formed area.

Because the material is worked and kneaded rather than removed, less stock is required than in conventional machining. And the Intraform process performs in one operation what formerly involved several distinct steps.

• The Hydrospin machine involves a forming process in which a piece is forced to take the shape of a hardened rotating mandrel. The material revolves with the mandrel and the desired shape is spirally generated by one or two hardened and polished rollers.

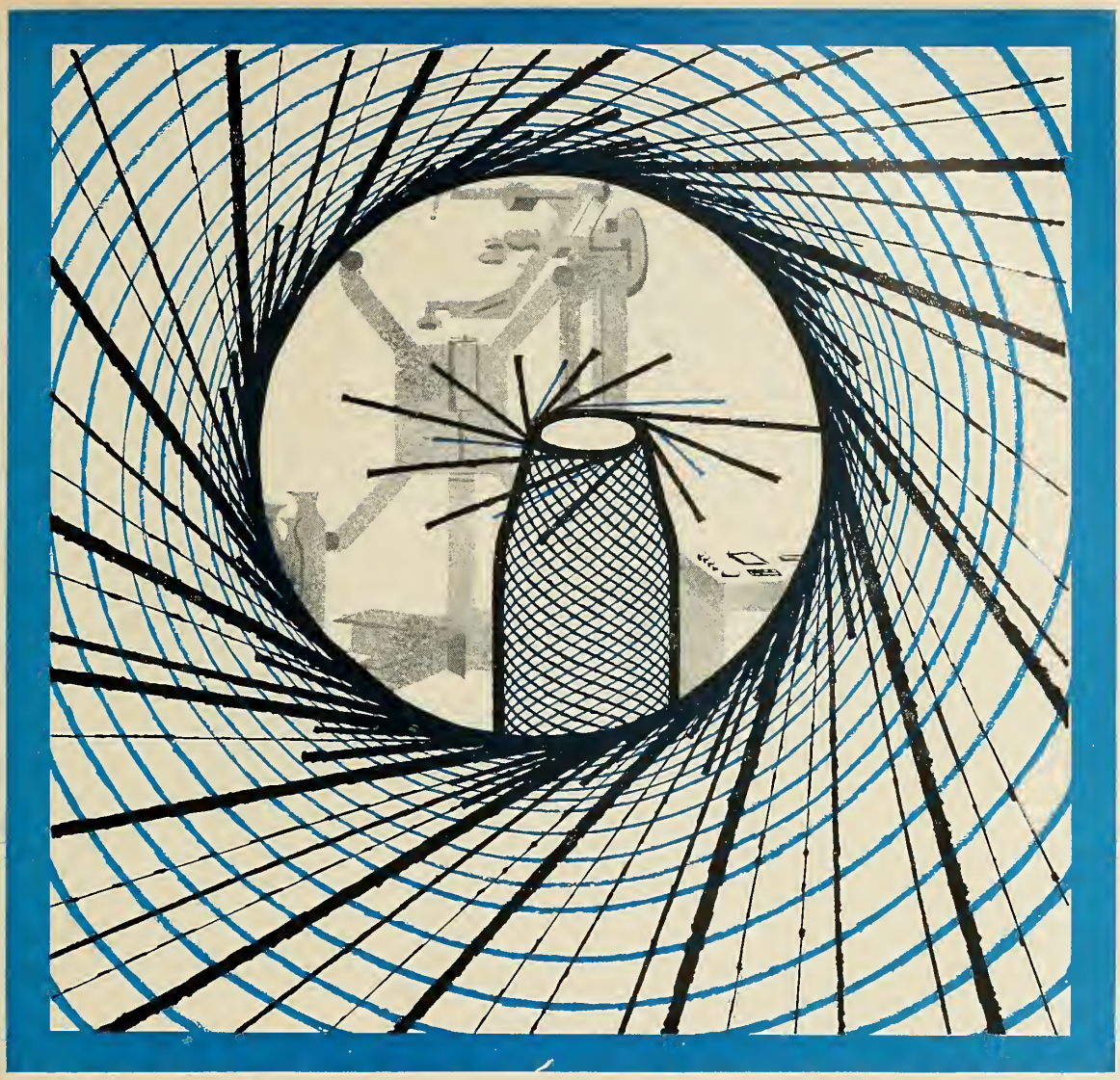
The deformation is usually done cold and, as with the Intraform, results in a work-hardened, tensile-strengthened product of high fatigue resistance. The Hydrospun part has no ruptures on its surface and its grain structure is greatly elongated.

Polaris engine case heads are formed by this method from a flat plate of 4340 steel. The result is a dished head 54 inches in diameter with finished wall tolerance of 0.150" ±0.007".

• Hydroforming is a simplified method of producing deep drawn shapes from sheet materials. The die and upper die holder of the conventional die set are replaced by a built-in, pressurized forming cavity sealed by a flexible diaphragm. This serves as the blank holder and as a universal die, accommodating any shape.

• **Extrusion research**—These processes will become more and more important as a means of producing required shapes for flight vehicles. The choice and use of a particular shape will be on the basis of pounds rather than tons, will involve shorter production runs and will consist of more complicated configurations than present structures.

The Manufacturing Methods Di-



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Get more information on how SBP can serve you. Write or call: The Brunswick-Balke-Collender Company, Defense Products Division Sales Manager, 1700 Messler Street, Muskegon, Michigan–today!

BRUNSWICK

MAKES YOUR IDEAS *WORK*

vision of the Air Material Command's Aeronautical Systems Center has been investigating development of the extruding capabilities of steel alloys and bare, pure beryllium.

In the steel extrusion program, the "H-11" grade (5% chromium hot work die steel) and the "A-286" temperature resistant ferrous alloy were chosen because successful extrusion of both would constitute a major advance in the art.

A "Tee" section 1.50"x1.50" with 0.06" thick legs was chosen as the typical shape. **Allegheny Ludlum Steel, Harvey Aluminum** and **C.I.E.P.M.** of Paris, France, participated and, at the end of a given period of time, each submitted samples of the steels and shape chosen to the **Northrop Corp.** for evaluation.

Both Allegheny and Harvey believed the goals possible with certain modifications in equipment and technique. C.I.E.P.M. went on record as stating the minimum thicknesses in the sample steels to be slightly greater than the 0.062" specified, but indicated later that research would lower the practical limits. While neither Allegheny nor Harvey was able to effect an extrusion in A-286, both extruded H-11, with Allegheny being the more successful.

Lyle M. Christensen of Northrop disclosed the conclusions of the initial phase of the program at the SAE Aeronautical Meeting in Los Angeles:

- Both of the alloys have definitely proven to be extruable to the stringent prescribed conditions—details remain to be worked out to establish consistency.
- The inadequacy of previous lubrication practices was established; strict adherence to present and amplified C.I.E.P.M. die lubrication techniques is necessary. There were several other conclusions regarding improvements in various components of extrusion presses.

Armed with this information, Allegheny began an extended development program. New equipment was fabricated and instrumented, and billet and die lubrication techniques were improved.

The A-286 was pushed successfully, but at a thickness of 0.093" instead of 0.062". H-11 was pushed at a lower temperature; the shape was excellent for 14 feet, before the die washed and the vertical leg was severed.

Both Allegheny and Northrop felt close to a breakthrough in the development of a technique to extrude ultra-thin steel extrusions. Allegheny was preparing for a full-scale operation in July, but the steel strike halted the effort.

(continued on page 43)

people


McCORMACK

Maj. Gen. James McCormack, USAF (Ret.), vice president of Massachusetts Institute of Technology, has been elected a director of the Perkin-Elmer Corp.

Gen. McCormack served in the Army from 1932 until 1949, when he transferred to the Air Force. He attained the rank of Major General in 1953, after having served as director of Military Applications for the Atomic Energy Commission, vice commander of the Air Force's Air Research and Development Command, and director of Research and Development, Hqtrs., USAF.

A graduate of the U.S. Military Academy, McCormack received advanced degrees from Oxford University and MIT.

Richard S. Leghorn of Itek Corporation has been named by Secretary of State Christian A. Herter to be top advisor on technical affairs to Disarmament Chief Charles A. Coolidge. He will serve on a part-time basis as a consultant until a joint State-Defense Department study is completed early next year.

Norvin E. Erickson will take over duties as base manager for Aerojet-General Corp.'s operations at the AF Missile Test Center, Cape Canaveral. He previously directed the Liquid Rocket and Component Test Department at Aerojet's Sacramento facilities.

Pieter van den Berg was elected president of Consolidated Electronics Industries Corp. Vice presidents will be: **Arthur W. Haydon, John Benita, Christopher H. Coughlin,** and **John D. Stout, Jr.**


WEBBER

Charles H. Webber has been appointed executive vice president of the Pacific Scientific Co. in a series of appointments following a merger with Pacific Aeroproducts. **Melvin H. Kennedy** moved into the position of secretary-treasurer.

Webber's duties include supervision and coordination of all activities of the company's Industrial and Aeronautical Divisions. His headquarters will remain in Los Angeles.

Other new PSC appointees were **Andre W. Reichel,** vice president of the Aeronautical Div., and **Leo A. Pfankuch,** vice president in charge of the Anaheim Div.

John M. Wild, developer of a three-dimensional boundary layer theory of aerodynamics, will join General Dynamics Corp.'s General Atomic Div. as director of Project *Orion*, and also become assistant director of the division's John Jay Hopkins Laboratory for Pure and Applied Science in San Diego.

Dr. Karl G. Kessler will head the Spectroscopy Section of the National Bureau of Standards. He will direct work in interferometry, analysis of spectra, and the study of hyperfine structure and isotope shift in spectra.

Brig. Gen. Benjamin S. Kelsey, USAF (Ret.), has been appointed Visiting Jerome Clarke-Hunsaker Professor of Aeronautical Engineering at the Massachusetts Institute of Technology for 1959-60. Since his retirement from the Air Force he has acted as engineering consultant for a number of industries.


TAYLOR

Dr. D. S. Taylor, vice president of the U.S. Borax & Chemical Corp., has been named president of its subsidiary, the U.S. Research Corp. He has been with the company and its predecessors for 14 years in various research and development capacities.

Dr. C. L. Randolph will be in active charge of operations at the facilities at Anaheim, Calif., as the new vice president of the Research Corp. He holds a Ph.D. degree from the University of Southern California and was associated with Aerojet-General Corp. before joining the company in 1957.

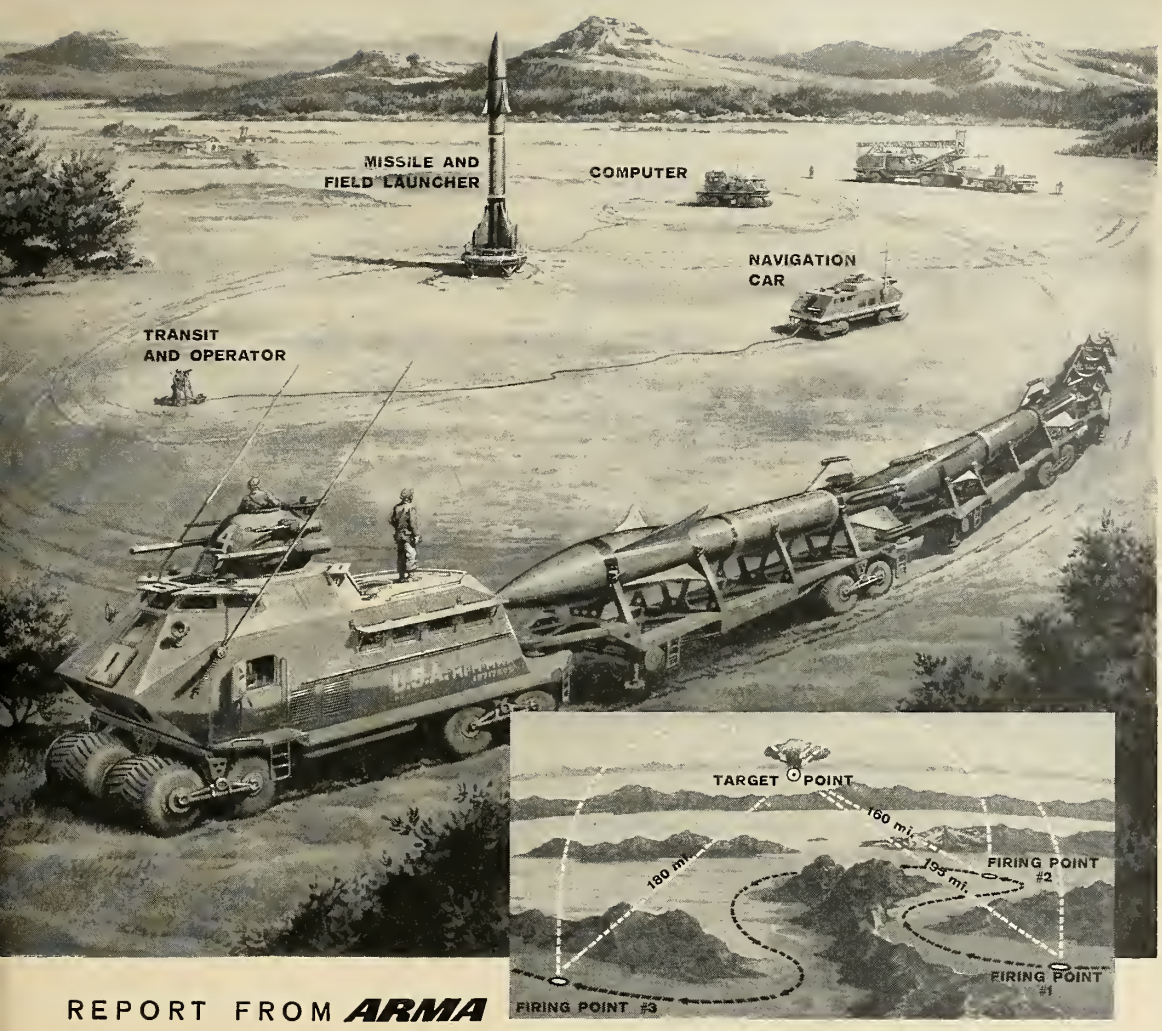
Richard B. Steinmetz, who has been with the Anaconda organization since 1929 and executive vice president since 1957, will succeed **William E. Sprackling** as president of Anaconda Wire & Cable Co.

Aaron Bloom, who has worked to translate the Latin of medicine into the equations of the engineer, has been appointed vice president in charge of engineering of the Sierra Engineering Co.


PALMER

Richard C. Palmer will manage Stromberg-Carlson's office in Washington, D.C., as a new vice president of the division of General Dynamics Corp. He succeeds **Andrew H. Bergeson,** who has resigned to participate in the formation of a small business investment company which will provide capital and management services to companies in the electronics and avionics fields.

Palmer, who previously held the posi-



REPORT FROM **ARMA**

The Missile Train—Mobile Sunday Punch

In the foreground above is the missile train—a hit-and-run Sunday punch for our modern Army. In event of war, the train could fire a missile with nuclear warhead, move rapidly miles away, then fire other missiles . . . without becoming a vulnerable stationary target itself. The missile train would be an ever-present threat to the enemy's tactical units over a wide area.

For such imaginative projects as the missile train, which combines maximum mobility with maximum firepower, ARMA has developed an equally imaginative universal navigation system. Not only can ARMA systems rapidly locate and aim all types of Army missiles, but they are applicable to all types of land, sea and air operations. To the Army, ARMA offers precise vehicular navigation systems for use in artillery and missile survey, combat vehicles, tanks, and helicopters as well as remote control types for mine detection and atomic blast survey. Precision navigation systems are ARMA's business from ships to ICBM's and—beyond.

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These manifold advantages combine to make DIMAZINE *the outstanding storable fuel*. We will be pleased to work with you in evaluating DIMAZINE and to supply detailed data on its properties and handling.

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tion of vice president in charge of communications at Fairchild Engine and Airplane Corp., will also assist Stromberg-Carlson in Rochester in the coordination of company-wide government relations programs and military marketing.

Dr. Howard Percy Robertson, professor of mathematical physics at the California Institute of Technology and a member of President Eisenhower's Scientific Advisory Committee, has been elected to the board of directors of Northrop Corp. He is also chairman of the Defense Science Board of the Department of Defense.

John B. Moss has joined Vertol Aircraft Corp. as assistant to the president. **Robert Scheinfein** has been appointed vice president of General Measurements Co., Inc., Instruments Div., and **Melvin Kutchin** joins the New England Instrument Co. of Waltham, Mass. as sales manager.

Barnet R. Adelman, vice president of United Research Corp., subsidiary of Pacific Aircraft Corp., has been elected general manager of the corporation and a member of its board of directors.

Arthur R. Christie, a management consultant since August, 1958, for the Martin Company, has been named manager of its Washington office.

As part of its development in handling Research and Development organizations, George Fry & Associates has appointed **William W. Buchanan** to head its Washington, D.C., office.

when and where

NOVEMBER

Institute of Aeronautical Sciences, Annual National Midwestern Meeting, Wichita, Kan., Nov. 2-4.

The Combustion Institute, Western States Section, Fall Meeting: Equilibria and Performance of High Temperature Systems, Los Angeles, Nov. 2-5.

Society for Nondestructive Testing, 19th Annual Convention, Hotel Hamilton, Chicago, Nov. 2-6.

41st National Metal Exposition and Congress, International Amphitheatre, Chicago, Nov. 2-6.

Mid-America Electronics Conference, 11th Annual Meeting, Kansas City Municipal Auditorium and Hotel Muehlebach, Kansas City, Mo., Nov. 3-5.

American Management Association, Briefing Session on the Defense Market, (Same program to be held at Ambassador Hotel, Los Angeles, Dec. 7-9,) Hotel Statler-Hilton, New York City, Nov. 4-6.

Institute of Radio Engineers, Fourth IRE Instrumentation Conference, Biltmore Hotel, Atlanta, Nov. 9-11.

Prototype MHD Power System Produces 1 KW

PHILADELPHIA—The successful generation of about 1 kilowatt of electrical power by means of a magnetohydrodynamic (MHD) power system has been accomplished experimentally here by **General Electric's** Aerosciences Laboratory. A continuous current flow was maintained for a period of 5 seconds.

In development for less than a year, the system will eventually find application in space vehicles by GE's Missile and Space Vehicle Dept.

The basic principles of MHD have been known for some time. Efficiency of such a device theoretically is higher than any heat-to-electrical energy power generation process now known, but application of theory to a complete working system has been a difficult problem, said GE.

The experimental unit directly converts the energy contained in a high-temperature (5000°F) air plasma into electrical energy. In comparison with a conventional generator, MHD employs the ionized gas as the conductor that moves through a magnetic field. Thus, it uses no moving parts.

Typical turbo-generators now in use convert thermal energy to useful electrical power at a rate of 0.35. General Electric expects future MHD generators to enjoy a conversion rate from 0.40-0.50.

The next step in MHD system development, said company spokesmen, is to reduce weight and increase reliability and efficiency. Also, there will be needed a refined power source and better high-temperature materials.

Soviets To Maintain Defense Spending in '60

WASHINGTON—The Soviet Union in 1960 will spend the same amount for defense and related fields as it is this year.

The expenditure—about $45 million—is approimately the same as anticipated U.S. defense-connected spending for the same period. But the outlay represents about 25% of the 1960 Russian gross national product, compared to 10% of America's GNP.

The comparisons were made by experts here last week after the Soviet Government in Moscow announced plans for a record overall budget in 1960 of $186 billion.

Because the total budget has risen, the $24 billion devoted to strictly military spending in 1960 represented 12.9% of the budget, a drop from 13.5% this year.

The space race will get a boost in funding—spending on scientific progress will be increased by 15.4% to a total of $8,150,000,000.

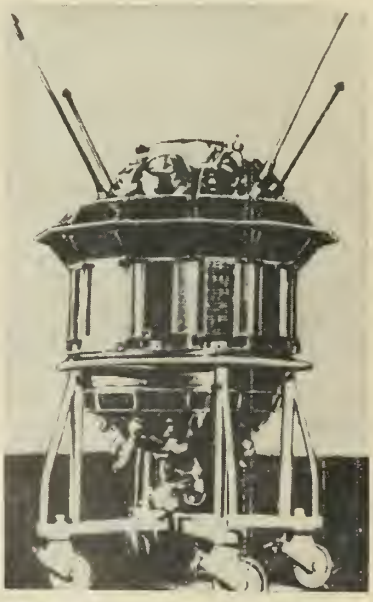
Other food for thought in the official budget forecast:

- Anticipated revenues for 1960 were put at more than $193 billion—a jump of $12 billion over this year. This would mean a surplus of nearly $7 billion at the end of the year.
- The government promised to abolish personal taxes "in the next few years."
- Total spending on consumer goods and food will rise by 13.6%.

Moreover, a Soviet report on economic development included these points:

- Industrial development in 1959 exceeded the targets for this year under the current seven-year plan; planned output of industrial goods would be exceeded by 4%, consumer goods by 10.5%.
- Gross industrial output in 1960 will rise 8.1%. Steel production will be 65 million tons, iron ore 105 million tons, and oil up by 15 million tons to 144 million tons.

Lunik III Model



MODEL OF Soviet automatic interplanetary station, in photo released by Tass. It's believed to be the type which photographed moon's far side (p. 13).

House Group Schedules Space Lag Investigation

WASHINGTON—The House Space Committee next January will conduct a month-long investigation to determine why the United States is behind Russia in space.

Chairman Overton Brooks (D-La.) announced the investigation would cover all phases of the nation's civilian and military space programs. He said that among the points that will be covered are:

- The future missions of the Air Force, Army, Navy and ARPA in space.
- The role planned for the Army Ballistic Missile Agency under NASA.
- The Administration's plans for the *Saturn* program and whether it should be accelerated.
- Whether more millions should be put into civilian or military space programs.

"The Congress and this country are not prepared . . . to sit back and twiddle their thumbs while we fall further behind in the race for space supremacy," Brooks said.

"I am convinced that this is a field in which we cannot play a subordinate role and still remain a first class nation. It is as simple and important as that."

'Space Ferry' Concept Told by Hughes-Lockheed

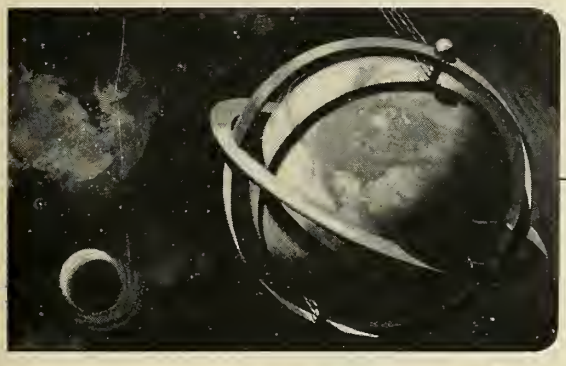
LOS ANGELES—Concept of a "space ferry" capable of making a manned roundtrip into a 300-500 mile orbit with a 14,000-pound payload was revealed by **Hughes Aircraft Co.** and **Lockheed Aircraft Co.**

Most striking feature of the jointly-developed design is a 1000-square-foot folding "arrow wing" configuration somewhat similar to one being developed by NASA's Langley Research Center. The wing unfolds when the vehicle nears its target station—exposing the payload cylinder which has room for the pilot and three passengers.

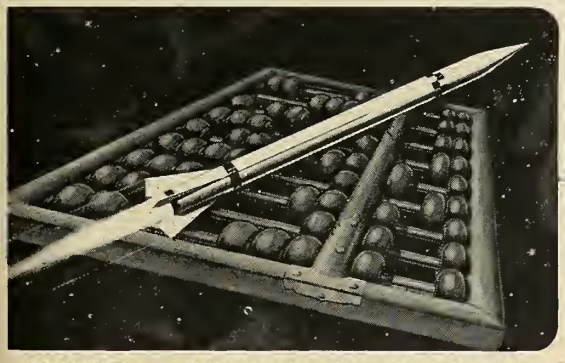
The "space ferry" would require a three-stage booster with takeoff thrust of 1.3-to-1.5 million pounds. Gross takeoff weight would be about 1 million pounds; orbital injection weight would vary from 20,000 to 32,000 pounds. The design calls for a 7500-pound thrust throttleable engine for space maneuvering, retro impulse and landing assistance.

Pioneering Achievements in Electronics at JPL

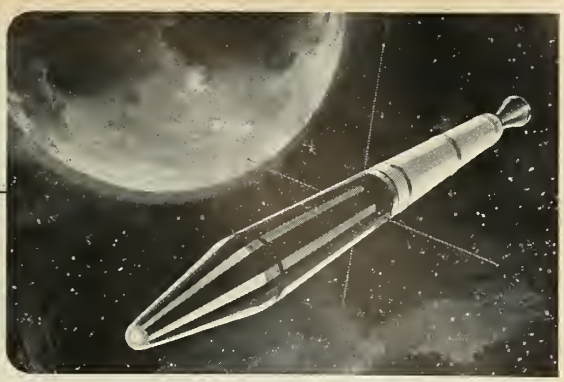
GUIDANCE RESEARCH . . . by JPL has led and advanced the field of missile guidance. Among these achievements are the application of Wiener RMS methods to multiple-input, multiple-loop servos, and matching missile trajectory to missile control transfer function for optimum accuracy.



GUIDANCE SYSTEMS . . . both inertial and radio-command types employing new concepts of radar communication have been pioneered at JPL. This guidance system development activity is supported by basic research in all phases of electronics.



COMPUTERS . . . and the application of computing techniques to missile guidance systems have been pioneered by JPL. The Laboratory is now searching for new techniques that will further advance the state of the art in digital guidance components and computer systems.



DATA TRANSMISSION . . . brings news from space via the Explorer series. Explorer III used a tape recorder the size of a cigarette pack capable of transmitting two hours of information in 5 seconds. Electronic payload weight was approximately 11 lbs.

INSTRUMENTATION . . . of the moon probe provided measurement of radiation environment at distances far from the earth. Telemetered data revealed the existence of high intensity radiation. Miniaturization resulted in an instrument payload weighing only 10 lbs.

COMMUNICATIONS . . . pioneering in interplanetary communications resulted in this giant parabolic radio antenna, 85 feet in diameter, developed by the Laboratory which enables the tracking and reception of scientific data from great distances.

jpl

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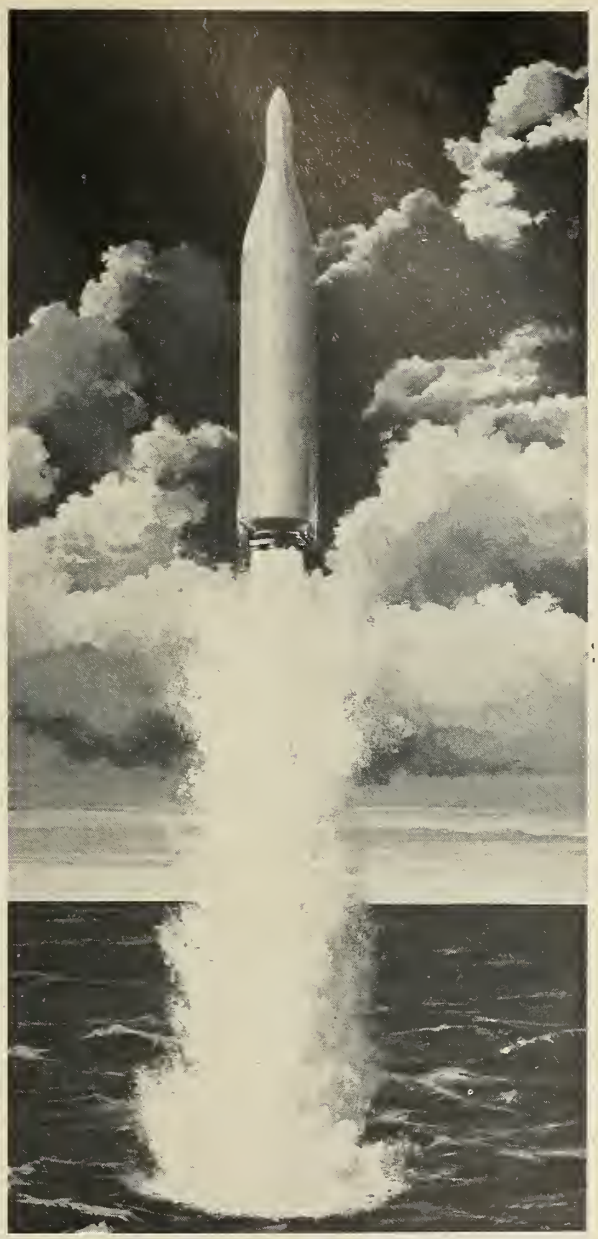
The Log of the Navy's Polaris

1958 In January, just a year after the Navy had announced its p
for a Fleet Ballistic Missile, the first Polaris test vehicle was
cessfully fired. Firings continued throughout 1958. By Septe
the test vehicles were close to the final configuration of the Po



1959 Operations Skycatch and Peashooter tested methods for ejecting the Polaris... Operations Pop-up and Fishhook tested a submerged launcher. In August, a Polaris test vehicle was launched from the deck of the USS Observation Island.

1960 The Polaris is scheduled for active duty in late 1960. Each of the Navy's nuclear subs will carry 16. Lockheed is prime contractor and missile system manager of a team that includes Aerojet-General, General Electric, and Westinghouse.

LOCKHEED

MISSILES AND SPACE DIVISION

MISSILE RESEARCH & DEVELOPMENT • BALLISTIC MISSILE SYSTEMS MANAGEMENT
ROCKETRY • ULTRASONIC AERODYNAMICS • SPACE INVESTIGATIONS • NUCLEAR PHYSICS
ADVANCED ELECTRONICS • HIGH-SPEED AUTOMATIC DATA REDUCTION
RAMJET PROPULSION TESTING

——more about the missile week——

• **Huntsville**—Maj. Gen. August Schomburg, 51, Army deputy chief of ordnance, will succeed Maj. Gen. John B. Medaris as chief of the Army Ordnance Missile Command. Medaris retires Jan. 31. Schomburg, after presiding over the transfer of ABMA to NASA, will have a command comprised of the Army Rocket and Guided Missile Agency, which is responsible for missile maintenance and supply, and the White Sands Missile Test Range.

• **Washington**—Two U.S. satellites have plunged out of orbit, leaving five American satellites and Russia's *Sputnik III* still circling the earth. The casualties: *Discoverer VI,* launched last Aug. 19 by the Air Force from Vandenberg AFB; and *Explorer IV,* launched July 26, 1958, by the Army from Cape Canaveral.

• **Cape Canaveral**—A report that six missiles had been destroyed recently by spurious harmonics from commercial radio and TV broadcasts touching off destruct packages was branded "ridiculous" by Maj. Gen. Donald N. Yates, commander of the missile test center.

• **New York**—U.S. Missile and space programs are being pinched by the steel strike. Shortages in special types of steel, said Defense Secretary McElroy, are causing serious delays in missile fabrication. Space Chief Dr. T. Keith Glennan said work also has been set back on the three-stage *Vega* rocket, with which the U.S. hopes to match some of Russia's early space work.

• **New York**—Big increases in earnings for the first nine months of the year were reported by **Thiokol Chemical** and **Aerojet-General Corp.** Thiokol's net of $4 million on sales of $128 million was up 134% over the same period last year. On record sales of $258 million, **A-G** earned $6 million—up 63% from 1958.

• **New York—Republic Aviation** reported earnings of $2.6 million on sales of $152 million for the first nine months of the year compared to a $3.9 million net on sales of $133 million for the like period last year. On Sept. 20, the company had a $500 million backlog.

• **Los Angeles—Northrop Corp.,** which acquired **Page Communications Engineers** this year, said consolidated net income for the FY ended July 31 was $7.3 million on sales of $263 million compared to a net of $7.2 million on sales of $274 million for the preceding year. Earnings per share were $4.01.

• **Arnold AFS, Tenn.**—The Air Force dedicated a gas dynamics laboratory at the Engineering Development Center to rocket pioneer Dr. Theodore Von Karman.

• **Washington**—NASA expects to launch NERV (nuclear emulsion recovery vehicle) from the PMR next year using the four-stage D-8 research rocket. Designed to obtain more complete measurement of the Van Allen radiation belts, NERV is being developed by **General Electric** under a $536,000 contract.

• **Fort Sill, Okla.**—Three more *Lacrosse* battalions will be activated by the Army early next year. It will put **Martin** *Lacrosses* in seven operational units.

Mergers & Expansions

In a diversification move, **Acoustica Associates** is negotiating for the purchase of **Ender Monarch Corp.,** Garfield, N.J., manufacturer of fluorescent light fixtures . . . **General Mills** has acquired the **Magnaflux Corp.,** Chicago, 30-year specialist in non-destructive testing of materials . . . Another Chicago firm, **Langmar Corp.,** has been purchased by **Basic Products Corp.** for its **Hevi-Duty Electric Co.** division at Milwaukee. Langmar makes vacuum pumps . . . A producer of magnetic components for missiles, **Luther Mfg. Co.,** North Hollywood, Calif., has been purchased by **Giannini Controls Corp.** . . . **Republic Electronics,** Farmingdale, L.I., is creating a new bio-dynamics division to specialize in aero-space instrumentation . . . A missile environmental testing facility will be built at Orlando by **Associated Testing Laboratories Inc.,** Caldwell, N.J. . . . and **Aeronca Mfg. Corp.** is regrouping all of its West Coast activities into a newly organized **Aerocal Division** at Torrance, Calif. The division has a $500,000 subcontract from **Boeing** for *Bomarc* structures.

First Released Photo of Bold Orion——

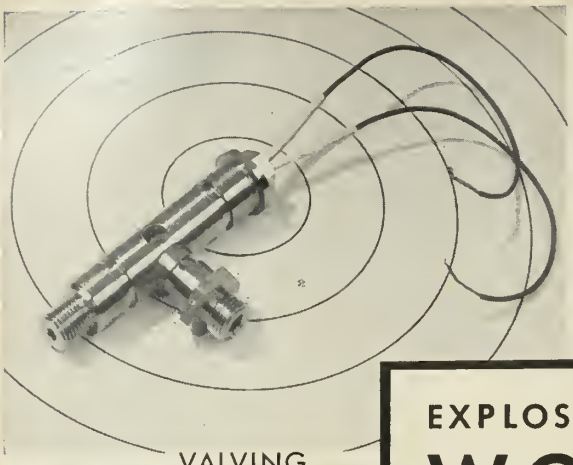
MARTIN BUILT 199B *ALBM* shown attached to B-47, manned by a Martin Company crew, which took off near Baltimore Oct. 13 and fired the two-stage Air Force R&D bird into the vicinity of paddlewheel satellite *Explorer VI* over Atlantic Missile Range near Cape Canaveral.

Hawk Nerve Center Put in Aluminum Shelter

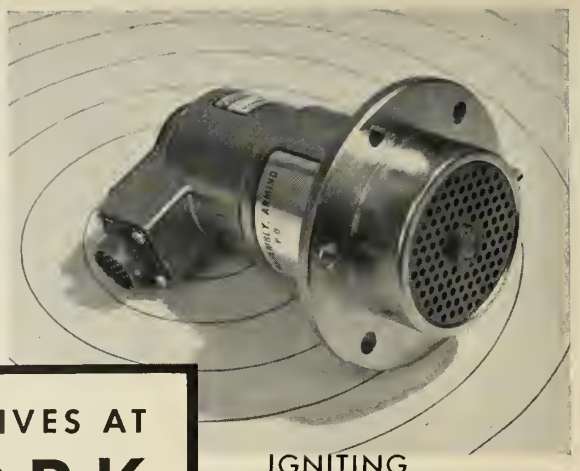
ANDOVER, MASS.—A new lightweight, aluminum shelter housing the battery control system of the *Hawk* missile system was displayed at the recent Open House held by the **Raytheon Company.**

Manufactured by **Craig Systems Inc.,** the shelter is easily transportable and is constructed of high-strength aluminum panels bonded together with epoxy resins.

The unit is insulated and contains a combination air conditioner and heater which maintains optimum operating temperatures in all types of weather conditions.



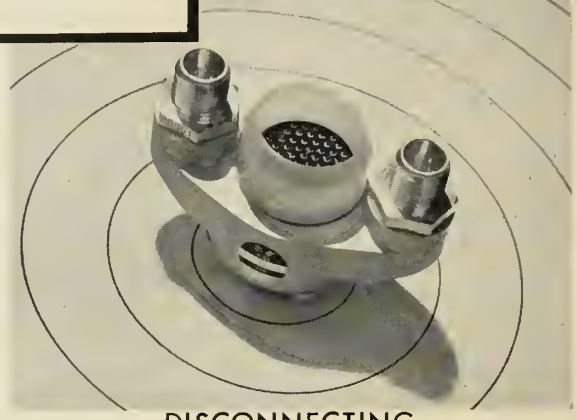
VALVING



IGNITING

EXPLOSIVES AT
WORK

DESTRUCTING



DISCONNECTING

missile hardware

When it comes to the problems of putting propellants and explosives to work on the actuating jobs in and around missiles, Beckman & Whitley offers a background gained in ten years of pioneering. Examples shown are just a few selections of solutions to typical problems.

They include a zero-leakage re-usable non-contaminating valve, a lanyard-armed destruct package, a rocket-engine starter for operation at altitude, and a standard electrical connector adapted for propellant-actuated disconnecting. Our case-history files are full of other examples, and if these don't happen to touch on your present problems, some of the others undoubtedly will.

This engineering capability, these production facilities, and our tradition of performance and reliability are at your disposal. Applications-engineering assistance is available in the solution of your problems.

Beckman & Whitley INC.

SAN CARLOS 16, CALIFORNIA

MACHINING

(*continued from page 32*)

• **Beryllium**—This program presented a different picture. **American Beryllium and Nuclear Metals Inc.** participated in an initial phase similar to that in the steel effort.

Conservation was a factor here; development extrusion billets of beryllium run well over $100 a pound. One extruder backed up each billet with a less expensive alloy so that none of the valuable metal was lost as billet butts, the residue at the end of an extrusion run.

The extrusion processes were similar to those in the steel program, but the participants had to use heavier tooling because beryllium characteristically resists deformation at extrusion temperatures.

By far the most important consideration was the choice and technique of billet and die lubrication. Glass proved to be the best material but a host of application problems accompanied the early extrusions. It is still a headache. The reason for this is that beryllium is highly abrasive; should the lubrication fail for any reason, the die is quickly washed out.

The possibility of bare beryllium extrusion was proven. Future process improvements are expected to make popular structural shapes of the metal available within two years.

SOLID FUELS

(*continued from page 25*)

weight 19, can do the same job. Some way must be found to use fluorinated oxidizers.

The third ingredient of a composite propellant is the metal additive—now usually aluminum, weight 27. There are three light elements—lithium, beryllium and boron—that might be able to do the same job.

Chemists also are investigating the mechanism of combustion and stability of the product gases at the temperatures produced in rocket flames. N_2, CO and HF are quite stable, even above 5000°F. But H_2O and CO_2 are considerably dissociated. Energy that might have added to the impulse is used in dissociation, another reason for introducing more fluorine into solid propellants.

Even when higher-impulse propellants are developed, one problem may stand in the way of their use. Higher impulse often depends on higher flame temperatures. Unless new materials are developed, we may not be able to make use of the improved propellants.

new missile products

Radiation Furnace Operates at 4200°F

A new refractory-free, high-temperature vacuum furnace for critical heat treating has been announced by **General Electric's** Industrial Heating Department.

The new furnace operates at temperatures up to 4200°F and is designed for use in laboratories or for production work where vacuum operation is required. Parts or material up to 10 inches in diameter by 10 inches in height, weighing up to 50 pounds, can be processed in the furnace. Heating space is 15 inches in diameter by 16 inches high to provide temperature uniformity in the load area.

The console units are factory-assembled, and include the radiation shield furnace, its vacuum system, furnace transformer, General Electric's Reactrol control system, and full instrumentation. The entire system is prewired and prepiped so that only power, water and vacuum system connections are needed when installed.

Double-wall furnace casing is entirely of stainless steel with radiation shields surrounding the load to provide thermal insulation. Radiation shields provide thermal insulation by reflecting heat back into the load. Inner shields closest to the load and which operate at highest temperatures are tungsten. Those furthest from the work which operate at lower temperatures are molybdenum. The last shield, which supports the others, is stainless steel.

Shields are constructed in small overlapping segments providing reduced distortion and fatigue due to repeated changes in temperature, according to company engineers.

The furnace cover is raised and lowered by screw-type mechanism, and top radiation shields move up and swing out for ease of loading and full access to heating chamber.

Heating elements for the new furnace are 1/8-inch tungsten rods, connected in parallel, and operate at less than 10 volts. Rods can be replaced individually. The electrical rating of furnace is 50 kilowatts. Power is supplied to the tungsten elements through water-cooled copper flanges.

Vacuum system operates on 6-inch oil diffusion pump rated 900 cfm at 0.01 micron, 1500 cfm, at 0.1 micron. Inert or reducing atmospheres can be used at partial pressure.

Typical applications include heat treating, brazing, sintering, solution heat treating and degassing of metals such as stainless steels, super alloys, tungsten, tantalum, molybdenum, columbium (niobium), titanium, vanadium, zirconium, hafnium and ceramics.

Circle No. 237 on Subscriber Service Card

Color Film Tracks High-Speed Missiles

A high-speed color motion picture film—fast enough to track a speeding missile and sharp enough to pinpoint almost indistinguishable changes in flame patterns—has been introduced by **Eastman Kodak Company.**

Eastman Color Reversal Film, Daylight Type, SO-260 has a normal exposure index of 160. It can capture motion in color under lighting conditions that challenge the highest-speed, black-and-white cine films. In use for missile data recording, the film has been exposed at indexes up to 500. Almost as sensitive is the new film's tungsten-balanced (artificial light) companion, Eastman Color Reversal Film, Type B, SO-270, which has a normal exposure index of 125.

The new film's speed combined with adequate sharpness, moderate grain pattern and good color reproduction make them suitable for recording all types of scientific and technical data under unfavorable lighting conditions. Tests indicate that they will be particularly useful in the missile and aircraft industries in missile tracking, flame and aerodynamic studies—especially when data is required concerning color changes. Another probable major application will be in filmed progress reports and in facilities presentations.

Because of the new films' increased sensitivity to light, the colored nose cone of a missile is said to be easily distinguished against the sky in motion picture footage. In addition, the films' speed allows photo engineers to take advantage of the superior resolving power of longer focal length lenses (which require smaller lens openings and consequently more light.)

As an example of what the higher speed of the new Daylight-balanced SO-260 film means in terms of exposure under low light levels: at a shutter speed of 1/50 second at 24 frames per second sound speed with a lens aperture of f/1.4, the new film may be exposed at the normal 160 rating with only 14 foot-candles of incident illumination.

Circle No. 238 on Subscriber Service Card

propulsion engineering . . .

By JAY HOLMES

Are we throwing away $800,000 . . .
in cancelling the *Pershing* titanium-case program? **Pratt & Whitney,** a sub for **Thiokol** and **Martin-Orlando,** spent this much money in the last year developing the case for the Army's solid-fuel battlefield missile.

Money alone was the issue . . .
in the decision to scrap the program. Army spokesmen say there were no technical problems involved. The switch to steel saved many dollars; the exact sum is classified. One source says it cut 4% from the unit cost of the missile.

The decision cut 50 miles . . .
from *Pershing's* range, which approaches 700 miles. This is far beyond the Army's theoretical limit of 200 miles. Army money has been getting scarcer and scarcer. And so, planners reasoned: Why spend it on extending the range of *Pershing* far beyond the limit?

This makes good sense . . .
from the Army point of view. But how about the national viewpoint? Must we throw away a valuable technology because one of the three services has no need of it? Pratt & Whitney is far ahead of the field in fabricating titanium, industry sources say.

P&W makes one-piece weldless cylinders . . .
by flow-turning titanium. Others making experimental titanium cases weld them with a longitudinal seam. Titanium makers fear that welding technique is not advanced enough to do this with the new metal, although it has been successful with steel. They are afraid weak spots may develop in seam welds.

Circular weld seams are not so critical . . .
The geometry of a burning rocket motor puts far less strain on a circular weld than on one extending the length of the case. Thus, there may be some strength to spare in the seam that holds the hemispherical head to the case.

Much study is still necessary . . .
before anyone can make a final evaluation of titanium for missile cases. Much research is in progress. We are learning about tensile strengths, notch sensitivity, elasticity, heat treating and how to weld the metal. Knowledge of this sort is increasing every day.

But the ultimate test . . .
is in making a case. Using the knowledge available, will it do the job? This is what P&W was doing. All of the preliminary work had been completed. Small-scale cases had been fabricated successfully and P&W had just begun to make full-scale cases. Then the program was cut off.

In final analysis cost may still be prohibitive . . .
Mill titanium costs $7 a pound, compared with $1.50 for vacuum-melted steel. We certainly must think twice before spending this much extra, particularly for large cases. But it seems silly to scrap the program without learning all the facts.

We have two other missile programs . . .
that might make good use of P&W results, for comparison with their own experience. The **Boeing** *Minuteman* and the **Lockheed** *Polaris* have solid-fueled motors that face the same problems as the *Pershing*. Their ranges are longer but the principles are the same.

There is one roadblock, of course . . .
Minuteman is an Air Force weapon and *Polaris* belongs to the Navy. There is the question whether either would be willing to take over an Army program. Stated more simply, the question is whether the services are truly unified.

—letters—

Space Vehicle Power

To the Editor:

Your article on "The Search for Space Vehicle Power" by C. Paul Means (M/R, July 27) was of great interest, especially your discussion of rotating electrical machinery.

S. M. Weinberger
Chief Engineer
Advanced Development
Rotating Machinery
The Louis Allis Co.
Milwaukee

Auburn's Role Clarified

To the Editor:

We were extremely happy to read the articles by Frank G. McGuire regarding ignition in M/R Oct. 5 and Oct. 12.

In the Oct. 12 story, we would like to make the following corrections:

1) We do not make ignition systems for sale. We do make jet plugs, shunter surface igniters, torch igniters, aircraft connectors, etc.

2) On page 24 you showed an **Auburn**-manufactured torch igniter, picture taken at **Aerojet-General**, with caption reading: "Torch igniter by Aerojet-General uses gasoline . . ." It should have read: "Torch igniter manufactured by Auburn Spark Plug Co., shown in photo by Aerojet-General, uses gasoline, air and a spark plug. Units of this type, etc."

A. J. Battey
Chief Engineer
Auburn Spark Plug Co., Inc.
Auburn, N.Y.

Right Data, Wrong Photo

To the Editors:

The caption and cover data in the Oct. 12 issue of M/R are incorrect as they apply to the cover photograph. The piece of equipment shown is incorrectly described as a plasmatron; it is a drilling machine which a technician is using to drill a hole in the nozzle of the XLR99 (*X-15*) engine. The circle of light is a fluorescent lamp which provides illumination for the drilling operation.

Tom Johnston
Brown & Butcher, Inc.
Advertising
(For Thiokol Chemical Corp.)
630 Fifth Avenue
New York 20, N.Y.

M/R mismatched the caption and cover data with another photo.—Ed.

Written on LA Freeway?

To the Editor:

This world does not have an unlimited amount of space for an unlimited amount of people. The laws of nature have a statute of limitations; there are those who choose to ignore them, for which we all have to pay.

William R. Sullivan
1116 S. Flower
Los Angeles 15, Calif.

west coast industry . . .

By FRANK G. McGUIRE

The Small Business Administration tells this column that business in Southern California is in "pretty good shape." The number of loans being sought by small business is on the upswing, but SBA says this is a sign of additional working capital and expansion funds being appled for. About 55% of the loan applications are approved; most rejections are blamed on lack of adequate collateral. The two criteria necessary for obtaining an SBA loan are adequate collateral and a good earning record. ("This is taxpayers' money we're using, and we have to have both of these things before approving a loan.")

SBA prefers to work with private banks in helping small business, and will go it alone only if the local banks have turned down an application. Such a refusal by private lending institutions does not necessarily reflect adversely on the small firm's credit record; it might mean merely that the company needs the money for a longer period than the bank can accept. Thus, the small firm goes to SBA, which can make much longer-term loans than banks.

The Gabriel Company will integrate . . .

two of its divisions, **Talco Engineering Co.** and **Rocket Power, Inc.**, both in Mesa, Ariz. President of the two divisions will be Charles E. Bartley, formerly with **JPL** and founder of **Grand Central Rocket Company.** Rocket Power, Inc. is a producer of solid propellants and rocket systems, and has a new propellant facility nearing completion at its Mesa site. Talco Engineering manufactures cartridge actuated devices and pilot-escape systems.

Industrial Annual Reports . . .

have replaced the 16th-Century sonnets written by businessmen about their mistress' feet, says a report out of UCLA. "The annual report is the natural child of bureaucracy—whatever its uses, whether it is read or not, we can't do without it," says a university librarian. Among the suggestions given to report-writers are: digest details properly—and reject most of them; beware of deadliness; eschew technical language; determine reasons for the report, and at what group it is aimed; don't overuse statistics; and don't air internal administrative troubles and reorganization jangles in a public report . . . "if necessary, write two reports."

Convair Astronautics is trying to convince . . .

the Defense Department that advanced modifications of *Atlas* could carry greater payloads. The missile is under continual modification now, but **Convair** is apparently looking for a big step. The division has also expressed an interest in solid propellants, but diluted this with: ". . . but then, we're interested in all propellants."

Dozens of *Polaris* nozzle modifications . . .

have occurred since the program began. Original nozzles which used molybdenum extensively were modified when hotter propellants came along and other materials with greater high-temperature strength were substituted. One model utilizes half a dozen different materials: 4130, graphite, pyrotex, molybdenum, and a tantalum/tungsten throat. Even the shape of the nozzle has changed. The characteristic bell-bottom shape of the nozzle shown on models has given way to a straighter contour because the jetavators kept jamming on the "ball" of the nozzle during high-temperature phases. Some of the lastest models use tungsten to a greater extent than ever.

Visitors to Aerojet-General/Sacramento . . .

rocket engine test facility are often awed by the towering but strangely shaped structures used for casting and curing of solid-propellant rocket motors. Tour guides and part-time comedians who point out that "if we lose our missile contracts, we can always use it for a cathedral," had a jolt recently from a visitor who beat them to the punch (he had heard the story) by suggesting that the towers be used for "further hypergothic fuel development."

contracts

NASA

$536,000—**General Electric Corp., Missile and Space Vehicle Dept.**, Philadelphia, for development of a recoverable device for measuring radiation in space.

$111,875—**Jones-Mahoney Corp.**, Tampa, Fla., for services and materials for the construction of a radio tracking station.

$68,000—**Massachusetts Institute of Technology**, for design, construction, testing and delivery of a high energy gammaray detector.

$37,761—**Minneapolis Honeywell Regulator Co., Brown Instrument Div.**, Cleveland, Ohio, for 24-channel galvanometer type oscillograph for the Lewis Research Center.

NAVY

$1,291,000—**Sperry Gyroscope Co. Div., Sperry Rand Corp.**, L.I., N.Y., for field engineering services in connection with the maintenance, repair, installation and checkout of guided missile fire control systems, *Terrier* and *Talos* components manufactured by the contractor.

$517,518—**D. S. Kennedy & Co.**, Cohasset, Mass., for engineering, design, development, fabrication, assembly and installation of large antenna for satellite tracking and propagation research.

$356,004—**Sylvania Electric Products, Inc.**, Towanda, Pa., for materials, services and personnel to investigate and develop processes for producing improved quality molybdenum alloy sheets.

$279,020—**Daystrom, Inc., Systems Div.**, for services and materials to design, manufacture and install one multi-channel quantitative spectrum and analyzer.

$47,481—**Kaiser Alum. and Chem. Sales, Inc.**, N.Y., for synchro and resolver transmission cable for guided miasile system.

$43,000—**Massachusetts Institute of Technology**, for conducting an investigation of chromium-base alloys for use at elevated temperatures.

$41,854—**New York University**, for conducting an investigation to develop improved titanium organic compounds.

$35,285—**American Institute of Research, Inc.**, Pittsburgh, for research to insure maximum effectiveness of a weapon system.

AIR FORCE

$7,776,637—**Hughes Aircraft Co.**, Culver City, Calif., for repair and modification of fire control and weapons control systems components.

$675,680—**Amperex Electronics Co. Div. of North American Philips Co., Inc.**, Hicksville, N.Y., for electron tubes.

$550,000—**Century Electronics & Instrument, Inc.**, Tulsa, to develop calibration carts for the *Minuteman* ICBM test program. Subcontract from **Boeing Airplane Co.**

$476,000—**Radiation, Inc.**, Melbourne, Fla., for developing a tape format converter for the *Minuteman* ICBM test program. Subcontract from **Boeing Airplane Co.**

$287,820—**Radio Corp. of America**, Harrison, N.J., for electron tubes.

$80,458—**University of Chicago**, for continuation of research on nuclear emulsion studies of the properties of hyperfragments.

$63,497—**Sylvania Electric Products, Inc.**, N.Y., for electron tubes.

$55,900—**Raytheon Mfg. Co.**, Newton, Mass., for electron tubes.

$53,120—**Florida State University**, for research on "Ionization Processes in Nitrogenring Compounds."

$45,788—**Cornell University**, for research on "Analytical Applications of Flame Spectroscopy."

$41,828—**The University of Kansas**, for research on "Determination of Organic Functional Groups by Photometric Titration."

$32,640—**General Electric Co.**, Owensboro, Ky., for electron tubes.

$30,208—**Rensselaer Polytechnic Institute**, Troy, N.Y., for continuation of "Analysis of Dynamic Effects of Added Mass and Initial Stresses."

$25,000—**University of California**, for continuation of research on "Development of Arc Heated Low Density Wind Tunnel."

ARMY

Aerojet-General Corp., Azusa, Calif., has received a contract to conduct basic research studies of electrically exploded wires and films. Amount not disclosed.

$188,402,905—**Western Electric Co.**, N.Y., for research and development of the *Nike-Zeus* guided missile system.

$2,885,000—**The Martin Co.**, Orlando, for test and ground equipment for the *Lacrosse* missile.

$2,067,133—**General Electric Co.**, Phoenix, for digital computation facility operation at ABMA, Redstone Arsenal.

$2,003,400—**Hughes Aircraft**, Fullerton, Calif., for tracking systems associated with classified equipment.

$998,800—**The Martin Co.**, Orlando, for research and development of *Lacrosse* missile.

$700,000—**Vertol Aircraft Corp.**, Morton, Pa., for the manufacture of various components for the *Hawk* surface-to-air missile. (Included in this is an earlier contract for acquisition antennas for the *Hawk* missile.) Subcontract from **Raytheon, Inc.**

$500,000—**The Martin Co.**, Denver, for engineering services in connection with the *Saturn* program.

$326,958—**Douglas Aircraft Co.**, Los Angeles, for *Nike-Hercules* launching area items.

$304,000—**North American Aviation, Rocketdyne Div.**, for a classified project.

$275,000—**North American Aviation, Inc.**, Canoga Park, Calif., for rocket engines.

$240,000—**Hayes Aircraft Corp.**, Birmingham, Ala., for engineering and design services, ground support equipment for *Saturn* missile.

$239,699—**Bowen-McLaughlin-York, Inc.**, York, Pa., for increased vehicle engineering agency services for the T88 series, medium recovery vehicle, modification of three vehicles.

$154,638—**Brown Engineering Co. Inc.**, Huntsville, Ala., for engineering and machine shop services.

$130,357—**Aerojet-General Corp.**, for warhead.

$126,990—**Central Electronics Mfgrs., Div. of Nuclear Corp. of America**, Denville, N.J., for electron tubes.

$125,000—**Maurice H. Connel & Associates, Inc.**, Miami, Fla., for architect-engineer services in connection with launch facility.

$100,055—**The Martin Co.**, Orlando, for facilities for production of *Lacrosse* and *Pershing* weapon systems.

$92,632—**Aerojet-General Corp.**, for activation and operation of launching equipment.

$84,979—**Plasmadyne Corp.**, Santa Ana Calif., for experimental study of propulsion system.

$61,611—**Douglas Aircraft Co., Inc.**, for *Nike* replenishment spare parts.

$56,160—**Linde Co.**, Cleveland, for one item of liquid oxygen.

$47,722—**Hayes Aircraft Corp.**, for engineering, design services and specialized services for manufacture of special tooling and fixtures of missile components.

$45,082—**The General Electric Co.**, Cincinnati, for cesium ion rocket performance evaluation.

$39,924—**Redel, Inc.**, Anaheim, Calif., for mechanistic studies of igniters.

MISCELLANEOUS

Itek Corp., Waltham, Mass., has received more than $12,000,000 in contracts, one is for the development and manufacture of special equipment for the space program.

$1,000,000—**Hunter-Bristol Div., Thlokol Chemical Corp.**, for deisgn, development and production of a rocket-catapult ejection device for the B-58 supersonic bomber escape capsule. (Subcontract from **Stanley Aviation Corp.**)

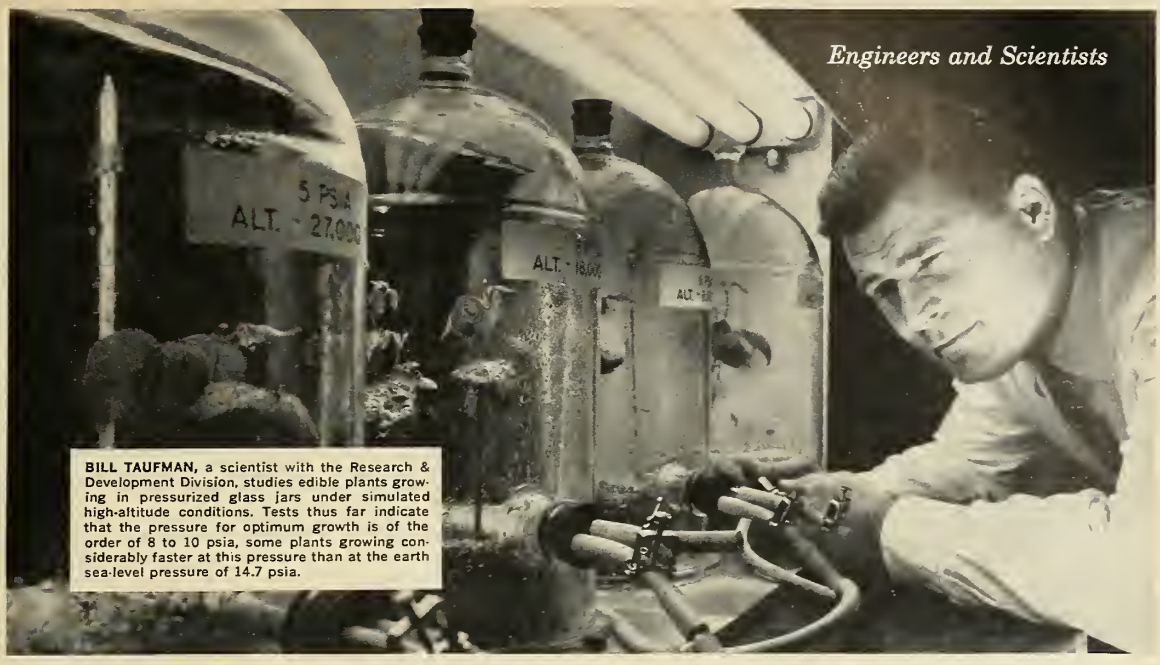
ADVERTISER'S INDEX

EMPLOYMENT SECTION

CLASSIFIED

WASH. REPRESENTATION Govt. sales liaison, Public Relations, cover all fields, J. V. Hurson Assoc., 412 Albee Bldg., D.C., RE 7-4122.

MISSILE INDUSTRY—Set of 20 outstanding Launch and Pre-launch Slides—$5.00. We have the largest commercial source of Missile Photography, The Cam-Ber Co.; 1109 Byrd Plaza, Cocoa, Florida.



BILL TAUFMAN, a scientist with the Research & Development Division, studies edible plants growing in pressurized glass jars under simulated high-altitude conditions. Tests thus far indicate that the pressure for optimum growth is of the order of 8 to 10 psia, some plants growing considerably faster at this pressure than at the earth sea-level pressure of 14.7 psia.

HOTHOUSE ON THE MOON

Studies in low-pressure plant growth for lunar application... just one of the unique programs for engineers and scientists at REPUBLIC AVIATION

An example of the scope of Republic's investigations into every ramification of space exploration is a study to determine the lowest pressure level which will permit normal plant growth. The project is part of an Air Force program to judge the feasibility of a moon base. Another aspect of the study seeks to find the effect of zero gravity on plant growth. Although zero gravity cannot be created on the earth, the potential problems were indicated when plants subjected to negative g, or up-side-down growth, showed only one-half the development of normally grown plants.

Every facet of flight technology, from advanced aircraft design and space vehicle propulsion systems to computer-based trajectory studies for planetary reconnaissance probes, is being explored in Republic's Research and Development program. Distinguished advances have already been made in space guidance concepts, in plasma and nuclear propulsion systems, in radiation physics, in new materials and processing techniques, and in prototype development of hardware (as an example: hydraulic systems that operate reliably up to 1500F.)

These programs will be intensified with the completion – early next year – of Republic's new $14 million Research and Development Center. As the date draws near, staff expansion for these modern facilities is creating in-at-the-beginning career opportunities for senior engineers and scientists capable of sophisticated thinking in theoretical and experimental research. Republic invites qualified individuals to discuss how they can make material contributions to advancing the state of the art.

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Send resume in confidence to: Mr. George R. Hickman, Engineering Employment Mgr., Dept. 4L-1

REPUBLIC AVIATION

Farmingdale, Long Island, New York

The Russians Score Again

Now that we have been permitted to see a photograph of the dark side of the moon by courtesy of the Soviet Academy of Sciences (Please credit Tass News Agency), do we sit back and wait for new triumphs from the Eastern side of the world?

And perhaps ponder on the words of our recent friendly visitor, N.S. Khrushchev on Oct. 6 at Vladivostok, after his return from the United States?

"The successes of the Soviet Union," he said, "are a vivid demonstration of the advantages of the socialist order over capitalism.

"Why is it that the United States, whose wealth and scientific and technical development have been a cause of universal amazement—why is it that that country is now repeatedly trying to launch a rocket to the moon, but instead of going to its target, it sinks to the bottom of the sea? It is not a case of their having insufficient dollars; they have plenty of dollars, they are richer. It is not a case of their having no materials; they have materials. It is not a case of their having no scientists; they also have scientists. What then do they lack? They do not have the kind of system that we have."

The Soviet boss makes a pretty good case, doesn't he? When he says we haven't the system, though, doesn't he really mean we haven't the will? That we have plenty of money, plenty of scientists, plenty of materials—but aren't using them?

That while the rest of the world applauds the Russian achievements, we sit back with a complacency that stems from heaven knows where and say these feats are not important, not significant? Just "another hunk of iron" up there?

(Khrushchev mentioned later in his speech that the Americans have begun to say "again" that they have more cars than the Soviet Union).

Somewhat in the same area, Russia made another significant announcement—its annual budget. In addition to reporting economic gains all along the way, it informs us that there will be no change in the Soviet military budget for next year.

The military funds set aside by the USSR have always been a little difficult to pinpoint, simply because no one but the Russians knows exactly what may be hidden where. But the major point is that the USSR is maintaining one mighty weapon, its military machine, while pushing ahead to new triumphs with the other, its space program.

At this moment the United States is working on its budget for the next fiscal year. It will be greatly concerned with the same two areas—its military machine and its space program.

There has been talk of a cut in the military—by as much as $2 billion. What turn of world events makes this an act of wisdom is difficult to see. The visit of Khrushchev? Perish the thought.

Of equal or perhaps greater importance is what the Administration does to the NASA budget; whether you approve of this fact or not, NASA is the all-in-all of our space program. Whether we catch up with the Russians, whether we succeed in space or fail, whether we compete or accept second place—it is all up to NASA.

This agency has recently inherited the Army's space team and that team's major project—a million-and-a-half-pound booster which might enable us to leapfrog some of the Russian space achievements. The team is experienced and capable and has chalked up some brilliant achievements.

Under NASA it can continue to be brilliant—if it gets the funds and the imaginative encouragement, the enthusiasm and the support that it should have.

These ingredients so necessary to success must come from the Administration, from our national leadership—as indeed all of NASA's programs must have such Administration backing if they are to go forward boldly and fruitfully. They cannot be starved and squeezed and neglected, financially or morally.

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NEW PRODUCT BRIEFS

OWER CONTROL. A new line of ower control units utilizing magnetic ating amplifiers driving sicilon conolled rectifiers has been introduced Magnetic Amplifiers, Inc. Desigted Universal Power Control Units, e new equipment will, to a large exnt, replace conventional electromeanical equipment such as amplidynes d motor generator sets. Described a "solid state marriage" of the magtic amplifier and the solid state thyraon or silicon controlled rectifier, the ower units are said to offer a subsntial reduction in size compared to vices now in use. They are reported be approximately two-thirds smaller d weigh four-fifths less than present paratus performing the same funcon. The Magnetic Amplifiers, Inc., uipment provides voltage/current gulation, AC servo motor control, C motor speed and position control, d temperature and light dimming conol. Military applications for the power its are found in missiles, jet and conntional aircraft, ground support handlg equipment, and radar tracking sysms. Industrial applications cover semitomatic or completely automatic conol system for processing, packaging, d machine tool and material handling erations, including conveyors, cargo ndling and lifts.

cle No. 225 on Subscriber Service Card.

FE-ARM INITIATOR. McCormick Selph sociates is now marketing a new SAFE-M initiator to be used for missile or cket high explosive destruct applicans or placed in an igniter configura-n for initiating solid and liquid proellant rocket motors. Weighing less in 0.50 lbs., the mechanism is capable remote arming and disarming by ans of an electrical signal either rried by land lines prior to missile nch or by telemetry when the missile n flight. The initiator may be changed m the SAFE to ARM condition or m the ARM to SAFE condition reely and may be manually disarmed the unit. Manual arming, howaver, is possible, resulting in safety of perinel and equipment. The ARMED or FE condition is shown by a red inator light either at the unit or at the note location. The case is anodized minum and all electronic and explo-e components are potted in foamad stic. There are no moving parts in the arming system and the explosive train is series-paralled for maximum reliability. Arming can be accomplished in seconds using fractions of an ampere of electricity. Arming and firing voltages can be varied to meet arming system requirements. The unit may be mounted on any type surface through the use of Twist-Loc or equivalent fasteners: the primary advantage being the rapid installation of the unit under any condition and without the use of special tools. The SAFE-ARM initiator is permanently sealed prior to installation and no moisture or other damage can occur. This condition may be held indefinitely as is necessary in many missile firing operations. A single Bendix Pygmy connector is provided for connection to all external electrical circuitry. A full range of qualification and reliability testing is being accomplished and the unit will operate at 99.85% reliability under any environmental condition encountered by missiles, rockets and space vehicles.

Circle No. 226 on Subscriber Service Card.

BUTTON SWITCHES. A new line of miniature push button switches for console and instrument applications has been announced by Transistor Electronics Corporation. Designed to match their line of indicator lights, the MBS series of switches feature gold-plated contacts with wiping action to assure positive trouble-free operation and low contact resistance. Rated at 100 ma with a life of 500,000 operations, the MBS is offered with form A, B or AB contacts. The unit mounts with a single nut in a 3/8" hole and is available with all standard button colors.

Circle No. 227 on Subscriber Service Card.

DIAL READER. Parabam, Inc. has announced the production of an Angle Dial Reader designed for precision semi-automatic reading of elevation-angle and azimuth-angle dials on cine-theodolite and radar data film. By projecting the dials on a viewing screen and by utilizing a cross wire measuring system, the machine provides a rapid, accurate and efficient means for reading angle dials. An integral keyboard and selector switches are provided for entering additional data and the information is semi-automatically recorded on punched cards.

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MISSILE LITERATURE

SOLDERLESS WIRING DEVICE. Showing the user how to choose the best kind of terminal for his particular wiring application, a new brochure is offered by ETC Inc. A wide choice of basic types of electric terminals and connectors is shown, ranging from the "ring" and other standard tongue designs through multiple-wire conectors and quick-disconnects. The five ETC barrel styples are illustrated, including insulated, non-insulated and vibration-proof styles. Performance features of each are compared. A cutaway view shows construction details of a typical terminal. All ETC terminals feature the full 1/4" barrel length that eliminates loss of time finding a critical crimping location, eliminates squeeze-outs and sheering, allows a wider crimp for extra-strong connections.

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STAINLESS STEEL. A new by-monthly publication for users of steinless steel is being produced by the Stainless and Strip Division, Jones & Laughlin Steel Corp. Entitled "Explorer," its purpose is to review new developments and applications of stainless for industrial, commercial and defense products. The Explorer is designed to alert readers to potential production economies, new product and profit opportunities, and possible methods of improving existing products. Variations on familiar uses of stainless steel as well as dramatic new applications are detailed with the extensive use of art and photography. Special coverage is planned for new applications which are the result of increased demands for high strength, corrosion resistance and heat resistance.

Circle No. 201 on Subscriber Service Card.

SAFETY STARTER. Six important safety features of Westinghouse Electric Corp.'s new Type L combination safety starters are discussed in a new booklet which they call "Industry's Safest Line of Combination Starters." Type L starters, designed to meet recommendations of the Joint Industries Council, are used to control industrial equipment such as heavy machine tools.

Circle No. 202 on Subscriber Service Card.

COLD HEADING WIRE. Universal-Cyclops Steel Corp. announces the availability of a new four-page brochure on stainless steel cold heading wire. This new brochure compares the cost, corrosion resistance, and cold heeding characteristics of the commonly used grades of stainless steel cold heading wire.

Circle No. 203 on Subscriber Service Card.

WELDING NEWS. A 7500 ton press ram overlaid with 5000 feet of aluminum bronze filler metal is described in the third quarter 1959 issue of the Ampco Welding News. Also included in this issue of the publicetion are articles describing the repairing of cast-iron gears and advantages and applications of Ampco's new line of extruded rectangles.

Circle No. 204 on Subscriber Service Card.

MAGNET WIRE. Anaconda Wire and Cable Co. announces a publication to help manufacturer, maintenance and repair firms choose magnet wire for Hermetic Motors. Titled "Enameled Magn Wires for Hermetic Motor Applic tions," the 19 page booklet includes table of test data for each of t types of insulation Anaconda recor mends for hermetically sealed mot service. These are anavar, anather epoxy, formvar, and lecton.

Circle No. 205 on Subscriber Service Ca

PROCESSOR. Details of MicroSADI a high-speed analog-to-digital proc sor are presented in an illustrated, fo page bulletin offered by Consolidat Systems Corp., subsidiary of Consc dated Electrodynamics Corp. The m chine acquires, digitixes and stores da at a maximum rate of 10,000 sampl per second. Operation, design deta and specifications are described.

Circle No. 206 on Subscriber Service Ca

CAPABILITIES. American Bosch Arr Corp. has issued a facilities and cap bilities brochure which outlines the e gineering services and products automatic measurements and control processes by electronic and electr mechanical techniques which it has p vided both industry and the milita Various types of ground support equi ment and production test equipment both missile and aircraft systems, a test equipment for automotive industr use are depicted.

Circle No. 207 on Subscriber Service Ca

WELDING WIRE. A revised edition the Air Reduction Co.'s welding w pocket guide has just been publishe The 84-page booklet includes the lat information on Airco's line of g shielded metal-arc welding wires, cluding data on the A675 steel wire a the new A666 steel and A556 aluminu The guide provides answers to questic concerning the steel, aluminum, copp and copper base, stainless steel, titani and special welding wires used with Reduction's Aircomatic welding proce The guide contains technical informati such as chemical composition, mecha cal properties, and operating pro dures, as well as wire diameters a packaging data.

Circle No. 208 on Subscriber Service Ca

ELECTRICAL CONTACTS. A 4-pa catalog published by Gibson Elect Company, describes materials, prop ties, forms and uses of its line electrical contacts. Discussed are co tacts manufactured from fine silver, c silver, palladium, gold, platinum, all known as Gibsalloys," and many po dered metal compositions designated "Gibsiloys." A feature of the catal is an outline showing contacts for va ous applications such as contractors, struments, circuit breakers, switches a many others.

Circle No. 209 on Subscriber Service Ca

NOISE GENERATOR. A four page b letin describing a 166 decibel Acous Noise Generator developed by the A Research and Advanced Developm Div. is now available. The genera uses an electro-mechanical transdu of moving-coil type producing 166 of random noise and 170 db at discr frequencies.

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