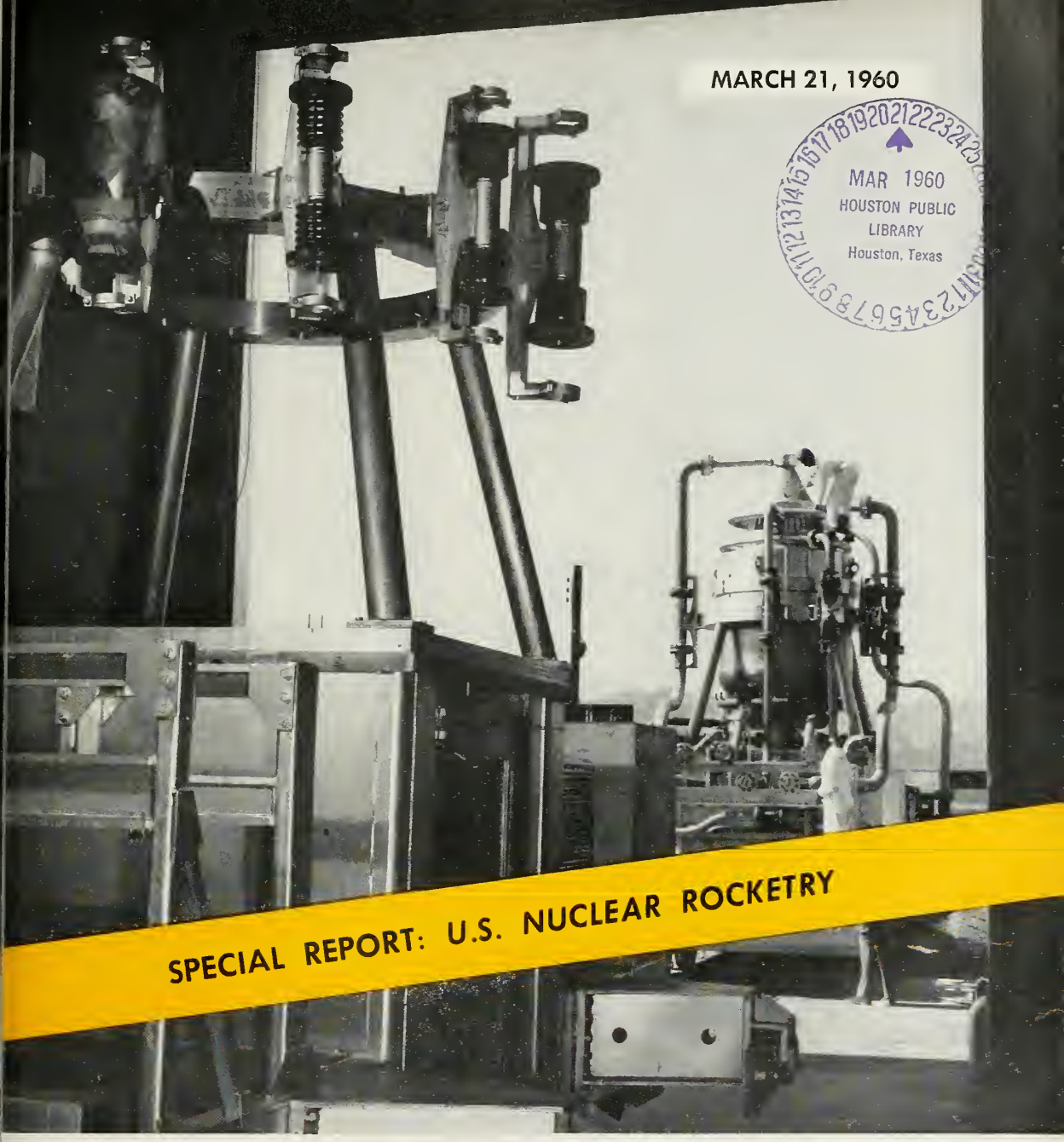

MARCH 21, 1960



SPECIAL REPORT: U.S. NUCLEAR ROCKETRY

# missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS



AN AMERICAN AVIATION PUBLICATION

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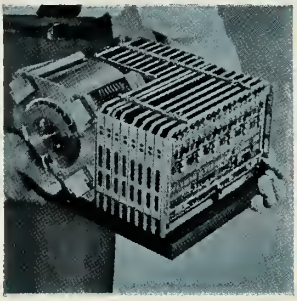
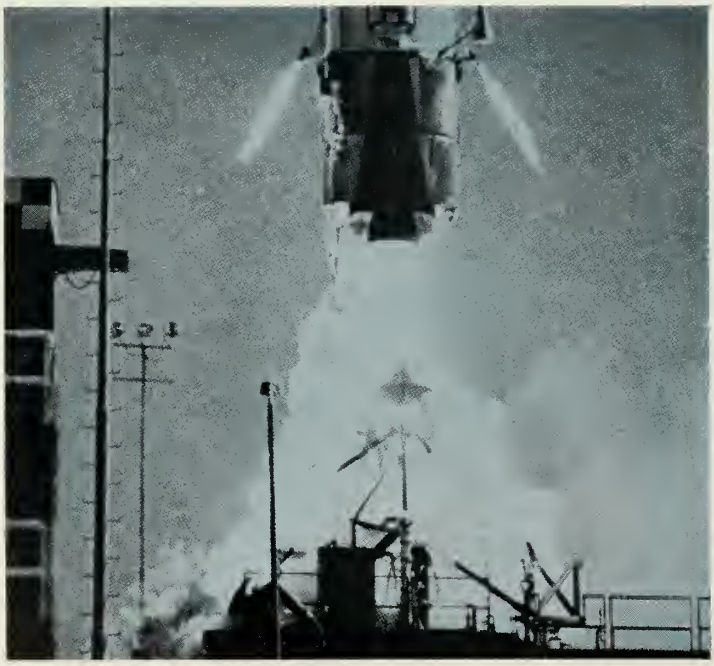


*computers that pace man's expanding mind*



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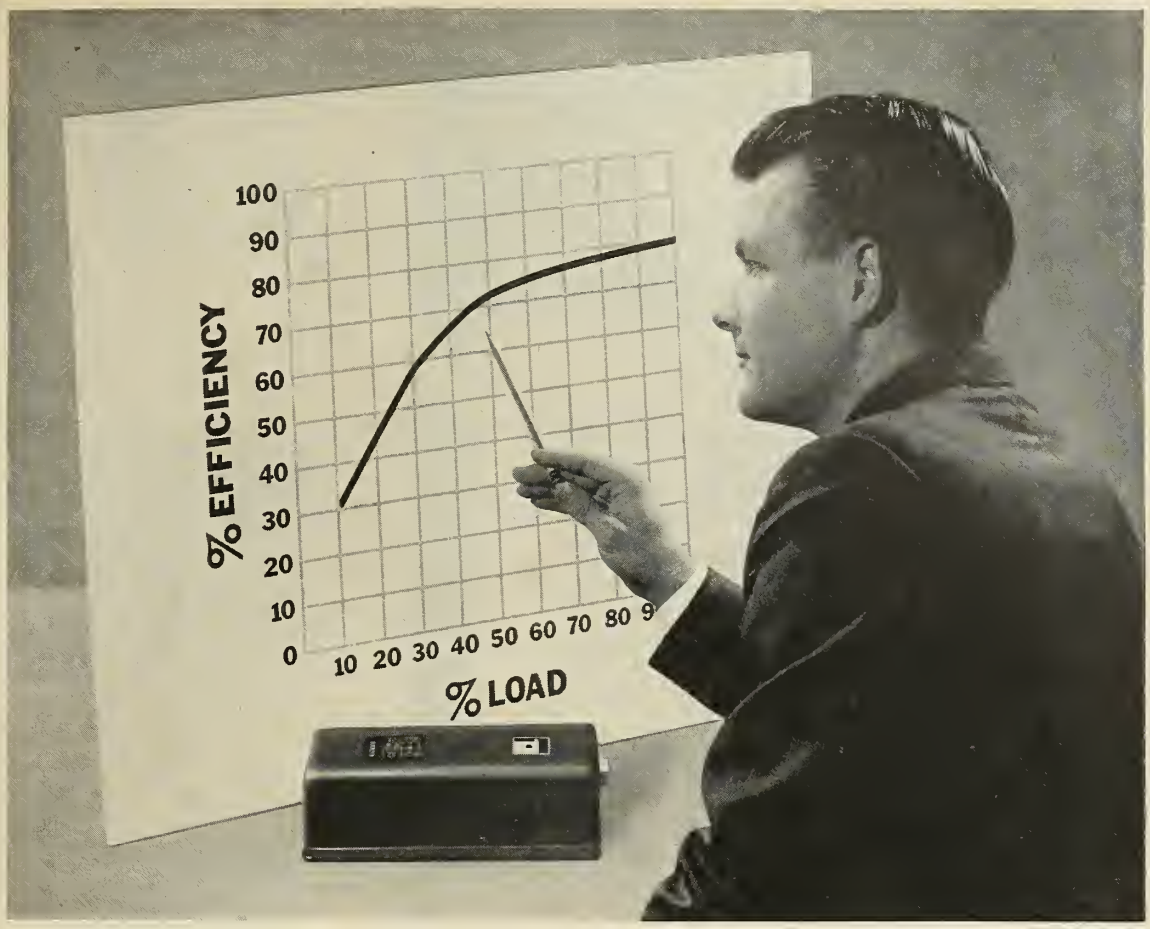


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Close frequency control and accurate phase displacement is obtained with crystal-controlled digital countdown circuitry.

The nearest approach yet to a flat efficiency curve for a static inverter is achieved by a new Kinetics design. Even at a fraction of full load, good efficiency is obtained. The Kinetics unit is ideal for aircraft and missile applications in the range from 15 VA to 15 KVA per phase.

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Missiles and Rockets Volume 6 Number 12

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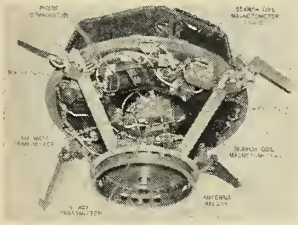
**COVER:** Crew works on mock-up of *Kiwi-A*, the nation's first nuclear rocket engine, at the Atomic Energy Commission's Nevada Test Site. A report on the status of this vital program starts on p. 18.



**PAYLOAD** of *Pioneer V*, mankind's first significant planetoid. The 94.8-lb. system has transmission more powerful than that of any previous space vehicle. A story on the historic launching begins on p. 12.

**REPUBLIC** scientist studies vegetables growing in low-pressure "lunar greenhouse" designed to show how astronauts might grow food. For a report on how Republic is expanding R&D to meet Space Age, turn to p. 14.

**STEEL** casting is poured in seven seconds at American Brake Shoe Co., where a process developed for power shovel fabrication has resulted in castings with 280,000 psi tensile strength. See p. 36.


# missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

*31,200 copies this issue*


## MARCH 21 HEADLINES



## PROPULSION ENGINEERING



## ASTRIONICS



## GROUND SUPPORT EQUIPMENT



## ADVANCED MATERIALS



## PRODUCTS AND PROCESSES



## THE MISSILE WEEK

U.S. Reg. Pdg.



## DEPARTMENTS


**KEARFOTT** developed and now produces the Bomarc-B all-attitude mid-course guidance system.

***Engineers:*** *Kearfott offers challenging opportunities in advanced component and system development.*

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*Other Divisions of General Precision Inc.—GPL—Librascope—Link*

# Washington Countdown

## IN THE PENTAGON

### Air Force space shots . . .

scheduled within the near future:

. . . The first launching of an R&D *Samos* reconnaissance satellite.

. . . The second launching of an R&D *Midas* early warning satellite.

• • •

### Tactical antimissile missiles . . .

are a growing Army requirement. The need is for a missile capable of downing Russian versions of U.S. *Sergeants*, *Honest Johns* and *Pershings*.

• • •

### Installation of Asroc . . .

antisubmarine missiles aboard surface ships is expected to cost more than $1 million for each system. The Minneapolis-Honeywell missile is expected to be operational next January.

• • •

### First undersea launching . . .

of a live *Polaris* is now scheduled for March 25 from an underwater launching pad off San Clemente Island. The Lockheed missile will have a cut grain, reducing its flight to only a short distance.

• • •

### Soviet IR spies . . .

are reported to be keeping watch on British *Thor* bases. The Reds are understood to be using infrared cameras aboard high-altitude reconnaissance aircraft.

## ON CAPITOL HILL

### Part payment . . .

for proposed congressional increases in spending for *Atlases* and *Polarises* may come from the hide of the *Bomarc* program. House Defense Appropriations Subcommittee members are honing their knives.

• • •

### The big question . . .

is whether Congress can bring enough political pressure on the Administration to spend extra dollars for more strategic missile power. Present indications are the Administration will spend some of the extra money but not all.

## AT NASA

### The return of *Vega* . . .

to the active list of NASA programs is understood to be a strong possibility. General Electric completed about a dozen of the 35,000-pound-thrust X-405 H upper-stage engines for the *Vega* program before NASA axed it. Now NASA may try to get back some of its money by using them.

• • •

### Old and battered things . . .

sometimes are best. *Pioneer V*'s payload, which had been picking up rust and dust at Cape Canaveral for months, had to be given last minute first aid. The *Able* upper stage used in the successful launching was the one damaged by faulty crane handling and removed from an ill-fated *Atlas-Able* vehicle last November.

• • •

### Opening day . . .

for the new Goddard Space Flight Center is scheduled for next August. All of the center's three buildings will be completed and occupied by November. The NASA budget allows for a 786-man staff.

## INTERNATIONAL

### Swedish space exploration . . .

will move forward on two fronts:

. . . The launching of sounding research rockets purchased either in the United States or Japan.

. . . Development of Swedish research rockets by Svenska Aeroplan Aktiebolaget for later space exploration.

• • •

### More missile ships . . .

will join the navies of five European nations. Britain, France, Russia, Italy and Sweden have announced plans to begin construction of missile ships or conversion of older ships for missiles this year.

• • •

### Purchase of *Skylarks* . . .

is reported under consideration in the United States. The British solid-propelled research rocket has a thrust of more than 11,000 pounds. The Royal British Aircraft Establishment manufactures it.

# VICKERS ECM COOLING SYSTEM plus

## 3M's FC-75 dissipates 47 kw input in 74 lb package

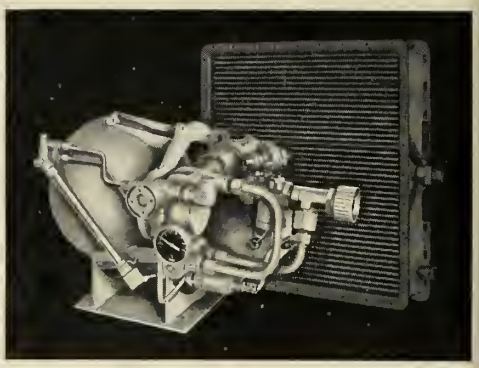
Vickers' 38 years of specializing in handling of fluids has been directed to "application-tailored" airborne cooling systems . . . reliable systems that are light weight and feature a broad range of flow and pressure characteristics.

This typical Vickers system circulates Minnesota Mining and Manufacturing Co.'s heat dissipating dielectric coolant, FC-75, through Sperry's advanced design electronic countermeasures system.

Heart of the Vickers cooling system is a single-stage, centrifugal pump that generates relatively low pressure and moves fluids at high flow rates. Because it is inherently simple in design, the Vickers pump offers high reliability and simplifies maintenance. Bearing design permits operation with fluids having low viscosities, in this instance FC-75, a fluordinated hydrocarbon.

Included in this package are safety interlocking devices for the protection of the pumping unit and ECM system. Maximum operating efficiency is assured even under unusually severe operating requirements. Such assurance stems from Vickers proven skills developed by long experience in designing and building components and systems for handling all types of fluid.

Write for Bulletin A-5244 for more details.



**PUMPING UNIT AND CORE.** Large airborne cooling system developed by Vickers' Aero Hydraulic Products division makes efficient use of 3M's FC-75 dielectric coolant to dissipate heat from electronic countermeasures equipment. Output pressure is required to be approximately 100 psi with fluid flow rates as high as 52 gpm. Operating range is from —65°F to 210°F. Pumping unit weighs 54 lb. dry and the heat exchanger core only an additional 20 lb. Sbown below is part of the extensive testing program conducted by Vickers to prove out the new design. It included extremes of heat and cold as well as vibration, shock, attitude and other physical tests.

8485

AERO HYDRAULICS DIVISION
**VICKERS INCORPORATED**
DETROIT 32, MICHIGAN

*division of*
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# Industry Countdown

## MANUFACTURING

### In the wind . . .

a procedural change in the way the Air Force tackles the development of new weapon systems. Starting late this year, ARDC will establish "Technical Forecasts" for industry, replacing the present Technical Program Planning Document and Applied Research Planning Document Release programs. The new "forecasts" will contain a summation of research to be done in a particular technical area, programed by years—enabling industry to plan far into the future to meet Air Force requirements.

• • •

### ARDC's new approach . . .

will be built around a three-step planning philosophy—basic weapon system studies, analysis of the systems under a Technological Force Structure Plan, and a Planning Objective Structure. Planning Objectives will have two dates; one for when applied research required by a new weapon is expected to be complete, and the second for when the weapon is expected to enter the operational inventory.

• • •

### Out-of-pocket outlay . . .

of $28 million for new research facilities caused United Aircraft's 1959 earnings to drop sharply. Earnings were $28.6 million on sales of $1 billion, compared to 1958 profits of $42 million on sales of $1.2 billion. The company, now moving into the solid rocket field, hopes to recoup in 1960.

• • •

### New entries in missile . . .

electronics field are Sunbeam Corp. and General Mills. Sunbeam is buying John Oster Mfg. Co. of Milwaukee for $13 million and General Mills is acquiring the Daven Co., Livingston, N.J., electronic component supplier.

## PROPULSION

### Failure in a generator valve . . .

in the second stage caused the unsuccessful flight of a *Titan C-1* fired March 7. During the second-stage engine start sequence, the valve failed to open and start sequence terminated. Flight continued along trajectory established by first stage.

### Three industry groups . . .

want the AEC to allow industry to convert and fabricate the uranium fuel elements for the Project *Rover* nuclear rocket. The Manufacturing Chemists Association, National Association of Manufacturers, and Chamber of Commerce are urging Congress to look into government competition with industry in the atomic field. AEC says the uranium is drawn from stocks maintained for nuclear warheads.

## ASTRIONICS

### Gyro drift rate . . .

for Air Force ICBM's, now set at a maximum of 0.0001%, is creating a fantastic accuracy requirement for the manufacturers of miniature precision ball bearings. Only six bearings are used in an inertial system, but manufacturers find they must produce more than 500 to get a half-dozen that are acceptable.

• • •

### Guidance packages . . .

could be produced in about three months, except for the bearing problem. They have a five-month lead time.

• • •

### Big counter-countermeasures . . .

push has been started by the Navy to protect the *Terrier, Tartar* and *Talos* missiles from jamming. A new study has revealed that "one or more portions" of these missile systems can be jammed by likely enemy countermeasures.

## WE HEAR THAT

### Rumors in Paris . . .

have Bell Aircraft negotiating with Nord for the U.S. license to make the *CT 41* Mach 2 target missile . . . The U.S. Army expects to be using upwards of 75,000 electronic emitters during the 1960's in field commands . . . Avien Inc. is making a double acquisition—Colvin Laboratories and Pressure Elements Inc., both located in East Orange, N.J. . . . The G. H. Leland Inc. has been pushing its solenoids and line of switch gear for missiles for years under the trade name "Ledex." As of April 1, the company has decided to drop its present name and take Ledex Inc. as a new title . . . Even big companies find the old saw "if at first you don't succeed, try, etc." pays off. A disclosure by RCA's Dr. N. I. Korman: RCA made more than 50 presentations to the Air Force before it was awarded the BMEWS prime contract.

# Liquid Hyperjet Passes Tests

## *Marquardt's combined rocket and ramjet engine with boron fuels proposed for advanced Bomarc, has other uses*

**by William J. Coughlin**

LOS ANGELES—A liquid-fueled hyperjet engine under development for the Air Force by Marquardt Corp. has been flight-tested successfully at Edwards Air Force Base, MISSILES AND ROCKETS has learned. The test vehicle was a modified Lockheed *X-7*.

The hyperjet is a combined rocket and ramjet engine which has been proposed for an advanced version of the Boeing's surface-to-air *Bomarc*. It also has application in the air-to-surface, target drone and space fields.

Flight test at Edwards has proved out efficiency of the engine for speeds of Mach 4-8.

Boron fuels have been employed to power the hyperjet, which is designed to combine the optimum performance of a rocket engine with the optimum performance of a ramjet in a single, integrated engine system.

Most of the test work has been on a small scale, although some large-scale testing has been carried out at Edwards. The test program has been short and relatively inexpensive, it was learned, but the performance demonstrated is said to have been attractive.

• **$I_{sp}$ doubled**—Marquardt says the hyperjet "delivers twice the average specific impulse of today's best rockets, permitting heavier payloads at minimum cost."

The company would not comment further on the engine or on the test program.

Work on the engine began under an Air Force contract because of its possible application to an advanced *Bomarc*. Its use would enable a surface-to-air missile to take off on rocket power at early warning of an enemy bomber or ballistic missile launch, cruise on ramjet power in the area where penetration was expected, and then revert to rocket power for the final attack.

Such an engine also could have an application in Project *CLAM* (chemical low altitude missile). Most promising field for the range-limited chemical hyperjet would be in an air-to-surface low-altitude missile. Its potential as a target drone is obvious.

Marquardt also is working with Grand Central Rocket Co. on a hybrid engine which employs a solid propellant in its rocket-ramjet combination and could be used in the above ways.

Most attractive space application of the hyperjet engine appears to lie in its use as a powerplant for a "space truck" which would carry material to an orbiting space station. This ability to make use of the earth's atmosphere would reduce costs well below those of conventional rockets.

• **Boron revival**—One of the most interesting aspects of the development of the Marquardt hyperjet has been its use of boron fuels similar to those scheduled for the chemically-powered version of the North American Aviation B-70 supersonic bomber.

(Plans for two large boron fuel plants were cancelled when the B-70 program was dropped. These were the Olin-Mathieson plant at Niagara Falls, N.Y., and the Callery Chemical plant at Muskogee, Okla.)

Virtues of boron hydrides as a fuel in the hyperjet engine include their high heat of combustion and relatively low-molecular-weight exhaust products. Boron is a relatively high-cost fuel which has to be justified by considerable gains in performance.

Raw material for the fuels is borax; U.S. Borax is the major producer.

Boron fuels can be produced in either liquid or solid form, depending on the mission. U.S. Borax Research Corp. currently is carrying out work under two classified Air Force research contracts for Air Research and Development Command.

One contract is for continuing research on high-energy fuels of the type slated for B-70 use. The other is for the study of boron-containing components for use in high-impulse solid-rocket propellants.

• **Big advance**—Use of liquid fuel in the Marquardt hyperjet marks a considerable advance in the field of rocket-ramjets. Earlier engine combinations employed a solid-propellant rocket propulsion unit to accelerate the ramjet to its operating velocity, when it used a liquid fuel to become self-sustaining.

Use of liquids permits the design of a controllable rocket engine which can be shut down when ramjet operating velocity is reached and then restarted when the vehicle leaves the atmosphere, or is called upon to resume rocket operation for any other reason.

The outer case of the rocket unit in the hyperjet serves as the central contoured surface of the ramjet inlet and is aligned within the inlet for proper establishment of the shockwave. The rocket unit fires through the ramjet combustion chamber and nozzle.

Flame from the rocket nozzle is used to ignite the air/fuel mixture of the ramjet engine. Ignition must, however, occur early enough to prevent overheating of the ramjet's fuel injector and flame holder by the rocket blast.

## Traveling Hound Dogs

**A FLYING launch pad, this Boeing B-52G Stratofortress can destroy three targets in one mission; two with the *Hound Dog* missiles under the SAC bomber's wings, and a third with the regular bombload.**

# 15 Quit Von Braun Team To Join New Belock Facility

**By Paul Means**

Belock Instrument Corp.'s announcement Wednesday that the company had hired a team of 15 Huntsville German scientists headed by Dr. Frederick K. Mueller, deputy director of the ABMA Guidance and Control Laboratory, precipitated a minor storm in the space and missile field, including the following:

- ABMA issued a corollary statement that the Huntsville NASA division has received no resignation from Dr. Mueller, or from any other member of the guidance and control laboratory;
- Dr. Mueller at first denied that he had accepted the Belock offer.
- Dr. Wernher von Braun, in Washington to testify before Congress, declared that NASA's new George C. Marshall Huntsville facility which he heads as chief scientist no longer required the services of Dr. Mueller or his associates, and said he doubted that Belock's new Huntsville subsidiary would do any business with his team or the Army.

The Belock statement said the company was establishing a new facility at Huntsville called Astro-Space Electronics Corp., headed by Dr. Mueller and a "team of German-born scientists."

A Belock spokesman told M/R that besides Mueller there were about 15 other German scientists including original Von Braun team member Heinrich Rothe, Chief of the gyro and stabilizer plant of the Guidance and Control Laboratory, and his brother Wilhelm Rothe, also of the Guidance and Control Lab. Very few of those joining Belock are original Von Braun team members.

The Belock announcement said its Huntsville facility will "conduct a research and development laboratory in every phase of the guidance and control field, and is being financed by the New York firm of Karl N. Loeb, Rhodes Co. Original outlay, according to a Belock spokesman, will be $1 million.

Contacted four weeks ago by M/R about his future association with Belock, Dr. Mueller termed the story a "lie" and intimated he would sue if it was printed. Wednesday, after the Belock announcement, Dr. Mueller said he had not handed in his resignation, but that "circumstances led me to consider this offer seriously."

Contacted in Washington where he is taking time out from a vacation to appear before the House Appropriations Committee, Dr. von Braun said that the news did not come as a surprise to him. Belock and the Mueller team had been negotiating for some time, he said.

The German space scientist said Dr. Mueller and his associates were experts in gyro platforms. With the transfer of his organization from missiles to space vehicles and from the Army to NASA, Dr. von Braun said there was little need for his team to do future extensive work in this area.

He said he thought it was a mistake for Belock to establish its new facility at Huntsville, "at least if they expect to do business with us."

"We have done business with Belock," he said, "and I think it would be well to add that we have no plans to do further business in the future."

What Belock gains by hiring his ex-associates, Dr. von Braun said, was a capability in gyro-stabilizers.

# EIA Hears DOD Budget Defense

The Defense Department has to make some "hard choices" but it comes up with the right answers in safeguarding the national security, a top-level Pentagon official told the Defense Market Planning Seminar in Washington.

John M. Sprague, Deputy Assistant Secretary of Defense, vigorously defended current DOD budget requirements and spending, pointing out that they have been equated with a multitude of national and international considerations.

The seminar, a prelude to the annual three-day spring conference of the Electronics Industries Association, sought answers to the problem of how to get "more defense per tax dollar." More than 400 representatives of the industry, military and government attended the two-panel daylong meeting.

Sprague said the crux of the problem within the executive branch is to strike a proper balance, in terms of priorities, among military requirements, space exploration, civilian needs, future economic growth, the tax burden, debt management, etc. The Defense Department must provide for national security —but within the available resources.

"There is no question but that the 1961 budget reflects some very hard choices. But in the judgment of the President and the Secretary of Defense the 1961 defense budget does provide for those programs which are essential to our national security."

In discussing our changing defense market, J. H. Richardson, Hughes Aircraft Co. marketing director, stated that electronics and propulsion today have taken on strikingly greater significance and in fact have become the main segment of the new military missile/space market.

Other panelists were Dr. L. E. Root, Lockheed; Dr. R. C. Raymond, General Electric; Col. E. C. Lavvier, Air Research and Development Command; and Dr. H. Wilcox, deputy director of research and engineering, DOD. Sidney R. Curtiss, Stromberg-Carlson, was Panel Chairman.

- **Other highlights**—An increase from 14 to 20% of total defense expenditures for electronics during the next 10 years was predicted by Rear Adm. L. D. Coates. This, he said, would amount to $2.4-billions of additional business for the industry. (Figure is based on a constant total defense budget.)

He also called on industry to strive more for "healthy diversification" to minimize risk and provide more stability. This spread should be in the defense market as well as the consumer market. Finally, he emphasized the need for more company-sponsored research and improved reliabilities at more sensible prices.

As evidence of the steady upswing in electronics requirements, Brig. Gen. E. L. Littell, Commanding General, U.S. Signal Supply Agency, estimated that the field army of the 60's will be equipped with over 75,000 electronic emitters—2.5 times that used in World War II.

To get the most out of its Budget, he said, requires more understanding between the military and industry. The major problem is an intelligence gap. More avenues of communication, both horizontal and vertical, are needed to better pool resources, know-how, creativity, and producibility.

"The quantity and quality of information that can be obtained from the military by any industrial firm varies directly with the quantity and quality of its effort or contribution," said RCA's Dr. N. I. Korman.

The paradox is justified, he said, because no company can expect to be merely a sponge—always seeking and absorbing without giving in return. The amount of information received on a "need-to-know" basis represents not only the degree of confidence in the company held by DOD officials, but the return the military might reasonably expect by sharing data.

*first meaningful planetoid . . .*

# *Pioneer V* Narrows the Space Gap

## *Third try with Thor-Able vehicle brings successful orbit of payload with unprecedented transmission power*

The belated but highly successful launch of *Pioneer V*, March 11, helped to close the gap between the U.S. and Russia in the race for space accomplishments.

Though preceded by *Lunik I* and *Pioneer IV* into orbit around the sun, the 94.8-lb. *Thor-Able*-launched payload is man's first significant and useful planetoid.

Three major "first" to be accomplished by *Pioneer V* are:

- The first payload to send back information from outside the earth's gravitational field and to relay information from and about the solar system;
- A new tracking record (the old record was 407,000 miles by *Pioneer IV*); the payload should be able to send back receivable signals for about five months during the first half of its journey around the sun (over 250 million miles), and until it reaches a distance greater than 50 million miles from earth.
- The first payload to be placed in a solar orbit inside the earth's own orbit.

NASA announced soon after launch that the payload's instruments and transmitters were all in working order. Jodrell Bank and other larger radio telescopes were receiving strong signals.

• **Third try success**—*Pioneer V's* successful launch came after 10 months and two unsuccessful attempts. NASA originally scheduled the shot last June when Venus would have been in the most desirable location for intersection. This shot was called off because the payload was not ready. A December attempt also ended in failure.

Original intent was to place the payload in a trajectory that would take it close to the orbit of Venus at perihelion. This is a difficult feat: an error in the rocket's velocity of only one mile per hour, would have missed the orbit of Venus by as much as 60,000 miles. Actual error was 120 feet per second at burnout (36,480 feet per second), meaning that *Pioneer V* will come within 7.7 million miles of Venus' orbit.

This was the first time in three attempts the BMD-STL *Thor-Able* vehicle has achieved escape velocity. Its performance was highly accurate. First-stage burning time was within a second of normal; second-stage burning time was within a tenth of a second of normal; and third-stage burning time was also within a second of normal.

• **Instrument lead**—*Pioneer V* displayed to best advantage the U.S.'s strong point in the space race: though behind in thrust, payload weight, and possibly in guidance, the U.S. can pack more sophisticated instruments into smaller spaces.

This lead in electronics and instrumentation becomes significant on deep space missions where transmitters must be powerful enough to be received over millions of miles and instruments must take up a minimum of space.

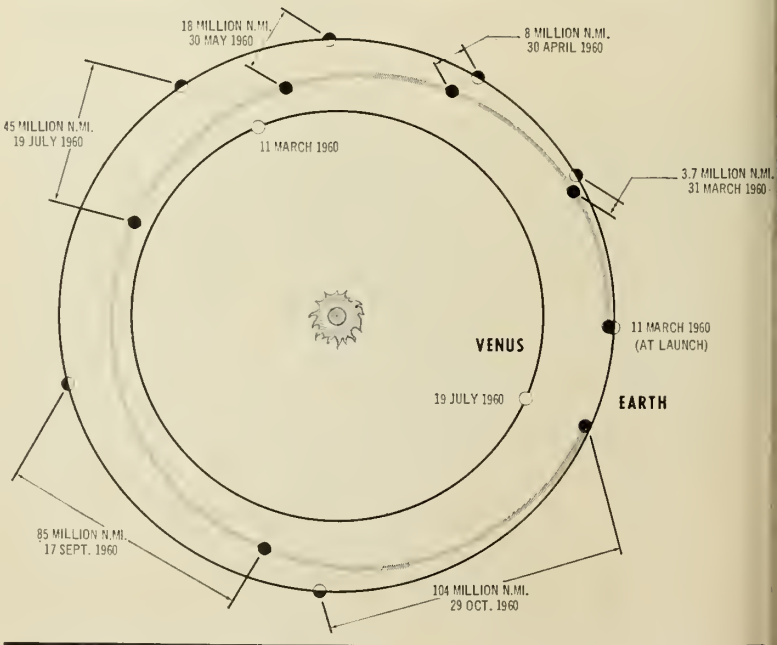
*Pioneer V*'s payload, designed by Space Technology Laboratories and similar to the "paddlewheel" payload of *Explorer VI*, has less than 10 lbs. of structure, 40 lbs. of instruments, and close to 50 lbs. of power package and solar cells.

• **Satellite's assignments**—The 26-inch diameter, top-shaped sphere is designed to study interplanetary gas and solar terrestrial relationships. (M/R, Oct. 19, p. 33).

Studies by Van Allen in earlier earth satellites indicated that the sun emits quantities of plasma gas into the solar system, some of which is captured by the earth's magnetic field to form belts of charged particles.

A one-half pound coil magnetometer developed by STL will study these streams for fields of gas. The instrument possesses a sensitivity of at least $10^{-5}$ Gauss.

The satellite will also study the magnetic fields of plasma globs floating through interplanetary space and try to determine the mechanism for the propagation and transportation of plasma




**FIRST SATELLITE to go into a solar orbit inside the earth's own orbit, *Pioneer V* will come within 7.7 million miles of the orbit of Venus.**

streams from the sun to the earth and into the rest of the solar system.

Other duties of the payload will be to observe meteorites and dust particles in solar space outside the earth's gravitational field, and to collect data on the sun's ultra-violet and X-ray regions. The correlation of all this information should give a clearer picture of terrestrial relationships.

Long-range communication with the satellite will make possible satisfactory triangulations with the sun, which will help to make a more accurate determination of the astronomical unit.

• **Instruments**—Specific instrumentation which would perform these tasks (besides the magnetometer) are a five-pound radiation counter developed by the University of Chicago's Fermi Institute which is able to measure both high-and low-energy charged particles, an ionization chamber and Geiger-Mueller tube developed by the University of Minnesota which measures the total radiation flux encountered, a micrometeorite counter, and an aspect indicator which triggers electrical impulses each time it looks at the sun.

STL has also developed a black and white paint pattern for the outside shell of the payload which will maintain desired temperatures of between 35 and 80°F inside despite the increased radiation of the sun as it approaches the orbit of Venus.

The black paint absorbs the radiation of the sun which causes a temperature rise while the white paint reflects the radiation cooling the payload.

Helping to transmit the information received by the satellite's instruments is a compact telemetric digital unit developed by STL called "Telebit." Designed to transmit information over interplanetary distances upwards of 50 million miles, this instrument collects, stores, and tallies data while the transmitter is off, and sends the totalled information by radio signal to earth when the transmitter resumes operation. The payload instruments and transmitters are designed to last for 2000 hours of continuous transmission, and the payload will transmit about five minutes out of every five hours.

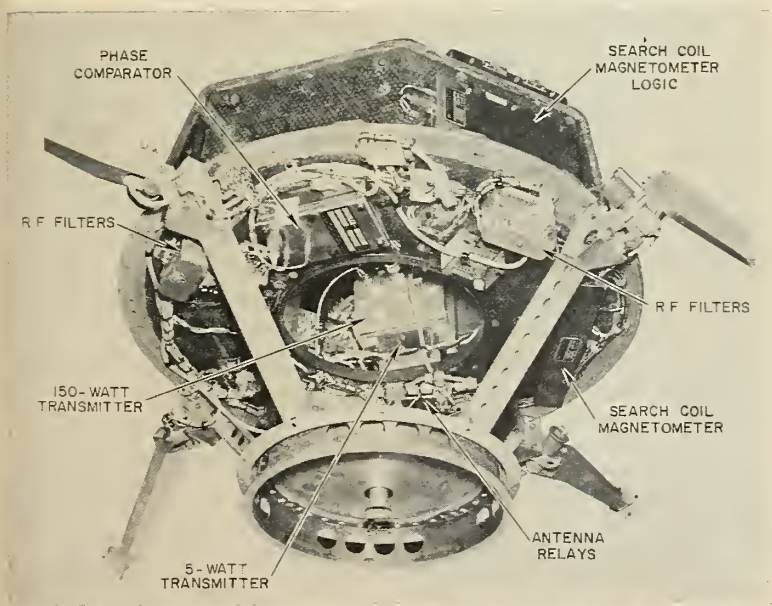
• **Potent transmission**—The great tracking distance to be achieved by *Pioneer V* is possible because its transmitting system is 30 times more powerful than that of any previous space vehicle. A five-watt UHF transmitter will function until the payload achieves a distance of about five million miles from earth. Then, upon command from the ground, it will become an amplifier for the 150-watt transmitter. Both operate on 387 MC. Lithium metal heat sinks control the transmitter's temperature.

Supplying power to the batteries and transmitters are 4800 solar cells made by Hoffman Electronics on the payload's four "paddlewheels." Though greatly reduced in number from the 8000 cells contained in *Explorer VI*'s paddlewheels, the closer distance that the payload will travel to the sun means that they should get 30 to 40% more intense solar energy.

An improvement to the *Able*'s guidance system for the *Pioneer V* shot was contributed by Space Electronics Corp. Under subcontract to STL, they produced a lightweight radio transmitter 10 times lighter than equipment previously available.

### Pioneer V Data

**Weight: 94.8 lbs.**
**Perihelion: 74,967,000 (Aug. 10)**
**Aphelion: 92,358,000**
**Period: 311.6 days**
**Orbit Path Length: 514,500,000**
**Mean velocity: 71,400**




**PROBE PAYLOAD of *Pioneer V*, with aluminum shell stripped away, looks like this. Near the earth, 5-watt transmitters is used; later, 150-watt unit takes over.**

## news briefs

**FIRST FIRING SUCCESS**—The Navy fired a test version of its *Corvus* air-to-surface missile in its first guided flight at Pacific Missile Range March 15, and reported that it was completely successful. The Temco missile was launched from an A3D jet at a surface target in the sea test area of PMR. Navy recently awarded Temco a $25-million contract for continued work on the missile, which uses a prepackaged liquid rocket engine.

**WAYWARD BIRD**—An Air Force *Matador* veered off course in a test firing and crashed into Formosa Strait near the Red Chinese Mainland, a military spokesman disclosed. He said the firing took place in January.

**IRBM's IN ITALY?**—*Jupiter* IRBM's were reported in Rome to be already installed "somewhere in Italy." U.S. plans call for turning over two 15-missile squadrons of *Jupiters* to the Italians.

**AICBM DEBATE**—Dr. Herbert York, Pentagon R&E Chief, said many top defense officials have "considerable doubt" that the *Nike-Zeus* antimissile missile will ever be able to discriminate between decoys and incoming warheads. The Army has insisted that *Zeus* will be able to pick out warheads.

**SWITCH URGED**—Deputy Defense Secretary James H. Douglas told the House Space Committee that the Civilian Military Liaison Committee should be abolished and an Activities Control Board put in its place. The main difference would be the elimination of a chairman.

**RENAMING** — President Eisenhower named the new NASA facility at Redstone Arsenal, Ala., for the late General of the Army George C. Marshall. The former ABMA Development Operations Division will be known as the George C. Marshall Space Flight Center.

**COMPLAINTS TO BE HEARD**—A House Government Procurement Subcommittee will hold hearings March 29-31 on charges by small firms that they are forced to give up trade secrets and technological data because Defense Department contracting officers allegedly require the information.

# Republic Takes Out Space Insurance

## *Company meets stiffer requirements and competition for defense orders by building $14 million worth of R&D labs*

**by William Beller**
**M/R Contributing Editor**

FARMINGDALE, L.I.—In May, Republic Aviation Corporation will dedicate a $14-million Research and Development Center at its headquarters here. Within five years the company expects to be putting $21 million more into the facility for salaries and additional equipment.

Republic is making this large investment in itself as insurance that it will continue to get Defense Department business.

Republic's way is just one means of buying such insurance. Other companies with different management philosophies see other ways. Some buy concerns outright to fulfill capabilities the parent company lacks. And, of course, there are purchases of controlling interest, mergers, joint proposals, or promises of subcontracts to highly knowledgeable cooperating companies.

Whatever the method, this much is clear: major defense contractors from now on will be continuously broadening their scope and lengthening their view—or they will no longer be major contractors.

This is a change from the way things used to be. During World War II, in the flush of the mass production of aircraft, R&D was considered time-consuming and costly. "Besides," said a then prominent aerodynamicist, "how much more performance can be squeezed out of an airplane?"

With the help of the engine manufacturer, the propeller manufacturer, and wind-tunnel reports from the National Advisory Committee for Aeronautics, the airplane designer had a fairly easy life. R&D took only a small part of his worry and the weapon dollar.

Today, in the instance of the *B-52* —which probably will be the last mass-produced large military airplane—we are experiencing R&D costs that have shot up to 20% of the weapon dollar.

In the missile field, R&D costs skyrocket. For the Convair *Atlas* ICBM, they amount to about 60% of the missile's cost. When we look at space systems, we see the hardware costs of the Project *Mercury* capsules probably amounting to only 10%, of the money allocated. The 90% goes for R&D.

• **Expand or quit**—in 1958 the handwriting on the wall was clear to Republic, as it was to other companies who wanted to stay in the defense field. Since the end of the Korean war, Department of Defense annual expenditures for R&D had risen about a billion dollars: $1.4 billion spent in Fiscal 1953; $2.4 billion estimated for Fiscal 1959.

The direct stimulus for Republic's R&D expansion came from two factors: (1) the Air Force's "Weapon System Requirement Studies" plan, and (2) a flood of competitors from non-aircraft companies.

Under the Air Force's new plan, the service in 1956 began demanding studies in depth as a preliminary to contract negotiation for advanced weapon designs. This meant that a company must now show a weapon system capability before a contract was awarded rather than after, which had been the practice.

The military's reason was plain. Large-scale aircraft production was falling while missile and space vehicle work was rising fast. Novel and untried weapons systems were being proposed. The least that could reasonably be asked were feasibility studies on the part of the manufacturers.

The high cost and short life of space hardware demanded a high probability of success. This was more reason for much pre-contract study. The result was that the contractors were going to play heavier and more responsible roles in weapon system development.

• **New faces**—Republic knew that to remain vital it must also recognize many new faces. In the 1950-53 period, the company counted only nine major competitors in the aircraft and missile field. In 1958 the count was pressing 40. It was easy to see why.

**IF ASTRONAUTS are going to stay long on the moon, they may have to raise their own food. Anticipating such a need, Republic has turned to raising carrots, beets, snap beans and turnips in a low-pressure "lunar greenhouse."**

The missile and space field with its problems of guidance, communications, and telemetering was fertile ground for electronics concerns. The propellant field was welcomed by major chemical concerns. Ground support equipment was of high interest to automotive companies—and such interest could be easily expanded to encompass the vehicle.

Competition came from organizations that wanted to diversify and felt that on the frontiers of technology they could more easily stake out their claims. Universities with academic talent were entering the picture, and also non-profit organizations whose claim to consideration, among others, was "objectivity."

It was true that the aircraft abilities developed by Republic over the years would hold the company in good stead competitively. Rapidly, though, novel problems were coming up. These were ones unfamiliar to the aerodynamicists, to the stress analysts, to the systems designers. These were ones in human factors calling for psychologists and physiologists, in radiation studies calling for nuclear physicists and applied mathematicians, in space exploration calling for astrophysicists.

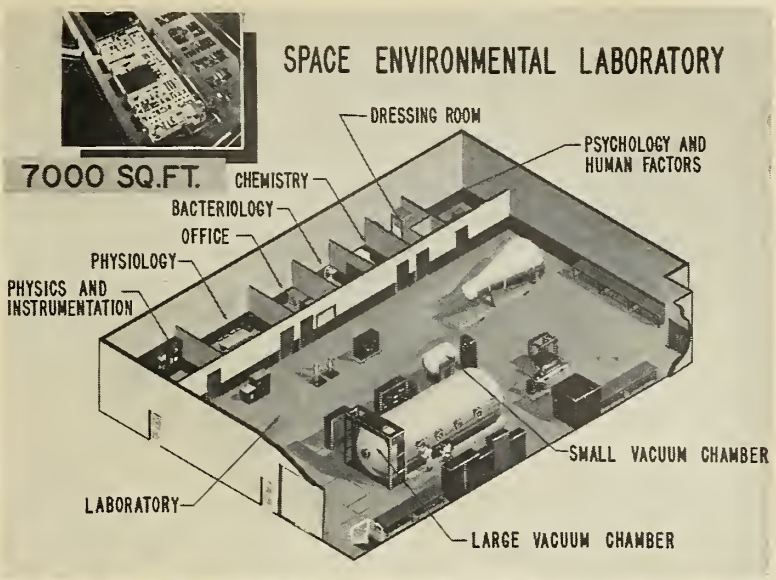
Where such specialized talents were needed, small companies often had the advantage. The owners were usually the experts; they needed only small capital investments; they were well known in their field, knew their field well, and could concentrate on developing segments of studies that major companies were ignoring.

Thus there arose scores of organizations in operations research, systems analysis, human factors, and applied mathematics. Also there was an avalanche of new firms entering the electronics field. Here in many instances only a moderate investment was needed, especially for one-product companies. These incidentally, could eventually get R&D money to grow on.

• **Fast start**—It was in such a climate, in 1958, that Republic proposed to its board of directors that an R&D facility comprising several laboratories be built. The idea was unanimously approved and money appropiated. Spark-plugging the effort were company president Mundy I. Peale and R&D vice president Alexander Kartveli.

Each laboratory was designed to be able to solve one major set of Space Age problems. The group of laboratories, each contributing its knowledge to weapon system studies, proposals and contract fulfillment, could enhance considerably Republic's defense capabilities.

Each of these laboratories would be seeking R&D contracts for itself.



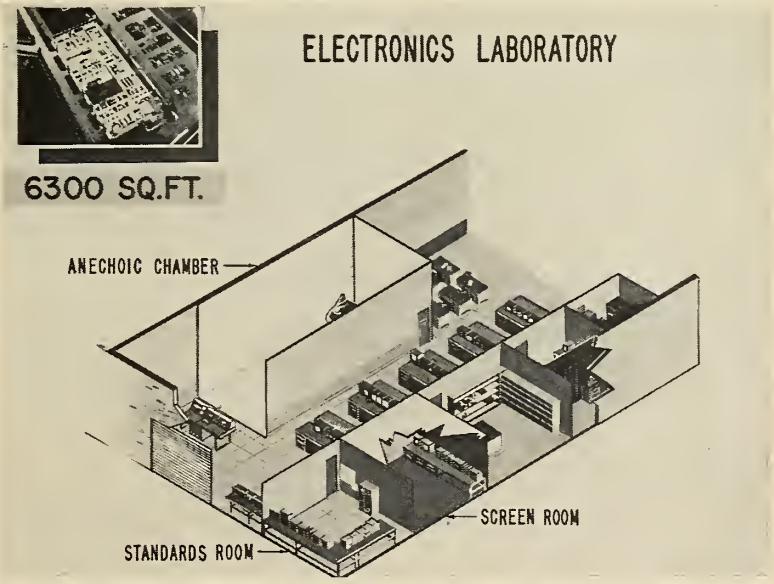

**FOR SPACE environment and life sciences studies, the laboratory features a large vacuum chamber which is able to test men up to a simulated 100 miles' altitude, and equipment up to 150 miles.**

Republic wants these units to be competitive with all companies, small or large. Only in this way can the parent company be assured it is abreast of modern technology, that it has the most recent data in its contract proposals and, perhaps, that it has a research laboratory paying its own way.

To compete effectively with the smaller companies, each laboratory is being staffed only by highly qualified personnel. They will have professional working conditions, will be given the latest laboratory test equipment, and will be encouraged to do original research that will promote the broad objectives of defense.

The company freely admits that its major research effort is contract-directed. Basic research—research whose sole purpose is to push back the boundaries of existing knowledge—is felt to be more appropriate to an academic atmosphere.

Suiting the deed to the belief, the company this past January gave 25 acres of its Farmingdale land to the Polytechnic Institute of Brooklyn. On




**ANECHOIC CHAMBER will be used for antenna work, the screen room for noise-free testing, and the standards room for referencing electronic measurements.**

**RESEARCH AND Development Center costing $14 million will be dedicated by Republic in May. The two-story front is for offices, one-story rear for seven of the eight laboratories.**

this site the college will build a research center for 1000 graduate engineering students and faculty.

With these men so close to Republic's new Center, it is certain that basic research will be inoculating applied research, to the advantage of each. In addition, advanced studies by Republic engineers and scientists will be a matter only of walking across the yard to classes.

The company is determined to be a major supplier in the aerospace field. It eschews any suggestion to diversify out of it. "There's a lot of space to explore," an engineer said, "so why should we dilute our efforts?"

• **Three markets**—over the next several years Republic will be looking for its business in three directions: aircraft, missiles and spacecraft. This is considered a safe and logical way for the company to proceed.

Its experience in the aircraft field led to the development of the much-applauded F-105 fighter-bomber, the Thunderchief. Second and third generation F-105s are being developed and the company has an intensive V/STOL program going on with Air Force contracts in mind.

The company is also making a systems requirement study for the Air Force of supersonic cargo transports. Out of this work Republic sees a chance to enter the commercial field for the first generation of supersonic airliners.

The company's Missile Systems Division is seven years old and in terms of work load is already mature. The largest contract is a $30-million one from the Army Signal Corps for a supersonic surveillance drone. Now being contemplated are an air-to-surface ballistic missile family, an anti-ICBM system, and development of antisatellite missiles.

In the spacecraft field, Republic is launching studies for the conventional miracles: vehicles for circumlunar missions, moon exploration, space platforms, and interplanetary vehicles.

We have a picture then of Republic Aviation stocking up on all the ingredients basic to the Space Age, but at the same time ordering fresh aircraft types for the more pedestrian but paying customers.

The guide line for the Research and Development Center was to keep it versatile and flexible. It had to be able to adapt easily and quickly to changing requirements in accord with a fast moving technology. The rule then was to invest in adequate but not elaborate facilities but be ready to build around a stable nucleus should an occasion call for it.

In its choice of laboratories for the Center may be read Republic's emphasis and also where the company feels her future lies. There are eight:

**Space Environment and Life Sciences.**
**Re-entry Simulation.**
**Materials Development.**
**Nuclear Radiation.**
**Electronics.**
**Guidance and Control.**
**Fluid Systems.**
**Wind Tunnel.**

The Center building is 500 ft. long by 150 ft. wide. It is two stories in front, one in back. The front of the building, having 67,500 square feet of floor area, will house the administrators together with the engineers and scientists not needing laboratory space.

In the rear of the building there will be 53,500 square feet of floor for the laboratories. There will be about 375 professional people in the building and 75 non-professionals.

• **Space Environment and Life Sciences.** Space conditions will be simulated for studies of man, materials and components. For testing men, laboratory equipment will duplicate pressures equivalent to those up to 100 miles above the earth's surface; and for testing materials and components, up to 150 miles. Effects of radiation on materials and components will be studied by exposing the vacuumized chamber to X-rays.

• **Re-entry Simulations.** A plasma jet system able to hold continuously 27,000°F will be duplicating temperature conditions existing during re-entry. A Mach 20 wind tunnel reaching 18,000°F will be used for studies in heat transfer, gasdynamics and hypersonics. Provisions are also being made for experimental work in magnetohydrodynamics.

• **Materials Development.** This laboratory will be studying the behavior of materials placed in drastic environments. Typical work will be (1) developing a surface treatment that will enable skin materials to withstand the rigors of rapid re-entry; (2) determining effects of precipitous temperature changes such as those that could arise in a space flight; and (3) learning properties of proposed new materials.

• **Nuclear Radiations.** With facilities that include two high-capacity hot cells with cobalt source, scientists will be studying radiation effects on materials, fluid power systems and electronic components. A low-level radiochemistry unit and counting room will be used for work in isotope utilization, basic dosimetry and general measurements.

• **Electronics.** Besides looking into systems being developed for company projects, the engineers will be working on vertical take-off (VTOL) blind landing systems, interspace communication systems, and advanced instrumentation. There will be on hand, besides standard equipment, an anechoic (anti-echo) chamber for antenna studies, a screen room for noise-free measurements, and a primary frequency standard accurate to 1 part in $10^{-8}$.

• **Guidance and Control.** This laboratory will be testing existing guidance system components. It will also be developing new navigation and guidance aids for aircraft, missiles and spacecraft. Further, it will be evaluating optical and infrared detection and reconnaissance systems.

• **Fluid Systems.** This laboratory will make studies and component developments in advanced fluid systems, liquid and gas, for application to high-performance craft.

• **Wind Tunnel.** The tunnels will give aerodynamic data, including flutter, to the designers. There will be two blowdown units operating, one for supersonic work and the second for transonic. This laboratory is adjacent to the Center.

Neither the laboratory facilities nor their programs are rigid. If they were, the purpose of the Center would be defeated.

# SAC has a Hound Dog that can slalom in the sky

SAC'S GAM-77 HOUND DOG air-to-ground missile has a built-in artifice. It can feint at pseudo-targets before turning toward its real objective. This dog-leg "slalom" approach is made possible by an inertial navigation system that is immune to enemy decoying and jamming.

Speed and altitude variations can also be programmed into the HOUND DOG'S target approach. This gives the GAM-77 even greater versatility for penetrating an enemy's defenses.

Armed with a HOUND DOG under each wing, a SAC B-52 bomber attains triple-threat capability. From a distance of hundreds of miles, enemy resistance posts can be obliterated while the B-52 wings its internal bomb load to destination. As an alternative, the supersonic HOUND DOGS can be sent right in on the main target itself.

Alternate HOUND DOGS are now being assigned to Air Force "Blue Suit Integration" crews for training use. In combination with SAC'S B-52 intercontinental bombers, they materially enhance America's strategic air power.

**MISSILE DIVISION**
**NORTH AMERICAN AVIATION, INC.**
Downey, California

# Nuclear Rocketry: How Are We Doing?

## *Upcoming Congressional hearing may result in calling in industry to speed development*

**by Jay Holmes**

Controversy over the timetable and the means of developing America's first nuclear rocket—muffled until now by security classification of the pertinent facts—should break fully into the open this week. Further, there's the possibility that an industry contractor will be brought in to speed development.

At stake in a hearing before the Joint Congressional Atomic Energy Committee March 24, is a propulsion system capable of carrying a crew of explorers to the moon—and perhaps later to Mars and Venus. The specialists agree that nuclear propulsion systems will be lighter and less expensive than chemicals for carrying heavy payloads, for traveling long distances or both.

As the struggle behind closed government doors gradually emerged into public sight last week, three viewpoints became apparent. Those choosing sides in the debate are lining up behind:

- A high-gear program to fly a nuclear rocket as soon as technology will allow—backed by many Atomic Energy Commission officials and Sen. Clinton P. Anderson (D-N.M.), chairman of the Atomic Energy Committee. Anderson has proposed bringing in an industrial contractor soon.
- A program calling for full-speed ground testing but a more cautious approach to flight testing—favored by some officials of the National Aeronautics and Space Administration.
- A slowdown—proposed by the Bureau of the Budget.

Two high AEC officials close to the nuclear rocket program—Brig. Gen. Irving L. Branch and Col. Jack L. Armstrong—have said the AEC could develop nuclear propulsion for a manned moon expedition in less than 10 years if such a requirement were given them. Armstrong said he spoke in terms of a 20,000-lb. payload.

Two NASA officials—Deputy Administrator Hugh L. Dryden and Harold E. Finger, chief of nuclear engines, have reported their agency wrote to the Budget bureau urging that AEC be permitted to conduct ground testing as fast as technology allows. However, Dryden said a manned moon expedition would be impossible in this decade regardless of progress in propulsion. Solving the problems of re-entry from a lunar distance will take longer than 10 years, Dryden predicted.

Budget Bureau officials maintained their customary silence. However, word got out that the bureau softened its slowdown stand following an appeal by AEC Chairman John A. McCone.

**CONVAIR'S Krafft Ehricke's concept of a spaceship powered by a nuclear rocket.**

The controversy over the nuclear rocket—Project *Rover*—was brought into the open by Sen. Anderson a week before his committee held a closed hearing Feb. 15. He issued a statement after the first hearing and more facts came to light when the House Committee on Science and Astronautics took open testimony Feb. 26. Still more are expected when the Atomic Energy group holds its open hearing on *Rover* Thursday as part of a four-day series, "Frontiers of Atomic Energy Research."

Sen. Anderson has proposed that, to speed the *Rover* development, complete responsibility be assigned to the AEC through the flight test phase, an industrial contractor be brought in soon to work with the AEC's Los Alamos Scientific Laboratory and the first flight test be scheduled for 1964 or as soon as possible thereafter.

- **Technical controversy**—In addition to the political dispute over funding and schedule, a second argument—largely technical—has nuclear propulsion experts divided. This latter dispute concerns the nature of the first flight test—likely to be conducted in the mid-1960's. One group favors a direct launching from the ground. Another group prefers that the first test be from orbit.

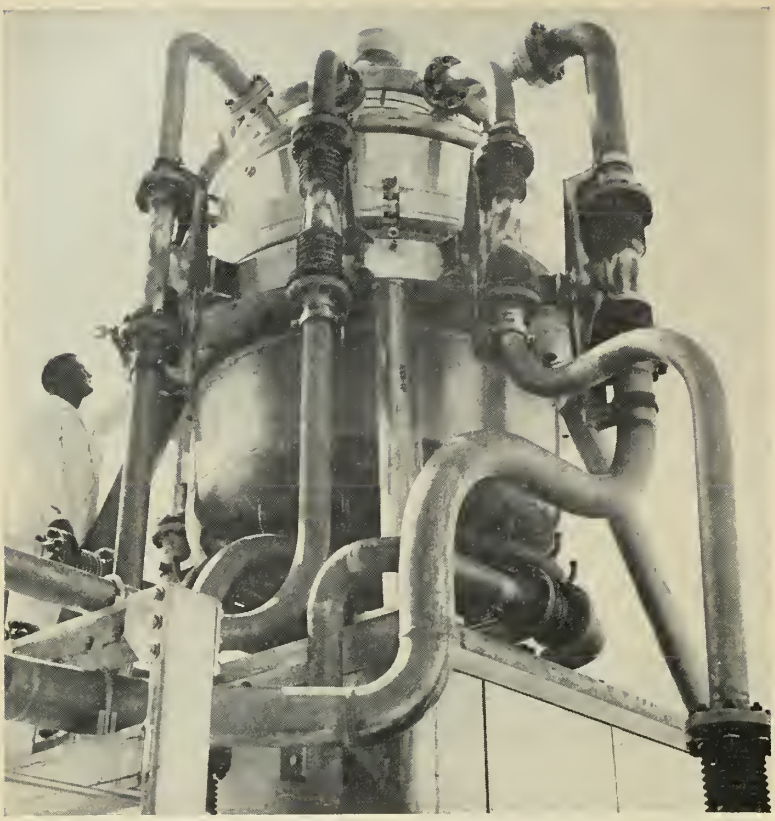
In general, AEC officials prefer ground launching while NASA's tend to favor orbital start. However, neither agency is unanimous.

Although discussions center on technical points, the argument is by no means purely technical. The AEC's Armstrong maintains stoutly that ground launching is the surest way to the first accomplishment of a feat that he says will command tremendous international prestige—the first nuclear-propelled flight in space. "I'd like to see the Stars and Stripes on this one," Armstrong told the Science and Astronautics Committee.

NASA's Finger contends that in the long run more prestige will come to the


***AC Seeks and Solves the Significant***—With GM's support, AC is taking giant strides toward leadership in the international technological race. And AC Reliability—characteristic of every aspect of AC's operation—plays a large role. It results in such successes as AChiever inertial guidance for Thor . . . and the more sophisticated AChiever being built for Titan./ This is AC QUESTMANSHIP. It's the scientific quest for new ideas, methods, components and systems . . . to promote AC's many projects in guidance, navigation, control and detection./ To Mr. Harold C. Yost, AC Director of Reliability, Questmanship is "the direction of scientific disciplines to achieve optimum reliability." His group constantly seeks improvement, "making creative contributions in every area from basic design to field operation". That takes engineers with broad knowledge, imagination and experience./ You may qualify for our specially selected staff . . . if you have a B.S., M.S., or Ph. D. in the electronics, scientific, electrical or mechanical fields, plus related experience. If you are a "seeker and solver", write the Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, Box 746, South Milwaukee, Wisconsin.

***GUIDANCE / NAVIGATION / CONTROL / DETECTION / AC SPARK PLUG*** *The Electronics Division of General Motors*



**CLOSEUP OF the experimental model of America's first nuclear rocket engine, *Kiwi-A*, before its first full-scale test at Jackass Flats, Nev.**

nation that accomplishes experiments more nearly related to the eventual scientific use of a nuclear rocket. "I think the first practical use of a nuclear rocket will be as an upper stage of the *Nova* vehicle," Finger said.

Armstrong, deputy chief of the AEC's Aircraft Nuclear Propulsion Office, has proposed the construction of the first flyable *Rover* by the mid-1960's. AEC calculations call for a bird weighing 40,000 lbs., with a rocket generating 52,000 lbs. thrust at liftoff and continuing for more than five minutes. The device would carry a 1000-lb. scientific payload to an altitude of about 1000 miles. Unprotected by a nose cone, the vehicle would be destroyed upon re-entry into the atmosphere.

Finger said he believes the first nuclear rocket can be flown just as quickly if it is started from orbit. But even if the orbital flight plan should cause a delay of as much as a year, the NASA official said, he still would prefer it.

• **Project review**—Sen. Anderson reviewed the history of Project *Rover* in a statement he issued at the close of the Feb. 15 hearing. He reported that:

• The project began in 1955 as an AEC-Air Force program, with a 1960 target date set for completion of the engine's feasibility ground tests. In 1957, Secretary of Defense Charles E. Wilson downgraded *Rover*'s priority, reduced its projected funding level and stretched out the time schedule. The feasibility ground tests were rescheduled for 1963.

• The AEC successfully conducted its first test of a reactor device for *Rover* last summer.

• This winter, the program was stretched out again. At the instance of the Bureau of the Budget, President Eisenhower moved the feasibility test back to 1964. Funds requested by the AEC for the 1961 fiscal year were reduced by $12.8 million—about 31%. Mr. Eisenhower's 1961 budget called for $28.5 million for nuclear rocket propulsion—$23 million for the AEC and $5.5 million for NASA—which had taken over the original Air Force role of responsibility for developing non-nuclear components of the vehicle.

NASA announced at about the same time the broad outlines of a 10-year program of expected progress in rocketry. The program included no mention of a nuclear rocket. NASA spokesmen said it was not included because they did not feel sure an operational nuclear rocket could be developed within a decade. The first launching of the *Nova* booster—with its six to nine million lbs. of chemical thrust—was set for fiscal 1968 with two more the following year.

Anderson said before the hearing that he had believed *Rover* would be speeded as a result of last year's successful experiment. "But instead," he said, "we seem to be moving into a period of stretch out, indecision and drift comparable to the aircraft nuclear propulsion project."

The senator said the committee's examination would include the effect of security classifications.

"I have difficulty seeing how this project can be classified when the military have set no requirement for it and NASA does not even mention it in its 10-year program," he said.

Following the first hearing, committee sources said AEC officials defended the security classification on the ground that America still seems to be ahead of the Soviet Union in nuclear technology.

However, the *Rover* development schedule was declassified in part. Anderson reported that the Budget Bureau had increased its spending authorization for *Rover* in Fiscal Years 1961 and 1962 after an appeal by AEC Chairman McCone. However, no more money was allowed. The AEC had requested $20 million for construction in the 1961-62 fiscal years. The Budget Bureau cut this to $13 million. After the protest, the AEC was told that the other $7 million might be shifted to *Rover* by re-programing.

On March 8, Anderson made public a letter from John F. Floberg, acting AEC chairman, disclosing that the commission had reprogramed to add $8 million in construction funds and $3 million in operating money to *Rover* for fiscal 1961.

For the construction funds, $4.4 million was taken from Eniwetok Proving Ground construction, $1.9 million from the Tonopah Test Range in Nevada and $1.7 million from additions to the electrical power system at the National Reactor Testing Station, Arco, Idaho. The operating funds were taken from the Euratom program.

At the Science and Astronautics Committee hearing Feb. 26, NASA's Dryden and Finger testified they had supported the AEC's proposed schedule in a letter to the Budget Bureau. Afterward, MISSILES AND ROCKETS asked Finger whether NASA had supported AEC's request for the funds necessary to carry out the schedule.

"No," he replied. "We did not feel it was up to our agency to say whether the AEC budget should be $2.6 billion

or $2.61 billion."

• **Transfer considered**—Sen. Anderson has said the Joint Committee on Atomic Energy will consider whether *Rover* should be transferred entirely to the AEC.

"I frankly doubt that very effective administration of a project of this nature can be achieved through policy direction provided by an inter-agency coordinating committee," Anderson said in letters to McCone and NASA Administrator T. Keith Glennan. "I believe that one man and one staff should provide the overall project direction as has been done with the case of the nuclear submarine under Vice Admiral (Hyman G.) Rickover . . .

"But the most important thing to get this project 'off the ground' is that there must be a genuine sense of enthusiasm and urgency at the highest levels to give impetus to the project."

Anderson said he was heartened by the AEC's support of the project, "I only wish," he added, "that the rest of the Executive Branch, and particularly NASA and the Bureau of the Budget, would show a greater interest."

What is the mission of a nuclear rocket? The first point that must be made clear is that nuclear propulsion is justified primarily by its potential capability of delivering large payloads, of traveling long distances, or both.

Industry points out that if you think big in space travel, you must think in terms of nuclear propulsion. A nuclear reactor and its shielding make up a very large item, both of weight and cost. But as space vehicles grow larger, the time must come when the savings in propellant consumed will more than make up for the cost of the reactor system.

A nuclear reaction releases a tremendous amount of energy—millions of times as much as in the most furious chemical reaction. If we could convert all or even a large part of this energy to useful thrust, the nuclear rocket would provide specific impulses hundreds or thousands of times as great as for chemical systems.

One program in progress shows good promise of converting nuclear energy into useful thrust. Project *Orion*, conducted for the Advanced Research Projects Agency of the Defense Department by General Dynamics Corp., envisages a vehicle propelled by a series of low-yield nuclear explosions.

However, Project *Orion* is in a very early study stage. No one has yet developed a plan for early construction of such a vehicle. Also, testing might run afoul of an international ban on nuclear bomb testing.

Project *Rover*, however, takes a more conventional approach. The rocket will carry a large tank of liquid hydrogen, which will be boiled to a gas, heated by passage through the bowels of a nuclear reactor and expanded through a nozzle. The nozzle will be regeneratively cooled by the liquid hydrogen.

The AEC calculations of the *Rover* nuclear rocket's specific impulse are classified. However, nuclear scientists have published assumptions in the 700-800 second range—compared with 300 seconds for the LOX-kerosene combination in the *Saturn* and F-1 chemical rockets.

At a specific impulse 2½ times as great, it is obvious that much less propellant will be required for a specific mission with a nuclear rocket than with a chemical rocket. On the other hand, the nuclear reactor and its shielding will weigh more than the auxiliary hardware required by the chemical rocket.

Thus, for smaller tasks, the chemical rocket is more practical. But as we increase the size of the desired payload, the size of the fuel tanks, pumps and other equipment increases in steady proportion. A three-stage vehicle based on the six-million-pound-thrust *Nova* cluster would stand as tall as a 24-story building. For fuel alone, the cost of launching 50 tons might run into the millions of dollars. For the many tests

required to develop reliability in the vehicle, the cost is fantastic.

In the case of the nuclear rocket, however, the weight and cost of auxiliary equipment do not increase so rapidly. A reactor should not double in weight each time we double its output. As a matter of fact, if better materials can be developed, it may be possible to increase the output of a reactor with little or no increase in weight.

As we increase the total impulse of a nuclear rocket, we must increase the propellant supply. But since the specific impulse of a nuclear rocket is greater, the amount of propellant required rises more slowly than in a chemical rocket. Since the reactor weight remains relatively stable, the payload fraction of the nuclear rocket steadily increases as its size increases, while that of the chemical rocket remains stable.

• **10 years for crossover?**—The specialists are far from agreement on when the crossover in favor of nuclear propulsion is likely to take place. It is certainly a decade away. And it depends on such imponderables as how fast the overall space program will actually progress in the 1960s.

The first truly economic nuclear-propelled vessel might be a spaceship to carry a fairly sizeable crew of explorers to the moon. Or a smaller group to Mars or Venus.

Meanwhile, however, smaller vehicles must be built to test the concept in operation. The first will obviously be based on *Kiwi-A*, the nonflying prototype engine tested successfully last July 1.

This is the nub of the flight-test dispute: A series of ground tests, including the second scheduled for next summer, is to be completed by 1963.

Next comes the construction of a flyable rocket in a time not specified but apparently about two years. Armstrong would launch from Eniwetok, a Pacific island where the AEC has extensive facilities for nuclear bomb testing.

Finger notes that the projected development timetable for Project *Saturn*, the space vehicle based on the eight-engine cluster with 1½ million lbs. of thrust now under development at the new NASA facility at Redstone Arsenal, Ala.

By 1965, Finger points out, the booster should have developed a high degree of reliability and the powerful liquid hydrogen-burning upperstages should be available to propel the heavy nuclear rocket into orbit.

The NASA official feels the rocket should be started in space, after its orbit has been stabilized. The primary reason, Finger said, is that such a test is closest to the actual early mission of a nuclear rocket.

• **Safety**—A second reason is the question of safety. "We take a cold reactor in orbit," the NASA official declared. If it fires, it goes farther out. If it doesn't, it is still cold and relatively harmless."

Finger said the hazard of possible atmospheric contamination is a factor weighing against a ground launching, although not a primary one.

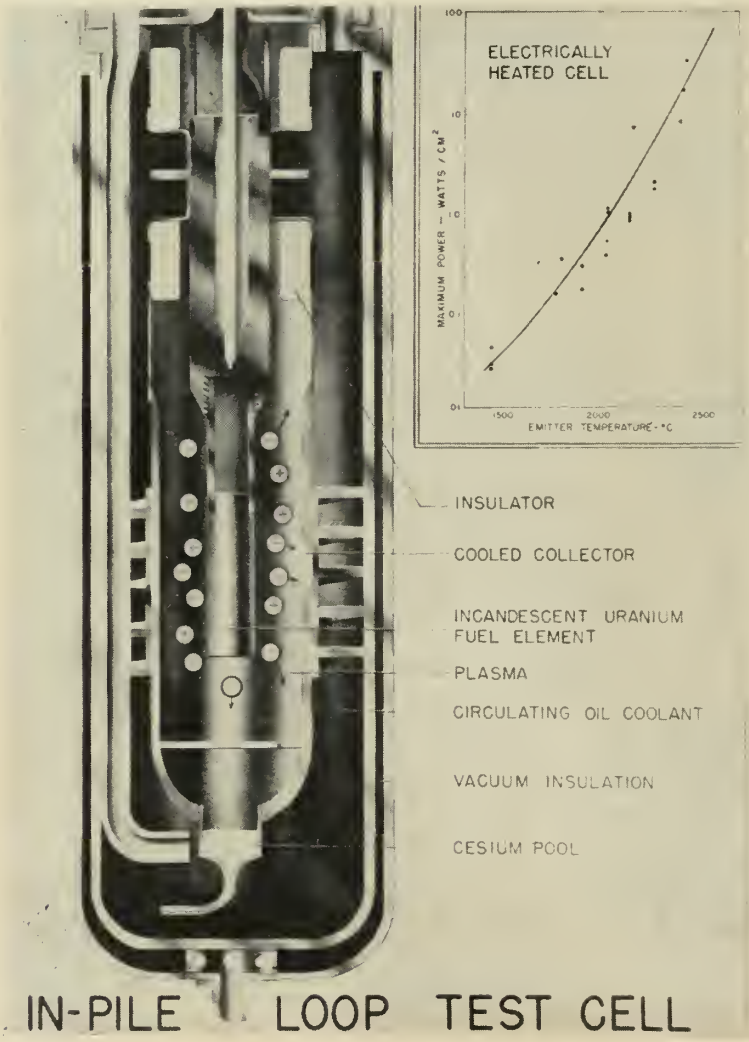
All the specialists agreed that the amount of atmospheric contamination caused by a *Rover* launching would be a tiny fraction of the contamination caused by a small nuclear bomb.

The primary question, Finger declared, is to design an experiment that will provide a maximum amount of information, and speed development to the maximum. "Let's try to design a program so that we can do a useful mission with it the first time," he said.

Armstrong maintained that a start from orbit is the most difficult way he knows to test a reactor device. It must be operated completely by remote control. Furthermore, the low level of knowledge about conditions in space makes it impossible to anticipate all the conditions that exist in orbit.

Nevertheless, Armstrong said, there are some reactors that should only be started from orbit—for instance, a SNAP II reactor, designed to provide auxiliary power in a space vehicle. "To all intents and purposes, this is an inanimate object at launching," he remarked. "We want to have the orbit stabilized and determined to be correct before we start the reactor."

Armstrong argued that the major consideration is the prestige value of



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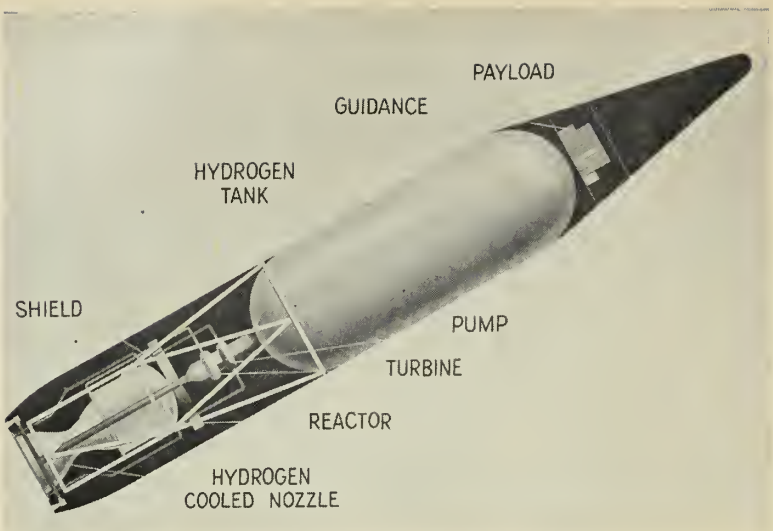


**SCHEMATIC SHOWS typical components of a nuclear rocket.**

sending the first nuclear-propelled vehicle into space. It isn't just a stunt, he said, because the first flight would be a small model of the ultimate primary mission of nuclear propulsion. It will have all the major components of a space ship—reactor, shielding, hydrogen tank and payload—and will lift from the ground in the same way.

• **Shielding**—Since shielding on the first flight must be kept to a minimum, he said, equipment in the scientific payload would have to use tubes instead of transistors. Also on the subject of shielding, he noted that some would be necessary in any case to protect against Van Allen radiation. Not much more is needed to shield against the reactor, he added.

To help settle the issue, NASA plans to have a study of all aspects of the problem made by an industrial contractor. Finger said he hopes to circulate bids on the study within a month or two. The contract would be awarded about a month afterward, and the study would take from six to nine months.

The contractor will seek to learn what type of test program will provide the most meaningful results in terms of development of the rocket. "The study may not provide us with the answers," Finger said, "but it will give technical information on which it will be possible to base judgments."

He said the cost of the study would be paid with Fiscal Year 1960 funds. He declined to estimate how much would be involved.

Shielding is of course but one of a host of technical problems that must be solved in designing a nuclear-propelled vehicle. Actually, it may be one of the easiest. Everyone's design of a nuclear-propelled vehicle calls for reactor and rocket in the rear, a large liquid hydrogen tank in the middle and payload in the nose.

Since the vehicle is long and narrow, the distance between reactor and payload tends to reduce the intensity of the radiation. In addition, the hydrogen tank and its contents act as a very effective shadow shield.

In the reactor itself, the problems are not so easily solved. First and foremost is a need to develop a reactor that operates at a much higher temperature than usual. The temperature of a reactor varies according to its application and its specific design characteristics. A typical temperature for a power reactor on the ground might be in the neighborhood of 1200°F. To develop specific impulses in the range of 700-800 seconds, using hydrogen as the propellant, the temperature must be brought up to the range of 2700°-4500°F.

However, even if the temperature cannot be brought quite that high, there is still a performance gain over chemical systems. Dr. Raemer E. Schreiber, who heads the scientific group working on *Rover* at the AEC's Los Alamos Scientific Laboratory, has calculated that hydrogen propellant has a specific impulse of 400 seconds—the top figure for a chemical reaction—with a nuclear reactor operating at only 660°F.

Specific impulse increases with the square root of the absolute temperature of the exit gas. Thus the performance increases with temperature. Specific impulse also increases in inverse proportion to the average molecular weight of the exit gas. This is why hydrogen, the lightest element, must be chosen as the propellant.

At a specific impulse of 800 seconds, Schreiber said in an article in the Fall-Winter edition of the Air University Quarterly Review, about 20 kilowatts are required to produce a pound of thrust. Thus, he said, a 50,000-lb. thrust engine requires about 1000 megawatts of power. In his testimony before the House committee, Armstrong said the latest AEC calculations called for an engine with 52,000 lbs. thrust for the first test.

The biggest reactors in existence on the ground put out less than 1000 megawatts. The largest in this country, the Dresden Nuclear Power Station, started up at Morris, Ill., last year by Commonwealth Edison Co., will have a maximum output of 626 thermal megawatts. The reactor for the nuclear ship Savannah, to be started this year, will put out 69 thermal kilowatts. Nuclear submarine reactors have about the same capacity.

A nuclear rocket big enough to lift a 750-ton space ship must develop upwards of two million lbs. of thrust. Hence, it requires a reactor that generates about 40,000 megawatts, more than 40 times as much as the most powerful reactor in existence today. This gives an idea of the advances in technology necessary before the nuclear spaceship can be flown. It makes clear why the most optimistic estimates of the timetable are in excess of 10 years.

• **Third possibility**—In addition to ground launch and orbital stage, there is a third possible method of testing a nuclear rocket: as an upper stage, started on the ground but not put in operation until the chemical stage burns out.

Finger says there is no consideration of a test of this sort at first because the first nuclear rocket developed would not be of a size that would be easy to mate with an existing chemical booster.

However, some in industry have been suggesting combinations. There is some talk, for instance, about the possibility of using a *Titan* first stage to lift the nuclear stage above the atmosphere.

In flight testing such a device, a trajectory would be chosen such that, if the nuclear rocket failed, it would just fall into the ocean. This would be a relatively harmless inventory of $U^{235}$ in a non-critical configuration.

If it should fail on leaving the atmosphere, it would probably burn up on re-entry. Thus the absence of a suitable nose cone is protection for those below.

As for the in-between case, where the reactor starts too slowly and stops within the atmosphere, the amount of

fission produced would be small. This is because the amount of fission products varies with the power level and time at which the reactor operates.

• **Hybrid nuclear** — Krafft A. Ehricke of General Dynamics' Convair Division has been plumping for an interesting hybrid nuclear-chemical engine that may combine the advantages of the nuclear booster and the nuclear upper stage lifted by a chemical booster.

Ehricke's design calls for two liquid hydrogen-LOX booster engines that would give the overall system initial velocity, fed by a relatively small ring-shaped lox tank. When the LOX runs out, at an altitude of 120,000 to 140.000 ft., the booster would fall off, just as the *Atlas* booster engines. Then the hydrogen flow would be directed through the reactor for the remainder of the mission.

At last month's National Missile/Space Conference in Washington, Ehricke declared that a choice must be made soon between chemical and nuclear propulsion for the generation of booster rockets after *Saturn*.

Ehricke said a decision should be made this year on whether to push Project *Rover* or Rocketdyne's 1½-megapound F-1, which is designed to be clustered into a booster generating between six and nine megapounds thrust. The development schedules for the F-1 and *Rover* make them closely competitive. However, the F-1 is funded for $41 million in President Eisenhower's 1961 budget, almost double the $23 million in the AEC budget for *Rover*.

The overall total for chemical rocket development by NASA alone is $390 million, more than 13 times as much as the AEC-NASA total for nuclear rocket propulsion.

• *Rover* **schedule**—What is the *Rover* test schedule? "This is not a crash program," says Armstrong. "It is moderately paced by the degree of success. Between experiments, there is construction to do."

Armstrong says the first experiment last summer, which was designated *Kiwi-A*, "proved to us we were on the right track."

Another test is scheduled for the coming summer. It will be designated *Kiwi-A*-Prime. "We shall probably ask many of the same questions," Finger said. "Many more reactor tests will be required, to supply much necessary data," the NASA official declared. "We are hoping to move rapidly. We need money, but that is not all."

If the program were to be speeded, Finger said, there would be the problem of running several test reactors concurrently. Also, since a test releases some long-lived fission products, it is

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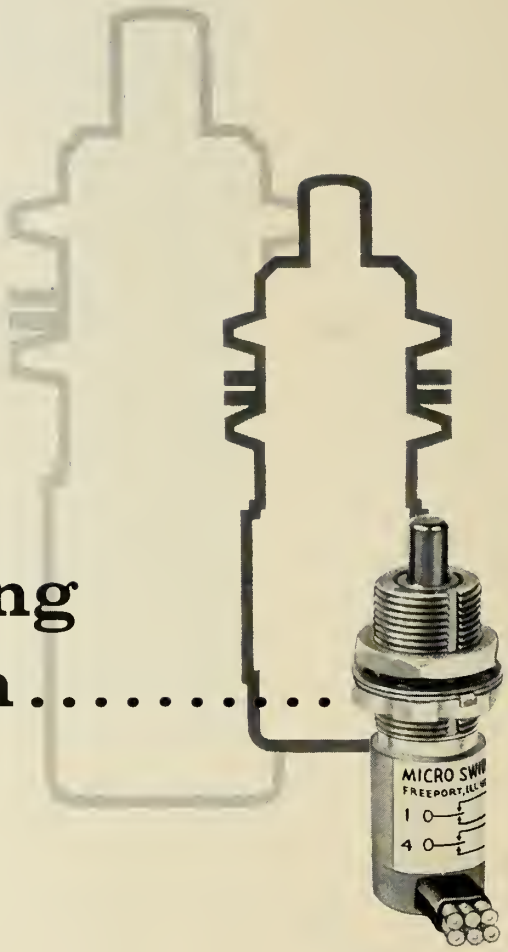


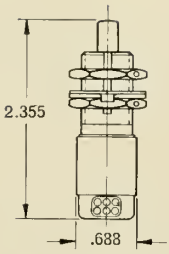


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necessary to wait until the site cools before approaching it.

• **Materials problem**—Developing a high-temperature reactor, Finger declared, is largely a materials problem. "We are looking at the whole range of high-temperature materials, asking such questions as whether they are compatible with uranium compounds; will they corrode more readily under intense radiation; do they react with hydrogen at high temperature; and what are their structural and other physical properties, such as neutron cross-section, when combined with uranium?"

Another major materials problem, he said, is the effect of radiation on the properties of materials at cryogenic temperatures. Liquid hydrogen, the only propellant under consideration, boils at −423°F. NASA has contracted with the Georgia Division of Lockheed Aircraft Corp. for a major research project.

"It may be possible to protect materials, such as with shielding," Finger remarked. "However, if these material tests prove negative, we may conclude that the *Rover* rocket is simply not feasible."

AEC's Armstrong has this view of feasibility:

"To establish the feasibility of a nuclear rocket reactor, one must in effect build a prototype. All experiments prior to that are useful and necessary tools.

"Theoretically, you could prove the feasibility of any nuclear device without regard to the end requirements as it pertains to the engineering requirements such as light weight, compactness, etc. However, you might end up with something that couldn't be built. Naturally, we do not proceed in this manner. In demonstrating feasibility, we always keep the end objective and the engineering requirements in mind."

The AEC official declined to estimate how many experiments might be required to demonstrate the feasibility. "I have tried to avoid any such indication," he said.

The time between experiments is no sure indication of the pace of the program, Armstrong continued. "If we ran two experiments in one summer, it might not be as much of an increase in pace as if we stopped one line of experimentation and built new facilities to begin another—resulting in a long period in between."

At this week's hearing, the Atomic Energy Committee will try to determine how much increase in pace is possible. James T. Ramey, the committee's executive director, has asked Dr. T. Keith Glennan, NASA administrator, and Gen. A. R. Luedecke, AEC general manager, to comment on this outline of suggestions by the committee:

• Immediate establishment of performance specifications for the engine for flight test.

• A schedule calling for ground launching at the earliest possible date.

• Complete responsibility for development assigned to the AEC through the flight test phase—with the proviso that NASA will provide consultation and assistance.

"We want to be assured that, looking to the future, the *Rover* program is receiving the proper emphasis," Sen. Anderson declared.

# Industry's Role in Nuclear Rocketry

Industry is playing a growing role in nuclear propulsion. Almost every major company involved in rockets, aircraft and electrical equipment is engaged in research and development aimed at the day not too far off when large-scale government contracts will be let.

So far, only a few large contracts have been awarded. The major share of the work is performed at government installations such as the Los Alamos Scientific Laboratory, operated for the Atomic Energy Commission by the University of California.

But as Project *Rover* and other propulsion projects shift from R&D to hardware construction, the share of the work performed by industry will increase.

Sen. Clinton P. Anderson, chairman of the Joint Congressional Committee on Atomic Energy, has proposed that an industrial contractor be brought in at "an early date" to work with Los Alamos on *Rover*. He did not specify the timing further, however.

Actually, there are three major areas of work on nuclear propulsion: manned aircraft, air-breathing missiles and rockets. Each area has distinctive problems. But many of the problems are similar. Any flying nuclear device must have a high-power reactor of extremely light weight. Any nuclear propulsion system faces the vexing problem of engineering the shielding of equipment and in some cases men from nuclear radiation.

Thus a company with R&D experience on any nuclear propulsion system has a good selling point when bids are asked on any other system.

How much money will be involved? No one in authority will make a public estimate of the eventual cost of a nuclear rocket. However, it is certainly safe to predict that the cost of R&D and construction for the nuclear propulsion unit in the first true space ship —including marrying the propulsion unit to the vessel—will be several billion dollars.

Despite the relatively low level of government funding, companies throughout industry are doing research at their own expense. Many companies are working on SR-149 and SR-151 contracts with Air Research & Development Command—under which cleared personnel of private companies are given access to classified data for work at company expense. In other companies, physicists and other scientists work purely with unclassified data.

In either case, the company's plan is to keep scientists at work on the problem in the hope they will come up with proposals that will interest the Air Force, the Atomic Energy Commission or the National Aeronautics and Space Administration.

• **Companies briefed**—NASA'S Harold B. Finger says all major companies were briefed on the outstanding problems in nuclear rocket propulsion. No effort was made to divide up the work, he said. Instead, the government agencies are relying on the competitive approach to produce best results.

The nuclear aircraft program, a joint Air Force-AEC effort, includes two major industry projects. The older of the two is the direct cycle system, under which air passing through a reactor is heated and expelled through a turbine and jet nozzle—providing thrust in somewhat the same fashion as a chemically powered turbojet engine. The General Electric Co. is carrying out the direct cycle program at Evendale, Ohio.

The other propulsion project is the indirect cycle system, under development by Pratt & Whitney Division of United Aircraft at CANEL (Connecticut Aircraft Nuclear Engine Laboratory) in Middletown, Conn. In this system, liquid metal is used to conduct the heat from the reactor through a radiator heat transfer system to the engine turbine and jet nozzle.

The indirect cycle system has a higher performance potential than the

direct cycle because liquid metal has greater heat-transfer capacity than the combination of air and other materials used in the direct cycle system. However, the direct cycle system is farther down the development road.

AEC Chairman John A. McCone has said that a decision will have to be made soon between these two competing systems.

Last March, the Air Force chose Convair Division of General Dynamics to work on initial design of a nuclear-powered aircraft.

Another air-breathing propulsion system is the nuclear ramjet, Project *Pluto,* in development under the supervision of the Lawrence Radiation Laboratory, an AEC installation operated by the University of California. The Marquardt Corp. is doing engine design and development for *Pluto* with Air Force funds. Atomics International Division of North American is doing materials research for the AEC.

Chance-Vought, North American and Convair have made studies for the Air Force of a *Pluto*-propelled missile named *SLAM* (Supersonic Low Altitude Missile).

A fourth major area where nuclear energy and propulsion meet is in some of the small SNAP (Systems for Nuclear Auxiliary Power) units under development for use in space. The SNAP devices break down in two major classifications. Small units with very low output, based on the heat from radioactive isotopes, are given odd numbers. Larger devices, based on nuclear reactors, have even numbers.

• **Heat from Polonium**—An example of the former is SNAP III, a device announced last April, which generated 2.5 watts from the heat given off by a small supply of Polonium 210. It still is in operation, although it has gone through several 138-day half-lives, currently generating about a half-watt. Such a small output would be of value only as auxiliary power, not for propulsion. Nuclear Division of the Martin Co. is developing the radioisotope units.

On the reactor side, under SNAP VIII, AEC and NASA are developing a reactor for a space vehicle that will generate 30 kilowatts of electrical power and weigh about 1500 lbs., exclusive of shielding. This is sufficient power to operate an electrical (ion or plasma) propulsion system that would develop a small but measurable thrust. Atomics International is developing the reactor-heated units for the AEC.

Early this year, ARDC requested bids on a 300-kilowatt SNAP-type nuclear reactor to power an ion propulsion device.

MISSILES AND ROCKETS asked the major companies for outlines of the

work they are performing related to nuclear propulsion. Most companies reported they are prevented by security from giving anything but sketchy details. Here are thumbnail sketches of what can be said:

• Rocketdyne Division, North American—Established special Nucleonics subdivision, employing about 45, to work in nuclear rocket engines, electric propulsion and advanced power conversion. Provided nozzles and propellant feed systems for Project *Rover* testing. Developed multistage axial flow turbopump for liquid hydrogen, which company says showed unusually high efficiency at pumping rates and discharge pressures not normally encountered in conventional rocket turbopumps. Working on nuclear rocket engine design at company expense.

•Bendix Aviation—Producing control systems for reactors used in nuclear ramjet and nuclear rocket engines (Projects *Pluto* and *Rover*). Delivered engineering research reactor to AEC for use by General Electric in development of aircraft nuclear propulsion project.

• Lockheed Aircraft Corp.—Georgia Division studying airframes for nuclear-powered aircraft. Research on effects of nuclear radiation on materials at cryogenic temperatures for NASA. Analytical studies of nuclear aircraft, rocket and advanced propulsion systems at Palo Alto Scientific Research Laboratory.

• Space Technology Laboratories —Evaluating performance capabilities of nuclear-propelled ICBM's, space vehicles designed for extreme payloads and those intended for extreme velocities. Research on advanced propulsion systems using nuclear energy, such as vortex or plasma core reactors, adiabatic compressors, plasma jets and combinations of these or similar methods. Applied research in related physical phenomena, such as diffusion phenomena, plasma behavior, reactor criticality and transfer of heat to a working fluid of low molecular weight.

• Reaction Motors Division, Thiokol Chemical—Carried out extensive studies in last three years on nuclear-propelled boost and space vehicles. Scientific personnel published numerous papers on heat-exchanger type nuclear rockets. Participating in Air Force studies; currently working on direct-conversion reactors, pebble-bed reactors, plasma systems, transient problems in control systems and nuclear space missions.

• Aerojet-General, Azusa Plant—Studied control systems and integration of reactor controls with propellant feed system on *Rover* in 1957 and 1958, while project was under AEC-Air Force jurisdiction. Has developed liquid hydrogen pump for hydrogen-oxygen chemical system that could be used in nuclear propulsion.

• Aerojet-General Nucleonics—Designed a special reactor called OPERA (Ordnance Pulsed Experimental Research Assembly) to produce pulses of as many as $10^{17}$ neutrons in a spectrum that peaks at 400,000 electron volts for studies of the effects of radiation on material.

• Grumman Aircraft — Studying heat transfer properties, reactor analysis, reactor shielding, radiation effects on materials and materials to make a missile more compact so as to investigate the application of a nuclear propulsion unit to a guided missile under a $1-a-year contract with the Bureau of Naval Weapons, allowing access to classified information.

• General Electric Co.—Employs more than 1500 in development work on direct cycle aircraft nuclear engine at Evendale, Ohio. Atomic Power Equipment Department, San Jose, Calif., has studied reactors from fractional kilowatt to a few megawatts as power supplies for electrical propulsion and auxiliary power. Designing reactors using both rotating and stationary converters, all at company expense. Officials feel large SNAP-type reactors should be developed more rapidly than at present, otherwise ion and plasma propulsion units will be available long before there are flyable reactors to power them.

• Pratt & Whitney—Important progress in the last year—although details remain classified—in such areas as test field elements, materials, liquid metal and critical assemblies for the indirect cycle aircraft engine. More emphasis to indirect cycle program is being given by the Air Force for Fiscal 1961.

• Westinghouse Electric—Astronuclear Laboratory established last August at Mt. Lebanon, near Pittsburgh, to study application of nuclear technology to outer space applications and advanced defense requirements. No actual government contracts signed in first six months but company says future looks promising. Laboratory making self-supported studies to analyze technical problems in programs under way to identify where it can help government efforts. Preparation of likely timetables for exotic propulsion systems.

• General Dynamics, Convair Division—Fort Worth plant selected to prepare preliminary design of nuclear aircraft. Krafft Ehricke studying numerous nuclear rocket and hybrid nuclear-chemical rocket designs. Company studied design of ramjet-propelled *SLAM*.

• General Dynamics, General Atomic Division—Studying feasibility of space vehicle propulsion through controlled nuclear pulses, for Advanced Research Projects Agency. Project to be transferred to Air Force.

• North American, Atomics International Division—Conducting basic materials research for Project *Pluto*, nuclear ramjet program. Produces SNAP reactors for AEC.

• North American, Los Angeles Division—Studied *SLAM* design.

• Martin Co., Denver Division—studying various applications of nuclear propulsion to space vehicles of the future; investigating fabrication of high-temperature reactor materials.

• Martin Co., Nuclear Division—producing isotope SNAP devices for AEC, developing air-transportable nuclear reactors, working with Navy on nuclear-propelled seaplane, producing nuclear components.

• Chance-Vought Aircraft—Studying *SLAM* with considerable outlay of company funds beyond those received under Air Force study contract.

• Douglas Aircraft Co.—Conducted detailed study of manned nuclear space systems; other classified work in progress.

• Tapco Group, Thompson Ramo Wooldridge—Spending about $1 million company funds annually developing power conversion systems devoted primarily to engines using liquid metal working fluids. Extensive component testing of mercury engines, including tests in zero gravity boiling, in a special Wright Air Development Center C-131B Flight Laboratory over Dayton. Corrosion research, condenser-radiator design, radiation heat transfer studies, experiments to determine meteor impact in radiator surfaces.

• Associated Nucleonics — Carried out conceptual and design studies of aircraft propulsion systems and facilities for developing systems as subcontractors to Oak Ridge National Laboratory, Martin, Pratt & Whitney and Curtiss Wright.

• Boeing Airplane—Studying powerplants, both propulsion and APU, comparing what companies active in field are doing. Keeping abreast of state of art. Not interested at present in building hardware.

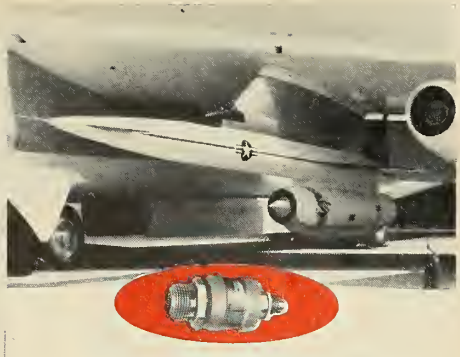
• Bell Aircraft—Classified nuclear research.

• Curtiss-Wright—Classified nuclear research.

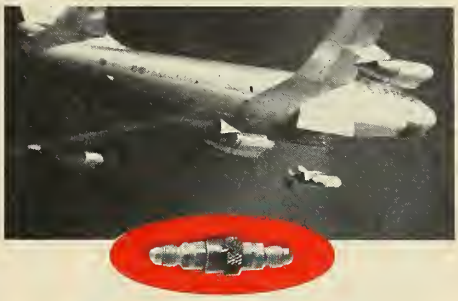
• Douglas Aircraft Co.—Studies of high-thrust nuclear rocket systems.

• Sylvania-Corning Nuclear Corp. —Materials studies.

• Blaw-Knox Co.—Studies of facilities for testing indirect cycle aircraft reactor.



The Air Force's new Hound Dog missile is equipped with Aeroquip Quick-Disconnect Couplings. Both handling and checkout of the hydraulic systems are facilitated through the use of this coupling on the missile's internal system and ground service checkout equipment.



Space and weight are at a premium on the Quail. To save space, yet retain complete reliability, Aeroquip 1010 Series Quick-Disconnect Couplings are specified. These Self-Sealing Couplings are used in the fuel, lube oil and pneumatic systems of the compact Quail.


The Navy's new supersonic missile, the Corvus, is rocket powered. This swift air-to-ground weapon is equipped with a special Aeroquip Quick-Disconnect Coupling used as an umbilical disconnect. This coupling was especially designed for the Corvus by Aeroquip.

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The rapid advance of U.S. missile technology sets continually new requirements for the development of fluid system quick-disconnect couplings. With the largest and most experienced engineering staff in the industry, Aeroquip has designed and manufactured special purpose couplings for many leading missile system contractors. Aeroquip can solve your coupling problems, too. Aeroquip can design and produce a quick disconnect coupling to fit unusual or complicated applications with minimum lead time.

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# RAMAC Computer Used for *Atlas* Spares

## *Transaction posting costs cut 12 to 20 cents: Convair expects to process 83,000 spare parts*

SAN JOSE, CALIF.—For the first time, spares programing for an intercontinental ballistic missile has become a major task. During 1960, Convair-Astronautics expects to process more than 83,000 spare parts orders for the *Atlas* missile system. This is twice as many as last year and the program will continue to grow.

To handle inventory for the nation's first ICBM, the company is employing an International Business Machines RAMAC computer (Random Access Method of Accounting and Control). Its use was described here at a recent Aircraft and Missile Production Management seminar.

The seminar was one of a series initiated a year ago by IBM's data processing division. Report on the RAMAC in use at Convair-Astronautics was made by J. A. Dufresne, controller, and F. J. Knight, chief of data processing.

Magnitude of the spares program for *Atlas* was spelled out by Dufresne, who noted that test and operational sites stretch across the entire nation and may each require any number of the 100,000 different parts in the system.

Although the missiles themselves need fewer spares than an aircraft since they fly only once, Dufresne pointed out, only a small part of the missile weapons system is airborne.

• **Spares for GSE**—"The majority of the system is involved in ground support equipment such as missile trailers, stands, launchers, test equipment, block houses and so forth, which is used launching after launching," he said.

In addition, rocket blast burns up certain umbilical connections and launcher parts at each launching. There also are a number of short-life items which must be replaced and, since development on the *Atlas* is continuing, some engineering changes still are being made.

"To manage a logistics task such as this," said Dufresne, "presents many complex and trying problems which can be solved only by efficient, rapid and reliable centralized control."

Convair's portion of the spares program covers research and development, pre-operational base activation, initial operational capability, training, operation and management of Azusa, the tracking system used in launching.

(Spares to support the Strategic Air Command operational bases are controlled and managed by the Air Materiel Command through the electronic data processing center at Norton Air Force Base, San Bernardino, Calif.)

Knight said use of the RAMAC at Convair has cut cost per transaction posting from 20¢ to 12¢ each. He said it has speeded up interrogation time and also includes in the system the recording and control of in-transit material between inventory centers.

• **Requests pour in**—Knight said that as the *Atlas* program approached the operational stage "all hell broke loose" and requests for inventory statistics and management reports reached the point where it was economically unsound to produce them manually.

"In other words, our system of inventory control was dying on the vine," he said.

Convair's system at that point had evolved from what Knight called "the old faithful clerk and Kardex combination." A National Cash Register posting machine had been added and transactions were being posted at 16¢ a line.

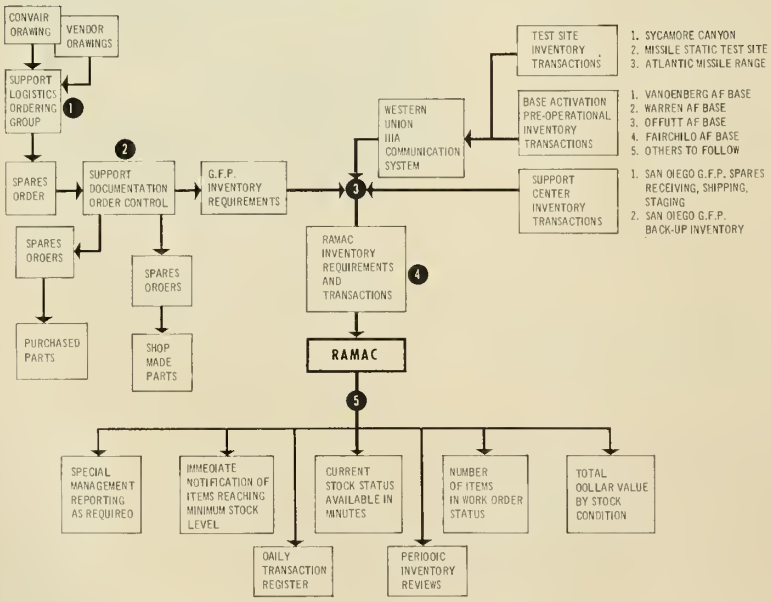
As the program was stepped up, Astronautics installed a tabulating card file offset system which offered improved random access, a reduction in the costs of publishing inventory statistics and management reports, and the ability to expand with the increasing number of items.

But this upped the cost from 16¢ to 20¢ per posting and still left much to be desired. The order for the IBM RAMAC was placed in April, 1958.

Time required to program the system, Knight reported, was one year and 5000 man-hours. The task was carried out by two of Convair's top data processing men and one IBM programing consultant. In addition, a task group was formed to finalize the system and to establish the format of the reports that would be required.

The RAMAC initially ordered was a single density system with a 407 Tabulator on-line which rented for

### *How RAMAC Is Utilized by Convair*



$5200 a month. This has since been replaced by a double density system at $6200 a month, Knight said. The single density system has been retained, however, to maintain control of the 15,000 items in an overhaul and repair depot Astronautics is operating for the Air Force. It also will be used to handle future overflow, if any, from the double density system.

Input to the RAMAC locally in San Diego is through the keypunch section. Inventory transactions from offsite bases are received daily through a Western Union 111A, five-channel, punched paper tape system. As it is received in San Diego, the tape is converted to cards on an IBM Model 047 Tape-to-Card machine. These then are fed into RAMAC along with the San Diego information.

The RAMAC system, according to data chief Knight, replaced 14 clerks who were maintaining the offset tab card files.

• **Easily pleased Miss**—"The gross earnings of these girls," he told the seminar, "including the fringe benefits, equalled approximately $6300 per month and we don't have to worry whether or not Miss RAMAC will be grieved if we paint the wall green."

With a three-shift operation, Knight said, down-time on the system is averaging 20 hours a month, including preventive maintenance. The data processing crew required to maintain the operation consists of one data processing analyst, one and one-half operators per shift, and three and one-half keypunch and verifier operators, for a total of nine people.

Convair-Astronautics' RAMAC unit record consists of 400 characters per part number. Of these, the first 150 characters are set aside for constant indicative information about the part such as stock number, minimum stock level, lead time and failure rate.

The remaining 250 characters are used to maintain control of the inventories located at San Diego, the three test bases (Sycamore Canyon, Edwards Air Force Base and the Atlantic Missile Range), and the pre-operational spare parts at Vandenberg, Offutt, Fairchild and the other operational sites. Information includes allocated quantity, quantity received, quantity in transit, serviceable balance, reject balance, surplus awaiting disposition by the Air Force, and total stock on hand.

• **Spare Group**—Spares support is initiated with the flow of Convair and vendor drawings into the Logistics Support ordering group. This group selects from the drawings those parts which they recommend be ordered as spares. After approval by the Air Force, the authorized spare parts orders are for-

warded to the order control group.

In addition to ordering the required spares, this group generates the spare parts keypunch source documents which become the basic input to the RAMAC.

Output from RAMAC, as outlined by Knight, includes:

- Immediate notification of all parts at the minimum stock level.
- Full history of all parts removed from the serviceable inventory for repair or overhaul. This is used for follow-up to determine that these parts are returned to serviceable status as rapidly as possible.
- Dollar value of spare parts by the inventory condition of the parts, including costs of serviceable inventory, scrap and overhaul.

The RAMAC record also is used for special management reports and for processing of the periodic inventory reviews required by the Air Force.

"The report reflects the complete requirements and inventory position of those parts being reviewed," Knight pointed out.

The IBM machine can be interrogated at any time, he noted, even while it is performing other tasks. This makes it possible to obtain the complete up-to-date history of any part in printed form within 60 seconds.

Currently, such inquiries are averaging about 90 per day.

## Sphere to Control Spacecraft Attitude

ANN ARBOR—By freely suspending a sphere in an electrical field, the Systems Division of Bendix Corporation says it has a key to a simple means for correcting and controlling the attitude of space vehicles. Company engineer Ralph Ormsby conceived of directing the rotation of such a sphere by signals from attitude-control sensors. The reaction to the rotation would then position a space vehicle.

The sphere is rotated by an electromagnetic torque introduced in proper measure into three mutually perpendicular windings connected to attitude sensors.

An example of the mechanism's use is in a satellite in which a particular window has to point to the sun. If the satellite moves out of this orientation, sensors pick up the information, send appropriate signals to the windings, which in turn spin the suspended sphere in the proper direction. The reaction to this rotation is transferred by magnetic linkage to the satellite which then begins correcting its error.

Bendix calls the mechanism a *Free Reaction Sphere*. Working models have performed successfully, one of which uses an 8-in. diameter, 20-pound sphere for the controlling mass.

Several advantages stem from this system. There are no bearing problems because the control mass (the sphere) is electrically, not mechanically, connected to the space vehicle. For the same reason, no gyroscopic moments are introduced. The most apparent advantage is that only one control element, a single sphere, is needed to take care of attitude corrections along all three Cartesian axes.

## M-H Broadens Effort In Electronic Medicine

Minneapolis-Honeywell Regulator Co. has begun an extensive new program to expand activities in the field of electronic medicine. The company has assigned specialists to a newly formed medical instrumentation group to take over work already under way in three Honeywell divisions and institute new development programs in cooperation with medical authorities.

K. C. Rock, formerly chief engineer for Honeywell's Heiland Division, will head the new group. Headquarters will be at the Heiland plant in Denver, where much of the company's medical instrumentation work has been centered.

In addition to engineering responsibilities, the new group will take over marketing of all equipment Honeywell now supplies to the medical field, including body-function recorders, magnetic tape recorders, medical oscillographs, and other specially designed systems.

## Electronic Circuits Formed By 'Gyro-Electric' Plasma

A practical electronic circuit has been formed by "gyro-electric plasma," according to a Sperry Gyroscope research physicist.

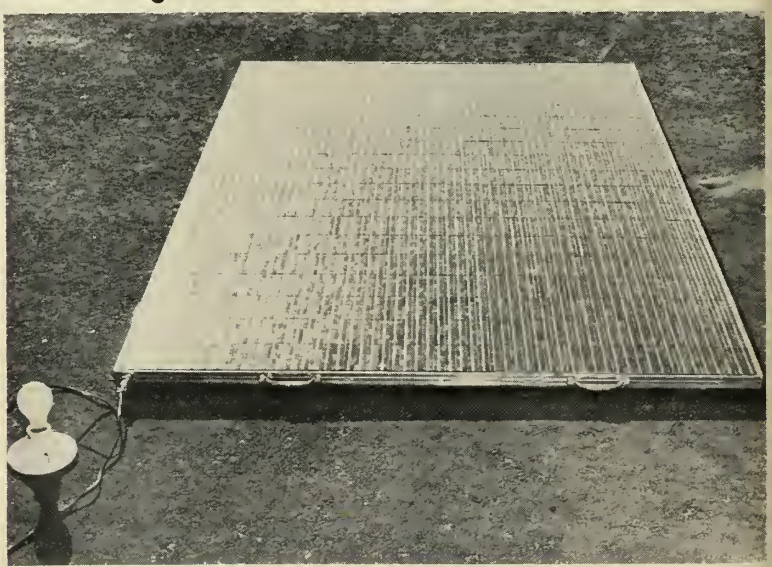
Speaking in New York before the Institute of Radio Engineers, Dr. James E. Hopson described the circuit as an electronic oscillator generating high-frequency radar energy. The research project has generated radar frequencies ranging from 700 to 2000 mc. Sperry scientists indicated that by redesigning their apparatus it will be possible with current technology to generate frequencies more than 100 times higher—a range approaching infrared.

The man-made plasma was formed by aiming a beam of electrons through rarified hydrogen gas contained in an electromagnetic envelope. The beam electrons strike the hydrogen atoms with sufficient force to knock them apart and create a plasma of charged pieces of hydrogen atoms and electrons.

The plasma behaves as an ordinary electric circuit which interacts with the electron beam and generates microwave radar energy. The plasma circuit couples into the electron beam which then serves as an antenna to convey the radar energy out of the plasma circuit for practical uses.

Plasma-formed electronic circuits may be used to replace devices that now use wires, capacitors, or conventional circuit elements.

## *World's Largest Solar Cell*



**"SOLAR KING"—the largest solar cell panel ever assembled, according to its creator, International Rectifier Corp.—can directly light a 100-watt electric bulb. It measures 26 square feet and contains more than 10,000 single silicon cells. IRC estimates that such panels can be made in mass-production quantities for $2000-3000. A similar unit, recently demonstrated, supplies energy to power the world's first sun-driven automobile.**

# *Blue Streak* Launch Platform Designed

**by G. V. E. Thompson**

LONDON—De Havilland Propellers Ltd. has released details of the launching platform they have designed for the *Blue Streak* LRBM. Several of these platforms are being constructed by Morfax Ltd., of Mitcham, Surrey, who has also carried out considerable development work since the building of the original prototype.

The completed platform weighs about 70 tons and is mainly fabricated from one inch steel plate. Each consists of two welded box beams (26x5x7 ft. high) with internal stiffeners of one and two inch plate. The two beams are connected by large pin-jointed cross braces of three inch plate. This assembly is carried by four bogies—one at the corner of each beam, set at an angle of 32½°—and rotates on a circular track. Each bogy is attached by a yoke bracket supported on a pivot pin and is capable of being jacked up and down on six inch diameter guide rods. This places the feet of the platform on the ground ready for firing the missile, or raises them when it is necessary to rotate the entire launcher.

The two box beams support the release for the rocket. It has four articulated arms, electro-hydraulically controlled.

Each bogy is fitted with two 20-in. diameter cast iron wheels driven through a straight-line gear box and chain drive. The total reduction is 357:1. The wheels rest on rails consisting of three inch square-sectioned bars welded on to a 1 in. by 9 in. section plate.

The prototype was built with mild steel, but later platforms have been made from Conlo 1, a notch ductile steel produced by Consett Iron Co. Ltd., Consett, County Durham. A typical analysis for Conlo 1 is 0.14% C. 1% Mn, 0.1% Si, 0.03% S, 0.02% P, and it is fully killed and grain refined (to ASTM grain size 6-8) by aluminum additions. This steel was used for the reactor vessels at Calder Hall nuclear power station. Most of the welding was done with Lynx manually-operated shielded metal-arc equipment, supplied by Quasi-Arc Ltd. of Bilston, Staffordshire (a member of the British Oxygen Company group). The shielding gas was Argonox (argon containing 2% oxygen).

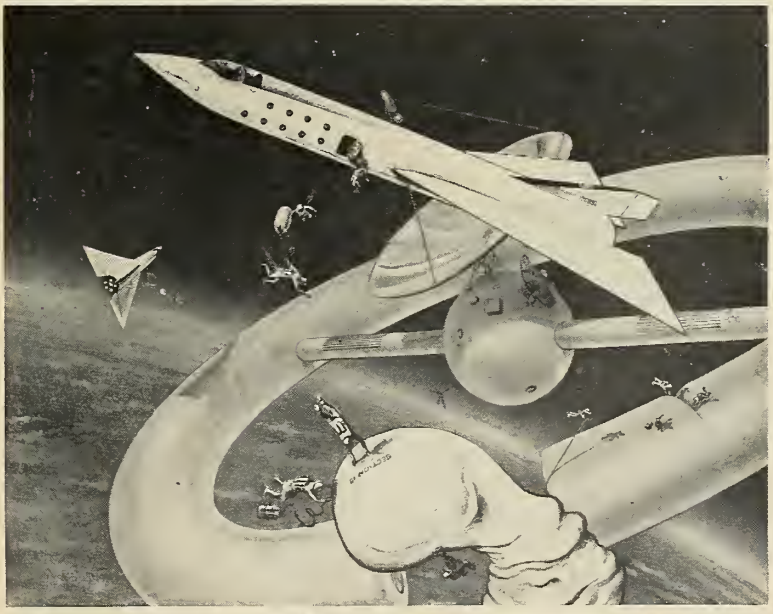
• **Welding process**—In welding the first platform, excessive distortion was observed, so subsequently each box beam was divided up into three subassemblies and the weld sizes were reduced. After the main welding operations were complete, but before the final assembly, the components were stress relieved. Heat treatment of the main box beams was carried out by G. A. Harvey & Co. (London) Ltd., of Woolwich Road, London, S.E.7., and consisted in holding at 650°C. for one hour per inch thickness and furnace cooling. Final machining and assembly followed.

Although the platform is massively constructed to enable it to withstand the shock loading and extreme temperatures to which it will be subjected, it also has to be produced to fine tolerance. The height of the trunnion bearings of the release gear arms above the level of the track has to be kept within ± 0.25 in. of 14 ft., while the centre distance between the trunnions also has to be accurately maintained. The maximum difference in level between any two points on the track itself is kept down to 0.006 in. by use of water-level micrometers.

Metalife liquid metal paint was used for protecting the surface of the structure. Tests have shown that this can withstand 12 hours' immersion in liquid oxygen. It also resists kerosene and prevents rusting under conditions of severe abrasion. Metalife Liquid Metals Ltd., Harrogate, Yorkshire also supplied the surface coatings for *Blue Streak* itself and other supporting equipment.

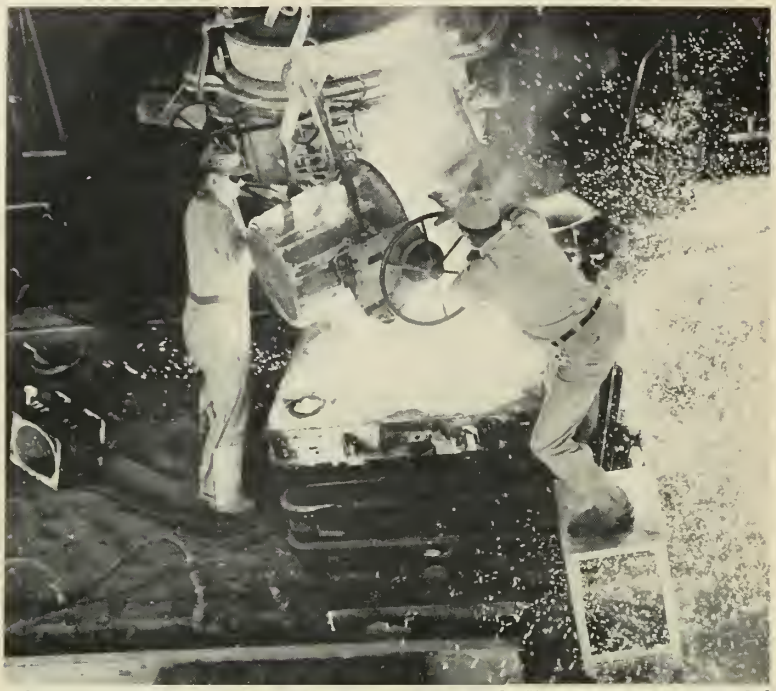
The bearing surfaces were considered to be too large for conventional plating and were therefore cadmium plated by the Dalic process, using equipment supplied by Metachemical Processes Ltd., 13 Strafford Road, London, W.3. In this process an absorbent pad attached to a tampon is soaked in the plating solution and serves as the anode.

## Goodyear Concept



**INFLATABLE SPACE STATIONS are envisioned by Goodyear Aircraft as a means of solving the problem of assembling metallic structures in orbit. Expandable coated fabric structures, according to GAC, could be packed in small containers for the trip into orbit, where they would be blown into shape like a balloon and "rigidized" by a quick-setting plastic foam. Large structures could be assembled from smaller "space cells." The technique also would provide a way to create a pressurized work area to put together space vehicles. Another application might be to use the cells for communications satellites, or for building structures on the moon's surface.**

# Steel Castings Have 280,000 psi



ACTUAL POURING of the cast takes only seven seconds. Temperatures are controlled to within a few degrees, insuring prompt filling and correct properties.

THESE COMPLEX structural steel castings have passed stringent inspections. Flaws permissible in normal castings would cause the rejection of these parts.

**by John F. Judge**

A process born in the fabrication of the business end of power shovels has developed into a promising source of complex, high-strength missile production parts.

It all started when metallurgists at American Brake Shoe Co. were faced with the problem of designing a special alloy tooth for a power shovel dipper. For certain applications, a very hard high-strength steel appeared to have distinct advantages. Research at American Brake Shoe to determine the best method of obtaining the needed properties led to development of a form of high-integrity steel casting.

Under Air Force sponsorship, high-integrity castings were studied and improved until many properties not available in conventional castings can now be produced by the proper selection of steel. Ultimate tensile strengths will range from 150,000 to 300,000 psi depending upon the nature of the working alloy. In some cases, tensile strengths of 260,000 psi can be guaranteed throughout the casting—with actual values running as high as 280,000 psi. When the criterion is extreme uniformity of properties rather than ultrahigh-strength, the tensile strengths will still range from 150,000 psi to 250,000 psi.

All of this is in marked contrast with conventional high-strength castings, which range around 150,000 psi —seldom reaching 200,000 psi.

• **Castings Inferior**—Castings have always been considered somewhat inferior to wrought steel products. This has been due to the higher strength of the wrought or worked steel—the mechanical properties being improved in the direction of the working.

On the positive side, castings have been attractive because of their ability to produce a variety of shapes almost to the finished configuration. In addition to the reduction of machining, parts of almost any size—from few to thousands of pounds—made in one piece, at relatively low cost and excluding the problems associated with fastening joints, have contributed to the success of castings.

The American Brake Shoe development eliminates the main drawbacks of this forming process and permits cast steel components to become competitive on a strength-weight basis for

the first time in the missile field.

High-integrity casting introduces more strength than previously possible, extremely high reliability, improved total uniformity and sacrifices only weight per unit part in achieving these qualities.

The actual process is a combination of proprietary materials and methods with extreme care and control. Such is the care involved in each step of the process that even a relatively minor mistake will degrade the final product to a point below the required levels.

The starting material is usually Swedish sponge iron or electrolytic iron. Conventional castings depend primarily upon scrap steel which costs but a fraction of the high integrity casting raw materials. The metallurgy in the new process is rigidly controlled —to within hundredths of a percent for the critical alloying ingredients.

The molds, historically the heart of the casting process, are made of proprietary mixtures which control the shrinkage rate in the cooling casting, impart good surface qualities and close dimensional tolerance and stability.

The mold for a complex missile part may take up to a week to prepare while the actual controlled pouring of the molten alloy lasts about seven seconds.

• **High Strength Induced**—The ultra-high strength properties are induced through a three stage heat treating cycle. In the homogenization cycle the casting is held at 1850°F for three hours then air cooled. The second step, austenitization, subjects the casting to two hours at 1575°F followed by oil quenching. The final tempering cycle brings the casting to 400°F for six hours followed by air cooling.

American Brake Shoe utilizes X-ray, isotope radiography, Magnagle, Zyglo and other methods in checking the properties of the final product. Defects ignored in conventional castings will fail a piece in this process.

In the entire high integrity method the actual yield per part is low. A 360 lb. missile casting may take 1200 lbs. of metal. The excess goes into gates and risers which are subsequently removed. The excess is re-usable since its metallurgy is known exactly and it can be added to the charge of the next casting.

The "as-cast" surfaces are usually good enough to require little or no machining. The reliability from part to part is almost perfect.

The question of cost is relative. Compared to conventional casting it is quite high but this is not the area in which high integrity casting is designed to function. Where the final product is a highly stressed part, where complexity, high strength and light

**CORES ARE carefully set in specially prepared ceramic molds.**

weight go hand in hand, high integrity castings are competitive with forged, machined, welded or milled products—and are usually less expensive.

The difficulty in cost comparison in the missile field is that the comparison must rest on products of extremely tight tolerances and limited application. The dollar value is often lost in the attainment of a specific objective.

High integrity casting is still in a transistory stage. Work is continuing to improve the process and to broaden its applications within the metallurgical limits of casting.

American Brake Shoe has supplied Grumman Aircraft, Douglas Aircraft and Chance-Vought with high integrity castings.

## Space Vehicle Insulation Concept Gets AF Funding

Aerodynamic heating problems associated with re-entry and high speed atmospheric flight may be solved through Bell Aircraft's double-wall structural cooling concept.

The Air Force just granted a $1.4-million contract to the Buffalo, N.Y. firm for the development of manufacturing methods for the insulation concept.

Basically, the structure consists of an outer wall radiation shield and an inner wall, separated by a layer of thermal insulation. The outer wall is built with small expandable panels of heat resistant material which radiate some of the heat away from the vehicle surface. Tubes in the inner wall contain a circulating liquid which transfers absorbed heat to an expendable fluid such as water, and is later ejected as steam.

Company spokesmen say that leading edges will be made of some high heat sustaining material to provide additional protection.

Bell has been investigating this method for over six years and has successfully flight tested some experimental configurations.

The contract, awarded by the Aeronautical Systems Center of the Air Material Command, Wright Patterson Air Force Base, Ohio, calls for Bell to determine the best fabricating methods of double-walled structures and to further demonstrate the feasibility of the concept in solving re-entry problems.

## Ball Bearing Tolerances Improved at MIT Labs

Ball-bearings with tolerances of 20 millionths of an inch are being mass produced by the Barden Corp., Danbury, Conn., using specifications and methods perfected at the Instrumentation Laboratory of the Massachusetts Institute of Technology.

The program, initiated five years ago because of the rapid advances in gyroscope design, resulted in the production of bearings machined so precisely that it is termed a "significant technical advance" by engineers at the laboratory.

The bearings are used in ultra-precise inertial guidance systems and their contribution is such that the accuracy of these systems exceeds expectations of only a few years ago.

Air gages and linear transformer transducers were improved considerably during the project as were shop machine tool techniques for increasing the percentage of highly accurate bearings.

The advance was the result of a concerted push by the Ballistic Missile and Wright Air Development Divisions of the Air Force without waiting for the market itself to grow sufficiently to make the work spontaneous. The entire project was a joint effort of Barden, MIT and the Air Force.

## Reds Claim Extrusion of Microthin Lead Wires

The Russians have reported that they have successfully extruded lead wires in the 1-2 micron range from the molten metal.

V. Belov, engineer at the Electro-Physical Institute of Metallurgy of the Academy of Sciences, USSR, said that Soviet scientists have perfected a method of extruding aluminum and lead wires from the melt held under pressure in an inert atmosphere.

Plates rolled from the extruded aluminum wire have much greater structural strength than ordinary aluminimum plates because of the larger surface oxidation of the metal during extrusion.

Lead plates rolled from extruded wires increase the capacity of storage batteries because of the greater porosity of the material.

The Russian scientists used glass as the lubricant, and diamond dies.

The development was reported in the Soviet daily, *Sovetskaya Aviatsiya* (Dec. 24).

## Missile Fluid Systems Cleaning Facility Opened

A certified cleaning facility capable of meeting the requirements demanded of missile fuel, hydraulic, liquid and LOX systems has been opened at Dunbar Kapple, Inc., Batavia, Ill.

Originally designed to remove particle contaminants in the firm's production of flexible metal hoses, the facility is now open to missile component manufacturers.

Components are subjected to several cleaning phases in a dustproof room. Personnel wear special clothing to further reduce the danger of contamination. After cleaning, the parts are dried, inspected and packaged before being admitted to the shipping area.

# House Group Confers with Scientists

***In article written exclusively for M/R, committee chairman tells of plans for nation's first panel on Science and Technology***

**by Rep. Overton Brooks (D-La.)**
*Chairman, House Committee on Science and Astronautics*

This month for the first time in our nation's history, representatives of the scientific community will sit down around a conference table with Members of Congress and exchange views and recommendations on the scientific needs of the country.

On March 24 and 25, some 12 or 14 of America's outstanding scientists and engineers will come to Washington to meet with the House Committee on Science and Astronautics—the Committee which has been instrumental in gathering together this group of leading scientists to serve as a Panel on Science and Technology. Tentative plans call for two meetings a year.

Heretofore, there has been a lack of communication between the sciences and Congress, between the sciences and the general public, even between the various scientific fields themselves. The Committee believes the Panel will bridge this gap in communication, thereby keeping us constantly aware of new scientific advances that can be translated quickly into defense programs or into our own "spectaculars" in space exploration. We feel this capability is urgently needed as insurance against the aggressive ambitions of the Soviet Union.

• **Laws may follow**—The purpose, then, of the Panel is to increase the effectiveness of the Committee, both in the interest of Congress and of the scientific community at large as it represents national interests. Members of the Panel will present to the Committee their views and recommendations on scientific and space programs which they feel should be encouraged and initiated. The Committee will give these recommendations the utmost consideration and, if necessary, enact such legislation as is required to carry them out. It is planned later on to establish special task groups to undertake particular assignments as may be made by the Committee.

The Panel will, of course, greatly assist the Committee in keeping abreast of new scientific breakthroughs and developments.

Other ways in which the Panel will be called upon to help the Committee are:

• Advise as to current methods for conducting research;

• Provide information concerning the availability of scientific manpower and also on educational needs;

• Provide information concerning matters of international cooperation and organizations concerned with science, and

• Maintain channels of communication between Congress and the scientific community.

Members of the Panel have been selected on a strictly non-partisan basis —professional qualifications were the first consideration. Assistance in making the selections was given the Committee by the National Science Foundation, the National Aeronautics and Space Administration and the National Bureau of Standards. Scientific fields represented include biophysics, chemical engineering, applied mechanics, chemistry, meteorology, geology, medicine, aeronautical engineering, nuclear physics, astronomy, jet propulsion, genetics and zoology.

In subsequent meetings, written contributions from each Panel member will be invited and these papers, along with the recorded proceedings of each session, will be edited and printed for issue as public documents. It is expected that they will provide valuable contributions to scientific literature and serve to represent the informational function of Congress to general public and scientific community alike.

The Committee on Science and Astronautics is the first committee devoted to science in general in the Congress. Our interest in science and technology is motivated by the deep conviction that the greatest resource and strength of the American people and the nation lie in the ability to translate new ideas, new concepts, and new developments into reality through proper liaison, organization and the application of sufficient resources. Leadtime between concept and reality must continue to be shortened and every possible method to reduce the time lag must be explored. Important pools of scientific information and knowledge accumulating elsewhere in the world must be tapped and made available to the free world.

In response both to Soviet outer space achievements and to the Soviet propaganda exploitation of them, the world image of Soviet progress has been enhanced. There is no doubt that our friends abroad are watching our own future progress and achievements.

We on the Committee have no doubt that the new Panel on Science and Technology will help us greatly in our goal of keeping the United States foremost in scientific development. We have full confidence that through coordinated effort on a broad scientific front our country can and will demonstrate the leadership which is historically associated with free men.

## ——Weighty Panel——

Members of the first Panel on Science and Technology sponsored by the House Space Committee:

Dr. Lee A. Dubridge, *Physics, California Institute of Technology;* Dr. Thomas F. Malone, *Meteorology, Massachusetts Institute of Technology;* Dr. Edward J. Baldes, *Senior Consultant in Biophysics, Mayo Clinic;* Dr. Clifford C. Furnas, *Chemical engineering, Chancellor of the University of Buffalo;* Martin Goland, *Applied mechanics, Southwest Research Institute;* Prof. W. Albert Noyes, Jr., *General chemistry, University of Rochester;* Dr. Clarence P. Oliver, *Genetics and zoology, University of Texas;* Dr. Sverre Petterssen, *Meteorology, University of Chicago.*

Dr. Roger Revelle, *Geophysics and oceanography, Director, Scripps Institution of Oceanography, University of California;* Prof. Richard L. Russell, *Geology, Louisiana State University;* Dr. H. Guyford Stever, *Aeronautical engineering, Massachusetts Institute of Technology;* Prof. James A. Van Allen, *Nuclear physics, cosmic rays, State University of Iowa;* Dr. Fred L. Whipple, *Astronomy, Director, Astrophysical Observatory, Smithsonian Institution;* Prof. Maurice J. Zucrow, *Jet propulsion, Purdue University.*

CONGRESSMAN JOHN TABER (R-N.Y.), left, listens to Senator Leverett Saltonstall (R-Mass.), center, and Congressman Frank T. Bow (R-Ohio).

SENATOR WARREN G. MAGNUSON (D-Wash.) is greeted by Mr. Gross. Mr. Parrish is in background.

# Lockheed Chairman Gross Honored i

MR. GROSS, left, chats with Senator Stuart Symington (D-Mo.).

A host of Washington celebrities attended a reception recently honoring Robert E. Gross, chairman of the Board of Lockheed Aircraft Corp., and Mrs. Gross at the home of Wayne W. Parrish, president and publisher of American Aviation Publications, Inc., publishers of MISSILES AND ROCKETS MAGAZINE.

Among the 175 industry and government leaders attending were many Senators and Representatives, some of whom are shown here. Mr. Gross was in the capital to appear also at the annual Silver Quill dinner of the National Business Publications. He spoke on behalf of the aircraft/missile/space industry.

SENATOR HENRY M. JACKSON (D-Wash.) chatting with Mr. and Mrs. Gross. In rear are Mr. and Mrs. Parrish.

SENATOR HERMAN E. TALMADGE (D-Ga.) and Mrs. Talmadge are greeted by Mr. and Mrs. Gross.

ELWOOD "PETE" QUESADA, FAA Administrator, and Mrs. Quesada (left) talk with Mr. Gross.

# Washington

SENATOR KARL MUNDT (R-S.D.) and Mrs. Mundt are introduced to Mr. and Mrs. Gross by Mr. Parrish.

MR. J. W. CROSBY, president of Thiokol Chemical Corp., talks with Mrs. Gross. At rear left is Congresswoman Katharine St. George (R-N.Y.).

LT. GEN. JAMES H. DOOLITTLE, USAF (Ret.), Chairman of the Board of Space Technology Laboratories, Inc., center, talks with William C. Foster, Director of Olin Mathieson Chemical Corp., and Mrs. Foster.

SECRETARY of the Air Force Dudley C. Sharp chats with Mr. Gross.

# mergers and expansions

**TESTING, INC. BOUGHT:** Testing, Inc. Los Angeles, has been acquired by Idaho Maryland Mines Corp., Glendale, and reorganized as Universal Research and Testing Laboratories. Company will continue qualification, evaluation, research and reliability testing for electronic, electro-mechanical, pneumatic and hydraulic components and systems for aircraft and missiles. A new research department has been created to conduct studies and simulate space environment.

**AVIEN BUYS:** Colvin Laboratories, which recently merged with Pressure Elements, Inc., has in turn been acquired by Avien, Inc.

**NAME CHANGE:** CGS Laboratories, Inc. is in the process of changing its name to Trak Electronics Co., and for the present will operate under the name Trak Electronics Co., a division of CGS Laboratories.

**NEW FACILITY:** General Electric Co. is now in occupancy of its Special Programs Section facility in Radnor, Pa. It will concentrate on GE design and development capabilities on the system requirements of the Army.

**$500,000 EXPANSION:** Sylvania Electric Products, Inc. will spend $500,000 in the expansion of facilities for the production and processing of a single crystal germanium and silicon for use by the semiconductor industry. The Chemical and Metallurgical Division's program will be housed in existing buildings at Towanda, Pa., and operating within 90 days.

**ANOTHER DIVISION:** Bethlehem Foundry and Machine Co. organizes a new Environmental Engineering Division to specialize in electronics and missile field products.

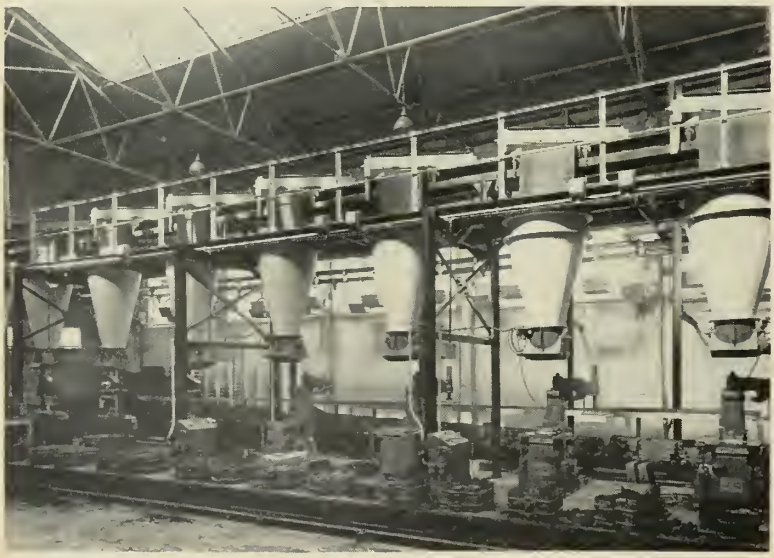
**PLANT DEDICATION:** Air Reduction Sales Co. Division of Air Reduction Co., Inc., dedicates the companies newest liquid air separation plant at Fairfield, Alabama. The multimillion dollar facility will produce liquid oxygen, nitrogen and argon.

**AEC EXPANSION:** The Atomic Energy Commission has let a contract for the construction of a new Metals and Ceramics Facility for the Metallurgy Division at the Oak Ridge National Laboratory. The entire project will cost $6,500,000.

**3M GROWS:** Minnesota Mining and Manufacturing Co. plans to double the size of its branch office and warehouse in Buffalo, N.Y.

**CENTER OPENS:** Food Machinery and Chemical Corp. Chemical Research & Development Center at Princeton, N.J. has been completed on schedule.

## Foundry Plant Expands



**GORHAM ELECTRONICS, Division of Gorham Mfg Co. is modernizing its microwave foundry facilities, in response to rising demands for microwave equipment.**

# financial news

Texas Instruments more than doubled its sales and profits in 1959.

The company financial report for the year just ended shows sales of $193.2 million and net income of $14.1 million. This compares with 1958 sales of $91.9 million and net income of $6 million. T-I's backlog on Dec. 31 was $101.1 million, including $47 million in government business.

Other financial news:

• **North American**—A 50-cent dividend on common stock has been declared, bringing to $1 dividends declared since Oct. 1. The company predicts FY 1960 sales will top $1 billion.

• **Ryan Aeronautical**—Sales rose in the first quarter of 1960, but profits slipped. The company's quarterly report lists sales of $20 million and net profits of $247,633 compared to sales of $16.9 million and profits of $560,527 for the same period last year.

• **Thompson Ramo Wooldridge**—Record 1959 sales of $417 million and net income of $9.7 million are reported. Sales in 1958 were $340 million and earnings $8.9 million.

• **Westinghouse Electric Corp.**—Officials said 18% of its 1959 sales of $1.9 billion were in the defense and nuclear propulsion field, about the same as the previous year.

• **General Controls**—Sales in 1959 hit a record $40 million. Profits were $1.6 million. This compares to 1958 sales of $33.7 million and net income of $1.4 million.

• **Textron Electronics**—In the first seven months after its organization in the middle of last year, it had sales of $9.8 million and profits of $384,000.

• **Perkin-Elmer**—Increased second quarter sales and earnings for the quarter which ended Jan. 31 reported. Sales for the quarter were up 39% and profits up 61% over 1958. Sales for the six month period were $8.6 million and earnings $342,919—slightly ahead of the same period in the previous year.

# letters

## Armour's Independence

*To the Editor:*

Your February 22 issue contained an item on page 32 about an Armour Research Foundation project for which we are deeply grateful.

The article, however, mentioned that Armour Research Foundation was part of the University of Illinois. The U. of I. has cast longing glances at Illinois Tech's campus in its efforts to obtain a Chicago campus, but so far we have resisted state legislators and governor's committees and still remain a private technological institution.

This is not a complaint, only a correction of a situation caused, no doubt, by the confusion of names. It happens every so often.

Daniel G. Cahill
Manager of Public Relations
Armour Research Foundation of
Illinois Institute of Technology
Chicago 16, Illinois

## 'Floating' *Saturn*

*To the Editor:*

I was interested and intrigued by the statement in the March 7 M/R that "NASA, incidentally, has run calculations to determine whether *Saturn* would float if it were filled with hydrogen."

Permit one whose art is optics to express that all maneuverable lighter-than-air vehicles do not suddenly shoot skyward like balloons when deprived of their sandbags. All maneuverable lighter-than-air machines such as blimps and dirigibles contain *just enough* hydrogen or helium to permit their *effective density* to equal that of the surrounding air, and thus the energy required for maneuvering them is minimal. Further, the gas bags of blimps and dirigibles have hundreds of thousands of cubic feet of capacity, and their supporting structures may be equal in weight, or just a little heavier, than the gas bags. But for you to state that NASA ran some calculations to see whether or not *Saturn* would float . . . with its hundreds of tons of mass, and small tank capacity . . . tsk, tsk.

Frank M. Cameron
222 Holmes Avenue, N.W.
Huntsville, Alabama.

*You're so right. But NASA made the calculations, not M/R. We merely reported that the results of the calculations show that it will not float—Ed.*

## Congress Slights Kaman

*To the Editor:*

Your issue of January 25 carried an article on Hébert Legislation and a compilation of defense companies. It listed Kaman as having 1270 employees. At the end of January 1960 we had 3050. Your information is badly out of date.

Weston B. Haskell, Jr.
Assistant to the President
The Kaman Aircraft Corp.
Bloomfield, Connecticut

*Information listed was compiled by Congress, not M/R.—Ed.*

# reviews

TUNGSTEN, A BIBLIOGRAPHY, Sylvania Electric Products Inc., Chemical and Metallurgical Division, Towanda, Pa. 39 pp. $1.00.

A compilation of domestic and foreign tungsten literature references, this book is the first such effort in nearly six years to present in one volume all of the important advances made in tungsten technology. The most complete table of the properties of this element ever published is included together with 19 binary and ternary tungsten phase diagrams, many of which were developed only during the last few years.

CRYOGENIC DATA BOOK, D. B. Chelton and D. B. Mann, National Bureau of Standards Cryogenic Engineering Laboratory for WADC. Order PB 151837 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 155 pp. $3.

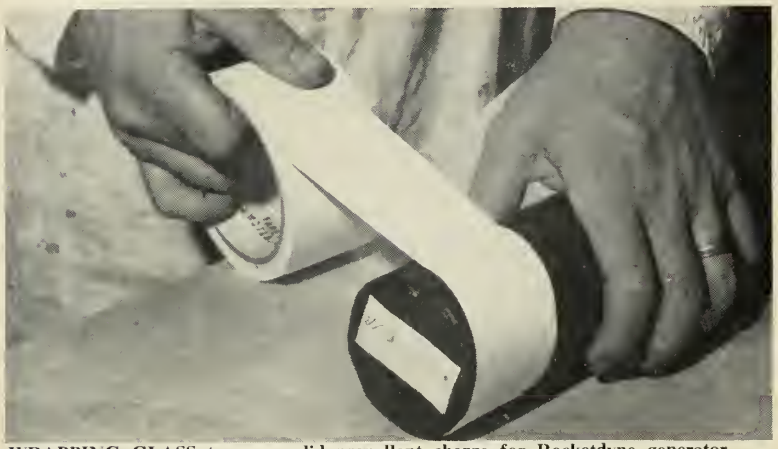
The physics of eight liquefied gases and over 140 solids at the same extreme temperatures are illustrated. More than 100 full-page graphs present curves for such factors as densities, vapor pressures, heats of evaporation and conversion, specific heats, surface tension, thermal conductivity, and percent of liquefaction for helium, para and orthohydrogen, and others.

Additional graphs delineate the properties at liquid gas temperatures of selected metals, glass and insulating plastics. The appendix includes handy tables of boiling points, characteristics of stainless steel, fluid properties, water vapor absorption and similar aids.

FREE-FLIGHT INVESTIGATION AT MACH NUMBERS BETWEEN 0.5 AND 1.7 OF THE ZERO-LIFT ROLLING EFFECTIVENESS AND DRAG OF VARIOUS SURFACE, SPOILER, AND JET CONTROLS ON AN 80° DELTA WING MISSILE. Eugene D. Schult. Order NASA Technical Note D-205 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. $1.25.

Tests were made of various deflected surfaces, spoilers, and inlet-air-jet devices to substantiate simple theory for deflected surfaces, and to determine some effects of chordwise location for spoilers and blowing direction and spanwise location jets.

The fuselage shape was modified for one case. The results demonstrated that all controls were satisfactory roll-producing devices except the canards immediately forward of the main wings and the spoilers at other than training-edge locations.



WRAPPING GLASS tape on solid propellant charge for Rocketdyne generator.

## Generators Built for *Tartar/Terrier*

Rocketdyne Division, North American Aviation, has developed two compact solid-propellant gas generators to provide electric power and drive the hydraulic system on the Navy's *Tartar* and *Terrier* surface-to-air missiles.

Both units were developed and are produced at Rocketdyne's Solid Propulsion Operations in McGregor, Tex. The MK2 generator serves the electrical systems. The MK3 develops power for the hydraulic turbines.

Each generator has a boost disc of fast-burning propellant cemented to the starting end of the main propellant charge. The disc provides the instantaneous burst of power needed for starting the machinery.

Both use a clean-burning extruded grain with ammonium nitrate oxidizer. Rocketdyne says the propellant leaves no detrimental deposit on turbine blades and units can be stored for long periods without special care.

The fast-burning boost disc uses a combination nitrate-perchlorate oxidizer. Control of the necessarily high boost pressure, which levels off within 0.8 second of firing, is achieved in the design of the propellant charge. After the boost disc burns, the main stage of the propellant consists of a relatively cool-burning adaptation of the ammonium nitrate propellant used in the M15A1 JATO.

The MK2 boosts the electric systems to rated output in about 0.5 second. The MK3 lifts the turbines to rated speed within 1 second.

Cases for the generators are made of 4130 steel. The charge is covered with an inhibitor and then wrapped with glass tape. Additional protection for the case wall is provided by a sleeve of insulation. In the head of each unit, a molded insulator is used.

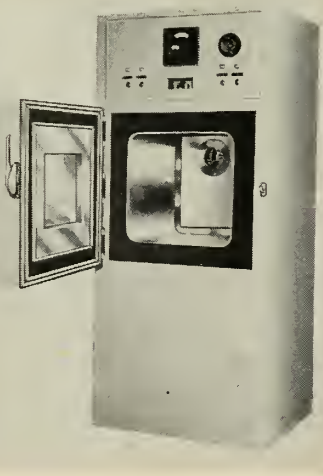
The *Tartar* and *Terrier* are manufactured for the Navy by Convair/Pomona, Convair Division, General Dynamics Corp.

Circle No. 225 on Subscriber Service Card.

## Environmental Test Cabinet

A new environmental test cabinet with special "add-on" facilities for altitude, vacuum, humidity and temperature testing answers the needs of laboratories with expanding environmental test requirements. The unit is available from the Hudson Bay Co.

Called the Com-pac Cab, it is designed specifically for low temperature operation with an adjustable temperature range from 300°F to —120°F. Varied testing can be had by merely adding optional equipment. The working chamber is 19" x 19" x 19".



Circle No. 226 on Subscriber Service Card.

## Honeycomb Core Materials

Hexcel Products Inc. has developed a series of new fiberglass heat-resistance honeycomb core materials for use in missiles.

The material, described as the "strongest and lightest plastic honeycomb ever produced," is the result of two years of research work carried out at Hexcel.

Trade-named HRP, the heat-resistant phenolic core consists of woven glass cloth impregnated with a high-temperature phenolic resin and separately applied high-temperature phenolic dip coats.

The entire HRP series includes six different core materials ranging in density from two pounds per cubic foot to 15 pounds per cubic foot in cell sizes of 3/8 in. and 3/16 in. permitting Hexcel to meet an extremely broad range of high-performance requirements.

The lower densities are designed for use in highly loaded aircraft and missile components, the middle densities for primary aircraft structures, and the higher densities for marine structures such as hydrofoils and underwater containers.

In addition to having a high strength-to-weight ratio, the HRP cores also have a higher resistance to moisture than any other type of honeycomb—including stainless steel and aluminum. The latter eventually suffer corrosive attack when continuously exposed to a salt spray environment. Under the same conditions, HRP cores remain intact.

Circle No. 227 on Subscriber Service Card.

## High Frequency Transistors

Pacific Semiconductors, Inc. announces the industry's first Very High Frequency Silicon Mesa Power transistors capable of delivering one watt power output at 70 mc. with a 28 volt collector voltage.

The two new types, designated as 2N1505 and 2N1506, are characterized by 3 watt collector dissipation, 40v collector-to-emitter rating, and low collector capacitance. The units are particularly well suited for VHF power application in communications and telemetry equipment where severe en-

vironmental conditions are encountered.

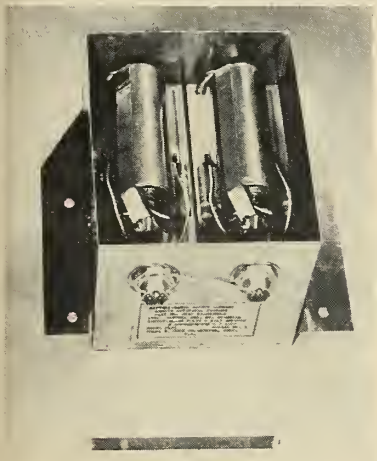
Type 2N1505 operates as an oscillator at 70 mc. with a power output in excess of 1 watt at an efficiency of 45%.

Type 2N1506 has a typical power gain of 12 db at 70 mc. with a useful power output of 1.0 watts. At 200mc the 2N1506 has a power output of 300 milliwatts.

Circle No. 228 on Subscriber Service Card.

## Silver-Zinc Battery

A dual battery in a single case provides complete auxiliary power for missiles and space vehicles. The two battery sections in the Model P42A have identical output and capacity. They are intended for applications



where standby capacity is required, or where one circuit must meet a heavy peak current demand, while the other would have a steady, nonfluctuating load. The special pile-type construction has a voltage change of only 10% under maximum surge loads several times normal.

Each 19-cell section provides a current of 3 amperes at 26.5 volts. Maximum current is 15 amperes, with a discharge time of 40 minutes at 3 amperes. Capacity is 2 ampere-hours.

Both sections are activated automatically. The reliable activating mechanism is a simple electrolyte tank and piston arrangement, operated by a solid-propellant gas generator. Activation time is only 0.5 second. The signal required is 4 amperes at 28 volts.

Circle No. 229 on Subscriber Service Card.

## Quenched Arc Cutting

A new line of three ELECTRO Band Machines, utilizing a new electrical machining process known as "quenched arc cutting," has been introduced by the DoAll Company. These machines are especially suited for machining honeycomb of aluminum, stainless steel or titanium, and other fragile cellular structures made of foil or thin-wall tubing.

As the name implies, ELECTRO Band Machining is an extension of the band sawing technique. It uses modified standard DoAll band machines and offers the band machining advantages of high-speed cutting and low material waste.

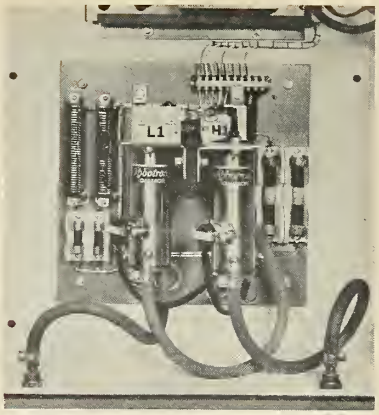
Work is sliced away by a band that removes as waste only 1/32 in. of material. Instead of making honeycomb core in rough individual blanks and grinding away waste material, it now is possible with ELECTRO Band Machining to start with a "log" and slice off pieces to finished size at substantial savings in both time and material.

Circle No. 230 on Subscriber Service Card.

## Weld Control System

A new welding control and power system that combines all the advantages of normal resistance, capacitor discharge and percussion welding with none of their inherent disadvantages has been made available to industry by Robotron Corp.

Referred to as "spike power" welding, the development is a result of five




years' research by Robotron engineers. The system revolves around a new type of tube called a coaxial ignitron tube contactor which is capable of handling very high peak currents for short time periods without misfiring or breaking down, it is reported.

Resistance welding jobs formerly demanding very large welding transformers can now be done with the new control principle using transformers of only a fraction the size ordinarily required, the firm has discovered.

Because minimum heat is generated

between pulses, welding electrodes remain virtually cold. Temperature of the work pieces is confined to the interface contact area of the two metals. With little latent heat left in the parts, they can usually be handled with bare hands immediately after welding.

Circle No. 231 on Subscriber Service Card.

## Portable Calibration Head

A portable, lightweight, calibration kit, designed to perform with laboratory precision and a high degree of dependability in field use, has been announced by the Electronics and Instrumentation Division of Baldwin-Lima-Hamilton.

This B-L-H SR-4 Calibration Kit provides a convenient versatile unit for checking and calibrating tension and/or compression loads output in weighing systems, jet engine test stands, missile thrust stands and similar applications. The kit contains a precision calibration indicator featuring digital readout and a high accuracy calibration load cell. Combined, these units are guarantee direct-reading accuracies of as high as 1/20% of reading.

One unique functional advantage of this kit is the ease of changing the broad range of operating capacities possible. Using available standard cells, these capacities range from 60 to 120,000 lbs. for tension service and from 60-240,000 lbs. for compression service. This is made possible by B-L-H's use of a special calibration model of its well-known SR-4 Load Cell as the load sensing element of this kit. It acts as a load transducer converting load changes into electrical values. A complete range of standard cells or cells specific applications may be supplied with this kit.

Circle No. 232 on Subscriber Service Card.

## New Literature

BROCHURE. Dedar Engineering, a division of Control Data Corp., has released a brochure describing its line of miniature electrical and electromechanical devices. Described and illustrated are the company's miniature rotary devices, linear acceleration devices, control amplifiers, and complete servo and time function assemblies. Also described are supporting activities such as gyro modification and repairs, custom winding services, and environment/qualification testing laboratory services.

Circle No. 200 on Subscriber Service Card.

THERMOSTAT METAL. How thermostat metal elements can be stacked to satisfy performance specification in space that prohibits the use of a single element with sufficient material volume is the subject of a new 2-page data bulletin, TRU-11 by Texas Instruments Inc. Multiple element assemblies in series, in parallel, and in parallel-series are discussed. Rules for determining the thermal deflection, mechanical deflection, and force of each type of assembly, as compared to the properties of the single elements that make up the assembly are given.

Circle No. 201 on Subscriber Service Card.

EPOXY RESINS. Three new and different epoxy resins—displaying novel structure, reactivity and curing characteristics—are described in a 24-page booklet just published by Food Machinery and Chemical Corporation. The booklet deals with physical properties of the OXIRON 2000 series and tells how these resins differ from conventional epoxies of commerce. Cure systems are thoroughly described by means of actual formulas used to obtain a variety of end properties. Thirteen different tables present the physical and mechanical properties of the cured and uncured resins while 10 graphs illustrate such properties as high heat distortion points, exotherm and molecular structures.

Circle No. 202 on Subscribed Service Card.

STEPPER MOTORS. Technical brochure SP9-1, a 12-page booklet describing a new line of stepper motors and pulsed stepping devices, is available from The A. W. Haydon Company. For each of the new units in Haydon's stepping line—series 18100 motors, rotary stepping switches, pulse dividers, precision sequences, counters, interval timers and positioning devices—complete information is given. This includes product features, application and construction details.

Circle No. 203 on Subscriber Service Card.

HIGH PRESSURE SYSTEMS. A catalog from the Airdox Cardox Products Co., provides performance and engineering data on central compression systems for supplying air, nitrogen or helium at pressures to 12,000 psi and 170 scfm., with less than 4 ppm oil content and any degree of purification necessary.

Circle No. 204 on Subscriber Service Card.

THEODOLITES. A new brochure describing a series of azimuth alignment theodolites used to obtain azimuth accuracy of inertially guided ballistic missiles, has been published by the Electro-Optical Division of the Perkin-Elmer Corporation.

Circle No. 205 on Subscriber Service Card.

# contracts

## AIR FORCE

$273,000,000—**Lockheed Aircraft Corp.**, Burbank, Calif., for satellite projects ($157 million for *Samos*; $60 million for *Midas*, $56 million for *Discoverer*).

$8,476,659—**Hughes Aircraft Co.**, Culver City, Calif., for GAR-11 *Falcon* missiles, shipping and storage containers, spare parts, data and ground support equipment.

$600,000—**Transval Electronics Corp.**, El Segundo, Calif., for two types of power supplies for activation of *Bomarc* ground support equipment.

$295,800—**General Electric Co.**, Owensboro, Ky., for electron tubes.

$206,135—**Radio Corporation of America, Defense Electronic Products**, Camden, N.J., for switches, relays and contact assemblies.

$183,700—**Hydromatics, Inc.**, Livingston, N.J., for flo-ball valves to be used in connection with the propellant loading system for *Atlas* silo launch complexes.

$99,300—**Milgo Electronic Corp.**, Miami, Fla., for eight 17-digit timing code generators and auxiliary support items.

$77,182—**Sylvania Electric Products, Inc.**, New York City, for electron tubes.

$74,995—**CBS Electronics**, Danvers, Mass., for electron tubes.

$52,457—**Northrop Corp., Norair Div.**, Hawthorne, Calif., for rocket catapult test program for T-38 aircraft.

$46,901—**Ronson Hydraulic Units**, Charlotte, N.C., for spare parts for rocket assemblies used on F84 aircraft.

$45,000—**Armour Research Foundation of Illinois Institute of Technology**, for research concerned with the formation and growth of defect clusters in solids.

$43,570—**Underwood Corp., Canoga Div.**, Fort Walton Beach, Fla., for central timing system for *Pershing* tracking.

$35,766—**Republic Aviation Corp.**, Farmingdale, N.Y., for spare parts for rocket assemblies used on F84 aircraft.

## ARMY

**Giannini Controls Corp.**, Pasadena, Calif., for 12 "photopot" units, a semiconductor device which can be used as a potentiometer in guidance systems of advanced space vehicles. Amount not disclosed.

$12,555,160—**Paul Hardemann, Inc.**, Stanton, Calif., for propellant loading system prefabs and interconnecting piping for ballistic missile operational and test facilities (7 contracts).

$5,333,673—**Sperry Rand Corp.**, Salt Lake City, for research and development on the *Sergeant*.

$3,230,166—**Sperry Rand Corp.**, for engineering services for *Sergeant* system.

$1,574,624—**Thiokol Chemical Corp.**, for the production of *Falcon* rocket motors.

$720,000—**Union Carbide Development Co.**, New York City, for research in physical and chemical principles affecting high-temperature materials in rocket nozzles.

$596,683—**Joy Manufacturing Co.**, Dallas, for air washer and dust collector units for ballistic missile projects (6 contracts).

$230,761—**Dean Hill Corp.**, Indianapolis, for centrifugal and turbine pumps for ballistic missile projects, various locations (6 contracts).

$227,168—**Trane Co.**, LaCrosse, Wis., for air conditioning fan coil units for missile projects (6 contracts).

$223,277—**Arvol D. Hays**, Lubbock, Tex., for guided missile field maintenance shop, Walker AFB.

$191,700—**Water Cooling Equipment Co.**, St. Louis, for cooling towers for ballistic missile projects (6 contracts).

$150,000—**Columbia University**, New York City, for program of research entitled "A Study of Target & ECM Simulator Problems."

$139,800—**Key, Inc.**, Winchester, Tenn., for construction of addition to propulsion wind tunnel office building, Arnold AFB.

$134,773—**Kearfott Div. of General Precision, Inc.**, Clifton, N.J., for design and fabrication of prototype integral rotary serve assemblies.

$69,257—**Butler & Cobbs**, Montgomery, Ala., for improvements to systems support equipment laboratory propellant and test area.

$60,264—**Oak Mfg. Co.**, Chicago, for vibrator interrupter.

$49,732—**Ampex Data Products Co.**, Atlanta, for FR-600 magnetic tape recorder/reproducer system with accessories.

$28,800—**Astrobell, Inc.**, Canoga Park, Calif., for *Nike-Ajax* parts.

## NAVY

$2,453,608—**Motorola, Inc.**, Chicago, for 484 all-transistorized 10 inch radar repeaters.

$250,000—**Precision Instrument Co.**, San Carlos, Calif., for instrumentation tape recorders and accessories. Subcontract from **Western Electric**.

$58,000—**Avien, Inc.**, Woodside, N.Y., for temperature and shock monitor control systems for use on the *Polaris* missile.

## NASA

$80,000—**Fred S. Gichner Iron Works, Inc.**, for outfitting six trailer vans to be used in Project *Mercury*.

## MISCELLANEOUS

**Southwestern Industrial Electronics Co., Div. of Dresser Industries, Inc.**, Houston, for designing and building a "prototype" power amplifier for a new type rate-of-climb meter for missiles and aircraft. Subcontract from **Summers Gyroscope Co.**

$75,000—**Datran Div., Automation Industries, Inc.**, Manhattan Beach, Calif., for digital strain indicators. Subcontract from **Budd Instrument Div., Budd Corp.**

## BIDS

Air Defense System Branch (low altitude) Industrial Div., Army Rocket and Guided Missile Agency, U.S. Army Ordnance Missile Command, Redstone Arsenal, Ala.-Pallet loading and storage guided missile *XM-1*—175 each—RFP-DA-01-021-ARGMA-1HPE-60-2Q—Drawings and RFP are available from nearest Ord. Dist. Final submission date will be established by each Ord. Dist.

Fort Worth Dist., Corps of Engineers, U.S. Army, Ft. Worth, Tex.-Guided missile field maintenance shop, approx. 12476 S.F. combination unit masonry and metal siding building. Site preparation, utilities, 475 tons asphalt pavement, 553 of curb and gutter, 1046 1F 7 ft. chain link fence and two cathodic protection units. Dyess AFB area, Tex. Bid sets avail. at purchase price $5 per set for half-size dwgs. Full size dwgs avail. at $0.50 per sheet to holders of half-size sets—Job—IFB ENG-41-433-60-24B—Bid opening 30 Mar. 1960.

Purchasing and Contracting Div., White Sands Missile Range, N.M. Oscillograph, magnetic, 36 channels, range 0-4, 800 CPS, direct writer. Bid sets avail. through 28 Mar. 1960—1 each—IFB ORD-20-040-60-187—Bid opening 5 Apr. 1960.

National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif. Rotating mirror cameras, 2000 RPS, 3 ea.—Kerr cell shutter—1 ea. IFB A-2218—Bid opening 28 Mar. 1960.

# names in the news

SANDBERG

**Harry A. Sandberg:** Joins Rosemount Engineering Co. as head of manufacturing. Previously headed the fabrication engineering department at the Liquid Rocket plant of Aerojet-General Corp., after holding manufacturing supervisory positions at Librascope, Inc., Roylyn, Inc., and Bendix Aviation Corp.

**Robert F. O'Neill:** Former quality control manager promoted to manager-manufacturing for Standard Steel Corp.'s Cambridge Division. **Thomas F. Duff, Jr.,** former chief inspector, succeeds O'Neill as head of the quality control department.

**Leo W. Ollila:** Appointed director of manufacturing for the National Forge Co. Was works manager for the Wyman-Gordon Co. and prior to that manager of metallurgy for that firm's Eastern Division.

**Dr. George E. Valley, Jr.:** Formerly chief scientist of the U.S. Air Force and a professor of nuclear physics at Massachusetts Institute of Technology, will serve as a scientific consultant to Northrop Corp.

McCALL

**Dr. Jerry C. McCall:** Named assistant to Dr. Wernher von Braun, director of the Development Operations Division, Army Ballistic Missile Agency. Duties will include carrying out special projects and program studies, maintaining liaison with laboratories, government agencies and industry. Joined the agency last year as a member of the scientific staff in the computation laboratory.

**W. Carlos Fox:** Appointed Washington representative of Westrex Corp., a division of Litton Industries. Was previously associated with Bendix Radio Corp., International Telephone & Telegraph Co., U.S. Department of State, Commonwealth Research Corp., and Raytheon Co.

**Charles F. Siebold:** Formerly with Aerojet-General, joins Lockard Tool & Engineering Co., plastics division, as production manager.

**Stan Burns:** Named director of engineering, American Electronics, Inc. Ground Support Division, with special interest in the electronic, pneumatic and mechanical fields. Previous posts: Vice president of research and development at Marathon Electric Manufacturing Corp.; general manager, Burke Electric Co.

**William J. Conner, Jr.:** Appointed manager of Defense and Business Planning for General Electric's Missile and Space Vehicle Department at Philadelphia. Before joining GE in 1957, held various engineering positions at Minneapolis-Honeywell Regulator Co. and as a research physicist at the Atlantic Refining Co.

**Stephen Hluchan:** Recently with Taylor Instrument Co., appointed sensor and materials engineer at Bourns, Inc.

CARVELL

**Frank R. Carvell:** General manager-rocket motors for the Aviation Products Division of the B. F. Goodrich Co., replacing **Harold W. Catt,** named director of purchases and traffic for the firm in Akron. Carvell was previously production manager at the Goodrich Co. development center at Avon Lake.

Space Electronics Corp. has made the following appointments to its technical staff: **John J. Davis,** formerly with Aeronutronics Division of Ford Motor Co.; **Gerald R. Dunn,** from Hughes Aircraft Co.; **Donald W. Fite,** formerly with Cooper Development Corp.; **Dr. Anthony Gangi,** from the Institute of Geophysics, UCLA; **Dr. Allan Harbaugh,** from System Development Corp.; **Thomas J. Hart,** formerly Gilfillan Brothers, Inc.; **Richard M. Jaffe,** from Hughes Aircraft Co.; **Thomas C. Larter,** from Aeronutronics; **Merlin E. Louape,** Douglas Aircraft Co.; **Stephen V. Marsh,** from Hughes Aircraft Co. and **Dr. Hamilton Wright** from Jet Propulsion Laboratory.

NICHINSON

**David B. Nichinson:** Former vice president - engineering, elected president of Kollsman Instrument Corp., effective April 1, succeeding **Victor E. Carbonara,** who is retiring. Nichinson for several years served as director of research and development and prior to joining the firm was a staff member with the Radiation Laboratory of Massachusetts Institute of Technology. Carbonara will continue as a consultant.

**William Littlewood,** Vice president-equipment research of American Airlines, and **Dr. Frederick Lindvall** of the California Institute of Technology, elected to the board of directors of the Marquardt Corp., replacing the late **George P. Tidmarsh** and **Robert L. Earle,** who resigned last month.

## Advertiser's Index



## CLASSIFIED



## when and where

### MARCH

**Institute of Radio Electronics, 1960 International Convention,** Waldorf-Astoria and New York Coliseum, New York City, March 21-24.

**American Rocket Society, Ground Support Equipment Conference,** Statler-Hilton Hotel, Detroit, March 23-25.

**Symposium on Optical Spectrometric Measurement of High Temperatures, sponsored by University of Chicago's Applied Science Laboratories, Jarrell-Ash Co., National Science Foundation,** University of Chicago, March 23-25.

**22nd Annual American Power Conference, sponsored by Illinois Institute of Technology, American Society of Mechanical Engineers and others,** Sherman Hotel, Chicago, March 29-31.

### APRIL

**University of Connecticut, Sixth Annual Advanced Statistical Quality Control Institute,** Storrs, April 3-15.

**Solar Energy Symposium, American Society of Mechanical Engineers, and Mechanical Engineering Dept.,** University of Florida, Gainesville, April 4-5.

**1960 Nuclear Congress: "What will the future development of nuclear energy demand from engineers?" includes 6th Nuclear Engineering and Science Conference; 8th NICB Atomic Energy in Industry Conference; 6th International Atomic Exposition,** New York Coliseum, April 4-7.

**Society of Automotive Engineers, National Aeronautical Meeting and Missile and Aircraft Engineering Display,** Commodore Hotel, New York, April 4-8.

**American Chemical Society, 137th National Meeting,** Cleveland, April 5-14.

**American Rocket Society, Structural Design of Space Vehicles Conference,** Biltmore Hotel, Santa Barbara, Calif., April 6-8.

**1960 National Meeting "Hyper-environments—Space Frontier," Institute of Environmental Sciences,** Biltmore Hotel, Los Angeles, April 6-8.

**Royal Aeronautical Society, Coventry Branch, "The Optimum Size of Rocket Engines,"** Coventry, England, April 7.

**Society of Instrument Technology, "The Electronic Computer as a Unit in an Automatic Data-Processing System for Missile Trials,"** Overheu, London, April 7.

**ASME-SAM Management Engineering Conference,** Statler-Hilton Hotel, New York City, April 7-8.

**IRE and ARS, Southern Ohio, Fourteenth Annual Spring Technical Conference,** Hotel Alms, Cincinnati, April 12-13.

**British Institution of Radio Engineers, Computer Group,** London, April 13.

**International Symposium on Active Networks and Feedback Systems, sponsored by Polytechnic Institute of Brooklyn, Dept. of Defense Research Agencies,** Institute of Radio Engineers, Engineering Societies Bldg., New York City, April 19-21.

# Who's Muzzling the Military ?

It would be refreshing to see some responsible American military leader stand up and publicly declare that the military has a mission in space.

At this moment Congress is conducting hearings which will determine what changes are to be made in the National Space Act and what roles NASA and the Defense Department will have in U.S. space activities.

NASA will undoubtedly be given the assignment of the exploration of space for peaceful purposes but thus far the role of the military is set out in negatives. "Nothing in this act shall be construed as preventing the military from utilizing space for the defense of the country, etc."

And we hear Maj. Gen. Leighton I. Davis, Assistant Deputy Chief of Staff for Development in Air Force tell representatives of the National Security Industry Association:

"Before we go too far into the fascinating business of space, I should like to clarify the interest of the military. The President has clearly stated that it is our national policy to explore space for peaceful purposes. The Congress has wisely created the National Aeronautics and Space Administration and charged this non-military organization with the exploration job. The same act—the legislation known as the Space Act—reserves to the Defense Department those aspects of operations in space which affect the security of the United States.

"We cannot exclude space from our defense considerations. We are already in it in a very important fashion with our IRBM and ICBM weapons. And certainly, the Russian rocket which transmitted television pictures of the far side of the moon could relay back to the USSR information of places *not* too far distant.

"Whether such information has military usefulness depends upon progress in electronics—so we are right back again on the importance to our defense position of dynamic progress in science and technology."

We cannot really believe that a two-star general whose assignment and duty it is to develop the future weapons of the Air Force would stand up and with a straight face make a statement like "we cannot exclude space from our defense considerations" unless he were under orders to say nothing else.

Or that he would seriously maintain that the value of reconnaissance pictures of the backside of the moon would depend on the progress of electronics—unless he was prevented from saying more.

We have been hearing a great deal lately about a single agency for space; a cabinet level secretary for space.

Space is not a project. Space is a place—an area. We no more need a single agency for space than we need a single agency for the sea—or for the South Pole.

In the years ahead a great many government agencies (like Commerce and State) will have business in space right along with NASA. And so, we hope, will a great number of U.S. industries (like Space Communications, Inc., and Space Travel, Inc.).

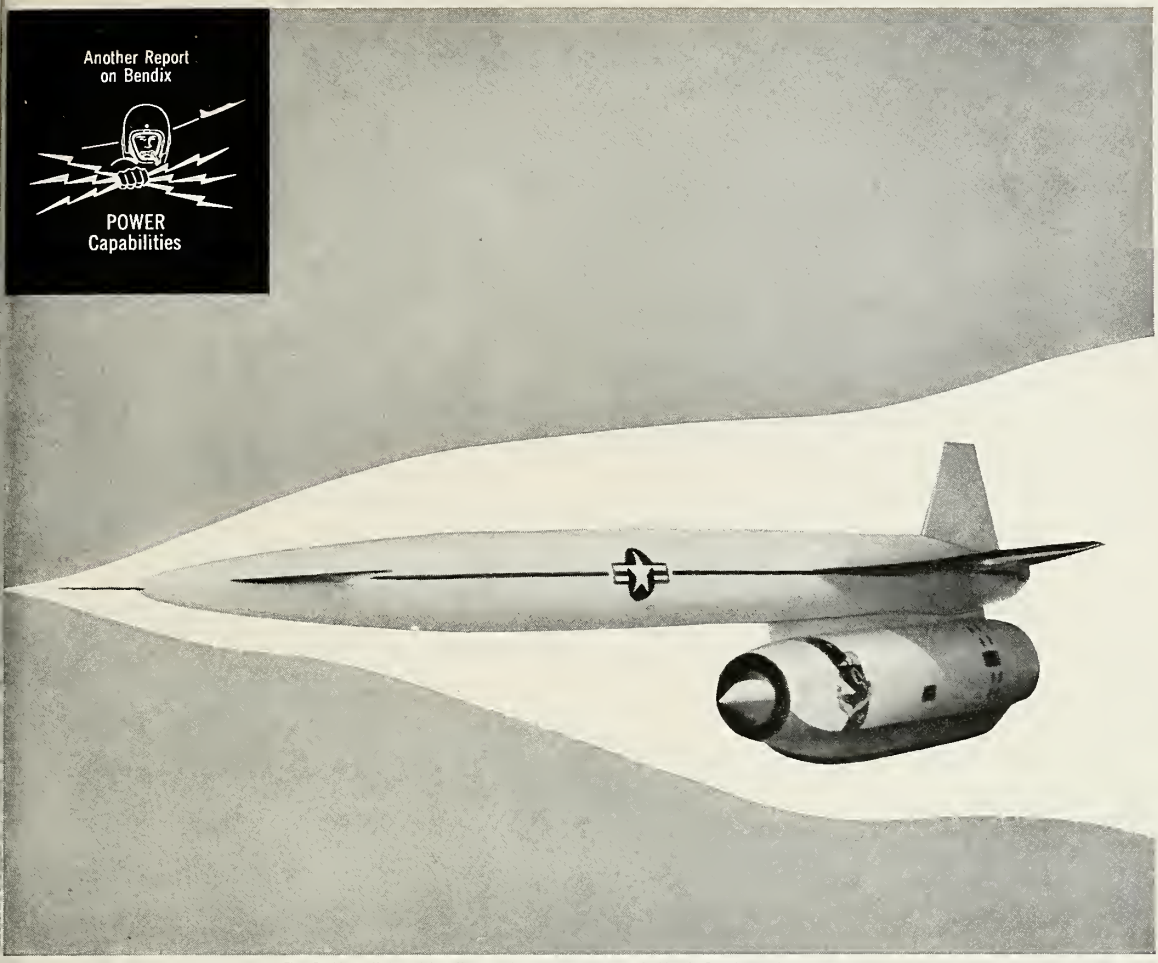
And in these years ahead there is also the mission of the military—to so plan and so build that it can defend space against any nation or group of nations who would deny the free world peaceful access to it.

We have declared that it is our national purpose to help explore and develop space for peaceful purposes. Are we naive enough to believe that man's predatory instincts will change once he leaves the atmosphere? That peace won't have to be defended? That the military shouldn't be given this defense mission now, clearly and unequivocably so they can begin planning for it, 10 and 20 years ahead?

**Clarke Newlon**

Another Report on Bendix

POWER Capabilities



*The GAM-77 "Hound Dog"—North American Aviation's Missile Division, prime contractor. This air-to-surface missile is carried by heavy bombers of USAF's Strategic Air Command.*

# BENDIX AC/DC PACKAGE GENERATES DEPENDABLE IN-FLIGHT ELECTRICAL POWER FOR "HOUND DOG"

The "Hound Dog" missile adds still more reach and punch to SAC's long arm. Carried by a B-52 bomber, the missile can be launched several hundred miles away from the target, and is capable of delivering a nuclear payload.

Before launching, the missile's electrical needs are supplied by the mother ship. Once "Hound Dog" is on its own, a Bendix® AC/DC generator fully meets electrical power demands. In a great new breakthrough in voltage control, the unit is equipped with a Bendix transistorized static AC/DC voltage regulator. The DC capacity of this Bendix AC/DC generator is provided with an addition of only five pounds in generator weight. Here is another example of the Bendix Red Bank concept of lightweight, reliable AC/DC power packages.

Get further details from RED BANK GENERAL PRODUCTS DEPARTMENT.

*"Hound Dogs'" Bendix AC/DC Generator, a brush-type unit rated at 9 KVA, 3 phase, 400 cycle, 120/208 volts AC, 60 amps, 28 volts DC.*

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Red Bank Division

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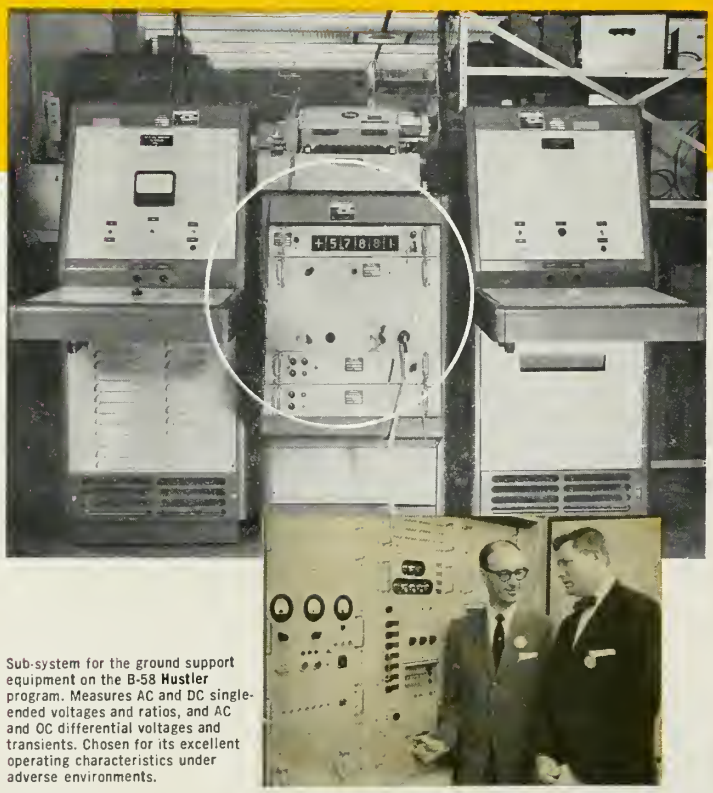
Systems shown here are typical of more than 200 designed and built by EI and now in use. They range in complexity from data logging systems for automatic scanning, measurement and recording of data from multiple transducers...to high speed, automatic checkout systems for missile and aircraft...to systems for automating industrial processes.

Because of the EI modular design approach, many of these systems can be delivered on virtually an off-the-shelf basis, eliminating the long delivery times usually associated with system development. This approach also results in a low cost system because the modules are manufactured in large quantities. Cost is almost a linear function of performance capabilities desired.

Why not talk over your digital system requirements with your EI Sales Engineer? His system experience will be a valuable help in solving your problem.

**Multi-purpose digital system** for measuring a variety of transistor parameters while the transistors are being subjected to environmental testing.



Digital read-out sub-system of a large, automatic, transistor production checkout system.

Sub-system for the ground support equipment on the B-58 **Hustler** program. Measures AC and DC single-ended voltages and ratios, and AC and OC differential voltages and transients. Chosen for its excellent operating characteristics under adverse environments.

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**MORE VERSATILITY**—AC and DC voltages, AC and DC voltage ratios, ohmic resistances, capacitance, frequency, phase, inductance, time, or combinations of these basic input quantities can be accepted by the EI system.

**MORE RELIABILITY**—Maximum use is made of solid-state and MIL-type components which are designed into conservatively-rated, field-proven circuits. All vendor-supplied parts are exhaustively tested and evaluated.

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