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# missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS



AN AMERICAN AVIATION PUBLICATION

# INSTANTANEOUS RESPONSE

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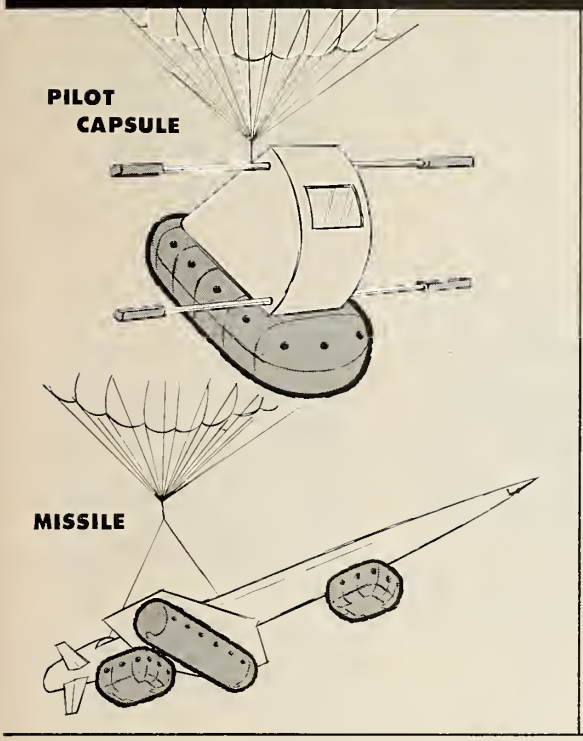


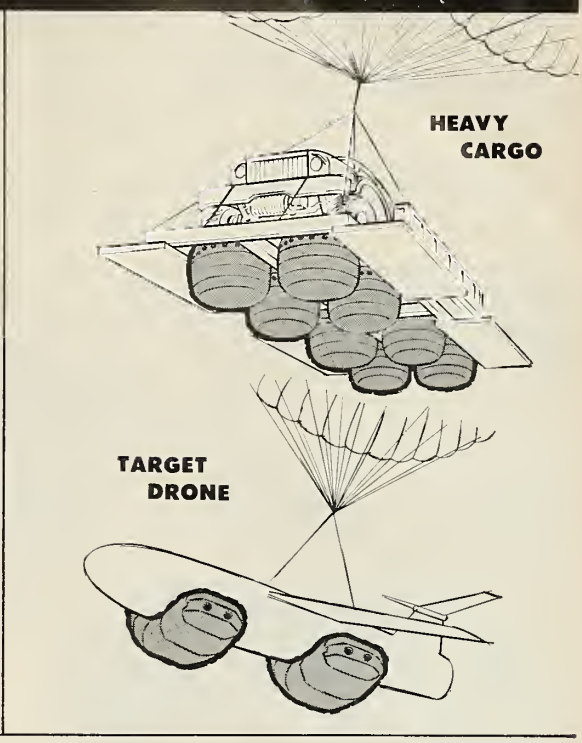


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Other Air Cruisers system designs include recovery of missile nose cones and component parts, and pilot capsule recovery which enables the crew to land safely in the sealed capsule.

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- Limit maximum "G" loadings
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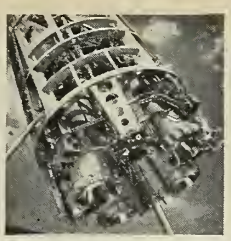
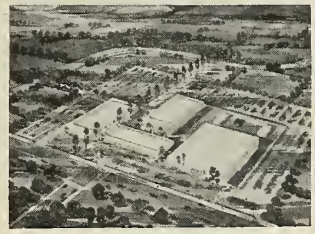


**COVER: the Gamma liquid propellant multi-chambered rocket was developed by Bristol Siddeley Rocket Division to power Britain's *Black Knight* re-entry research vehicle.**



**ARCHITECT'S drawing of new Atomics International facility being built at Canoga Park is representative of the flow of missile/space industry into San Fernando Valley. See p. 12.**

**PROTOTYPE of electrically-suspended gyroscope developed by Minneapolis-Honeywell. The guidance work of the future is going to demand big advances in gyros. A survey begins on p. 15.**

**PRE-LAUNCH check of *Vanguard* vehicle is supervised by Dr. John P. Hagen (at right), who directed the now-completed project for Navy and NASA. A review of the program starts on p. 35.**


# missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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## SEPTEMBER 28 HEADLINES



## ASTRIONICS



## MISSILE SUPPORT

U.S. Reg. Pdg.



## ASTRONAUTICS ENGINEERING

U.S. Reg. Pdg.



## NEW MISSILE PRODUCTS



## THE MISSILE WEEK

U.S. Reg. Pdg.



## DEPARTMENTS

# When the First Man Flies into Space... his Electronic Equipment will be Protected by ROBINSON!


**CONTROLLED ENVIRONMENTS – PASSPORT TO SPACE**

Soon, the X-15 rocket powered research vehicle, built by North American Aviation, Inc., will carry the first man into space. During this historic flight, many of the instruments installed in the X-15 will be protected against vibration and shock by Robinson mounting systems.

Robinson Model K710-14, all-metal mount, will protect 26 pressure transmitters connected with the rocket engine chamber, hydraulic fluid system, and the liquid oxygen, helium and ammonia supplies. Other Robinson mountings have been specified for the radio equipment and several other applications.

**RADIAL MOUNTING SYSTEMS—**
**THE ULTIMATE IN CENTER-OF-GRAVITY SUSPENSION**

Model K710-14 combines Robinson's MET-L-FLEX stainless steel resilient elements with an exclusive radial cushion, center-of-gravity design. The multi-directional isolation which results assures complete protection in the high intensity environments created by initial propulsion blast and re-entry.

During extensive development testing on the X-15 program, it was determined that vital instruments must be protected against vibration and shock to insure the calibration and accuracy required. ***Installation of Robinson mounting systems on the X-15 meets this requirement.***

**INDUSTRYWIDE ACCEPTANCE**

Twenty-three years of experience, plus unsurpassed creativity, make Robinson the choice of leading airframe manufacturers and weapon systems managers. These companies know that their equipment performs better and lasts longer when protected by mounting systems which have been engineered for reliability—by Robinson.

MODEL K710-14

**ROBINSON** *Technical Products Inc*

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# Washington Countdown

## IN THE PENTAGON

**A potentially hot study . . .**
of the nation's missile range operations is being made by a special Defense Department committee. Particular attention is being paid to possible overlapping of facilities. The committee—headed by Detroit Businessman W. L. Cissler—is scheduled to come up with a report by mid-November.

• • •

**An Air Force-Navy wrangle . . .**
over the Pacific Missile Range is one of the thornier problems the committee is certain to investigate. The Air Force wants to continue R&D satellite launchings from Vandenberg AFB next year after PMR goes into operation at Point Arguello. The Navy says this would mean halting operations at nearby Arguello every time a polar orbit launching takes place at Vandenberg.

• • •

**Some new codes names . . .**
for ARPA projects to pin in your hat:

. . . *Shepherd,* the Army-Navy satellite detection fence that stretches across the southern part of the United States.

. . . *Steer,* a polar-orbiting instantaneous repeater communications satellite.

. . . *Decree,* a 24-hour instantaneous repeater satellite.

• • •

**Killing the F-108 fighter . . .**
by the Air Force left the United States with no long-range defense against enemy bombers packing air-to-surface missiles. The Mach 3 **North American** interceptor was a victim of the budget squeeze. **Hughes Aircraft** will continue work on the *GAR-9* at a reduced level.

• • •

**The Army's *Pershing* . . .**
will soar about 150 miles above the earth during its surface-to-surface flights. The solid **Martin** missile—replacement for *Redstone*—will have a 700-mile range.

• • •

**The Navy's *Polaris* . . .**
is undergoing a new test series at Cape Canaveral. The latest test vehicles have a 900-mile range—only 300 miles short of the range operational models are scheduled to have by the end of next year.

• • •

**The Air Force's 609A . . .**
a modified version of the **Chance Vought** *Scout* being developed for NASA, will be used for testing Air Force equipment. Unlike the *Scout,* 609A will not be used for launching orbiting space vehicles.

## ON CAPITOL HILL

**Heavy favorable reaction . . .**
is reported by the House Space Committee in connection with its recent report on chemical-biological-radiological warfare. The report discloses some of the Army's latest work in the field. It also points out how new chemical gases and biological agents could be delivered in air-breathing and ballistic missiles.

• • •

**Heavy heartfelt slugging . . .**
is expected to result next year from Sen. John Sherman Cooper's bill proposing creation of a Defense Department director of procurement. Backers of greater unification of the services may use the bill as a rallying point. The military services will fight it down the line.

## AT NASA

**Space officials are worrying . . .**
about reports of off-the-cuff remarks by Air Force officials that they plan to try for speed and altitude records with the *X-15* when they get it. The NASA officials feel the rocket plane won't be ready for such attempts.

• • •

**Scotty Crossfield may quit . . .**
**North American** at least temporarily to join NASA so that he can be a member of the *X-15* pilot pool. Other members of the pool are Air Force pilots Maj. Robert M. White and Capt. Robert A. Rushworth, and Navy pilot Lt. Comdr. Forrest S. Peterson.

## AROUND TOWN

**The Soviet man-in-space program . . .**
may be suffering more difficulties than some have thought. A top Russian astronautics expert said recently when asked why Russia hasn't put a man in space: "Our rockets are not reliable enough yet."

• • •

**Some of the reports . . .**
being passed as "the latest" in the nation's capital:

. . . The Russians have a second *Lunik* booster ready for launching and may let it fly by the end of the year.

. . . The Canadians are seeking a greater role in joint defense-planning.

. . . Politics appears to be slowing down the installations of U.S. IRBM's in Italy.

the missile week

# Industry Countdown

## MANUFACTURING

**Look for keen competition . . .**
among the great variety of vehicles as the Army starts to choose those that will carry tactical missiles. The object is to find a vehicle system that is unrestricted by terrain, has efficient fuel consumption, and can provide rapid—but gentle—transit under a complete range of combat conditions.

• • •

**New glass-plastic mix . . .**
developed by **Armour Research Foundation** should have good missile application. It utilizes glass flakes in a resin-bonded laminate and has a fluxural strength of some 40,000 psi and a flexural modulus of 6-million psi. Tensile strength matches monofilament-wound structures but apparently with much greater rigidity.

• • •

**Still another plastic . . .**
is the TRC-X glass fiber phenolic laminate manufactured by **Riverside Plastics Corp.**, Hicksville, N.Y. The manufacturer claims it retains strength, dimensions and dielectric properties at temperatures in excess of 1000°F for minutes, which should give it real value in printed circuits and structures.

• • •

**Alloy steels in 500,000 psi . . .**
range have been developed by **Ford Motor Company's** Engineering division. In a process Ford calls "ausforming," austenitic steel is heated to 700°-to-1000°F, worked mechanically, quenched and tempered to a martinsitic steel at 500°F. Ford sees an obvious use in missile booster cases.

• • •

**Materials center . . .**
AF is proposing for Wright field may run into a snag with DOD Research and Engineering. The Pentagon wants all services to work on materials research.

• • •

**AF has started a new campaign . . .**
to assure larger participation of small business in defense production. Manufacturers will be required to file monthly reports of small and large business participation by weapon system.

## PROPULSION

**Plastic third stage . . .**
may be chosen for *Minuteman*. Successful firing of a *Vanguard* with glass-filament reinforced plastic third stage developed by **Hercules Powder Co.** gives a lift to Hercules' chances of winning the third-stage *Minuteman* contest with **Aerojet.** Hercules plans the same kind of plastic case, loaded with double-base propellant, for *Minuteman*. AF has cancelled a contract with Aerojet for development of the back-up first stage. **Thiokol** work has progressed to a point where the need for a back-up stage no longer exists, AF says.

## ASTRIONICS

**Thermoelectric device . . .**
with 50 times the capacity of any such device ever previously built has been developed for Navy by **Westinghouse Electric Corp.** It is, all at once, an air conditioner, space heater and refrigerator-freezer—designed for either submarine or space flight use.

• • •

**Hottest range . . .**
competition now in bidding stage is for a $30-million electronic environmental test facility at Army's Fort Huachuaca, Ariz. More than 60 companies in about 14 teams have submitted proposals. Cost bids are due Nov. 3. Contract will be awarded after Jan. 1.

## WE HEAR THAT—

**Lockheed MSD is transferring . . .**
all major functions of its three advanced satellite programs into its newly activated $8-million Satellite Production building. Some 2500 persons are involved in the transfer to the 346,000-square foot building . . . **Smith Electronics, Inc.** of Cleveland has been awarded a theoretical study contract for a missile and satellite interferometer tracking system at Eglin AFB . . . **Artloom Industries, Inc.** has acquired **Eastern Precision Resistor Corp.**, an electronics manufacturing company with three plants in Brooklyn . . . **U.S. Transistor Corp.** has moved into a new plant in the Syosset Industrial Park, Long Island . . . **Marquardt** will construct a $1.25-million engineering and administration building for its Power Systems Group in West Van Nuys. The company also has established a Nuclear Systems Division . . . **Sylvania Electric Products Inc.** will purchase 50% of capital stock of **Fabbrica Italiana Valvole Radio Elettriche S. P. A.**, Italy's leading manufacturer of transmitting and receiving tubes . . . **Tapco Group** of **Thompson Ramo Wooldridge Inc.** will have a $2-million plant in Anaheim, Calif. . . . **Packard Bell** broke ground Sept. 15 for a new facility in Newbury Park in Ventura County, Calif.

## ——more about missile week——

• **Groton, Conn.**—The nation's second *Polaris*-firing nuclear submarine—the Patrick Henry—was launched at **Electric Boat Co.** here on Sept. 22. In the 38th flight test of *Polaris* at Cape Canaveral the day before, the solid-fuel missile traveled about 900 miles.

• **Cape Canaveral**—Another operational *Thor* was fired Sept. 22 in an accuracy test. No attempt was made to recover the nose cone.

• **Washington**—DOD said the **Callery Chemical** plant at Muskogee, Okla., will be kept in "standby" status at least until next June 30. The $35.5-million Navy boron plant will not go into production.

• **Torrance, Calif.—Linde Co.,** Division of **Union Carbide Corp.,** broke ground Sept. 15 for a multimillion-dollar liquid hydrogen plant that will provide up to 3.3-million pounds of liquid hydrogen annually to NASA. Completion of the facility on a five-acre tract is set for May.

• **Stamford, Conn.—Norden** division of **United Aircraft Corp.** has acquired an 80-acre tract in Norwalk, Conn., and soon will begin construction of a multimillion-dollar engineering-research and manufacturing facility.

• **Los Angeles**—University of California has been awarded an Air Force Office of Scientific Research Contract for basic research in adaptive control systems theory.

• **London—Rolls-Royce** has started test firings with the **Rocketdyne**-type engine to be used in *Blue Streak*. Tests are taking place at the Ministry of Supply's facility at Spadeadam in Northern England. First launching is scheduled for the Woomera range in 1960.

• **Azusa, Calif.**—Army has awarded **Aerojet-General Corp.** a contract for a feasibility study of a small rocket lift device to power combat troops on special missions. A seven months' study is expected to culminate in a recommended practical rocket system design.

• **Everett, Mass.—Avco Research Laboratory** will use newly designed laboratory models of a gas accelerator and a shock tube to investigate magneto-fluid-dynamic forces and other phenomena with respect to problems of propulsion in cislunar space for the Air Force Office of Scientific Research. The project will be directed by Dr. Arthur Kantrowitz and will cost about $585,000 for the first year.

---

# Air Force Gets Bulk of ARPA Space Projects

WASHINGTON—The Air Force has all but won its long fight to become the one and only U.S. space force. Meantime, the Army received another strong shove toward the door.

This is the unavoidable conclusion resulting from the first, much sought distribution of ARPA space projects. (See page 21, this issue). However, there are several possible clinkers in what some defense officials thought was a smooth solution to their space problems.

The Defense Department announced Sept. 23 that the Air Force will eventually be given responsibility for all space transportation and military space boosters including the Army's 1.5-million-pound-thrust *Saturn*.

At the same time, the Department announced that four ARPA space propects had reached a stage of R&D where they could be turned over during the next year to the military services for final development. The four:

• *Midas,* the ballistic missile early warning satellite. It goes to the Air Force.

• *Samos,* the reconnaissance satellite formerly known as *Sentry*. It also goes to the Air Force.

• *Transit,* the navigation satellite unsuccessfully launched for the first time earlier this month. It goes to the Navy.

• *Notus,* code name for a family of communications satellites including *Courier, Decree* and *Steer*. They go to the Army.

The ARPA budget for FY 1960 includes $170 million for all four projects.

Defense Department R&E Director Herbert York said assignment of the projects to the services for final development and operational use was made by the Joint Chiefs of Staff, the Secretary of Defense and other top Pentagon officials.

The move ended months of squabbling over which service would get which project. In each case, projects were assigned to the service which had been developing them under ARPA's overall direction.

ARPA Director Roy Johnson and York stressed that the transfers were the first in a series that would result in eventual transfer to the services of all ARPA space projects, as they reached the proper stage.

However, they stressed that ARPA would continue to receive new advanced projects taking the place of old ones. Informed sources made clear that these would be both in space and other fields.

Underlying the announcements were several significant trends:

• The clear indication that although Redstone Arsenal space experts would continue to develop *Saturn,* the project probably would not be run by the Army (M/R, Aug. 31).

• The clear possibility of future interservice conflicts over the providing of Air Force boosters for Army and Navy space projects.

• The indication that the interservice fight over the rest of ARPA's present and future space projects is far from over. For example, assignment of Project *Shepherd,* the ARPA satellite detection fence developed by the Army and Navy, is overdue. However, no assignment was made.

Another significant turn was the shifting of all communications satellites to the Army, which for some time has sought control of all military communications systems. This assignment appears to give the Army a hefty push toward that goal.

*An M/R Exclusive:*

# Breakthrough in Heat Treating Promises Huge Gains in Strength

***Bassett process increases ultimate tensile strengths 10% to 60% with dividends in ductility—company confident of million psi in 18 months***

**by Frank G. McGuire**

GARDENA, CALIF.—A breakthrough in the process of heat treating has boosted ultimate tensile strengths of metals by 10 to 60%, with proportionate increases in yield strength, coupled with gains in ductility, fatigue strength and impact strength.

The process, developed with $1 million of private funds in a 2½-year program by **Research Development Corp. of America,** is termed Thermomagnadynamics.

Approximately 50 observers from the aircraft/missile industry were on hand at a demonstration of the new process, and saw results of tests conducted on the spot. Visibly impressed, some termed the results "fantastic." RDCA is presently seeking ways to prove its process on production items, rather than solely on R&D coupon test results.

The process, discovered by William I. Bassett III, rearranges the metallic grain into an isotropic granular structure during heat treat and after fabrication. Photographs showing a 200X magnification indicate great consistency and uniformity in the resulting grain. Notch sensitivity is minimized in the process.

• **Potential realized**—Bassett points out that his process does not give additional strength to metals, but discovers the greater potential strength of metals and alloys. RDCA, of which Bassett is president, is now averaging 30,000 to 40,000 psi increases in tensile properties of metals, with equal to, or better than, elongation and reduction-of-area factors. RDCA hopes to achieve ½ million psi by 1960.

Another characteristic is that tested metal of any Rockwell hardness up to Rc 62 can be bent within its own radius at least 100 degrees without fracture. Commercial, as well as lab results, have been achieved on Martensite alloy steels, Martensite stainless steels, Alpha-beta titanium alloys, precipitation-hardening steels, and stainless steel alloys; other samples will be checked out in commercial jobs.

Jack Taub, executive V.P. of RDCA, is confident that the Bassett process will produce metal with ultimate tensile strengths of one million psi within eighteen months. He feels that this will be done by a combination of the heat treat process and the use of new alloys now being developed by the firm for utmost utilization of the process. He expects sales to be $1 million in the first year, and approach $10 million in the second year.

The company is not presently seeking government funds, but is awaiting finalization of patent proceedings so the process can be licensed for use by industry. RDCA is planning to construct a new, larger production facility in Torrance, which will include a larger furnace than their present equipment, capable of handling specimens 10 x 10 x 17 inches. A privately-owned corporation, RDCA presently occupies a 3000-square-foot plant and employs fifteen people.

Gerald W. Middy, vice president of sales for the company, points out that, although present results are R&D, they are based on thousands of tests and have proven extremely consistent. He said RDCA is interested in production steels, especially high-temperature steels, for applications.

It is estimated that four or five hours total process time has been average in R&D work, and that about the same time would be needed in production. Eventually, furnace time is expected to be less than one-half hour, with cost, using present equipment, about $200 per half-hour. A special furnace is now in use at RDCA, although the company points out that the process is not one of heat-treat alone.

• **Serendipity**—The company's first indication that it had achieved a significant improvement occurred during a routine introduction of changes in

***Results Obtained Through Use of Bassett Thermomagnadynamics Process on Metals****

| Alloy | Ultimate Tensile Strength (PSI) | Elongation | Reduction of Area |
|---|---|---|---|
| 4130 | 280,000 to 300,000 | 11% | 30-40% |
| 4340 | 335,000 | 11% | 28% |
| 6150 (.53% carbon) | 375,000 | 9% | 25% |
| 6152 (.49% carbon) | 361,000 | 9% | 27% |
| Vascojet 1000 | 325,000 | 13.3% | 37.5% |
| 422M (12MoV) Stainless Steel | 305,000 | 8% | 20.8% |
| 431 Stainless Steel | 270,000 | 10% | 32% |
| Thermold J (Unimac #2) | 354,000 | 7% | 22% |
| A286 | 174,000 | 25% | 55% |
| Venango Special | 418,000 | 8% | 21% |

*Results verified by independent testing lab, Metals Control Laboratory, 2735 E. Slauson Blvd., Los Angeles, Calif.

some normal processing methods, after which it was discovered that a smaller, more homogenous grain structure had been achieved. Almost 700 tests were thereafter conducted, and the results correlated. The best methods were then chosen from this data, commensurate with tensile results, yield strength, elongation, reduction of area, and a 90° minimum bend test.

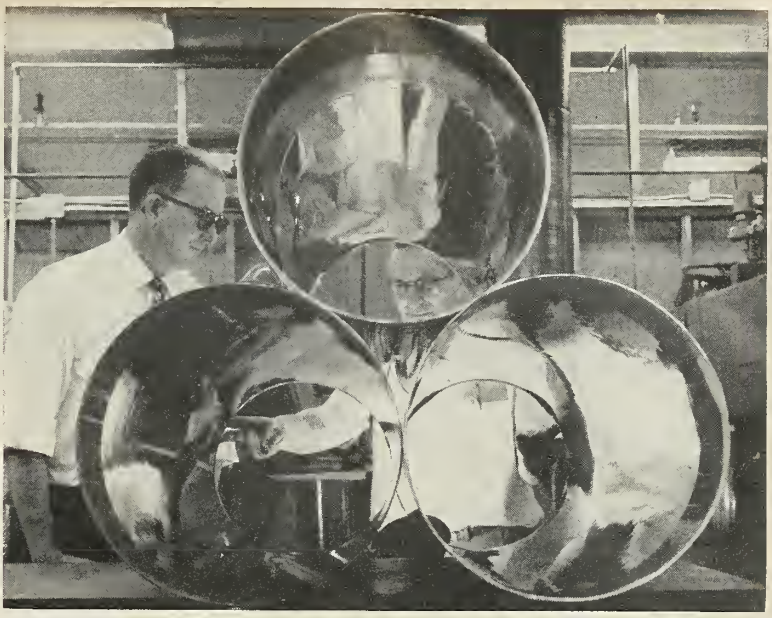
Bassett proceeded on the grounds that iron and other element metals are much stronger in the form of perfect crystals, and that this strength arises from the way in which atoms are uniformly distributed throughout the crystal, leaving no weak links. When crystallographic studies reveal that their iso-polar process influences the formation of an ultrafine and uniform grain, a tential stress applied in testing their parts with an equal elastic response occurring, the load is apparently evenly distributed. Additionally, they are free of heterogenous-sized grains, which serve as stress concentrations.

A good deal of the work thus far conducted by RDCA has been restricted by limited facilities, but large enough pieces have been processed to show that results do not vary with the size of the workpiece. The company's furnace has a guaranteed control of ±5°, an excellent dew-point control system (molecular sieve, gas cooled to −100°F.), and all parts are heated in an atmosphere which prevents the surface from oxidizing or reducing.

• **Help with titanium**—Fatigue life in type 431 stainless steel is around 14.6%, says RDCA, while the Bassett process consistently achieves a 50.8% fatigue life. Size effect is eliminated, enabling large sections to harden. Because of the excellent dispersion of carbides in the process, oxidation is slowed and there is more general resistance to all types of corrosion. The notch sensitivity of many alloys, titanium and stainless steel in particular, is greatly improved.

Also noteworthy is the Bassett process' effect on the glamor metal, titanium. Heat treatment of this metal is difficult, and reproducibility is often unattained. It is frequently impossible to meet strength requirements, or if these requirements are met, ductility suffers. The RDCA process provides 240,000 psi with an elongation of 11.5%, and guarantees reproducibility. RDCA says machinability doubles.

More common metals show similar results: 280,000 psi steels such as 4340 are now 317,000 psi with the same good usable properties: Chrome die steels are now over 325,000 psi with about 13.3% elongation and 37.4% reduction of area, compared with former levels of 280,000 psi, 7% elongation and 25% reduction in area.



**ENGINEERS examine gleaming rocket test chambers fabricated by using unique strip winding and spot welding techniques developed by Ryan for use in *Polaris* program.**

# Ryan Gets Contract for *Polaris* Rocket Chambers

SAN DIEGO—**Ryan Aeronautical Company** has been awarded a contract to fabricate full-size chambers for the solid-rocket propellant of the Navy's submarine-launched *Polaris* missile.

The order from the Navy Bureau of Ordnance, announced by company president T. Claude Ryan, disclosed that the firm has been developing a unique welded "strip-winding" technique while performing research on an earlier phase of this project, in which many sub-scale model chambers were built in recent months.

Paper-thin steel alloys of great strength were used, a company spokesman reported, and tests simulated the enormous internal pressures encountered in the *Polaris* rocket motor. The cylinders reportedly showed they could withstand stress up to 305,000 psi static tension ultimate stress—far beyond that ordinarily achieved in industrial use of solid wall cylinders.

In the strip-winding method, several extremely thin sheets of steel are wound around a mandrel, tackwelded, and then spotwelded to create the wall thickness desired. A major problem overcome in the first phase of the *Polaris* rocket chamber research is reduction of stress concentration around the spot-weld through improved spot-welding techniques.

In addition to the steel alloy work, Ryan has been authorized to build at least one sub-scale model chamber of titanium, a metal with which the company has had considerable experience.

Ryan said the *Polaris* rocket engine chamber contract will extend his firm's work on this project to almost the end of this year, and may lead to production orders not only for *Polaris* but also for other advanced missiles.

## Republic Designs New Missile Case for Solids

MINEOLA, N.Y.—A major technological advance in the manufacture of solid fuel rocket motor cases has been claimed by **Republic Aviation Corporation.**

The company reported that a fabricated missile engine casing made of low-alloy steel had successfully withstood pressures of more than 250,000 pounds psi, which represents tensile yield strength some 30% greater than that of similar-size operational casings made by conventional methods.

*Second of A Series . . .*

# The Move into San Fernando Valley

***R&D firms and electronics makers move into burgeoning industrial parks and campus-like centers; basic airframe industry follows slower pace***

*Gonna Make the San Fernando Valley My Home . . .*

*Popular Song*

Los Angeles—Already defined as "a great city of merging satellites," the Los Angeles area might also be described as a huge region of merging industrial parks and campus-like research centers. Eventually, the Southern California complex of communities and their supporting industries is expected to fuse into one 200-mile-long city extending from San Diego in the south to Santa Barbara in the north.

The fabled San Fernando Valley, north of the heart of LA, is a natural "void" like the Orange County area to the south (surveyed in M/R, Sept. 7) and, in common with that county, is receiving a flow of much of the cramped industry from more crowded areas. Large companies such as **Thompson Ramo Wooldridge, Lockheed, Litton, Atomics International, Marquardt,** and many others are building in the valley—mostly with pleasantly-designed groups of modern buildings.

All is not expansion, of course, even in the electronics segments of the missile business. And this apparently applies even more in the airframe business. A spokesman for Aerospace Industries Association told M/R that the trend toward facilities expansion is not universal by any means. "I don't think any of our people are expanding," he said. "I think the reverse is actually true."

**Douglas Aircraft Co.,** for instance, counts the wind tunnel development at its Aerophysics lab as its most significant expansion in the next year. Much of Douglas' future expansion depends on the fate of *Nike-Zeus*. The wind tunnel under construction at El Segundo is a three or four year program being handled in stages.

Similarly, **North American Aviation** is not contemplating any major moves in the near future, but is awaiting future developments. It recently completed a wind tunnel installation and is now building supporting facilities around it.

**ONE OF the valley's new facilities now under construction is this group of labs for Thompson Ramo Wooldridge, at Canoga Park, designed by Albert C. Martin & Assoc.**

The trend at NAA appears, then, to be a gradual but continuing movement away from putting all its eggs in the airframe basket. Electronics **(Autonetics Division),** rocket engines **(Rocketdyne Division),** nuclear energy (Atomics International), and other diversification has been underway for several years and is expected to continue.

In an industry where panic buttons are at a premium whenever a large contract is cancelled (*Navaho* is a perfect example), the lack of enthusiasm for undertaking multimillion-dollar construction programs is understandable. The aircraft companies, unlike electronics firms, are large enough already to handle any work they get . . . or if not, they team up with another company. It's cheaper than construction—and faster. The exception is research facilities.

• **Electronics must build**—Electronics is not in this position of being already big enough, nor is it so easy to establish teamwork in a technical and highly competitive small-item industry where proprietary information is so sensitive. This also applies to the electronics and research divisions of aircraft and missile companies, which are setting up new quarters just as quickly as pure electronics firms.

The electronics industry, one of the fastest-growing, has 461 plants in the Los Angeles area, employing 84,000 persons and doing an annual business of around $1.157 billion. Ten years ago, these figures stood at 43 firms employing 6700 persons, with annual sales at $97 million.

Although it would be impossible to list all the electronics firms doing business in this area, some of the "giants" of the industry with facilities here are: **Acoustica Associates,** with 65,000 square feet and 400 employes; **Amelco, Inc.,** with 105,000 square feet and 600 employes; **American Electronics, Inc.,** 353,596 square feet and 1450 employes; **Autonetics,** over 1 million square feet and 9000 employes; **Bendix-**

**FRONT VIEW of buildings in Hughes Aircraft Company's new ground systems group, located in gently rolling terrain of the former Sunny Hills Ranch at Fullerton.**

**Pacific,** 420,000 square feet and 3000 employes; **Cannon Electric Co.,** 300,000 square feet and 2900 employes; **Collins Radio,** 131,754 square feet and 700 employes.

**Elgin National Watch Co., Electronics Div.,** 30,000 square feet and 500 employes; **Hoffman Electronics Corp.,** 770,000 square feet and 3350 employes; **Hughes Aircraft Co.,** over 5 million square feet and 32,168 employes; **Kearfott Co., Inc.,** 60,000 square feet and 350 employes; **Leach Corp.,** 143,255 square feet and 708 employes; **Lear, Inc.,** 55,000 square feet and 587 employes; **Litton Industries,** over 1.2 million square feet and 12,000 employes; **Pacific Automation Products, Inc.,** 150,000 square feet and 900 employes; **Packard-Bell Electronics Corp.,** 500,000 square feet and 2400 employes; **Radio Corp. of America,** 165,000 square feet and 1000 employes; **Rheem Mfg. Co.,** 625,337 square feet and 2500 employes; **Servomechanisms, Inc.,** 20,000 square feet and 300 employes.

Two of the larger facilities under construction are those of Lockheed and Thompson Ramo Wooldridge, Inc. in San Fernando Valley, where the sites run into hundreds of acres.

• **Unusual construction**—Lockheed's California Division Research Center ultimately will occupy a 200-acre site near Saugus in the valley's San Gabriel Foothills. The center, first phase of which will cover 65 acres, was designed by **William L. Pereira and Associates,** and features an unusual set of construction techniques. The buildings to be constructed first will be based on a 48-foot module, with movable partitions and high bays for quick conversion into offices, shops, or laboratories. Each building will also be capable of external expansion to meet future requirements.

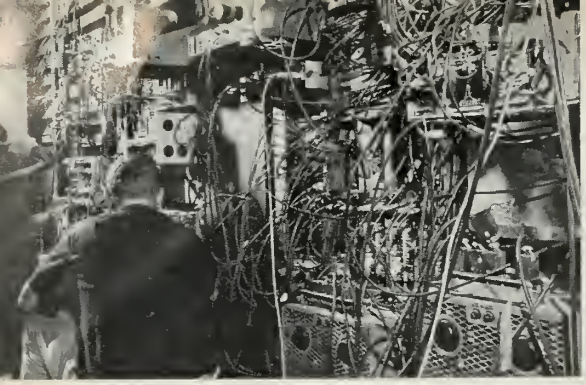
The second, more unorthodox feature of the Lockheed center is its utilization of surrounding natural canyons to provide high-bay, noiseproof future quarters. By spraying the canyon walls with gunite to stabilize them, roofing over the canyon with a slab containing all utilities, and installing flooring, it will be possible to use the chambers as multi-story buildings. This will eliminate the need for large scale earth-moving operations. In an interesting understatement, the architect says the plan will result in "an unprecedented example of integration of site and structure."

When completed, the center will accommodate two wind tunnels capable of Mach 10 velocities, environmental test chambers simulating space conditions, a computer center, radar antenna range, and facilities for research in physics, chemistry, physiology and all other fields related to atmospheric and space flight, as well as various service facilities.

• **Breathing room**—The new TRW laboratories at Canoga Park will house the Ramo-Wooldridge Division, Thompson Ramo Wooldridge Products Co., and the corporate west coast headquarters of Thompson Ramo Wooldridge, Inc. Designed by **Albert C. Martin & Associates,** TRW's laboratories will be occupied by November and represent another example of the campus-style design now in vogue. The LA quarters will be taken over by STL.

About 2300 will be employed at the new laboratories—many moving with the company from its present LA site, and some being employed from the new locality. TRW gave cramped LA quarters as a prime reason for the move into San Fernando Valley. Although still within Los Angeles City Limits, the 90-acre site gives more "breathing" room. Total floor space of the buildings will be about 810,000


**SOME OF the main industrial centers in the Los Angeles area. Eventually, the continuing merger of communities is expected to create a single city 200 miles long.**



**COMPLEXITY OF equipment produced by Mincom Division of Minnesota Mining and Manufacturing Co. is indicated in this photo. Mincom is expanding.**

square feet upon full development. Approximate construction cost will be $15 million.

A 63-acre site just north of the brand-new Ventura Freeway has been bought by Litton Industries, Inc. in San Fernando Valley, to house its Electronic Equipments Division. Designated the Woodland Hills-Canoga Park facility, the new buildings will house research, development and production activities. The company's Tactical Systems Laboratory is moving into quarters at the north end of the site, and the main building will be built at the south end.

The facility is being designed by Albert C. Martin & Associates in an industrial-park arrangement. In fiscal year ending July 31, 1959, Litton did $125 million worth of business, compared with the preceding year's $83 million—a 50% increase.

Packard-Bell Electronics Corp. has leased 50,000 square feet in the valley to house the ACRE-Octopus portion of the *Polaris* ground-checkout program. Meanwhile, the company is breaking ground on the first 50,000-square-foot unit of its new plant in Thousand Oaks, Ventura County, to be occupied in early 1960.

**Cooper Development Corporation's** effort is toward more efficient utilization of present space, with increases in professional personnel. CDC has jumped about 20% in personnel, and is concentrating its expansion program on the R&D side of its activities. The company had the best first quarter in its history this year, receiving about $2 million in orders. A super-*Asp* development is now on the drawing board, as well as a multi-*Asp* design.

**Consolidated Electrodynamics Corp.** recently opened a new Western Regional office for its wholly-owned subsidiary, **Consolidated Systems Corp.,** and the constantly expanding personnel of the parent corporation eventually will require more space. CEC has, however, one mostly vacant building into which it can funnel any expansion, and no planning for new buildings is under way at present. The company now has about 3000 employes.

The new CSC subsidiary has established three field offices (Washington, D.C., Atlanta, and Monrovia, Calif.) as the nucleus of a field engineering organization. The CSC custom-engineered instrumentation products will be aimed at the aircraft/missile, nuclear energy, petroleum and chemical industries.

The new Canoga Park R&D complex of Atomics International will consist of two two-story buildings of 106,500 square feet each. One will be used as a laboratory, the other for engineering and administration. A one-story building of 30,000 square feet will house service groups as cafeteria, personnel, security and clinic. A 135,000-square-foot building is already on the site.

Still another project of Albert C. Martin & Associates, the complex will cost about $4 million and is scheduled for completion by Dec. 31.

**Gilfillan Bros., Inc.,** with a brand-new plant adjacent to its executive offices, now has seven plants in the LA area. The new $350,000 building will quarter engineering and publications activities.

A large building program is also under way at the Marquardt Corporation, where a $1.25-million engineering and administration building for the firm's Power Systems Group is under construction in Van Nuys. A building of similar scope is planned for the Pomona Division, formerly **Associated Missile Products Co.,** before its acquisition by Marquardt. The firm's combined operations now employ about 5000 persons and occupy nearly a million square feet of space, not including the current construction.

**AiResearch Manufacturing Division** of the **Garrett Corporation** has started construction of a $2.6 million facility on a 66-acre site at Torrance. The building is the first in a million-square-foot complex and will contain 235,000 square feet in a two-story building for development and manufacture of electrical and electronic central air data equipment. Between 600 and 800 employes will be transferred to the Torrance site from the company's present location in six to eight months.

One major aircraft manufacturer, Lockheed, is on the upswing with its missile division. While not expecting any spectacular changes in the next year, LMSD at Van Nuys will gradually expand its personnel, rising from a low point of activity during the past year. The division's Van Nuys activity will attempt to develop some strong projects of its own, and will concentrate on high-speed, high-altitude target drones.

The group will handle engineering, design, manufacture and other aspects of drones such as *Kingfisher,* "which has taught us a lot, and we hope to be able to build up a good target business." In research vehicles, LMSD-Van Nuys anticipates more work on such projects as the *X-17,* which did so well in reentry work, and the *Argus* project. From the present level of 3100 employes, the division plans to increase to 4000 by the end of the year, and an eventual maximum of 4500.

**Telecomputing Corporation,** a family of six firms, has expansion plans in automation—both military and industrial. It anticipates building up its ability to weather seasonal fluctuations in business, and will improve test facilities, as well as finance research and development projects based on sales trends. TC is comprised of **Whittaker Controls, Whittaker Gyro, Brubaker Electronics, Data Instruments, Nuclear Instruments,** and **Engineering Services.** These six organizations have a combined work force of 2155, including 500 engineers. Total floor space occupied by the group is about 500,000 square feet.

**The Mincom Division** of **Minnesota Mining and Manufacturing Co.,** a new, small, and rising star in the 3M family, is producing complex recorder/reproducer equipment for telemetry application, and is expected soon to introduce a new system. Established as a 3M division in 1956, the group was the first to develop tape recorders for wide-band instrumentation applications. Now in a period of rapid growth, the division is pioneering its Isoloop tape-transport system for telemetry recording and reproducing, which minimizes wow and flutter to 0.1% peak, measuring all components from 0.1 to 4000 cycles.

Although much of the missile business is wrapped up by airframe companies, new programs, facilities, and enthusiasm are being provided by the electronics-oriented firms, and those organizations with extensive investments in all types of research facilities.

# Today's Gyros Won't Do Tomorrow

***Recent advances keep missile guidance gyros up to present demands but significant progress is needed for operational missiles and spacecraft***

**by Hal Gettings**

WASHINGTON—An estimated $620 million is being spent on missile guidance and control this year. Of this total, about one-third—over $200 million—goes for gyroscopes. Consequently, the development and production of these ultraprecise gadgets has a big place in the missile industry.

At least 14 large companies and many smaller ones are involved in the gyro and guidance business. **Sperry Gyroscope, Minneapolis-Honeywell (Military Products Group), Kearfott,** and **Bendix (Eclipse-Pioneer)** are the leaders in gyro development and manufacture. Other important firms include **Giannani, Norden-Ketay, U.S. Time, Whittaker,** and **Summers.**

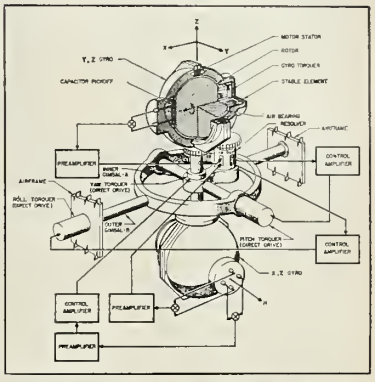
Three of these firms—Honeywell, Kearfott, and Sperry—are also prominent in guidance system production, along with **North American (Autonetics), AC Spark Plug, Arma, Litton,** and **Bell Aircraft.**

The average missile inertial guidance platform contains a minimum of three gyros. The stabilization package also contains three. Others may be used as accelerometers. In addition, the fuzing and arming system may contain one to three gyros. So a complete missile system may require from $10,000 to $50,000 worth of these sophisticated toys.

Gyros are expensive—up to $12,000 each—because of the fantastic precision with which they must be manufactured. For example, a shift of one microinch in wheel position of a gyro can cause a drift error of 0.03°/hr. Such an error could mean the difference between success and failure of a moon shot.

Obviously, an inaccurate guidance system is about as bad as no system at all; accuracy is the prime goal of a gyroscope. And cost goes up right along with accuracy. Much current research is aimed at obtaining required precision without making the units prohibitively expensive.

• **Problems**—Manufacturers generally feel that gyros are equal to the job that they're called on to perform today. But today's gyros won't be able to do tomorrow's job. The industry must see considerable improvement if it is to meet the multi-stage guidance systems required for long-range interplanetary and interstellar missions. There is confidence, however, that the challenge will be met.

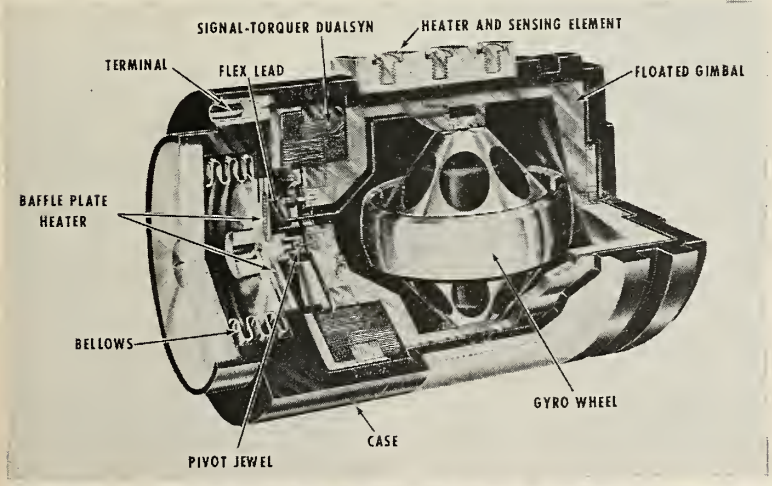



**"FREE-ROTOR" gyro developed by Autonetics may make guidance platforms simpler, stabler. Two replace usual three.**

Areas most heavily researched at present include accuracy, friction, size, spin-bearing design, and pickoff techniques and components. Reliability is the thorniest problem of them all. This, of course, is interrelated with the problems of accuracy and friction and the requirement for smaller and smaller units. Warmup times must be decreased to meet the demands of operational missiles.

### New Developments

Theoretically, only an entirely frictionless gyro would be 100% accurate. Consequently, much research has gone into the problem of friction and constancy of the motor and gimbal bearings. Gas- and air-bearing suspension has been developed to a point approaching the ultimate, but further progress comes hard. "Floated" gyros




**CUTAWAY of a miniature integrating gyroscope shows its complex construction. A chief aim of research today is to achieve precision without prohibitive cost.**

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—in which the inner gimbal is a can suspended in a liquid—are used extensively in missile guidance for their near-frictionless operation. The flotation liquid brings its own problems, however, in temperature-sensitive viscosity coefficients and density.

• **Electrical suspension**—Probably one of the most significant recent advances in gyroscope technology is that electrical suspension has been proven feasible. Honeywell has been researching this area for several years under contract to Navy Bureau of Ordnance and announced only this month the successful development of a prototype model. The unit uses a beryllium sphere rotor suspended electrically in a vacuum. No figures are available but the company claims potential accuracies far beyond the capability of conventional units.

• **Flotation fluids**—Sperry has developed a new "Gyrolube" bromo-carbon flotation fluid that reduces warmup time by about 50% and eliminates danger of gyro damage upon cooling. Developed for the B-58 guidance system, the fluid has a relatively flat viscosity rating over a wide temperature range down to less than −65°. Its successful use in floated gyros—the primary type for missile guidance—would do much to simplify operation. Conventional chloro-fluorocarbon compounds require that the gyro package be maintained at a constant temperature and need relatively long warmup and runup times. Heater failure can knock out the entire guidance system.

• **Unheated floated gyros**—Norden-Ketay has found another approach to the heating problem of floated gyros (M/R, Feb. 16). They have patented a "buoyed rate gyroscope" which achieves temperature compensation mechanically. The thickness of the flotation liquid film between the inner and outer cages is varied by a bellows arrangement which effectively changes the cage diameter in response to temperature changes.

• **Spring-powered gyros**—Several companies have developed units energized by "clock" springs. **Whittaker Gyro Division of Telecomputing Corp.** has one model which operates for 30 seconds and others designed for up to ten minutes of flight. Runup time is less than ten milliseconds. Once wound and armed at the factory, the spring-energized models can be stored for indefinite periods without loss of accuracy. **Waltham Precision Instrument** has announced one unit which sells for less than $200.

• **Gas-driven units**—Honeywell has developed an expendable two-axis gyro which is directly competitive with the spring-powered unit. This is a compressed-gas energized gyro with a drift rate of 0.5°/min. It weighs less than four pounds and has a predicted reliability of 0.988.

• **Free-rotor gyroscope**—A unique "free-rotor" gyro for guidance application has been designed by Autonetics. In this unit, the spherical rotor is supported and turns in a gas-lubricated bearing—with practically no friction. Overall mechanical assembly is less complex and gimballing and flotation of the rotor assembly is not required.

Only two of these gyros are needed to furnish 3-axis platform stabilization. A simple second-order type control servo system is sufficient, with inherently more stable characteristics and less complicated electronic circuitry.

• **Ferrite applications**—Kearfott—and possibly others—have successfully used ferrites as stators and rotors in floated gyros and look for expanding applications as gyro size is reduced. With conventional laminated stacks there are problems in maintaining good mechanical design and stability as laminations are made thinner. And the laminated stacks have been known to deteriorate in the flotation medium.

Ferrites are mechanically inert and do not require laminating with organic material. Consequently, their electrical and mechanical properties remain constant with time. In addition, the specific gravity of the ferrite is only 60% that of the laminate; suspending media of lower specific gravity—and corresponding low viscosities—can be used.

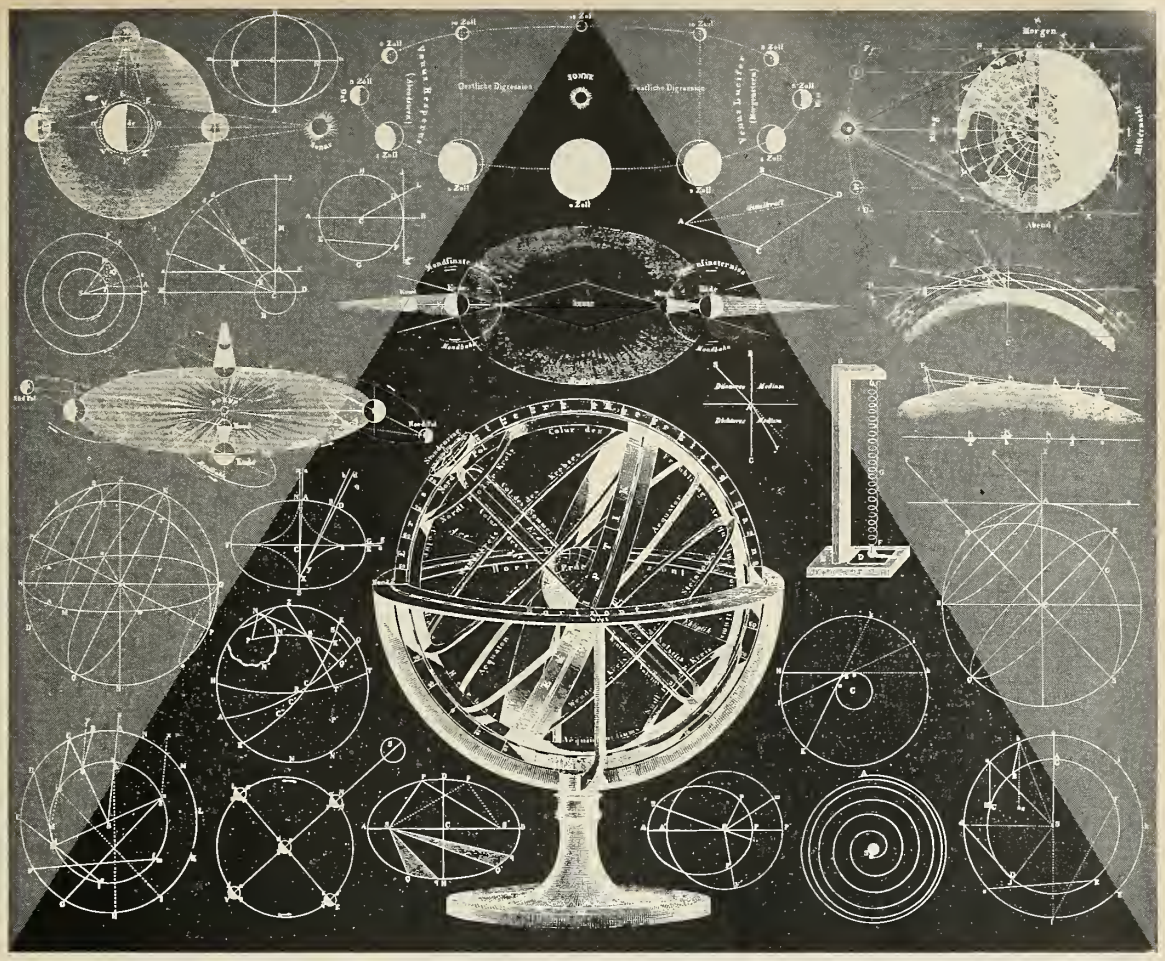
• **Bearing improvement**—Sperry Gyroscope, in a research program into the cause of gyro failures, discovered microscopic residual abrasive particles imbedded in the races and ball bearings of gyro assemblies. These particles were identified as the cause of many cases of bearing wear leading to drift and eventual breakdown.

To eliminate these particles, Sperry evolved a new (and undisclosed) method of assembly that precludes any contamination of parts. The resulting "Wear-less" gyro units have reportedly been run in tests for several thousand hours with no sign of wearing.

Company engineers have also developed "unitized" wheel-bearing assemblies in the quest for better accuracy. Such construction makes the bearing races part of the shaft and supporting structure. Gyros using this technique are now in production.

• **Future developments**—Work is continuing on many aspects of gyro progress. Some are already yielding worthwhile advancements; others are still in the future.

Gas bearing and supplementary suspension, as well as ball-bearing improvement, are getting attention from nearly all firms in the business.

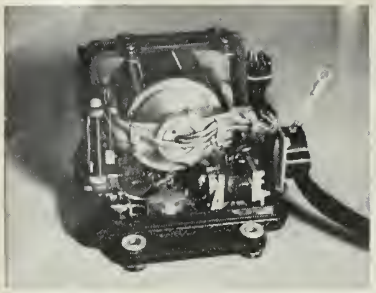


# *Guided tour of the solar system*

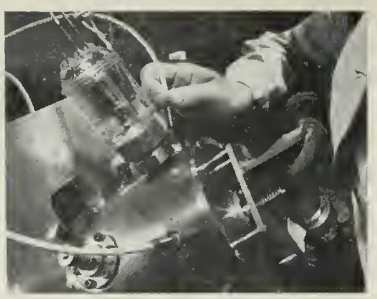
The new NASA Thor-boosted research rocket, DELTA, now being constructed by Douglas, will set up big signposts for further space explorations. Combining elements already proved in space projects with an advanced radio-inertial guidance system developed by the Bell Telephone Laboratories of Western Electric Company, DELTA will have the versatility and accuracy for a wide variety of satellite, lunar and solar missions. Douglas insistence on reliability will be riding with these 90 foot, three-stage rockets on every shoot. At Douglas we are seeking qualified engineers to join us on this and other equally stimulating projects. Some of our requirements are listed in our column on the facing page.

Maxwell Hunter, Asst. Chief Engineer—Space Systems, goes over a proposed lunar trajectory with Arthur E. Raymond, Senior Engineering Vice President of **DOUGLAS**

MISSILE SYSTEMS ■ SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND-HANDLING EQUIPMENT



**NEW RATE GYRO developed by Minneapolis-Honeywells Aeronautical Div. combines new design, ruggedness.**



**PROTOTYPE of Minneapolis-Honeywell's electrically-suspended gyro. Beryllium rotor is suspended in a vacuum.**

Beryllium—because of its desirable low density, high rigidity, and low coefficient of expansion—is being thoroughly researched for use in wheels and gimbals.

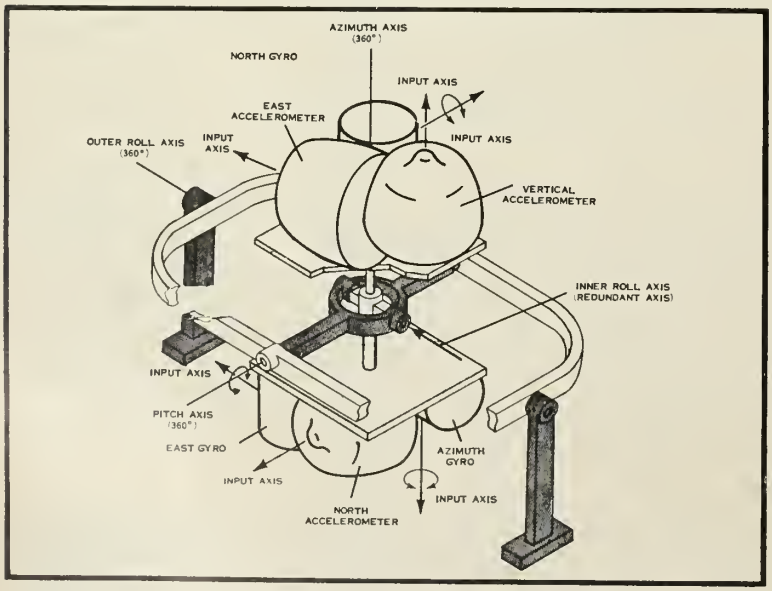
Several manufacturers are carrying on a continuing program for development of better flotation fluids. This has produced some significant results but the ultimate that can be stored and operated unheated over the full temperature range is yet to be attained.

Other research is aimed at decreasing power requirements and achieving longer operation cycles, shorter runup times, longer shelf life, and, of course, lower costs.

• **Buying procedures** — Guidance system specifications are usually set by the missile procuring agency. In some cases, the missile prime contractor may have this responsibility. For Air Force missiles, **Space Technology Laboratories** usually determines specs. Both ABMA and JPL have a hand in Army systems. Navy requirements are set by Special Projects Office and MIT. In general, broad operating parameters are set by the buyer and operating characteristics by the guidance designer.

• **Lack of standards**—Perhaps the biggest problem facing the industry is the fact that there are few or no standards for defining accuracy. This most important characteristic is measured, usually, by the tendency of a gyro to "drift". This tendency is not so much of a problem if it is a constant and predictable value. Establishing this value, however, is what keeps gyro designers and specifiers awake nights.

Drift is classified both by amount (displacement) and by rate. The latter is the more commonly used but here, again, standards are lacking as to methods and conditions of measurement and calibration. The sad fact is that the drift rate curve lends itself to varied interpretations.




**SCHEMATIC of inertial platform shows essential elements of any "pure" inertial guidance system: 3 accelerometers, 3 hermetic integrating gyros and gimbals.**

The overall problem was pointed out recently in a survey sponsored by Aerospace Industries Association. Hope is for better coordination by industry —led by the National Bureau of Standards—in setting up realistic standards and calibration techniques. This would be of inestimable value to gyro and guidance manufacturers.

• **Drift rate terminology**—Drift is commonly defined in four different categories:

1) Gravity-insensitive (degrees/-hour).—Caused by fixed unbalance torques which produce a steady-state error signal.

2) Gravity-sensitive (degrees/-hour/g).—Caused by mass unbalance around output axis. Varies as a function of acceleration.

3) Anisoelastic ($g^2$-sensitive drift). —Caused by inequality of elasticity of mass support along the input axis and along the spin-reference axis. Develops torque on the gimbal.

4) Random drift rate.—Non-controllable drift caused by uncertainty torques due to bearing, temperature gradients, etc.

In the case of gyros, many parameters must be defined relative to the accuracy measurements: platform orientation, environmental conditions, power inputs, number and duration of runs, and any number of variables that might influence test results must be considered. A unit, for instance, that is perfectly satisfactory for a ballistic missile—where moderate drift rate is not serious—would not do at all for a long-duration space vehicle.

It has been suggested that the biggest consideration in accuracy definition is that the acceleration-sensitive coefficient be small, and that this should be used as a yardstick of gyro performance. A further proposal involves a complicated procedure of integrating and replotting the drift rate curve in terms of drift angle versus elapsed time. By analyzing and summarizing the variations of accumulated angular error over the entire curve, a family of curves can be generated for displacement error—maximum, rms, and average—versus elapsed time.

One interesting technique for measuring gyro drift is being used by **Martin Co.** engineers (M/R, Jan. 19) for the *Mace* guidance system. Since the torques involved are so small and can be measured only with the gyro completely assembled, the method, in effect, uses the gyro to test itself. The earth's rotation and gravitational field are used as stable inputs. Total angular motion reported by the gyro in a given time period is compared with the actual motion of the earth in the same time. Difference between the two is due to the drift rate of the gyro.

# Hughes Research Reveals Advances In Infrared Detection Techniques

***Shielding technique doubles IR search and tracking range; cooling methods treble the detectivity of IR cells***

SANTA BARBARA, CALIF.—Significant performance improvements have been achieved with lead-selenide infrared detectors by employing new shielding and cooling techniques, according to **Hughes Aircraft Company.**

The developments have resulted from IR detector-cell studies performed here at the company's Santa Barbara Research Center.

• **Shielding**—One recent discovery at the Research Center pointed the way to improved performance of lead selenide detectors. It was found that detectivity is limited by ambient or room temperature radiation falling on the sensitive film. Although this effect is not new in the detector field, the company believes it had not been demonstrated previously with lead selenide.

By providing appropriate shielding in the detector package, improvements in detectivity of a factor of six to ten have been achieved. The shielding is designed to fit the optical system, since the improvement in detectivity is inversely proportional to the sine of half the angle subtended by the aperture at the detector. For example, with an f/2 system, proper shielding offers improvement of a factor of four, relative to the standard package performance.

Also, this improvement is attained by an increase in signal and noise level so that the shielded detectors are easier to use with conventional amplifiers. The time constant becomes longer with shielding; however, detectivity increases with frequency up to the frequency at which the signal begins to fall. Above this frequency, the detectivity drops about 2 db to 8 kc.

Another technique of restricting the amount of ambient radiation involves the use of spectral filtering. Selective filters on the detectors absorb light of wavelengths which are not contained in the signal radiation.

The results of employing these techniques are illustrated in Fig. 1: curve A is for a standard unshielded detector; B is for the same detector shielded for an f/6 system; and C is the same as in B with a quartz filter added. This detector was 3 x 3 mm² in area and was fitted with a sapphire window. The measurements were made at liquid nitrogen temperature (less than −195.8°C, sea level) at 780 cps with a bandpass of 1 cps.

Sizable improvements in system sensitivities can be obtained by taking advantage of these improved detectors. For example, the range of operation of a search and track system under development at SBRC was doubled when the former detectors were replaced with the improved version. To achieve optimum performance, it is necessary to design the detector package coincident with the system because of the detector dependence on optical speed and spectral filtering.

• **Cooling**—Cooled IR detectors

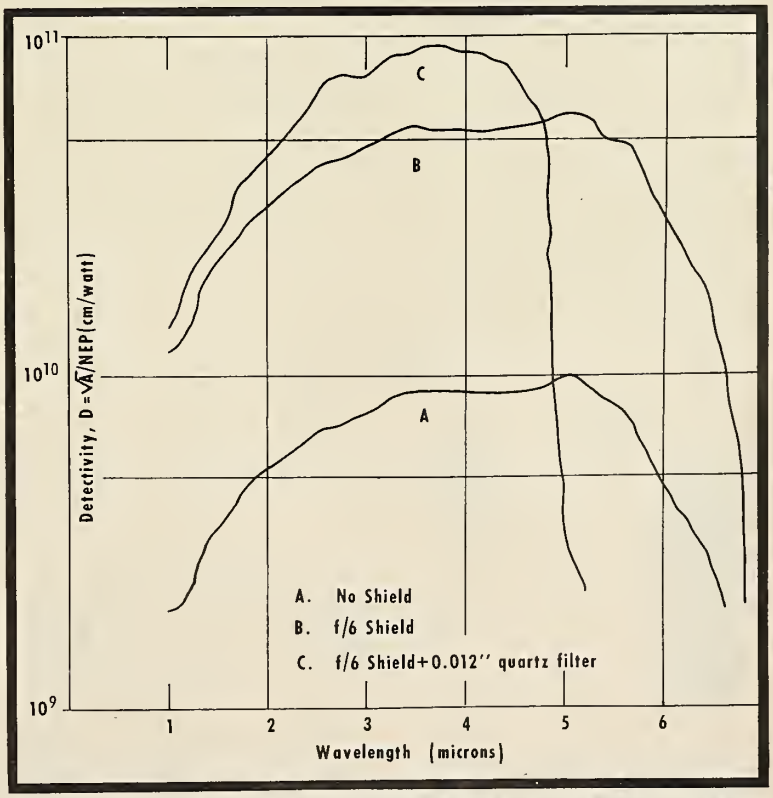



**FIG. 1—A comparison of results using shielded and spectral filtered lead selenide infrared detectors. Measurements were made at liquid nitrogen temperatures.**

have grown from laboratory tools to full-fledged components in missile systems. Because of this, there has developed an urgent need for a rugged, practical system of refrigeration to liquid $N_2$ temperature. The Research Center has developed several solutions to this problem with emphasis on engineering the system to operate automatically in the airborne environment.

The most satisfactory systems, SBRC believes, are Joule-Thompson coolers. Two types of these are operated on demand either by a liquid-level sensor or by pressure-regulated liquid transfer systems using uninsulated transfer tubing.

The first type of Joule-Thompson system is illustrated in Fig. 2. Compressed gas A, at about 2500 psia initial pressure, is transferred by capillary metal tubing through filtering unit B. Filter B removes particles and gases condensable at higher temperatures to a special solenoid valve C. When valve C is opened, gas flows through the Joule-Thompson cooler D, which is mounted in the inner tube of the detector dewar, and liquefies upon expansion.

A unique feature of this system is a germanium sensor placed just above the end of the dewar tube. When the liquid level drops, the germanium sensor rapidly becomes conducting and actuates the solenoid valve to restore the flow of gas.

By proper design of the Joule-Thompson cooler and the use of absorbent material in the dewar tube, the entire system may be operated upside down or at any altitude. The use of the automatic metering system assures economical operation, according to SBRC. This system has been flight tested successfully and its use is recommended for applications involving long standby times.

For installations in which weight and space are at a premium, the direct liquid transfer Joule-Thompson system offers a number of advantages. After some months of research, it has been determined that uninsulated tubing may be used for the transfer of liquid $N_2$ without excessive loss. The tubing material and size are critical, but may be varied within limits to suit the requirements of individual installations.

Fig. 3 illustrates one of several types of liquid transfer systems which have been developed (the system illustrated has been subjected to extensive actual and simulated flight testing). In the supply vessel, which is connected to the detector flask by a small-diameter uninsulated tube, is an electrical heater element. The supply of energy to the heater is controlled by a pressure-actuated switch using ambient pressure as a reference. An over-pressure relief valve is also provided, and this, too, uses ambient pressure as a reference.

In the head of the detector flask is a calibrated orifice through which gas generated by the evaporation of liquid in the flask is vented, also to ambient pressure. Typically, the pressure switch may be set to open at 4.5 to 5.0 inches Hg (mercury) above ambient pressure; the relief valve may be set to open at 5.5 to 6.0 inches Hg above ambient pressure. Any increase in rate of liquid $N_2$ flow above that for which the system is calibrated will increase the pressure difference across the orifice, will raise the system pressure, and so will open the heater control switch.

By using ambient pressure as a reference, the absolute pressure in the system, and so the temperature, will be lowered at high altitudes. According to SBRC, this is of peculiar advantage in cooling detectors such as gold-doped germanium which show improvements in detectivity by as much as a factor of three if they are operated at a temperature just above the freezing point of liquid $N_2$.

A typical liquid transfer unit would weigh 7.5 pounds complete when filled with liquid $N_2$. The company said it will cool a complicated eight-detector package for more than 6 hours under in-flight conditions and after a standby time of 24 hours.

## *Courier* Satellite Will Lead to Global Network

NEW YORK—The Project *Courier* communications satellite—scheduled for launch in early 1960—will be able to transmit six million bits of information in four minutes. The 500-lb. ARPA satellite will be the first step in establishing a global communications network for the free world's armed forces.

The system, under the technical direction of Army Signal Research and Development Laboratory, is designed to provide 20 continuously available 100-word-a-minute teletype channels to relay messages transmitted between ground stations. As the satellite passes over one station, it is commanded to transmit information "addressed" to that station. Simultaneously, the satellite records, for later transmission, traffic for other stations in the network.

The 28-foot antenna systems and associated instrumentation will be built by **Radiation, Inc.** under a recently awarded $1,283,000 contract. Ground terminal equipment is being designed by **ITT Laboratories. Philco Corporation** is responsible for communication relay equipment in the satellite.

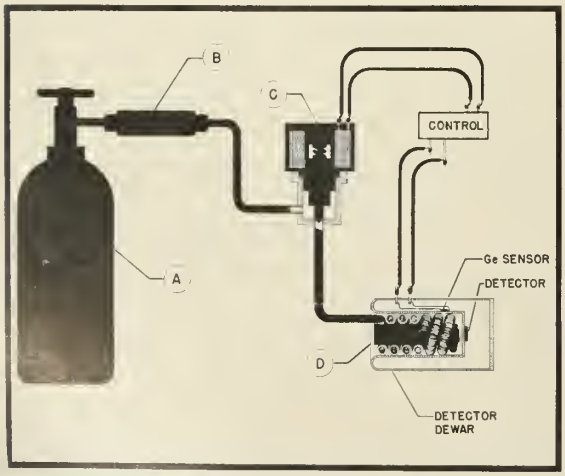



**FIG. 2—Flow diagram of a typical liquid-level sensor Joule-Thompson refrigeration system for IR detectors.**

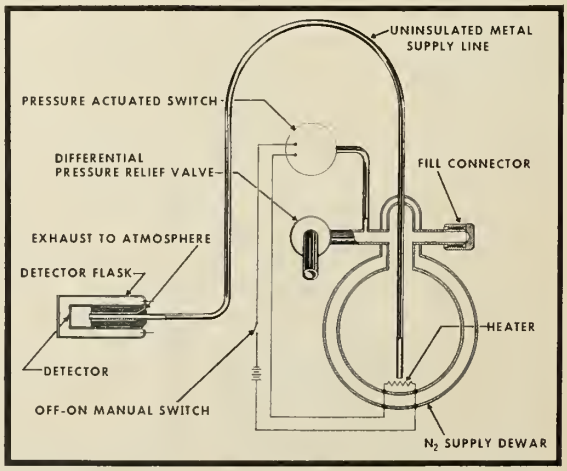



**FIG. 3—Diagram of a direct liquid $N_2$ transfer system for IR detectors by Santa Barbara Research Center.**

*as an adequate minimum . . .*

# ARPA Wants $550 Million for '61

***Principal problems are lack of money and project bottleneck resulting from intramilitary squabbling. Last of a series on Pentagon planning.***

**by James Baar**

WASHINGTON—ARPA—spawn of the sputniks and director of military space research and development—is moving toward its second anniversary stronger than ever but beset by two major problems.

One is money. The other—somewhat mitigated—is the intramilitary struggle over space missions.

The first stems directly from the freezing of the defense budget by the Administration at $40 billion or less for another year. The second stems directly from the failure of the Joint Chiefs of Staff and the Defense Department until now to assign developed space projects to particular services for operation. Assignments now being passed out by the Joint Chiefs are expected to ease the situation—at least temporarily.

Both in one way or another have affected ARPA plans to push forward next year with dozens of advanced R&D space projects ranging from *Discoverer* satellites and the huge *Saturn* clustered booster to the search for new materials for the Missile Age.

But most signs are that ARPA as an organization will continue to flourish. In fact, there are expectations that the Defense Department may soon assign it some new advanced R&D projects well outside the field of space.

This non-space role is one in which ARPA sees much of its future. Even today about 40% of its money goes for non-space projects.

As for ARPA's major problems, let's look at money first.

• **Fiscal uncertainty**—ARPA appears ready to fight for about a $550-million slice of the frigid $40-billion defense budget pie which the Administration plans to serve up to Congress for FY 1961. That's about $95 million more than ARPA asked for—and got—from Congress for FY 1960.

But the chances of the Administration agreeing on even $95 million more for ARPA next year offer no safe bet. Moreover, there is considerable sound argument in favor of ARPA's need for at least several hundred million additional dollars.

The extra money would be used for the most part to speed up work on ARPA projects across the board. It would enable more extensive experimentation, more rapid collection of data and in many cases more rapid arrival at conclusions. In turn, this would lead in many cases to speedier development of vital projects.

A prime example of the direct effect of funding on progress is Project *Defender*—ARPA's highly classified and highly complex search for an advanced anti-missile missile system more effective than **Western Electric's** *Nike-Zeus*.

Work on *Defender* next year will involve continuation of the collection of vast amounts of data on the behavior of ICBM's in flight and related physical phenomena.

It also is expected to involve some small-scale experimentation on the feasibility of various AICBM concepts. Here is the rub.

• **Limited choice**—Such experimentation—on any scale—is extremely costly. Although the price tag varies from case to case, tens of millions of dollars are generally called for.

Obviously, therefore, a limited budget greatly limits what can be done. It is not possible to choose between possibly good and possibly bad concepts for experimentation. ARPA must choose between the possibly good and possibly very good.

However, top ARPA officials are understood to feel that—within the context of the frozen $40-billion defense budget—an increase of ARPA's share to about $550 million would be adequate.

They are understood to argue that the return on money spent beyond this point on ARPA projects probably diminishes—particularly when the money must come from the hide of some other part of the defense structure.

But that doesn't mean the pinch isn't being felt.

For instance, ARPA had scheduled five *Transit* navigation satellite launchings: one this fall and three next year. And no plans are being made to change this schedule even though the first launching attempt on Sept. 17—all but failed because of trouble in the third stage of the *Thor-Able* rocket, a vehicle used successfully many times before—and not in the satellite.

• **Pentagon bottleneck**—The squabble over who gets what ARPA project has centered in the Office of the Secretary of Defense and the Joint Chiefs of Staff.

ARPA would like to see each of its projects assigned to a military service for operation two years before development is completed.

The policy behind this is to meet service criticisms that the ARPA system overlooks the need for designing a military system to meet the requirements of the service using it.

Unfortunately, in moving to meet this criticism, ARPA has run into the interservice space fight that centers at the Pentagon's top military levels.

The Air Force continues to insist that space—unlike Gaul—is not divided into three parts. But the Army and Navy insist Caesar applies in both cases.

The result has been a stalemate of increasing seriousness.

• **Jobs unwanted**—To date only one ARPA project—the satellite detection fence that stretches across the southern United States—had reached the point where assignment is overdue. But in a matter of months the list would have been much longer.

Continued delay in assigning projects would force ARPA to retain them—a role it does not want. Among other things, retaining them would violate ARPA's management system based on operating with a small, highly trained, flexible staff of about 80 members who provide overall direction to the services, universities and private companies handling ARPA projects.

• **The big four**—The biggest of these projects are *Saturn, Discoverer, Defender* and *Samos.*

*Saturn,* under development at the Army Ballistic Missile Agency at Huntsville, Ala., is expected to be operational about early 1962. The clustered 1.5-million-pound-thrust engine is scheduled to be the military workhorse for putting large payloads such as space stations into orbit.

ARPA considers *Saturn* a key to major military space missions. It plans to spend nearly $70 million on it in FY 1960.

*Discoverer* is an open-end program that will involve increasingly larger payloads and boosters. By the end of 1960 **Convair** *Atlases* may well be substituted for the **Douglas** *Thors* now being used. The ARPA FY 1960 budget includes some $60 million for *Discoverer.*

The *Thor* with the **Lockheed** *Agena* second stage in six launchings already has generally accomplished a major part of the early *Discoverer* series objectives. All three of the *Discoverer* satellites that have been placed into orbit have been successfully stabilized —the necessary forerunner to successful development of *Samos* and *Midas,* the ARPA-Air Force reconnaissance and early warning satellites.

However, bio-medical capsules ejected from all three satellites were never recovered. Further progress in the *Discoverer* schedule including the probable orbiting of monkeys is being delayed until the recovery system is perfected.

Officials now attribute the failures to date—particularly those of the capsule—to a breakdown of unnamed equipment including the capsule's radio. Another recovery attempt will be made with the launching of *Discoverer VII* late next month.

*Defender*—a drive to find the AICBM of the 1970's—probably will expand its activities during the next year to the Pacific to collect data on ICBM and IRBM firings from the Pacific Missile Range.

Two data-collecting ships—the American Mariner and the Arcania—already are operating in the Atlantic Missile Range. A ship or island data-collecting bases, or both, probably will be established in the Pacific—particularly to monitor *Nike-Zeus* and **Lockheed** *Polaris* tests.

*Defender* is scheduled to get more than $128 million of the current ARPA budget.

*Samos*—budgeted this year for $100 million—is potentially one of ARPA's most controversial projects. Little is said publicly by military and civilian officials about what the international political consequences of orbiting reconnaissance satellites may be.

Russia is known to be pushing development of a reconnaissance satellite as a top priority project. The first R&D *Samos* is expected to be launched about early March.

• **Nuclear deadend**—One of the smaller but most important of ARPA's projects—*Orion*—may be nearing a dead end before next year is out.

**General Atomic's** *Orion* is a study aimed at possible development of a nuclear blast-propelled rocket. The firm will continue its studies for another year under a recently renewed $1-million contract.

But the point may well be reached by the end of next year where work can no longer proceed without nuclear tests which currently are banned at least until Jan. 1.

ARPA sees much promise for *Orion* as the most efficient big rocket of the future—possibly the rocket that will be the basic booster for military missions not only on this side of the moon but far beyond.

At present, all such areas are officially designated as non-military scientific provinces where no military mission abides. However, with the successful flight of *Lunik II,* how much longer such a policy will be tenable is very much open to question in the minds of many inside and outside the government.

## Cheaper Epoxy Nose Cone Material Survives 5000°F

PHILADELPHIA—An epoxy resin heat shield material for nose cones has been developed by **General Electric's Missile and Space Vehicle Department.**

GE scientists said the new ablative material can be produced for much less cost than the phenolic materials currently in use. Space flight tests are expected to be conducted within a few months.

Dr. Leo Steg, manager of the company's aerosciences laboratory, reported recently that time as well as money could be saved in producing epoxy. Phenolic materials are either laminated from impregnated tape or molded under high pressure. Epoxy is molded at low pressure.

Another advantage of epoxy resin, Dr. Steg said, is that it can be made elastic, flexible or hard, depending on the job to be done, and has good heat-protective qualities in all forms.

The new material has been tested successfully in a supersonic flame of more than 5000°F.


VOUGHT VOLUNTEERS FOR ARMY RESEARCH

Army equipment once ran mostly to brass, steel and leather. Today's soldier needs are not so simple.

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Vought has pioneered and delivered the most advanced weapons. Accompanied by support equipment, indoctrination specialists and fast-acting Field Service, these weapons were *effective systems* immediately on receipt. This experience is being offered the Army in several new research areas.

*Battlefield weapons, along with anti-submarine warfare, missile and piloted aircraft developments, are specialties in Vought's Aeronautics Division. Other major interests are being aggressively advanced in the company's Astronautics, Electronics, Research, and Range Systems Divisions.*

CHANCE VOUGHT DALLAS, TEXAS


"How fast will it move?" This is one of the questions the modern U. S. Army asks first about new equipment. This is critical in the swift Army units that constantly train themselves to move even faster. Speed is the modern U. S. soldier's equalizer. It helps him overcome great distances in his world-wide watch over potential trouble areas. It can help him offset an aggressor's advantage in numbers. Equipment that can accompany, arm and sustain this fighting man anywhere on the globe is essential. In trained Army hands it will mean defense on the double — any time, any place!

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# Videotape Successfully Used To Record Radar Signals

***Signal Missile Support Agency finds great advantage in immediate playback capability for trajectory evaluation***

WHITE SANDS MISSILE RANGE, N.M.—The first successful use of Videotape for recording missile tracking radar signals recently was announced here by the U.S. Army. Inputs have been recorded from the screens at all five radar stations which are strung out over a 4000 sq. mile area.

The tape and recorder were originally developed by **Ampex Corporation** to record video and audio signals. Because the Videotape has a video response uniform within ± 3 db from 15 kc to 2.5 mc, it was found that it could be employed to record radar signals following their conversion through a radio receiver to a somewhat lower frequency.

The converted signals are still too high for most standard recorders, but the amount of conversion that can be accomplished accurately is limited.

**ANTENNA for new AN/FPS-16 instrumentation radar units at White Sands. It is considered the first radar designed originally for supersonic missile tracking.**

Hundreds of missile firings reportedly have been recorded by the Army's Signal Missile Support Agency. The technique is considered a significant advance because it permits immediate playback of recordings. Portions of the trajectory of a missile may be restudied without the need for screening many thousands of feet of film from standard optical systems as was previously necessary.

• **System description**—The recording of the radar signals is done in successive narrow, vertical bands on the Videotape by four small video heads which have a minimum life of 100 hours of recording time with normal routine maintenance. Sound, or audio recording, can be captured longitudinally along one edge of the tape.

The White Sands recorder has two audio channels. One channel records sounds of the blast-off. Another audio channel, added by Signal Agency engineers, is being used as a "cue" channel. This channel makes it possible to put an audio pulse on the tape at any point to identify certain portions of the radar data recording for special study.

(At White Sands the recorder operator puts a pulse on the "cue" channel to designate the tape footage of flight data especially important in evaluation. When the tape is reproduced, this pulse produces an audio tone through the "cue" head to indicate the portion of tape to be evaluated.)

Simultaneously with the video and

audio recording, a control track is recorded longitudinally along the opposite edge of the tape. This control track provides for perfect synchronization of tape and recording heads.

The system, comprised of electronics and a tape transport, fits into one double electronics rack and one console and requires less than 100 square feet of floor space. Providing a complete recording and reproduction system, the machine achieves up to 64 minutes of recording time (when using 12.5 reels).

Tape motion and modes of operation are controlled at the right-hand control panel on the console, or at a remote control unit. System operation may be monitored by means of indicators located on the control panel.

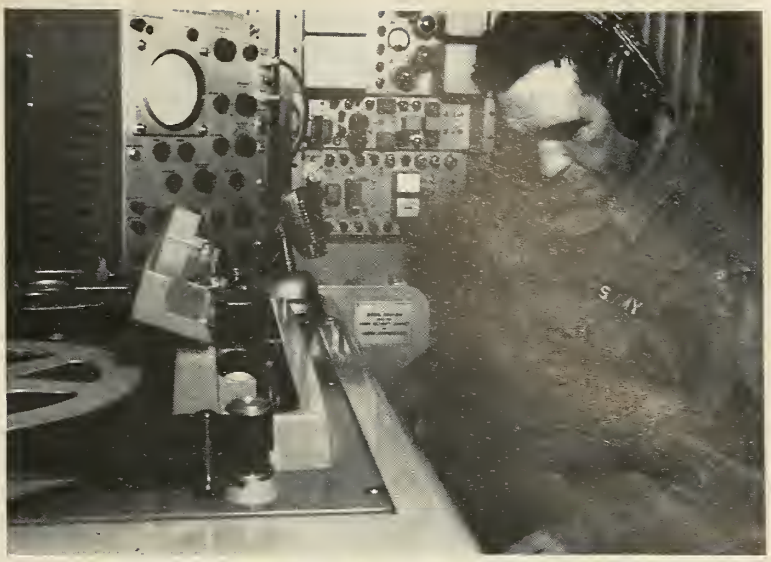
• **Recording techniques**—The converted radar signal modulates a high-frequency carrier. This frequency-modulated signal is amplified and then impressed on the video heads. A modulator circuit is in operation during the record mode. A demodulator circuit is in operation during the reproduce mode.

This modulator/demodulator circuitry serves the dual purpose of producing the frequency modulated signal during the recording process, and of recovering the original video signal by demodulation during the reproduction process.

• **Unique design**—To provide over an hour of recording time, Ampex developed a special helical method of recording which permits the video information to be packed on the tape in tight, vertical tracks. Even though basic recording principles lend themselves admirably to Videotape television recording, the video signal presents a space problem. Containing frequency components in a range which approaches direct current at the low end and extends to over 4 mc at the upper end, the video signal requires more tape area than does the audio spectrum.

For example, a conventional audio recorder, operating at a tape speed of 7½ ips, records a 15 kc signal at a rate of 2 kc per inch of tape; thus, the wavelength of that signal as it appears on the tape is ½ millimeter. To record a 4 mc signal so that its wavelength on the tape would be ½ millimeter (assuming the use of the same type head) would require a tape speed of 2000 ips—well over 110 miles per hour.

Obviously, to provide an hour of Videotape television recording with this method would require a reel of gigantic proportions. A study revealed that the use of very precise heads—incapable of being produced in quantity—could result in the required tape speed being reduced to approximately 200 ips, but a reel-to-reel tape speed of this magnitude still proved too high for a practical machine, as it resulted in a playing time (using reels of tape of a reasonable size) far too short to allow necessary recording time for test operations.



**VIDEO RECORDER is operated by Sgt. 1/C R. F. Perkins, radar technician, as it follows the flight path of a missile fired at the White Sands desert installation.**

To solve the problem, a special revolving head assembly capable of helical recording was developed. The 2-inch wide magnetic tape, moving at only 15 ips, curves past a rotating disc with 4 equally spaced magnetic heads. Despite the seemingly slow speed of the tape, information is packed rapidly onto the magnetic tape, for each head —in turn—records successive narrow, vertical bands of video information.

Speed of the head assembly is 14,400 rpm. In this way, a head-to-tape velocity approaching 1500 ips is attained. Simultaneously with the helical recording of the video information, stationary heads record the audio tracks and a control track in a linear manner along the opposite edges of the tape.

Despite the electronic complexity of this uniquely designed head assembly, it presents no human engineering problems, according to Ampex. Specialized employees are not required to operate the recorder, for it operates about the same as most voice recorders, the company said. Other applications—Videotape recorders also have been used for static test firings and other hazardous operations. Cameras are placed in the static test stands that are used to evaluate missile motors, and the recordings are made of flame characteristics and acoustic factors. Mounting the cameras in climatic and environmental chambers, the reaction of missile components to extreme degrees of temperature and humidity is captured and preserved for study. The recordings are made from television cameras placed in shock and vibration-proof testing equipment.

• **Future uses**—Two additional uses are planned at White Sands for Videotape recording.

Work is presently underway to install television cameras in impact areas. From these strategic spots, it is believed the recorder will capture information of the final phases of the missile's trajectory.

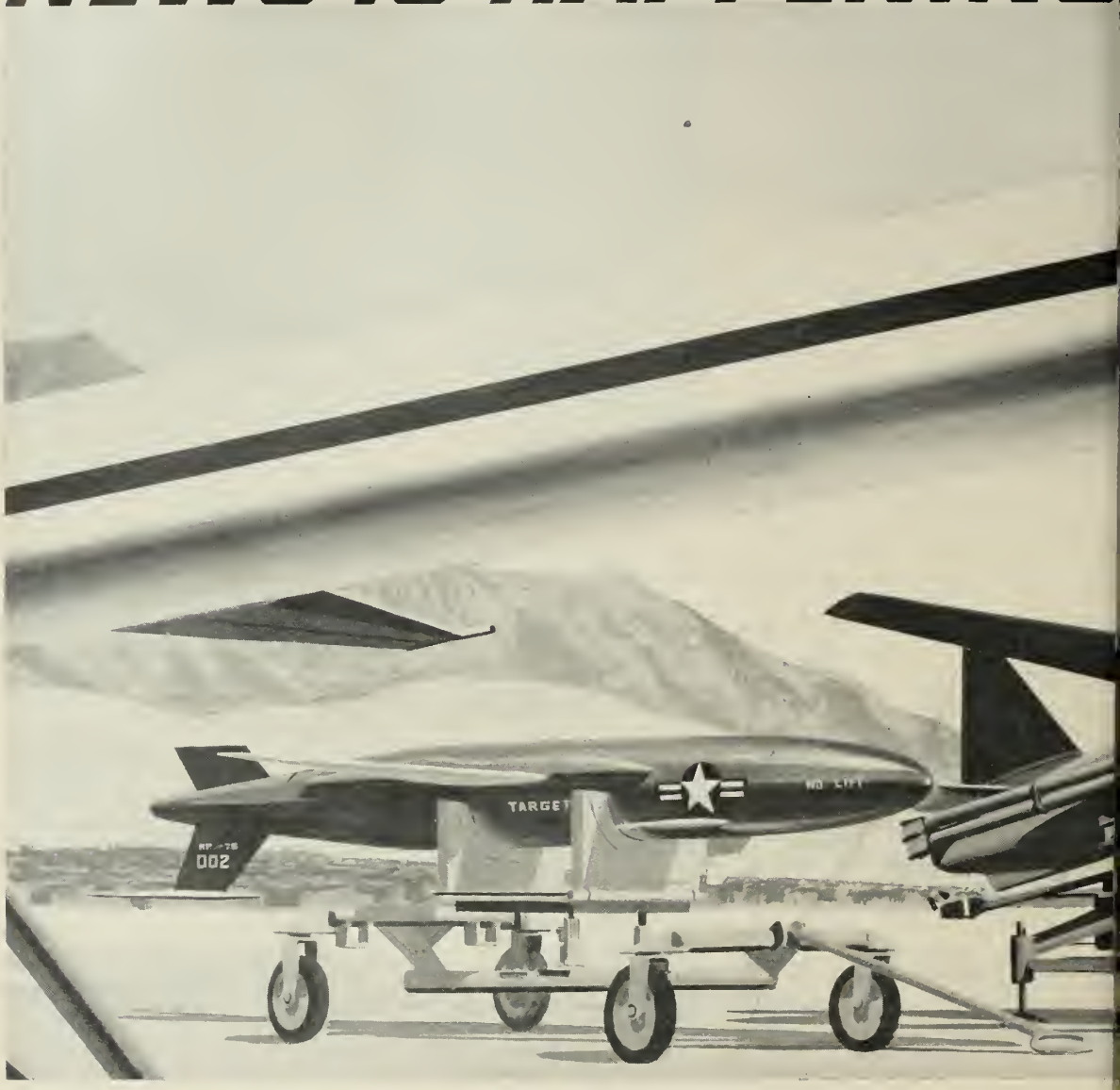
It may also be used to train radar operators. Through reproduction on an oscilloscope of the Videotape, trainee operators will be schooled in what they can expect when they first man an oscilloscope for radar tracking of a missile. Tapes will also be used for operator critiques.

## New Tracking Beacon Weighs Under 10 Pounds

SCHENECTADY, N.Y.—A tiny transistorized radar beacon for missile and satellite tracking has been developed by **General Electric.**

The C-band unit weighs less than ten pounds, occupies only 70 cubic inches, and is capable of 400 watts output. GE engineers say it is the lightest and cheapest device of its type and power yet produced.

# NEWS IS HAPPENING



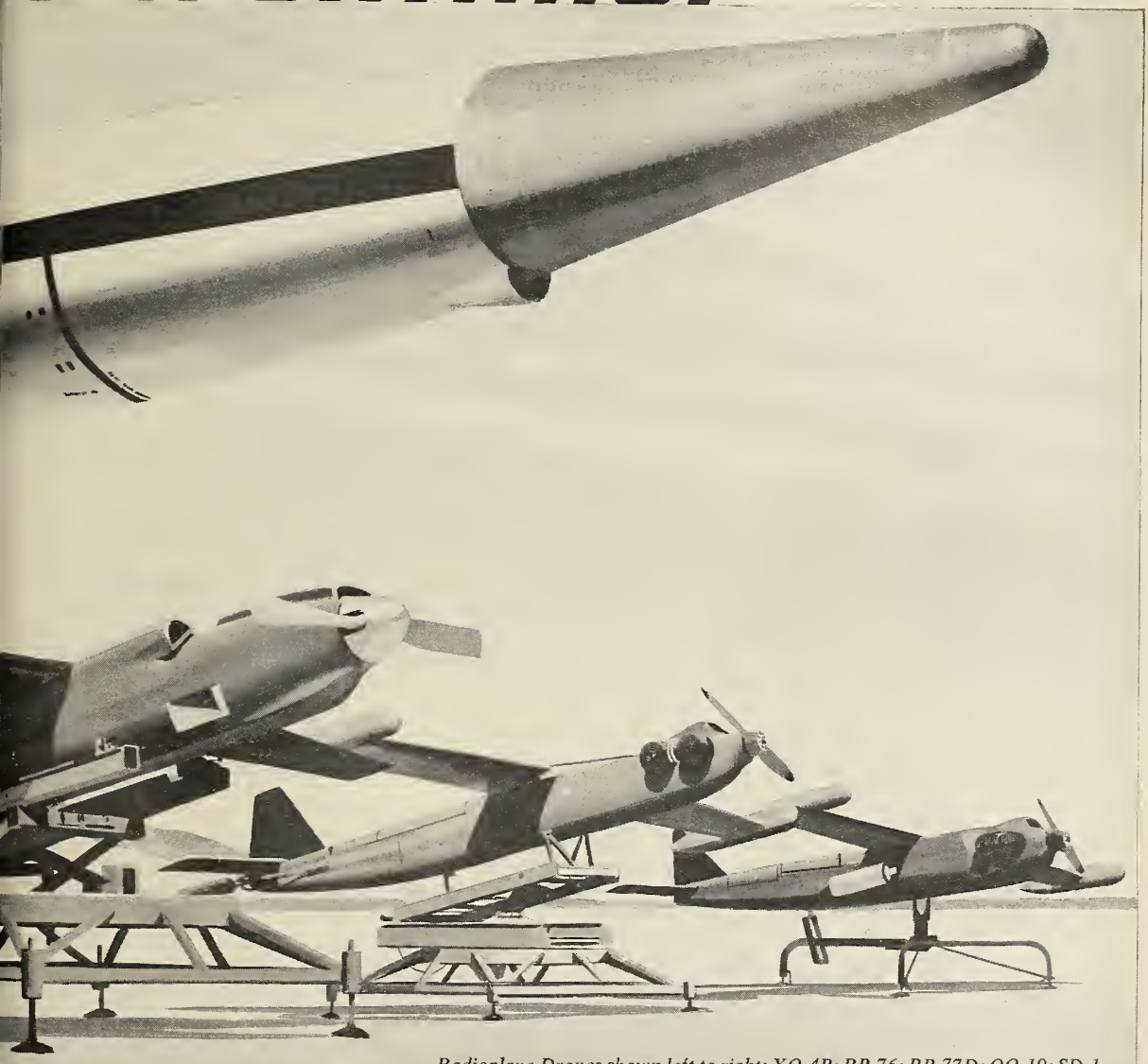

## RADIOPLANE CREATES FIRST FAMILY OF UNMANNED AIRCRAFT TO TRAIN MEN, EVALUATE WEAPON SYSTEMS, AND SURVEY ENEMY TERRITORY

Radioplane produces an entire family of multi-purpose drones that fly by remote control. As targets, drones perform as aircraft, then are recovered by parachute for re-use. As evaluators, drones simulate the action of enemy aircraft while they score our weapon systems' effectiveness. On surveillance missions, drones fly cameras, take photos, return with information within minutes.

For 20 years, Radioplane has been the leading producer o drones. Radioplane's leadership in the field typifies the year ahead thinking of Northrop Corporation and all of its Division The Corporation's continuing goal: design concepts for tom row, hardware for today – developed, produced, and delivere on time – and at minimum cost.

**NORTHROP CORPORATION** *Beverly Hills, California*

# AT NORTHROP



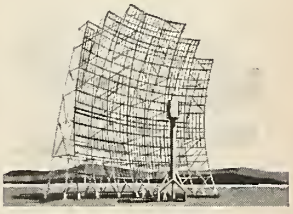
*Radioplane Drones shown left to right: XQ-4B; RP-76; RP-77D; OQ-19; SD-1.*

**NEWS FROM OTHER MEMBERS OF THE NORTHROP FAMILY**

**NORAIR** designs and builds complete weapon systems, missiles, airframes, related products. In production: Snark SM-62 and the first low-cost twin-jet trainer for America's airmen–the T-38 Talon.

**NORTRONICS** makes news with America's 2 most advanced inertial and astronertial guidance systems – LINS and A-5 – is also a leader in automatic test equipment and mechanical ground support.

**INTERNATIONAL,** Division for foreign operations, is now introducing the supersonic N-156F Freedom Fighter to provide our allies with maximum combat effectiveness – at minimum cost.



**PAGE** Communications Engineers, builders of strategic global networks, has been selected by USAF to link England-Spain-Morocco with troposcatter, telephone, teleprinter and data communications.

# British Astronautics

- ***Double Spectre rocket engine used to power Blue Steel***
- ***Further spending proposed for Australia's Woomera Range***
- ***Largest U.K. aviation firm sets up advanced projects group***

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

LONDON—It has now been announced that the **de Havilland** Double Spectre rocket engine D. Spe. D 1 (M/R, Aug. 24) is being used to power the stand-off bomb *Blue Steel* developed by **A. V. Roe.** Double Spectre consists of a variable-thrust Spectre 5 engine mounted beneath a fixed-thrust Spectre 4, both running on kerosine and high test peroxide. The thrust of the combined engine can be varied between 800 and 16,000 lb.

Static tests of the Double Spectre engine mounted in *Blue Steel* have been made at de Havilland's test site at Hatfield, Hartfordshire. Environmental tests of the missile have been carried out at the Weapons Research Establishment, Salisbury, Australia.

• **Further development of Woomera**—WRE, Salisbury (near Adelaide) is the headquarters establishment for the joint U.K./Australia missile testing project. It is 320 miles from its better-known outstation at Woomera, which is the launching base stretching 1300 miles to Broome, on the north-west coast. This is the longest overland testing range outside Russia.

The establishments have been constructed, equipped and staffed by Australia, and so far over £200 million have been spent on the project. The range has been used for testing the Australian-designed rockets *Malkara, Long Tom* and *Aeolus,* but the majority of the missiles fired have been developed in the United Kingdom.

A frequent courier service of Comet 2 aircraft carries Ministry of Supply or contractors' staff between the United Kingdom and Edinburgh airfield (near Salisbury) or the airfield 25 miles from the Woomera rangehead. Airstrips have also been built at Evetts Field, on the range itself, and are used for launching Meteor, Jindivik and Canberra pilotless target aircraft.

Prototypes, guided missiles and research vehicles are assembled at Salisbury from components and sub-assemblies flown out from Britain. Pre-flight inspection and tests are made both at Salisbury and at Woomera. The headquarters establishment includes a comprehensive group of workshops and research laboratories, with facilities for carrying out environmental tests, investigating defects, and analysing data obtained in the trials. The range itself is provided with every modern instrument for obtaining records of the behavior and performance of the missiles during flight trials.

The weapons which have been tested on the range include the **Bristol-Ferranti** *Bloodhound,* the **English Electric** *Thunderbird,* **de Havilland's** *Firestreak,* the **Fairey** *Fireflash,* **Armstrong Whitworth's** *Seaslug,* and the Australian *Malkara.* Three firings of the **Saunders-Roe** *Black Knight* rocket have taken place this year; on the third flight a maximum height of 500 miles was attained, the horizontal range being 75 miles. In addition Woomera has been used for upper atmosphere research, including work with in connection with the IGY. For this purpose, *Skylark* rockets have been used.

Other research activities include unmanned balloon flights to over 100,000 ft. to record cosmic rays, and supersonic aerodynamic studies.

It is now proposed to spend another $150 million on the programme. This will be used to develop further facilities. Woomera is likely to become the base for the British spaceflight programme. There are reports that the U.S. may also use the range, and possibly even launch a manned satellite from Woomera.

• **Progress with** *Blue Streak*—Nearly £3 million has recently been spent in extending the range into Western Australia. Meanwhile large concrete underground launchers are being constructed in cliffs 30 miles west of Woomera. These are intended for the British long-range ballistic missile *Blue Streak.*

Ballistic tests on *Blue Streak* will soon be held at Woomera. The stated range of the missile is 2875 miles, or over twice the length of the range, so that eventually it will travel out over the Indian Ocean. The weapons to be used in the present series of tests will not carry explosives; in service, they will be fitted with thermonuclear warheads.

*Blue Streak* is intended to be the principal weapon in the British armoury, and has been designed to satisfy the requirements arising from Britain's geographical position. The prime contractor is **de Havilland Propellers Ltd.** No design information has yet been released, although the public can see the complete airframe (manufactured by **de Havilland Aircraft Co.**) in test towers at Hatfield.

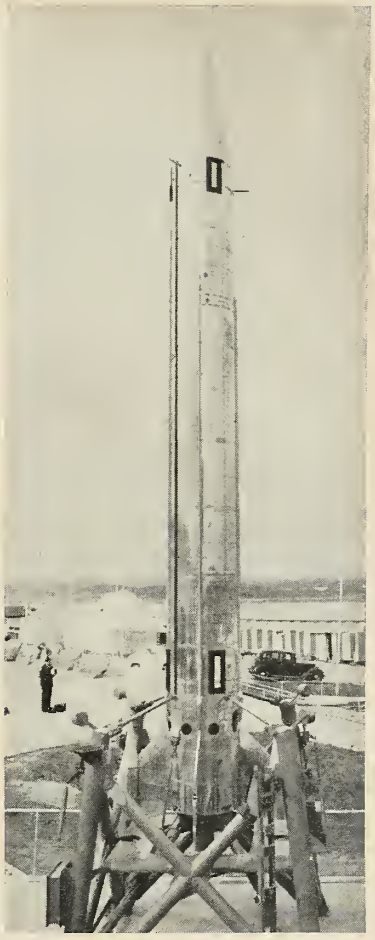
The missile appears to be about 75 ft. high by 10 ft. diameter, and made from thin stainless steel stiffened by axial corrugations. It is a single-stage vehicle propelled by two kerosine/-LOX engines built by **Rolls-Royce** to modified **Rocketdyne** designs. Tests on the engines themselves at Spadeadam, Cumberland, have now been followed by static and strength tests on the assembled vehicle at Hatfield. Guidance is by the Sperry Gyroscope Co. Several designs for satellite and space-research vehicles utilising *Blue Streak* as a first stage have been drawn up by de Havilland and were discussed at the Commonwealth Spaceflight Symposium.

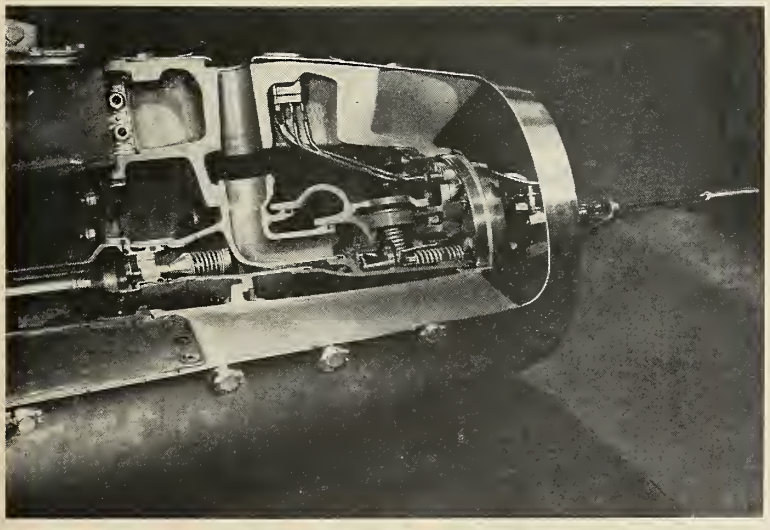
• **Hawker Siddeley establish astronautics group**—The largest aviation organization in Britain, **Hawker Siddeley,** has just set up an Advanced Projects Group, which will work on various aspects of astronautics and on supersonic transports. The Group will be located at Kingston-upon-Thames, Surrey. Initially, it has been formed by drawing some of the senior personnel from within the other members of the organization: **Hawker Aircraft,** A. V. Roe, Armstrong Whitworth, etc., but additional staff are now being recruited.

# British Missiles At Farnborough Show

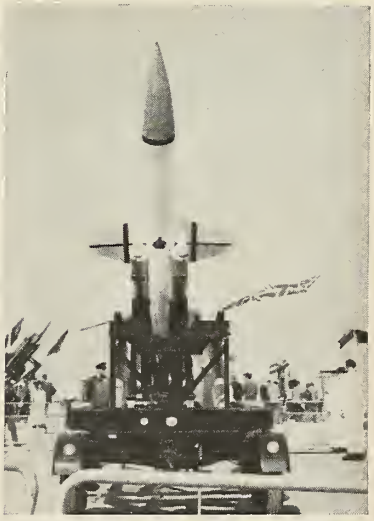
MINISTRY OF SUPPLY's two-stage research vehicle *Black Knight* was on public display for first time. Nose section of an experimental head that re-entered atmosphere from height of 500 miles and 12,000 fps was also demonstrated.

BRITISH Army now has first units of English Electric's solid-propelled *Thunderbird*. Improved version is in development stage and firm is working on solid-propellant tactical missile.





FOR FIRST TIME, cutaway ramjet—Bristol Siddeley's Thor BT-1—was demonstrated. Powerplant for early version of *Bloodhound*, the ramjet has a centerbody-type intake. Nose cone projects forward of the intake lip to focus the shock waves. A secondary shock wave occurs in the annular duct between the lip and centerbody island.



HIGHLIGHT OF SBAC display was helicopter-lifting of Bristol/Ferranti *Bloodhound* and trolley weighing some two tons. U.K. intends to keep surface-to-air-missile developments in the same family.

# Mail By Rocket Over North Sea

**from an M/R Correspondent**

CUXHAVEN, WEST GERMANY—Rockets are carrying mail regularly across the North Sea.

The German Rocket Society has begun mass production of mail-carrying rockets, it reported last week at its eighth national convention in this seaport city. The first 10 were fired successfully and landed by parachute on islands off the coast.

The German society, which helped in the early 1930's to open the way to space, recently increased its activity with a series of projects emphasizing peaceful uses of rockets.

Late this year, the society will introduce an oil-spraying rocket that will be used to facilitate shipwreck rescue operations off the German coast.

The rocket is fired like a crossbow from the launcher shown below. A shield protects the archer from exhaust gases. Inclined stabilizing fins make the rocket spin around its longitudinal axis. Two little holes open in its "warhead" immediately after blastoff and the centrifugal force propels a quart of oil over a great distance.

Though the rocket flies only 900 feet, it can spray a thin oil film over an area of about 90,000 feet and rough waves will be calmed immediately. It is believed that the oil-spraying rocket also could help seafaring airplanes and helicopters land on rough sea.

**OIL-SPRAYING rocket is fired from this launcher. Shield protects archer.**

**THESE TEN mail-carrying rockets already have been fired successfully across the North Sea. The German Rocket Society has begun mass production of the proven model.**

**ROCKET BUFFS ready the postal rocket for firing. It will deliver postcards and letters to North Sea islands where it will land by parachute and be returned.**

# System May Bring Circular Orbits

***General Electric's 'GESOC' method of control is designed to correct elliptical orbits at apogee using infrared horizon sensors***

PHILADELPHIA—The conventional elliptical orbit of a satellite may be circularized by a new method developed by **General Electric** engineers here. The system, called GESOC—General Electric Satellite Orbit Control—is made up of two basic elements: a computer and a small solid-rocket gas generator. Scheduled for early flight test, GESOC uses an infrared sensor to determine orbit parameters. The transistorized analog-digital-analog computer weighs 2½ pounds.

Circular, or low-eccentricity, orbits are desirable for many of the application satellites being designed—such as mapping, photography, and fixed-range communication vehicles. This circular orbit, however, is practically impossible to achieve with present launching techniques. The satellite must be put into an elliptical orbit which is then modified to a circle. This is accomplished by the computer, which measures and calculates the exact original orbit and compares this with the desired orbit. The computer then commands the gas generator to fire the proper nozzle to inject the vehicle into the new orbit.

The control system has a cluster of four nozzles positioned in opposite directions. The generator supplies gas to any number of the nozzles as commanded by the computer. Nozzle control is possible down to intervals of 300 microseconds.

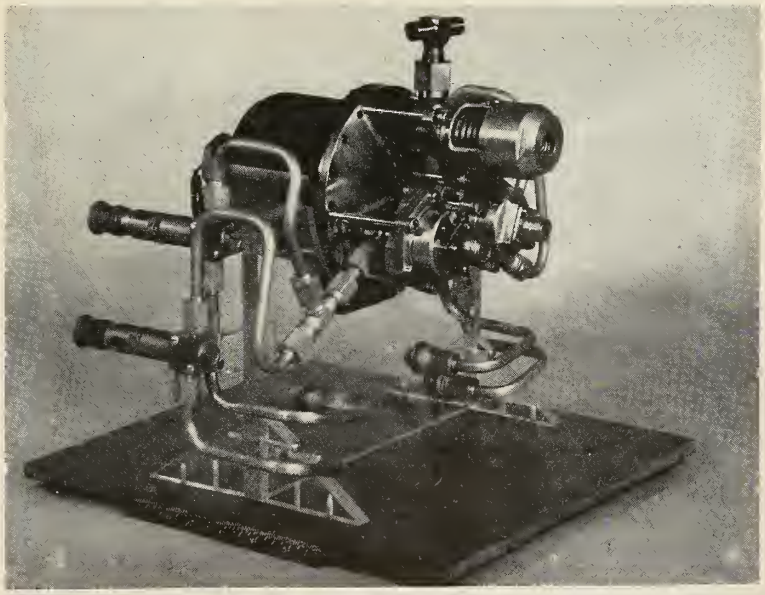
In the case of an elliptical orbit with an apogee and perigee of 600 and 200 nautical miles, for example, the magnitude of the velocity vector may be increased by 520 ft./sec. at apogee and the orbit will become circular. GESOC can compute the necessary impulse and initiate the correction by firing a solid or liquid-fueled reaction thrust system at the proper point on the orbit.

The vehicle must be attitude-controlled. However, the required stabilization is achieved by the same equipment which provides the intelligence for the computer. This is one of the major advantages of the apogee method of orbit transfer. The use of such a satellite orbit control system is a way of compensating for inaccuracies arising from error tolerances on the launching vehicle guidance and control system.

• **Choice of sensing systems**—The vehicles for which the GESOC computer is designed are attitude-stabilized around their pitch and roll axes by an IR horizon sensor system. The third (yaw) axis can be stabilized by a number of different sensing systems such as a magnetic aspect sensor, which makes use of the earth's magnetic field to sense yaw motion, or a pitch rate system. This stabilization keeps the vehicle oriented in such a way that its axes are fixed relative to the earth. The yaw axis of the vehicle is coincident with the vertical axis of the earth; therefore, the roll and pitch axes of the vehicle are in a plane perpendicular to the vertical axis passing through the center of the earth (assuming that the earth is a perfect sphere).

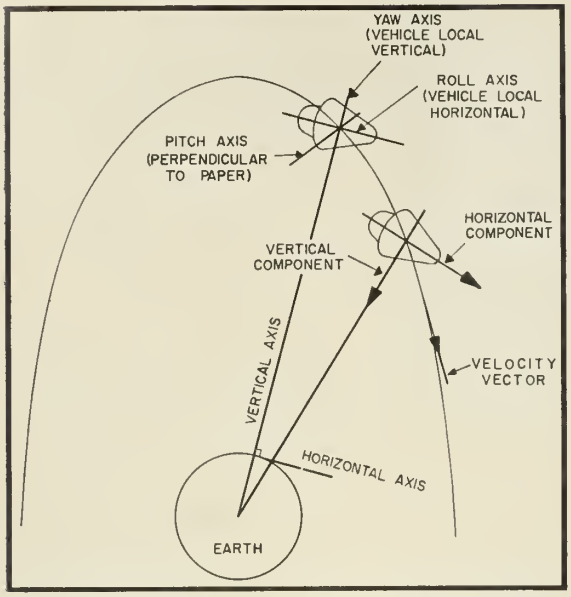
In order that a vehicle be travelling a circular orbit, the magnitude and angle of its velocity must satisfy the definition of such an orbit at the given altitude. For a circular orbit, the velocity of the vehicle varies inversely with the square root of the distance from the earth's center. If the earth is assumed to be spherical, the angle which the velocity vector makes with the horizontal axis of the attitude-stabilized satellite is always zero. A vehicle in an elliptical orbit is specified by a velocity vector which has horizontal and vertical components along the local axes of the vehicle.

For the attitude-stabilized vehicle



**GESOC system consists of 2½-pound transistorized analog-digital-analog computer and a small solid-rocket gas generator which supplies fuel at computer's command.**

## corrections at apogee only . . .




**IN ELLIPTICAL orbit, the velocity vector makes a zero angle with orbit path at apogee and perigee.**

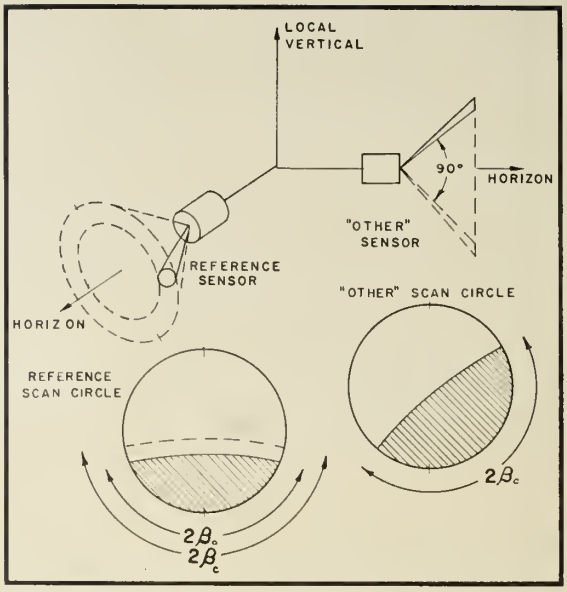



**DIAGRAM shows how GESOC's two infrared sensors are mounted perpendicular to each other.**

discussed, these components are also defined by the earth's coordinate system. The magnitude of the velocity vector is a function of the altitude at apogee, perigee, and the given point on the orbit.

• **Simplified computer**—To circularize an elliptical orbit, the vertical component of the velocity vector must be removed and the horizontal component altered in such a way that it is equivalent to the magnitude of the velocity vector of a circular orbit at the given altitude. The magnitude and angle of the correction impulse are specified by these conditions.

At apogee and perigee of an elliptical orbit, the angle which the velocity vector makes with the orbit path is zero. Therefore, only the horizontal component of the correction impulse is necessary to circularize the orbit. Because of this and other considerations, the GESOC correction computer is greatly simplified since it is designed to correct orbits only at apogee. However, this is no limitation because any desired orbit can be obtained if the proper transfer orbit is utilized. This, of course, involves two corrections.

The necessary inputs to the computer or calculation of the correction impulse are altitude measurements. For a correction computer that can correct an orbit at apogee only two altitude readings—those at the apsides—are necessary to calculate the velocity impulse needed to circularize the orbit. An infrared horizon sensor system provides altitude information for GESOC. The primary use of this system is attitude stabilization, but it has been adapted to yield altitude information.

• **Hot earth, cold sky**—The IR horizon sensors make use of the fact that the earth is relatively "hot" (250°K) while the sky is "cold" (about 5°K). Their voltage output is inversely proportional to the amount of infrared radiation falling on the detectors and thus, to the relative amounts of sky and earth which they "see".

The GESOC system contains two infrared sensors mounted perpendicular to each other, as shown in the diagram. The cone angle of the scan is 90 degrees, and is referenced at 180-degree intervals. If one sensor is taken as the reference, its output is a voltage pulse proportional to the amount of scan that intersects earth.

In the vehicle for which GESOC is designed, the reference scan axis of the horizon sensor system coincides with the horizontal axis of the vehicle. The second, or "other," sensor measures the attitude error. This is the angle between the vehicle local horizontal and the reference sensor scan axes. This information is provided by a phase-shift detection in the "other" sensor.

The first circle in the diagram represents the scan from the reference sensor. The shaded area is the amount of earth which the sensor sees. This information is measured as pulse width data. The "other" scan is shown in the second circle. For the application taken, the "other" scan axis is oriented along the vehicle pitch axis. If there were no tilt about either axis, these two scans would be identical.

• **Advantages of GESOC**—There are several advantages in the apogee correction technique for which GESOC is designed:

1) Minimum energy is required in making the correction since the thrust is applied parallel to the original satellite vector velocity.

2) Direction of thrust is horizontal. This simplifies orbit control computation to that of velocity change only.

3) Orbit parameters have minimum time variation at apogee and perigee. This decreases the effect of finite propellant burning time and errors due to initiating thrust before or after apogee or perigee is reached. (This characteristic, however, may also be a disadvantage.)

With this system, there are only two possible altitudes for a circular orbit from a given ellipse. If neither apogee or perigee are at the desired new orbit altitude, then a transfer orbit is necessary. Also, it is difficult to distinguish exactly where apogee and perigee are, since the rate of change around these points is very small, especially for low-eccentricity orbits.

# No Future for Solids in Space Ships

## *American Chemical Society hears that solids lack momentum needed for large vehicles. Convention also views advances in plastics, elastomers and polyurethanes*

**by John F. Judge**

ATLANTIC CITY, N.J.—Solid propellants are out of the space flight picture. According to Dr. Lloyd A. Wood, chief of the research grants and contracts division of NASA, there are many specialized uses for solids, particularly in small rockets, but the larger vehicles will depend on other means for space propulsion.

Speaking before the Gas and Fuel Chemistry Division at the American Chemical Society's 136th Annual Meeting, Dr. Wood explained that in such systems it is the momentum that counts. What is needed is maximum momentum per unit mass of fuel, and in this respect, solids are not the answer.

Dr. Wood also said space technology will have little effect on everyday life until men can project great masses into space. This will require some dramatic developments in propulsion methods.

Until this occurs, the activity in space can best be described as intellectual effort, resulting mainly in accumulation of knowledge in communications, navigation, weather and scientific matters.

• **Plastic nozzles**—Results of a series of tests by George Epstein and Harry King of **Aerojet-General** show that plastics may find use in the toughest position in rocketry—the nozzle.

The heat-resistant types of plastics reveal promise with phenolic and phenolic-silicone compounds lasting longest at a 5400°F temperature.

A reinforcing material known as Refrasil, cut in half-inch squares and positioned at right angles to the blast, provided the best results.

The two scientists told the Division of Paint, Plastics and Printing Ink chemistry that the properties of the phenolic-Refrasil nozzles may be improved greatly by increasing molding pressure in fabrication. The tests were part of a program initiated to establish materials, processes and design criteria to provide lighter weight nozzles that are dimensionally stable under firing conditions.

Aerojet-General's Robert F. Chaiken, speaking on the role of binders in composite solid propellants, said that the importance of the oxidizer monopropellant layer and the decomposition characteristics of the solid oxidizer and binder have been largely ignored by many contemporary investigators. If the burning propellant surface is pictured to consist of individual oxidizer particles which can decompose in their own individual flame zones, then the binder's task can be considered to manifest itself as a perturbation of the monopropellant thermal layer surrounding the decomposing oxidizer particles.

Depending on the decomposition characteristics of the binder used, the effects of the binder on the burning rates can be shown.

• **Mixing checks**—The detection of nonuniformity in propellants during mixing by radioactive tracer techniques was explained by A. M. Hoffman of Aerojet-General. Reliable methods have been developed in pilot plant and production scales. A composite propellant, before casting, is a slurry containing finely divided crystalline solids consisting of oxidizer and additives in the binder. Reproducible ballistic performance and curing properties are dependent upon the uniform dispersion of these additives.

Hoffman said that the results of tests with curing agent and burning rate modifier showed that regardless of the size of the mixer, the materials were incorporated into the slurry in 15 to 20 minutes.

Walter C. Hourt of **Atlantic Research Corp.** said that there is need for definition of the chemical structure of plastics in relation to mechanisms of carbonization and the thermo-chemical properties of reinforcements to ensure continued development of plastic heat insulators for solid motors.

A theoretical evaluation of a model insulator indicated that char formation of highly endothermic pyrolysis and gaseous decomposition products are of primary importance to good performance.

• **Polyurethanes**—Certain basic resin parameters are superior to weight recipes in describing polyurethane propellants, said H. E. Marsh, Jr., of **Jet Propulsion Laboratory.**

Because of variations in raw materials, Marsh disclosed, the ratio of isocyanate to hydroxyl, the ratio of triol to total hydroxyl, the average molecular weight between branches and the degree of branching are all useful parameters.

The scientist stated that tensile capacity had been observed in the characteristic way that related propellant formulations trade off tensile strength with elongation over broad ranges of formulation parameters. These effects can be readily seen from a graphical comparison of tensile capacities.

• **Shear strengths**—A unique alkaline surface treatment which consistently produced tensile shear strengths in excess of 5000 psi using ¼-inch bonded overlap of a non-stainless steel alloy was developed by Aerojet-General. George Epstein and Sidney Litvak of the structural plastics division reported that the treatment was extended to other metals such as titanium, nickel, beryllium and stainless steel with considerable success.

The scientists explained that improvements in tensile shear strength of metals were also effected by the use of a vinyl-phenolic primer followed by a complete cure.

Other methods included the evacuation of entrapped air from liquid epoxy-base adhesive systems and curing under pressure for powdered epoxy-base systems.

Multi-ply metal laminated pressure cylinders are being developed and produced in quantity and their performance depends upon the quality of the adhesive bond.

# Space Probes Must Be Sterilized

LONDON—Biological pollution tolerances should be kept to less than $10^8$ dead organisms per probe for moon and planetary shots.

The introduction of terrestrial organisms and contaminants might so distort the biology of a planet as to constitute a scientific catastrophe, said Richard W. Davies and Marcus G. Comuntzis of **Jet Propulsion Laboratory.**

The two scientists told the 10th International Astronautics Congress that, because of the exponential growth rate of bacteria, space probes that have any possibility of extraterrestrial contact should be carefully sterilized.

A combination of ethylene oxide—carbon dioxide gases, radiation, and heat will permit the sterilization of 95% of the payload parts without seriously degrading their performance characteristics.

Elimination of substances of biological origin, such as casein glue or shellac, and the incorporation of those organo-metallic in nature might prove valuable in reducing contamination during initial stages of probe assembly.

Davies and Comuntzis said sterilization may be maintained by a protective shroud housing a disinfectant through the final countdown and initial atmospheric flight.

Although the environment of space is hostile to terrestrial organisms, the scientists said that such self-sterilizing mechanisms are not very effective. For example, ultraviolet radiation will destroy exposed organisms but its penetrating power is so low that organisms can survive if surrounded by a small number of dead ones.

The biologists also suggested the creation of an agency specially qualified to perform terminal disinfection and to ascertain the degree of sterilization necessary.

## Astronauts' Eyes Could Be Damaged by Sun Rays

LONDON—The sun's bright rays in space, undiminished by earth's protective atmosphere, will make it necessary to design space ships to protect astronauts' eyes.

Dr. Hubertus Strughold, research adviser at the U.S. Air Force School of Aviation Medicine, San Antonio, Tex., and an M/R contributing editor, called attention to the problem in a paper sent to the 10th International Astronautical Congress here recently.

Solar illuminance at the earth's mean distance from the sun is about 30% higher in space than the maximum brightness at the earth's surface, Strughold reported. At the distance of Venus' orbit, this is almost doubled, while the figure for Mars' orbit is reduced by more than 55%. He gave these figures for the illuminance in lux (lumens per square meter) at the mean distances of the various planets:

| | |
|---|---|
| Mercury | 938,000 |
| Venus | 268,000 |
| Earth | 140,000 |
| Mars | 60,000 |
| Jupiter | 5200 |
| Saturn | 1500 |
| Uranus | 380 |
| Neptune | 150 |
| Pluto | 90 |

The maximum solar illuminance observed on earth is on the order of 100,000 lux, Strughold added. In space, the brightness of the sun-illuminated earth may be enough to cause a dazzling glare, he added.

"The direct solar rays coming out of a dark sky produce light-shadow effects in the cabin which pose problems with regard to visual adaption, and require special attention in design of windows," Strughold continued.

Looking into the sun with the naked eye may lead to retina damage even a retinal burn that would cause a blind spot. This danger increases on a trip toward the sun, such as a Venus expedition. Strughold said the danger probably disappears on an outward trip somewhere beyond Jupiter.


**ASTRONAUT Lt. Malcolm Scott Carpenter, NSU, in the gondola of the human centrifuge at the U.S. Naval Air Development Center, Johnsville, Pa., in a recent space flight simulation.**

## Viewer To Guard Pilot's Eyes from Nuclear Blast

PITTSBURGH—Space pilots will use a viewing device, similar to conventional flight periscopes, being developed by **J. W. Fecker, Inc.**

Designed to eliminate the thermal problems posed by windshields, the instrument features a rapid closure system capable of shielding the pilot's vision in 500 microseconds or less from high intensity light flashes. This is designed to protect the pilot's eyes from the glare of a nuclear explosion.

The device will give the pilot a broad view, comparable to present wind-shields, and will conform to military weight and dimensional requirements.

The project is supported by a recently awarded Air Force contract.

## Figuring Human Element Speeds Missile Progress

HUNTSVILLE, ALA.—Money is saved and delays are avoided in Army missile development by figuring in the human element early in design, scientists meeting at Redstone Arsenal have reported.

One missile expert said his firm uses men typical of those who will operate the finished weapon to try out inexpensive mock-up models during initial design, thus determining whether their final product will be compatible with the physical and mental capabilities of its crew.

*death of a program . . .*

# *Vanguard* Aided Our Space Technology

***The nation's first designed space vehicle was a greater success than failures indicated and its components are used in most newer spacecraft***

**by C. Paul Means**

WASHINGTON—Amidst the relic machines that dot the final resting place of man's historic scientific successes and failures—the Smithsonian Institution—stands the last existing *Vanguard*.

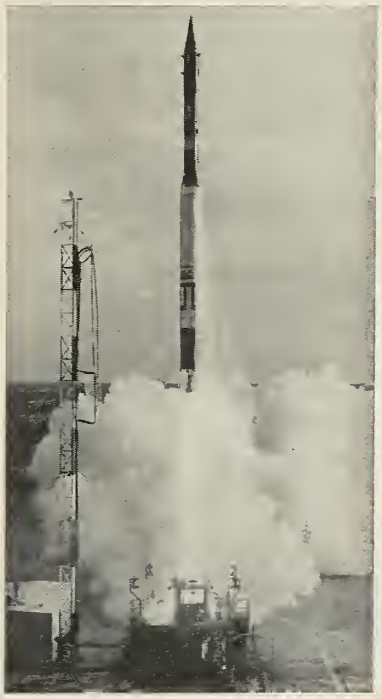
And as the nation's first rocket designed as a space vehicle leaves the scene to become a museum piece, the final assessment of its worth seems to be that the program was—in spite of its failures—a rewarding success.

*Vanguard* goes into the history books an enigma. In the early days, too little was given to the program and too much was asked of it. The hopeful, slightly boastful praise that met the announcement of its first launch attempt changed to derision, even ridicule, with each successive failure.

It was with a sense of relief that those connected with the program watched the last launch attempt become the program's greatest success. *Vanguard* III, after going through two days of its trying, traditional false starts last week, launched 100 pounds (50 pounds of payload) into a stable orbit. The payload, which includes various types of radiation experiments, has a perigee of 319 miles and an apogee of 2329 miles, and will map uncharted regions of space for future manned flight by detecting high-radiation pockets, temperatures, X-rays from the sun, magnetic storms and moving particles of all kinds.

The record shows that the *Vanguard* program tried to orbit satellites with four test vehicles and seven launching vehicles. It succeeded three times out of eleven. A fair estimate of the program's cost (minus the funds for the Minitrack network) is about $95 million. Each vehicle cost about $3 million, and each pound orbited cost about $1,223,000.

• **Lasting benefits**—But *Vanguard's* worth is not indicated by its batting average.



**A LAUNCHING of *Vanguard*—the U.S.'s first rocket designed from the ground up as a space vehicle.**

The 75 pounds that were orbited gave scientists their first insight into the true shape of the earth; allowed mapmakers to correct serious errors; and continue to give scientists a great deal of useful information about space and its properties.

*Vanguard's* real heritage lies in the wealth of technology obtained which will aid the designing, launching, and tracking of future space vehicles.

The program's impact has already left its stamp on present and future space vehicles. *Atlas Able, Thor Able, Scout, Thor Delta,* and *Vega* are a few of the newer space vehicles which use *Vanguard* engines, either in their original or in a modified form.

Other "fallout" benefits of the *Vanguard* program include:

• The telemetering equipment developed as part of the ground launching facilities and the worldwide Minitrack system;

• The optical equipment developed to track *Vanguard* visually;

• The technology — painfully learned—of how to build a non-missile space vehicle from the ground up, and how to design and integrate the various stages and engines;

• The indirect benefits gained from the *Vanguard* program by the ballistic missile program;

• The experience gained by many still employed in the nation's space effort.

• **Born in strife**—The decision to build *Vanguard* was made by the Department of Defense's Advisory Group on Special Capabilities four years ago. It was chosen as the best of three proposals to orbit a satellite payload during the International Geophysical year.

The losing proposals would have used existing hardware developed in the ballistic missile program. The Army's proposal, "Orbiter" was to have used the *Redstone,* and the Air Force's proposal the *Atlas.*

The decision to build *Vanguard* provoked a controversy which still rages. The Army claimed, and later proved, that their proposal could orbit a satellite before *Vanguard* could be developed.

On September 23, 1955, the **Glenn L. Martin Co.** received the prime contract from the Navy to build *Vanguard.* The Navy transferred direct control of the project to the Naval Research Laboratories, and to Dr. John Hagen. The program was transferred to the National Aeronautics and Space Administration last fall.

The *Vanguard* program did not meet its time schedule, but the vehicle

was developed in the fraction of the time it takes to develop an ICBM. The program, surprisingly, met its reliability objectives.

Dr. Hagen stated before a Congressional committee that the original proposal envisaged a reliability that would give a "reasonable chance" of putting one satellite in orbit in six tries, or a reliability factor of about 15%. The program actually put 3 vehicles in orbit in 11 tries, for a reliability factor of over 36%.

The reliability of *Vanguard* has seldom been judged in comparison to the program's original objectives, or in comparison to the time and money spent on the program. The Russian orbiting of *Sputnik* brought pressure on the *Vanguard* program to achieve a rate of success that it was not capable of.

• **Learning the hard way**—A final benefit of the *Vanguard* program was that it demonstrated to the nation how a space vehicle development program should not be run.

Organizational difficulties hampered the program from the start. Project *Vanguard* became a political football in the Pentagon, with top defense leaders showing little more than apathy for the program.

According to a report by the House Appropriations Committee, "there was divided responsibility in the program to define properly the duties and authority of organization units and personnel. The Martin Co. found it difficult to get timely decisions at Cape Canaveral . . . It is the opinion of . . . those consulted at Cape Canaveral, that good 'team' effort early in the program might have reduced some of the launching delays and made it possible to expedite the test program."

The "looseness, lack of formalization, and early management problems" burdened the *Vanguard* program with a permanent liability according to the report, because the "short time scale allocated for *Vanguard*, the complex design, and the necessity for producing a relatively large number of vehicles in a short time, made it necessary to carry on many facets simultaneously and to adopt production-lines techniques . . ."

As one top rocket expert at the National Aeronautics and Space Administration put it last week, "It's a marvel *Vanguard* worked as well as it did."

## CHRONOLOGY OF VANGUARD LAUNCHINGS

(TV=Test Vehicle,
SLV=Satellite Launching Vehicle)

**TV-0**—*December 8, 1956: Viking rocket No. 13 (no Vanguard components) launched successfully to test Cape Canaveral range facilities, tracking and telemetry systems.*

**TV-1**—*May 1, 1957: Viking rocket No. 14, carrying a Vanguard prototype third stage, was launched successfully for test of control system and separation, spin-up, and ignition of third stage.*

**TV-2**—*October 23, 1957: A complete Vanguard configuration with "live" first stage and dummy second and third stages was successfully launched for tests of aerodynamic soundness and engine gimballing.*

**TV-3**—*December 6, 1957: First complete three-stage Vanguard failed at lift off, preventing separation and flight test of second stage.*

**TV-3 Back-up**—*February 5, 1958: Complete three-stage Vanguard launched, but broke up after 60 seconds of normal flight when the control system malfunctioned. Rocket fell into the sea.*

**TV-4 Vanguard I**—*March 17, 1958: Successful launch of a complete three-stage Vanguard placed a 3.25-pound test satellite and the 50-pound third stage in an orbit expected to last more than 200 years. A staff report issued by Congress describes the satellite as "the most stable of any earth satellite launched to date."*

**TV-5**—*April 28, 1958: Last test vehicle launched with a 21½-pound instrumented satellite. First and second stages operated successfully, but a control system failure prevented activation of third stage. Rocket coasted to an altitude of 358 miles and fell to sea.*

**SLV-1**—*May 27, 1958: Three-stages launched successfully, but faulty second-stage burn-out threw rocket off course. Rocket flew 20 minutes to 1850 miles in space before falling.*

**SLV-2**—*June 26, 1958: Second stage ignited successfully but cut off prematurely, preventing achievement of orbit.*

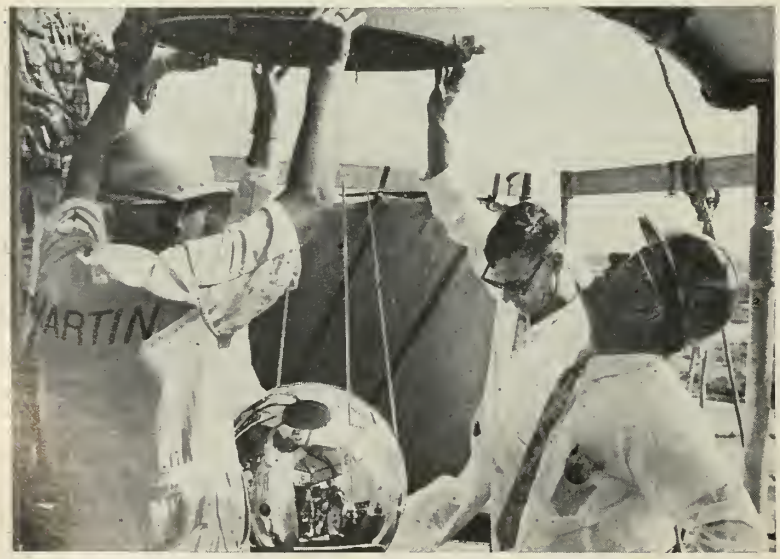
**SLV-3**—*September 26, 1958: Orbiting of a 20-pound satellite missed by the narrowest of margins due to failure of full second stage thrust.*

**SLV-4 Vanguard II**—*February 17, 1959: Successful three-stage launch placed a 23.3-pound satellite and the 50-pound third stage in an orbit now expected to last 200 years.*

**SLV-5**—*April 13, 1959: Launch was aborted after a malfunction in the separation of the second stage from the first stage.*

**SLV-6**—*June 22, 1959: Launch unsuccessful due to failure of second stage pressure regulator.*

**SLV-7 Vanguard III**—*September 18, 1959: 100-lb satellite in orbit.*




**DIRECTOR of *Vanguard* project, both under Naval Research Lab and NASA, was Dr. John P. Hagen, here shown (at right) making a last-minute check before launching.**

**BEFORE-DINNER joke is shared at the M/R critique by (from left) James J. Haggerty, Jr., Fred Hunter, Clarke Newlon, Dr. Peter Castruccio, Wayne W. Parrish, Conrad H. Hoeppner, Dr. Arthur Kantrowitz, and Heyward E. Canney, Jr.**

# M/R Advisors Give Critique

WASHINGTON—Members of MISSILES & ROCKETS' Advisory Board and Contributing Editors met in Washington Sept. 17 to analyze the magazine's editorial content and to present their views on areas of expanded editorial coverage.

Preceding the critique, moderated by M/R Executive Editor Clarke Newlon, was the annual dinner held in their honor.

Members of the Advisory Board present were: Dr. Peter Castruccio, Director of the Astronautics Institute of the **Westinghouse Electric Corp.**; Mr. Conrad H. Hoeppner, Chief Scientist of **Radiation Inc.**; and Dr. Arthur Kantrowitz, Director of the **Avco Research Laboratory.**

Contributing Editors present were James J. Haggerty, Jr., of the Aerospace Industries Association, and Heyward E. Canney, Jr., Aeronautical Research Administrator of the National Aeronautics and Space Administration.

Members of the Advisory Board and Contributing Editors unable to attend sent critiques by mail which were discussed at the dinner.

Attending besides the M/R staff were Wayne W. Parrish, President of American Aviation Publications Inc., Leonard A. Eiserer, Executive Vice President of AAP, and Fred Hunter, Vice President and Editorial Director of AAP.

M/R staff members present besides Mr. Newlon were Publisher E. D. Muhlfeld, Managing Editor Donald E. Perry, Advertising Sales Manager W. E. Brown, Associate Editors Reed Bundy, James Baar, Charles D. LaFond, Jay Holmes, John F. Judge, C. Paul Means and William E. Howard, and Editorial Assistant David Newman.

**PROBLEMS OF outer space travel are discussed by W. E. Brown, Heyward E. Canney, Jr., John F. Judge, Jay Holmes, Dr. Arthur Kantrowitz, and C. Paul Means. The dinner was held in the Cabinet Room of Washington's Sheraton Carlton Hotel.**

## reviews

INSTRUMENTATION FOR THE DETERMINATION OF PHASE DELAY IN A RADOME WALL; B. Carpe, Dalmo Victor Co. for WADC. Order 151549 from OTS. U.S. Dept. of Commerce, Washington 25. D.C. $1.

Described is the development of an instrument suitable for accurate measurements of relative changes in electrical thickness in radomes.

Electrical thickness and effective dielectric constant are functions of the reflected phase and amplitude of a radome, according to the theory of operation that was developed. Certain inherent sources of error, effect of loss tangent, and horn requirements were established.

DEVELOPMENT OF NIOBIUM-BASE ALLOYS; Richard T. Begley. Order No. PB 151 739 from OTS, U.S. Department of Commerce, Washington 25, D.C. 192p. $3.00.

Flows and fracture studies indicate that the ductile to brittle transition of niobium is little affected by oxygen content in the range 0.01 to 0.1% $O_2$. Strain-hardening and strain aging in niobium were studied.

The recrystallization behavior of electron-beam melted niobium was studied in detail. Creep-rupture data were obtained on electron-beam melted niobium at (871 C) 1600 F and (982 C) 1800 F. The effect of temperature on the modulus of elasticity of niobium and tantalum was determined in the range 25C to 900C.

FUELS AND LUBRICANTS; Milosh Popovich and Carl Hering. John Wiley & Sons, New York. 312p. $8.50.

Presented is a survey of fuels and lubricants written primarily as a college text but applicable to industry as well.

Emphasis is on the correlation between the properties of fuels and lubricants and their performance in an engine or machine, and on the significance of the standard tests that are conducted on these materials.

Along with detailed coverage of the fuels and lubricants obtained from petroleum and common solid and gaseous fuels, the book includes a survey of synthetic lubricants, rocket propellants, and nuclear fuels.

A chapter is devoted to an outline of organic chemistry. The refining of petroleum and other manufacturing processes are described briefly to show their influence on the properties of the products. High energy fuels and rocket propellants are discussed generally.

INVESTIGATION OF HIGH TEMPERATURE RESISTANT MATERIALS; J. D. Walton, N. E. Poulos, and C. R. Mason. Order PB139926 from Library of Congress, Photo Duplication Service, Publications Board Project, Washington 25, D.C. 213p. Microfilm, $9.60; photocopy, $33.30.

Molybdenum-sheet substrates, 1/16" thick, were coated with aluminum, gold,

nickel, platinum, rhodium and silicon, respectively, as single films by evaporation, sputtering or electroplating.

In general, film thicknesses were 0.000015 to 0.000025". A mixture of 3.5 parts of four parts aluminum and one part vanadium pentoxide with three parts silica gave a desirably rapid and high temperature reaction, producing fused coats.

DESIGN AND DEVELOPMENT OF REFRACTORY CERAMIC LINING FOR COMBUSTION CHAMBER OF UNCOOLED ROCKET MOTOR; Dwight G. Bennet and Robert F. Kimpel. Order PB 140004 from Library of Congress, Photo Duplication Service, Publications Board Project, Washington 25, D.C. Microfilm, $2.40, Photocopy, $3.30.

Zirconia, through the design of a thermal shock-resistant $ZrO_2$ tile, may possibly be used for a segmented rocket-engine combustion-chamber liner. Zirconia has high insulating value but poor thermal shock resistance.

STEADY-STATE PROPERTIES OF A SIMPLIFIED MODEL OF SOLID-PROPELLANT BURNING; Leon Green Jr. Order No. PB 140 356 from Library of Congress, Photo Duplication Service, Publications Board Project, Washington 25, D.C. Microfilm, $2.70, Photocopy, $4.80.

A model of solid-propellant burning is postulated, in which the complex chemical-reaction and heat-conduction problem in the gas phase is replaced by a simplified boundary condition which assumes convective heat transfer to the surface from a parallel flow of gas at flame temperature.

The effective heat-transfer coefficient is assumed to be an inverse function of propellant burning rate, which in turn is assumed to be an Arrhenius function of the surface temperature.

The model permits calculation of steady-state surface temperatures, burning rates, and temperature gradients which show the proper qualitative dependence upon the propellant and gas-flow parameters which, for the assumed values of these parameters, appear to be of the proper order of magnitude.

NOTCH SENSITIVITY OF HEAT-RESISTANT ALLOYS AT ELEVATED TEMPERATURES. PART I. PRELIMINARY STUDIES OF THE INFLUENCE OF RELAXATION AND METALLURGICAL VARIABLES; Howard A. Voorhees and James W. Freeman. Order No. PB 140 005 from Library of Congress, Photo Duplication Service, Publications Board Project, Washington 25, D.C. 111p. Microfilm, $6.00, Photocopy, $18.30.

Additional data for three alloys with conventional heat treatments: S-816 at 1350°F, Waspaloy at 1500°F, Inconel X-550 at 1350°.

Test results included stress-rupture time properties, short-time tensile properties and creep properties when stresses were changed from one level to another during a test. Cold working had the greatest effect on notch sensitivity of the several conditions investigated, but no severe case of notch weakening was observed for either S-816 at 1350°F.

# missile business . . .

**By WILLIAM E. HOWARD**

In the windup scramble to avoid Khrushchev, Congress left withering on the legislative vine a bill of considerable importance to missile/space R&D contractors. It was HR 5326, introduced by Rep. Richard M. Simpson (R-Pa.), to extend for four more years the Office of Civil Defense Mobilization's rapid tax amortization program. Failure to act on the measure—it never got out of the House Ways & Means Committee—means all fast tax write-off certification will end on Dec. 31.

**We hear an attempt to revive the program . . .**
will be made in January when Congress reconvenes. However, the chances that it will succeed do not look very promising. The Eisenhower Administration has apparently decided against supporting such a step—even though NASA and DOD are definitely in favor of it (M/R April 20, p. 19). Even if Khrushchev's disarmament proposals have no effect on the Defense Department budget for FY 1961, there will be no great pressure to give industry a tax break.

Undoubtedly the recent Hébert Committee investigation and the revival of General Accounting Office charges of excess profits being made by defense contractors influenced the Administration decision against continuing the program. It certainly would not have been the politic thing to do at the time.

**Come January, the defense industry again can expect . . .**
some sharp criticism from Capitol Hill. The Hébert Committee is expected to report on its preliminary findings and then continue the investigation of company practices in hiring retired military officers. So the climate isn't likely to improve.

**Since June, 1958, the rapid amortization program . . .**
has allowed many companies to write off 50-75% of the cost of expensive, specialized R&D equipment in five years, instead of the normal 20 to 40 years. This practice has helped the cash position of firms obtaining certification—allowing them more funds to plough back into basic research of their own and to assume the financial risks involved in taking on big DOD and NASA R&D programs.

The Treasury doesn't lose any money. It gets it in the long run. But many experts believe that the country will be the loser if curtailment of this tax benefit results in a cutback in basic research. This is the point that gets obscured by political considerations.

**About the only chance to get this point across . . .**
will come on Dec. 3, when the House Ways & Means Committee holds a hearing on R&D expenditures in connection with a general tax reform bill. Only two industry witnesses are scheduled so far—William Horne Jr. of **Olin Mathieson Corp.** and Charles Orem Jr. of **Sylvania Electric Products Corp.** There should be several more, if industry hopes to build a case for including fast tax write-offs in the reform bill.

**There seems to be no escaping the fact . . .**
that the Soviet bullseye on the moon has failed to register any effect on the U.S. space program. There will be no step-up: that's the word from NASA Chief T. Keith Glennan. And it comes as no surprise, for the Administration has been noticeably lacking in enthusiasm for overtaking Russia in the space race.

Many people in industry apparently are reconciled to the fact that no changes will be forthcoming for some time and are keeping space proposals in their pockets. A top official of one of the nation's leading missile/space companies summed it up rather bluntly to M/R the other day. Said he:

"Our company has made a policy decision to concentrate on fundamental research for the next year and half—until the administration changes."

## Leak Detector is Easily Serviced

New features for reduced maintenance downtime and improved performance are incorporated in a redesigned mass spectrometer leak detector now available from **General Electric.**

Among improvements for the new model are a quick-change self-aligning filament, a new automatic balance measurement circuit, enlarged capacity vacuum pumps, new easy-to-read panel meters, and general maintenance improvements.

The M-60 mass spectrometer leak detector locates leaks as small as $1x10^{-10}$ cubic centimeters of air per second, so small that less than one cubic inch of air at atmosphere pressure would pass through in 5,000 years. It is used to check vacuum tubes, transistors, valves, connectors, missile devices, nuclear systems, and other products where extremely small leaks may seriously impair quality.

Leaks are located by applying helium tracer gas to one side of the enclosure while the leak detector draws a sample of air from the other. If helium is present in the gas analyzed by the detector, an alarm is given.

Among maintenance improvements in the new M-60 unit is a quick change filament procedure that is performed without shutting down the vacuum pumping system. Downtime required for replacing the filament is less than five minutes, as opposed to thirty minutes to an hour in previous models.

The M-60 also features platinum-clad ion repeller that can be flame-cleaned during the same five-minute period. According to company engineers, flame cleaning eliminates the more time-consuming abrasion and rinse method used normally in this type leak detector.

Maintenance of the electronic portions of the M-60 model has been simplified by mounting the components on individual removable panels according to their basic function. Convenient check points for the complete circuit are located on one connector strip.

An improved vacuum pumping system can exhaust the units to operating pressure in about thirty minutes from a cold start. Consisting of a 60-liter-per-second, air-cooled diffusion pump and a 1.2 cfm mechanical pump, the system is believed to have the largest capacity supplied with any mass spectrometer leak detector.

The stainless-steel vacuum system includes a new low-loss cold trap that requires less than one-half liter of nitrogen every eight hours—about half that needed by other available models. The new wide-mouth allows filling without a funnel, and permits use of dry ice-acetone as the refrigerant.

The filament is protected by an over-pressure circuit, triggered by an easy-to-clean, cold-cathode-type vacuum gauge that cuts off filament power when pressure exceeds a safe operating value.

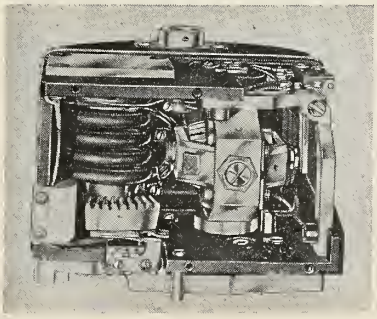
A new automatic balance circuit allows the M-60 unit to operate effectively despite the presence of helium within its sensing circuit, company engineers said. While other available mass spectrometer leak detectors often require an hour's wait to dissipate helium contamination after encountering large leaks, they reported, the M-60's automatic balance circuit eliminates this time delay because it limits detection to increases in helium concentration.

General Electric
Schenectady, 5, N. Y.

## Gyro Guidance Control Unit is Economical

A two-degree-of-freedom gyro whose rotor is energized in a fraction of a second by wound helical spring has been developed and manufactured by **Waltham Precision Instrument Co.**

Providing guidance over a period of several minutes—applicable to short range missiles and target drones, Waltham's spring driven gyro is comparatively simple and consequently more rugged and reliable.



The spin axis of this new gyro is along the pitch axis of the missile; the outer gimbal is along the roll axis; and the inner gimbal is along the yaw axis. A potentiometer pick-off about the outer gimbal axis indicates the angle of roll. For short duration guidance, no erection system is necessary.

In operation, the WG-14 gyroscope is caged before take-off or launching. The starting signal releases the wound spring which energizes the rotor. When the rotor is up to speed, the gyro uncages and acts as a free gyro during flight. Effective angular momentum is maintained for a period of 3 minutes after firing and drift rate is controlled at less than 1 degree per minute.

Waltham Precision Instrument Co.,
221 Crescent St.
Waltham, 54, Mass.

## DC Timer Features Automatic Reset

A direct current reset timer for automatic control of industrial and machine process functions has been


made available by **Automatic Timing & Controls.**

This timer is a DC version of the Atcotrol Series 305 miniature reset timer designed for AC operation. The DC Series 305 will control DC loads within variable timed intervals or sequences with a repeat accuracy of ¼ of one percent. It will reset full scale length in less than ⅒th of a second, or stop on power failure or power interruption.

Seven basic circuit arrangements provide an infinite number of combinations for control of automatic functions, and exclusive metal to neoprene impingement clutch allows millions of operations without clutch wear or slippage. The Series 305 also features self-cleaning heavy duty silver contacts and

a wiring schematic printed on the cover to eliminate errors in circuit identification.

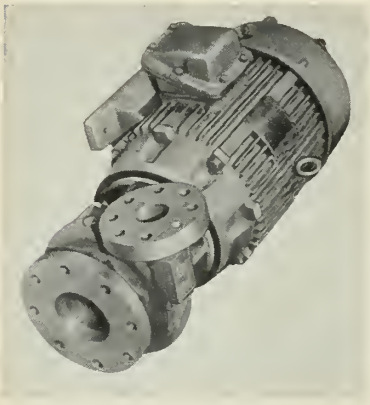
Two or more Series 305 Timers can be combined for repeat cycle operation, with each timer adjustable to be desired timing interval, either for reset or non-reset on power failure.

Automatic Timing & Controls Inc.
King of Prussia, Pa.

## Transfer Pumps Have 8,000 gpm Capacity

A family of close-coupled (built on) petrochemical and cryogenic transfer pumps, for high-flow continuous or intermittent duty from 10-8,000 gpm capacity with differential pressures up to 300 psi outlet, is available from **Turbocraft, Inc.**

Known as the Series 3000, the Turbocraft units operate at low values of



net positive suction head (NPSH) without adversely affecting performance. The pumps are supplied close-coupled (built-on) to an electric motor drive. A complete range of separate bearings housing allows direct coupling to other drives such as steam or gas turbines, and hydraulic motors.

Advantages of the Series 3000 are said to include minimum maintenance, horizontal or vertical mounting, and easy removal from the system without affecting suction or discharge piping. Of particular interest in cryogenic applications are the minimum "wet end" weight to reduce "cool-down" time and minimize loss of liquid; open construction between pump and drive to reduce hazardous collection of gas in the pump area; and the use of a thermal barrier between pump and motor to minimize heat transfer.

The pump can be supplied with two types of mechanical seals: conventional seal or packing for normal applications, or the Turbocraft all-metal Series AMB shaft "bellows" seal for severe environments such as cryogenics.

A wide range of materials is available for either the cryogenic or petrochemical applications to meet special requirements or weight or corrosion resistance.

Turbocraft Inc.
492 E. Union St.
Pasadena, Calif.

## Recording Equipment Has Extended Low Frequencies

A new recording/reproducing system with greatly increased capabilities has been delivered to **Sandia Corp.** by the **Mincom Division** of **Minnesota Mining and Manufacturing Company.** The system, Mincom's model CV-107, has an extended low frequency range through the use of fm lows.

The low frequency range extension is provided by the inclusion of three fm tracks capable of accommodating frequencies from ½ cycle to 100 kilocycles. The three tracks will operate simultaneously with four analog tracks, with a frequency response of 400 cycles to one megacycle.

Sandia's application for the CV-107 is twofold: measurement of time intervals in the mc range, and recording of transient wave forms. This latter function will utilize the entire video bandwidths provided by the system.

A three-mode operational capability is afforded by CV-107, and it will accommodate the following: Seven direct-recording and playback channels with a frequency on each track ranging from 400 cycles to one megacycle; four analog tracks from 400 cycles to one megacycle, along with three fm tracks from ½ cycle to 100 kilocycles; and three channels composed of fm lows and analog highs, giving full bandwidths ranging from ½ cycle to one megacycle, plus an additional track with a frequency response ranging from 400 cycles to one megacycle.

Mincom Division
Minnesota Mining & Mfg. Co.
2049 S. Barrington Ave.
Los Angeles 25, Calif.

## Sensing Device Aids Control Technology

**Brush Instruments,** a division of the **Clevite Corp.,** has developed a new sensing device which is said to overcome many of the obstacles that have plagued control instrumentation for many years.

The new motion sensing device—known as "Metrisite"—is essentially a type of transducer which has a unique near-perfect combination of desired performance characteristics . . . said to be several orders of magnitude greater than any other transducer or control device.

Resolution of the device is said to be such that measurements as small as one ten-millionth of an inch can be made with ease. The limit of resolution is dependent only on the mechanical system with which it is used.

An extremely light operating force will activate the Metrisite's one moving element due to minimum bearing friction and low inertia. Reactive force is so low (a fraction of a milligram in most cases) that the monitoring of the system under control cannot be detected.

True linearity is achieved from zero to full range due to the absence of hysteresis losses. Production models have a proven linearity of 1/10th%.

Electrical output is of such a magnitude that the Metrisite can provide full-scale operation of a sensitive rectified-type meter directly without an amplifier. Units have been made with outputs as high as 100 volts.

Metrisites adapt a variety of configurations from subminiature to sizes capable of measuring over four inches of linear motion. Units are in production to measure directly either angular or linear movements, and thus eliminate complex or error-producing mechanical linkages.

Brush Instruments
37th and Perkins
Cleveland, 14, O.

## Resistor Sizes Cut by One-Half

A totally new method of deposited carbon resistor manufacturing by the **International Resistance Company** has resulted in reduction in size and weight of resistors by more than 50%.

The technological breakthrough which signalled this important advance was the development of a radical new deposited carbon alloy, but this in turn required a redesign of almost every element in the resistor. An insulating spiral path, which determines the resistance value, is now diamond-cut in the much harder alloy film, rather than sand-blasted as formerly. The result is a much more precise incision, with consequent improvement in stability and reliability.

The highly conductive terminating point, which bonds the end-cap connections to the film, is still another new development. Over the resistance ele-

ment are two new types of moisture resistant undercoat, also especially developed for this product.

Completing the double-barrier insulation is a new-type molded, break-resistant casing, which, though heavy duty, is well within MIL size. This molded insulation results in improved load-life characteristics, better dielectric characteristics, and greater opposition to the effects of moisture. It provides all the advantages of ceramic solder sealed types, without the hazards of seal leakage, breakage and low dielectric strength.

These radically improved resistors are available in ¼ watt, ½ watt and 1 watt sizes, in resistances from 10 ohms to 25 megohms. Standard tolerance is 1%, although 0.5 and 2% types are also available.

International Resistance Company
401 N. Broad St.
Philadelphia 8, Pa.

## Total Reliability Claimed for Cryogenic Value

A relief valve for cryogenic service, Model K5120T, said to be totally reliable is now available from **James, Pond and Clark, Inc.**

The new valve, with both body and spring of stainless steel, is designed for use in liquid oxygen or nitrogen systems. It is available with cracking pressures ranging from 100 psi to 2400 psi.

The in-line design of the valve provides ease of mounting, lightweight construction and exceptional flow characteristics without the complications arising from pilot operation.

The poppet ports open fully when the valve starts to crack, but the flow is throttled between the poppet shoulder and seat, providing regularly increasing flow area with increasing flow rates. When the valve is closing, a spring equalizer transmits only the axial component of spring force to the poppet, causing it to slide smoothly in the bore. This provides even "O" Ring seating against the sealing surface.

The Teflon "O" Ring is effectively removed from the flow pattern when the valve is open, and provides a dead tight seal when the valve is closed. This dead tight seal prevails at normal system pressures against the passage of liquids or gases at temperatures down to −320° F.

The K5120T is manufactured with tube connections in sizes from ¼" to 1" and is also available in pipe sizes from ⅛" to 1".

James, Pond and Clark, Inc.
2181 East Foothill Blvd.,
Pasadena, Calif.

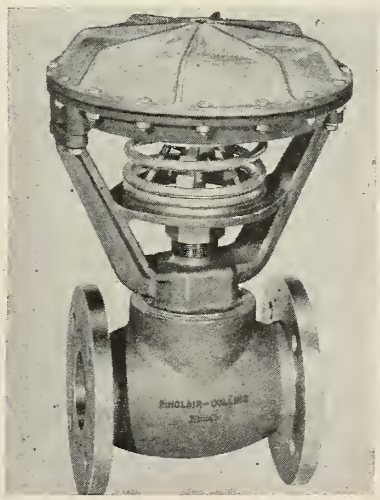
## Vacuum Valve Has High Flow Rate

A line of diaphragm-operated vacuum valves, for use in vacuum processing applications where high flow rates and positive sealing are of importance has been produced by the **Sinclair-Collins Valve Co.**

Capable of sealing and holding vacuum to within .5 inches Hg absolute for an indefinite period of time, the new valves feature resilient synthetic O-ring seat seals combined with direct metal-to-metal seat stops to give a positive seal without O-ring deterioration in heavy-duty service. According to the manufacturer, side-to-side contact of the O-ring seal with the seat plus specially designed stem packers assure consistent leak-free performance and longest possible service life.

S-C vacuum valves are offered in flange or screw-mounted 2-way types, and in sizes up to 3 in. NPT. Valve bodies are of Navy M bronze, with Monel stems and stainless steel trim. Full interchangeability of parts simplifies in-service maintenance. The valves are designed for actuation by any suitable pneumatic or electro-pneumatic pilot, cycle control unit, or for remote manual operation.

Sinclair-Collins also manufactures a complete line of ½ to 3 in. NPT diaphragm-operated medium and high pressure control valves for oil, air, steam gas and hot or cold raw water service, as well as a variety of automatic valves for special applications.



Sinclair-Collins Valve Co.
454 Morgan Ave.
Akron, 11, O.

## Compactness Featured In New Scanner

A compact, self stepping crossbar scanner complete with optional remote dial control is currently being marketed by **James Cunningham Son & Co., Inc.**

The unit, an adaptation of crossbar equipment in wide use throughout the electrical and electronic industries, was developed as a portable, high-capacity pilot plant or laboratory testing device.

Designated Model SC-5F, this latest scanner is a modified Cunningham Type F crossbar switch with simplified drive circuitry enabling it to connect sequentially a six-wire circuit to each of 100 sets of six-wire terminals at up to 50 sets per second. The six wires can be further divided into single-, double-, and three-wire circuits. Though the Model SC-5F takes up only 27" of standard 19" relay rack space fully assembled with power supply control chassis and switch chassis, it is designed for reliable operation without service or adjustment over millions of cycles with low crosstalk between adjacent circuits at frequencies up to 10 megacycles.

Because of its twin gold contacts with 30 gram minimum contact pressure which permits scanning of low level signals, it is readily adaptable for thermo-couple and strain gauge scanning. Other typical applications include testing and selecting automatic circuits, diode and transister testing, instrumentation computer and data processing. The unit is unique in that it can scan sequentially as well as at random. Three modes of control are available; self pulsing, external pulsing and random access by means of a telephone dial.

The Cunningham Model SC-5F scanner has a bridging capacity of 20 mmfd. to ground and between conductors. Breakdown voltage: not less than 1500 VAC between switching conductors and frame and across switching contacts. Insulation resistance: 10,000 megohms and higher. Conductor resistance through longest path: 0.3 ohms. Current carrying capacity: 100 milliamps non-inductive at 50 VDC for 20,000,000 operations. Contact bounce less than 200 microseconds on make; none on break.

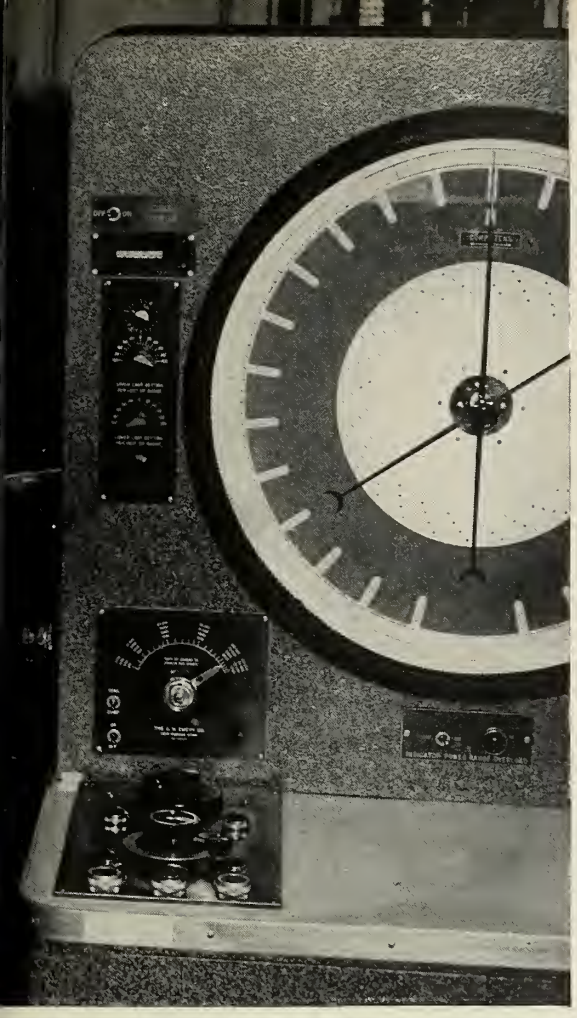
James Cunningham Son & Co.
101 Litchfield St.
Rochester 8, N.Y.

# WHO READS MISSILES AND ROCKETS?

**Well, for example . . . TOP ENGINEERS AT MARTIN**

Martin Company engineers have successfully fabricated stress-resistant sheets which have been used to build the *world's first beryllium structure* in accordance with primary structural standards. Until now, however, the extreme brittleness of beryllium has been the stumbling block to fabricating sheets that will meet the structural requirements of space flight.

Beryllium has exciting possibilities as a major structural material for missiles, rockets and space vehicles. It is very strong and light. Only 70% as heavy as aluminum, it has the strength of the best aluminum alloy and a stiffness 1 and 1/2 times that of steel. It is an excellent absorber of heat, having a specific heat more than twice that of other structural materials and a melting point more than



**BERYLLIUM BREAKTHROUGH** Charles J. Giemza, (left), Supervisor of Metals Research at The Martin Company, discusses the testing of structural beryllium with William Howard of the editorial staff of Missiles and Rockets magazine. Mr. Giemza recently received the Achievement of the Year Award from the American Rocket Society for his part in the development of structural beryllium. The use of beryllium as developed by The Martin Company will make it possible to solve many of the aerodynamic and structural heating problems associated with space flights and re-entry into the earth's atmosphere at speeds up to 18,000 miles per hour.

"Today's missile and astronautics engineer must know the products and capabilities of the *other* companies throughout the industry. Here's where Missiles and Rockets magazine fills the bill." — Richard Allen, (right), Scientist, Cryogenics, Research and Development.

"Why do we like Missiles and Rockets magazine? The answer is simple. Missiles and Rockets deals exclusively with *astronautics*. Missilery and outer space exploration today is an industry by itself, long divorced from aviation." — Robert R. Drummond, (left), Chief, Structures Research, Martin — Baltimore. Eric L. Strauss, (right), Supervisor of Non-Metals Research, shows extreme high temperature test examples of ceramics and plastics being developed for re-entry vehicles.

"News to the missile engineer *must be news* and must be technical . . . on a frequent basis — not a month old. From concept to proven flight — it takes thousands of parts from hundreds of companies to put a bird in the air." — Jack Lennard, Scientist, Research and Development.


WHY YOU SHOULD ADVERTISE IN MISSILES AND ROCKETS . . . Missiles and Rockets has *no waste* circulation—just those who manufacture missiles, space vehicles and allied equipment—and active Government and military personnel. *Over 29,000 missile technicians pay for their subscriptions to Missiles and Rockets*—the *best* circulation story among magazines covering the missile market. Missiles and Rockets reaches the thousands of companies, NASA and the Department of Defense who are purchasers in this multi-billion dollar market.

**TELL YOUR PRODUCT OR CAPABILITY STORY THROUGH THE PAGES OF MISSILES AND ROCKETS—THE TECHNICAL/NEWS WEEKLY OF THE MISSILE/SPACE MARKET.**

M/R

**missiles and rockets**

AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

Jay Holmes and **John F. Judge** have been appointed associate editors of chemistry and propulsion for MISSILES AND ROCKETS magazine. The appointment of these two men follows the magazine's policy of increased technical news coverage of the missile/space market. It has opened a more specialized department to give exclusive coverage to the physics and chemistry of prime interest to engineers and military.


HOLMES

Holmes, a graduate of Queen's College in New York, has been awarded a certificate from the advanced science writing program of the Graduate School of Journalism, Columbia University, where he specialized in technical writing geared to the Missile/Space Age. Holmes served as New York correspondent for M/R and also spent a number of years with the AP in the same area. He recently authored a book, "The Nature of The Atom" for the Doubleday Science Club. During and after World War II he served with the Army counterintelligence corps as a special agent.

Judge came to M/R from the Patent Department of the Union Carbide Corp. He received his B.S. in chemistry from LeMoyne College in Syracuse, N.Y., and was formerly a research chemist for the Harris Research Laboratories in Washington. He is a member of the American Chemical Society.


JUDGE

**Gordon N. Smith** has been named chief engineer of the recently formed Monitor and Control Division of Fenwal Inc. Smith was previously associated with Paige Industrial Corp. and prior to that Electronics Corp. of America.

Several engineering staff changes have been announced by Daystrom Transicoil, division of Daystrom, Inc., as part of an overall "growth and expansion plan:" **William Hargeaves,** vice president, engineering, becomes engineering assistant to the general manager; **Dwight Bloser** vice president, engineering, takes charge of special projects; **Panos Yeannakis** is made chief engineer and **Carmine D'Amico** becomes assistant chief engineer.

**Dr. Everett T. Welmers,** director of plans and programs for Bell Aircraft Corp., has been selected to work with the Department of Defense's Advanced Research Projects Agency on special space projects.

Dr. Welmers, who has been with Bell Aircraft since 1944, has been granted a one-year leave of absence and will join ARPA on September 14.

Atlantic Research Corp. has announced that **Philip K. Reily, Jr.,** assistant to the president, has assumed responsibility for the firm's Development Department. Reily replaces **DeWitt O. Myatt,** who has resigned to start his own research and consulting firm in science communications and is now a consultant on development to Atlantic Research.


REILY

Prior to joining ARC in 1956, Reily was director of the Solid Propellant Information Agency of Johns Hopkins University Applied Physics Laboratory. He has published articles on solid propellants and has patents pending on the stabilization of aralkyl halides.

Other new members of the Development Department are: **William S. Jones, David B. Roberts, B. Brooke Bright, Floyd Swanson, John W. Selph** and **John Sodolski.**

Jones, previously in Government service, is in charge of research project development activities.

Bright, formerly on the staff of the National Science Foundation, has joined the technical personnel recruitment staff.

Roberts and Selph, chemical engineers, are conducting project development and liaison work for the company's rocket activities. Roberts was formerly with the nuclear engineering operations of Westinghouse Electric Corp. and Selph worked with Eastern Gas and Fuel Association as a senior research engineer.

Swanson, formerly of Giannini Controls Corp., is assigned to the development of new projects in electronics, acoustics, instrumentation and physics for the company's electromechanical division.

Sodolski will be engaged in development, administration and management services.

**Dr. George C. Sponsler III** has been appointed a senior scientist at Hoffman Electronics Corp.'s Science Center, to head a newly-formed system study group. He will direct a scientific team charged with developing studies in satellite communications and anti-submarine warfare. He has authored journal articles and technical reports and was formerly with the Office of Naval Research where he was in charge of the Naval Analysis Earth-Satellite Study.


SPONSLER

**John Robert Clark, Jr.** has joined the Washington office of Thiokol Chemical Corp. Clark will work on matters dealing with technical and contractural liaison with various agencies of the Dept. of Defense and with prime contractors having major rocket systems from the government.

Space Electronics Corp. has appointed **Irving Stokes** to the newly established position of chief engineer. Stokes was previously with RCA as manager, Advanced Projects and Planning in the Missile and Surface Radar Dept. Prior to joining RCA in 1955, he was deputy director of the Radar Division of Engineering Laboratories and holds four patents in radar and IFF techniques.

Lockheed Missiles and Space Division has announced the appointment of **Dr. William F. Whitmore,** nationally-known expert in military operations research and weapons system evaluation, as a consultant scientist on the chief scientist's staff. He will concentrate on problems associated with Navy weapons systems and will conduct various operational research studies and system evaluations.


WHITMORE

Prior to joining Lockheed, Dr. Whitmore was chief scientist to the Director of the Special Projects Office, U.S. Navy Bureau of Ordnance.

**Milton V. Ratynski** has accepted a position as Director of Engineering with Craig Systems, Inc. He will supervise research design and development activities and coordinate the work of the electronics, mechanical and research departments. Ratynski previously served as chief of the General Engineering Laboratory with the Air Force Rome Air Development Center. His prior associations were with the Signal Corps Engineering Laboratories, National Broadcasting Co., Hercules Powder Co. and Ryerson Steel Co.


RATYNSKI

**Richard W. Black** has been named government project engineer at Vitro Engineering Co. division of Vitro Corporation of America. Black was formerly manager of the Baltimore division of Burns and Roe, Inc., consulting engineers, and prior to that project engineer for Conlan Electric Corp.

# propulsion engineering...

By M/R STAFF

### Callery Chemical's parent company . . .

**Mine Safety Appliances,** stays in the space business despite cancellation of boron fuel production contracts—thanks to MSA's long familiarity with gas absorbing chemicals, gas properties and analysis. NASA has awarded MSA Research Corp. a $70,000 contract to study two super oxides as possible oxygen suppliers to manned space flights. They are potassium super oxide ($KO_2$) and sodium super oxide ($NaO_2$).

### Next step is propellant oxidizers . . .

at least that's the conclusion observers draw from MSA's enthusiasm for a contract so small in dollar value. This will be afield from MSA's work in mine gas analysis techniques and devices, but so was the **Callery** boron venture. The super oxides themselves probably will not become propellant oxidizers, but merely provide the hook on which the company hangs its "legitimate interest" in oxidizers. Work with the super oxides can lead to the build-up in facilities, manpower, and knowledge that might make MSA want to jump into the missile propellant field with both feet—*and salvage Callery's work on boron.*

### Callery is out of business otherwise . . .

so Dr. W. H. Schechter, Callery vice pres., told the House Committee on Science and Astronautics. Now that the limited amounts of boron fuels are no longer needed for evaluation in manned aircraft, he says, they can be used in research leading to boron missile fuels. Since some studies already have ruled out this possibility, observers believe MSA will try to save Callery via the other route—oxidizers.

### Most significant remarks on Russian rockets . . .

made during the House Committee attempt to determine whether the USSR really did launch a rocket in the direction of the moon last January, came from Col. Linscott Hall, Air Force Intelligence. He testified that our information indicates the Russians "are quite good in their guidance systems, in their propulsion systems." He added the customary qualifier that the Russians had a head start on the U.S., but then went a step further—a significant step, the Committee felt—in saying that we still have a way to go to "catch up with the Soviet in terms of guidance and propulsion."

### Exactly how we are behind . . .

in propulsion has never been made clear in any of the voluminous testimony indicating we definitely trail Russia in propulsion. Is our failure one of chemistry or one of engineering—do we lack the propellants or do we lack the plumbing?

### It's the plumbing . . .

said top missile people who were queried by M/R. The consensus reads about like this: "We have the propellants, are probably neck and neck with the Reds in the propellant battle; we even have equally good propulsion systems, but they simply make their plumbing larger—blast off with brute force." These missilemen, in and out of government, say we could do the same but all it would prove is that "A bigger pile of dynamite makes a bigger explosion."

### Free radicals remain a top item . . .

for scientific research, but not as possible propellants. This is the conclusion of the National Bureau of Standards' Fourth International Symposium on Free Radical Stabilization. It agrees with a report Air Force scientists are now drafting to the effect that free radical study will continue as a means of learning more about chemical reactions, but not with an eye on free radical propulsion. The National Bureau of Standards three-year crash program on free radical research is coming to an end, but the Bureau will continue basic studies on a smaller scale.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Manufacturing production techniques, such as ultrasonic drilling of microscopic holes in extremely hard and dense materials, are developed by the laboratories. Electronics and solid state research makes possible smaller, lighter, and increasingly reliable components and systems for accurate guidance, sensing and communication at extremes of temperature, vibration and acceleration.

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CAPE CANAVERAL, FLORIDA
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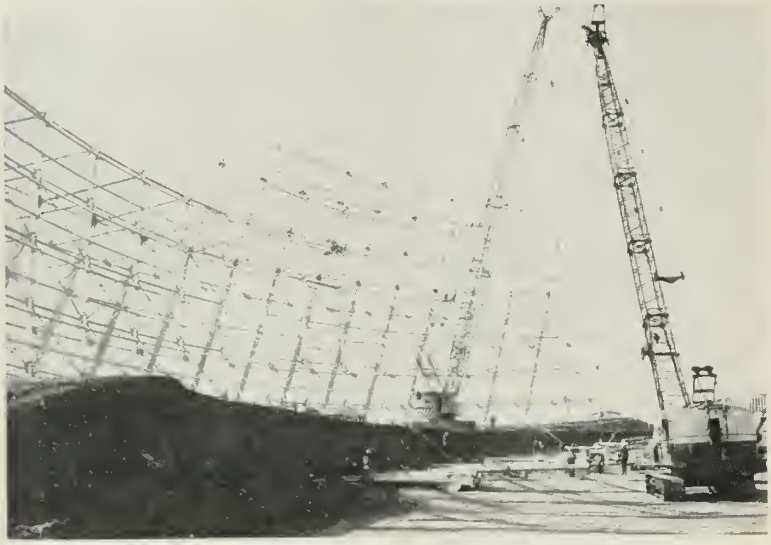
# BMEWS Rises in the Arctic



**THE FIRST STATION** of the huge Ballistic Missile Early Warning System is being built at Thule, Greenland. Another far less along is being built at Clear, Alaska. Another may be built in Scotland. The giant radars designed to detect oncoming ICBMs 3000 miles away are supported by huge stays capable of supporting them in a 185-mile-an-hour wind. The multimillion-dollar system is being constructed for the Air Force by the Army Corps of Engineers. The Defense Department in releasing these pictures identified the location only as "the wind-whipped Arctic Circle."

## Naval Research Laboratory Abandons Project ORCON

WASHINGTON—It looks like the guidance manufacturers can breathe easily again—the Navy has abandoned its "pigeon-guidance" program.

Wrapped in security for six years, Project ORCON (organic control) was a study conducted by the U.S. Naval Research Laboratory to determine whether it was practical to use specially trained pigeons as the sensing and guidance elements for homing missiles onto seagoing targets.

The use of animals as a sensing-and-control device was suggested as an answer to the effective countermeasures already developed to harass the more usual electronic and electromechanical controls.

Pigeons were selected not because of their inherent homing instincts but because they were readily obtainable, small in size and weight, and trainable.

Initial tests proved that the pigeons could be trained to peck at a distinguishable spot on a contrasting background. Grains of corn were the reward for each successful peck operation.

These first tests were halted at the end of World War II, but the project was revived again in 1948.

A simulator was devised comparable to the concept of a workable weapon system application. It was determined that a lens could be installed in the nose of a missile. The target image would be projected through the lens onto a current carrying screen. A pigeon, trained and fitted with an electrical probe, would be located behind the screen.

The pigeon, trained to peck at the most distant object on the screen, would indicate target position by the varying voltages transmitted with each peck. Pickoff of the intelligence would be directed to servo controls for suitable course correction.

• **Varying reliability**—Under test conditions, it was found that the pigeon peck frequency was sufficient to guide a 300-ft./sec. missile. Also, it was found that tracking reliability varied from 30-80%, under favorable conditions.

Biggest problem was that tracking capability was limited by visual range—that is, targets had to be easily recognizable in daylight.

The fact that none of the guidance pigeon trainees ever achieved missile flight status might lead one to believe that there was some lack of faith on the part of the Navy. One might also speculate on the flight course resulting from a weekend of shore leave, acute indigestion, or a birdlike scope image during the mating season.

# contracts

## MISCELLANEOUS

$30,000,000—**Bodenseewerk Perkin-Elmer & Co.** of Germany, subsidiary of **Perkin-Elmer Corp.**, Norwalk, Conn., for producing *Sidewinder* infra-red-guided air-to-air missiles.

$157,520—**Ford Instrument Co.**, Long Island, N.Y., for design and development of inertial devices.

$50,000—**Columbia University**, N.Y., for analysis of radar noise in the *Nike*.

$49,990—**General Electric Co.**, Syracuse, N.Y., for research study entitled A Study of Thermoelectric Generator Materials.

## NASA

$2,244,695—**Humphreys and Harding, Inc.**, N.Y., for construction of flight control and range operations functions of the Goddard Center.

$31,685—**Baldwin-Lima-Hamilton Corp.**, Waltham, Mass., for fatigue testing machine.

## NAVY

$1,600,000—**Servonics, Inc.**, Alexandria, Va., for radar simulators.

$853,112—**Farmers Tool and Supply Co.**, Denver, for rolleron type wing assemblies for *Sidewinder* motor.

$450,000—**Allen B. DuMont Laboratories, Inc.**, for study and evaluation of test requirements for future air-to-surface and air-to-air missiles and target drones.

$35,299—**Robert & Co. Associates**, Atlanta, for the preparation of preliminary report for a *Polaris* submarine overhaul facility, Charleston, S.C.

## AIR FORCE

$2,166,420—**General Electric Co., Ordnance Dept.**, Pittsfield, Mass., for long range search radar antennas.

$605,150—**The M & T Co.**, Philadelphia, for technical, non-personal operation and maintenance services for SAGE utilities systems.

$500,000—**Aeronca Manufacturing Corp.**, Longren, Calif., for chassis assemblies for the *Bomarc* IM99A missile. (Subcontract from Boeing Aircraft Co. Aerospace Div.)

$457,305—**American Hydrotherm Corp.**, Long Island, N.Y., for maintenance and operation services.

$439,314—**International Telephone & Telegraph Co.**, N.Y., for services for Spain-Morocco tropospheric scatter communications system.

$80,850—**Radio Corp. of America**, Harrison, N.J., for electron tubes.

$67,200—**General Electric Co.**, Owensboro, Ky., for electron tubes.

$59,570—**Bendix Aviation Corp.**, Eatontown, N.J., for electron tubes.

$26,625—**Albert Einstein Medical Center**, Philadelphia, for research and reports on the Mechanism of Action of the Thiouronium Class of Radiation Protective Agents.

$26,167—**Boston University**, for research directed toward the study of the crystal structure of appropriately selected materials of use in solar energy conversion.

## ARMY

$10,995,680—**Western Electric Co.**, for continued work on *Nike-Hercules* anti-aircraft missiles.

$2,600,000—**Minneapolis-Honeywell**, for miniaturized inertial guidance systems for surveillance drones.

$772,155—**Douglas Aircraft Co.**, Santa Monica, Calif., for launching area items. (Four contracts.)

$496,703—**Brown Engineering Co. Inc.**, Huntsville, Ala., for engineering and machine shop services.

$365,745—**The Martin Co.**, Orlando, Fla., for concurrent repair parts for *Lacrosse* system.

$266,706—**Allen B. DuMont Laboratories, Inc.**, Clifton, N.J., for development and fabrication of an engineering test model electronic countermeasures set, together with instruction books, manufacturer's drawings, spare parts list and technical reports.

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

$179,900—**Samuel N. Zarpas, Inc.**, Pittsburgh, Pa., for construction of ground/air transmitter-receiver.

$179,454—**Duval Engineering & Contracting Co.**, Jacksonville, Fla., for construction of *Saturn*, complex 34, bypass road.

$149,378—**Aeronutronics Div. of Ford Motor Co.**, Newport Beach, Calif., for study of an infrared decoy system.

$147,622—**Hughes Aircraft Co.**, Culver City, Calif., for study and design on infrared decoy system.

$109,471—**Western Electric Co., Inc.**, N.Y., for *Nike* spare parts, components and repair parts. (Three contracts.)

$49,754—**Raymond Engineering Laboratory, Inc.**, Middletown, Conn., for research and development.

$26,711—**A. B. Cullen & Son**, Oxford, Miss., for construction of concrete launching ramps and appurtenances.

$26,253—**Duke University**, Durham, N.C., for research study in the field of microwave and radiofrequency spectroscopy.

## BIDS

Dayton Air Force Depot, Gentile Air Force Station, Dayton, Ohio, Att: Directorate of Procurement and Production—Tube electron type 6W4GT S/N 5960-239-1993, 10300 ea. Tube electron type 6AW8A S/N 5960-663-7966, 7300 ea. Tube electron type 6173 S/N to be assigned, 5000 ea.—IFB 33-604-60-24B—Bid opening 2 Oct. '59.

Procurement Office, MTK, Patrick Air Force Base, Fla.—Rocket engine fuel, (UMDH) MIL-F-25604B, in non-returnable 55 gal. mild steel drums—6030 lbs.—IFB 08-606-60-46—Bid opening 29 Sept. '59.

Directorate of Procurement and Production, Kelly Air Force Base, Texas. 6635-NL11145 unit X-ray fine focal multiple foci-0.4mm and 2.5mm 150KV norelco model MG 150/3 catalogue nr 11145 or equal, 1 ea.—6635-NL12105 fluoroscope electronic image intensifier 5" fluoroscopic screen ½" viewing screen metal housing. Norelco catalogue nr 12105 or equal, 1 ea.—IFB 41-608-60-72B—Bid opening 6 Oct. '59.

Procurement Officer, National Aeronautics and Space Administration, Langley Air Force Base, Va. Pickups, pressure, electrical and pressure adapters—1 lot—IFB L-659—Bid opening 5 Oct. '59. Oscilloscopes, approx. 10 inches high by 6.8 inches wide by 17 inches deep; approx. 23.5 pounds weight—1 lot—IFB 350—Bid opening 2 Oct. '59.

Supply Officer, Naval Ordnance Laboratory, White Oak, Silver Spring, Md. Following items are procured under IFB 60921-16-60B—Bid opening 14 Oct. '59. Oscilloscopes, model 545A—2 ea.—oscilloscope, all phosphor cathode ray tube, Model 535A—1 ea.—oscilloscope, Model 551, 1 ea.—preamplifiers, dual trace, type CA, 2 ea.—preamplifiers, plug in, type 53/54D, 2 ea.—scope-mobile, type 500/53A, 1 ea.—Material as manufactured by Tektronix, Inc. or equal.

Electronics Supply Office, Great Lakes, Ill. Semiconductor device, type 1N459, MIL-E-1D, QPL, FSN N5960-543-0490—1489 ea.—alternate A, 2000 ea., alternate B, 2500 ea.—IFB 126-302-60B—Bid opening 12 Oct. '59.

U.S. Army Engineer District, Mobile, P.O. Box 1169, Mobile, Ala. Construction of IM-99B support facilities at Santa Rosa Island, Eglin AFB, Fla.—Job—IFB ENG-01-076-60-11B—plans and specs available 1 Oct. '59—Bid opening 21 Oct. '59.

Base Procurement Branch, Wright Air Development Center, Wright-Patterson AFB, Ohio. Engineering services of a testing laboratory to conduct environmental and electrical testing to determine operational suitability and reliability of components comprising part of Tacan-1FF antenna multiplexing system—Job —IFB 33-616-60-16—Bid opening 14 Oct. '59.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# letters

## Refractories Research

*To the Editor:*

In the Aug. 31 issue of MISSILES AND ROCKETS there is a story on R&D on refractory metals which makes no mention of **McDonnell Aircraft's** work in this field.

This naturally was disappointing to our project people and to us in public relations since we had sent your magazine a release relating to an Air Force contract of $980,680 we reccived for refractory metal studies as related to spacecraft.

Edward J. Regan
Public Relations

*To the Editor:*

We read with considerable intcrest the article entitled "Pressing R&D on Refractory Metals" in the Missile Support section of your Aug. 31 issue.

We were, however, somewhat disappointed that **Firth Sterling** was not mentioned as one of the companies that is active in the refractory materials field. At present, we are producing large, pressed and sintered, pure tungsten rings, called Entrance Caps, for prototype models of an ICBM, which is scheduled to be operational in 1961. Further evidence of our R&D in the refractory materials field is indicated by our appointment of Dr. C. H. Toensing, recently with **General Electric Company**, as manager of our powder metals research.

I appreciate how difficult it is to keep abreast of all the companies who are active in this field, and the purpose of this letter is to ask that Firth Sterling be considered as an active participant in R&D in refractory metals, as well as in high temperature metals produced by air arc, induction vacuum, vacuum arc, and Hopkins Process melting techniques.

Thomas E. Pickering, Manager
Advertising & Sales Promotion
Firth Sterling Inc.
Pittsburgh 30, Pa.

*To the Editor:*

I certainly enjoyed reading your fine article on refractory metals in MISSILES AND ROCKETS for Aug. 31. Your coverage of work in this interesting field was most complete and easy to grasp. I was sorry, though, to see that **General Electric** was not listed as one of the metals companies specializing in refractory metals. Actually, we are one of the foremost producers of tungsten and molybdenum metal products in this country. The original development work on "non-sag" wire for lamp filaments was performed at GE. Through the years we have expanded our engineering and manufacturing facilities to include a rather complete line of products ranging from metal powder through rod, wire, sheet, fabricated parts, and sintered billets for forging. Today, we are one of the leading suppliers of sintered tungsten and molybdenum billets used for forging missile parts and components. Also, we are a leading supplier of electrodes made from these refractory metals used in consumable electrode vacuum arc melting.

If any future articles are planned for refractory metals, we certainly hope you will include a mention of General Electric's contributions in this field.

C. W. Irish
Marketing Section
Lamp Metals and
Components Dept.
General Electric Co.
Cleveland, Ohio

*We usually prepare such survey articles well in advance and probably information was not received in time for publication. Regrets!*—Ed.

## Thoughts on Integrity

*To the Editor:*

Your editorial ("Integrity Cannot Be Legislated") in the Aug. 24 issue is a jewel! It should have been on the front cover.

J. W. Sessums
Maj. Gen. (USAF-Ret.)
Grand Central Rocket Co.
Redlands, Calif.

## Incomplete Listing

*To the Editor:*

In your Pennsylvania-New Jersey survey (Aug. 24 issue), the list of firms engaged in missile work does not include **Stavid.** I suppose it is not possible to mention all the companies due to space requirements, but for the record let me enumerate some of our projects:

1. Development ond production of the Radar Course Directing Centrals AN/BPQ-2 (command guidance for *Regulus*); 2. Instrumentation of Project *Silo* at Edwards AFB; 3. Design and construction of Central Telemetry Facility at Edwards AFB; 4. Design and production of Radar Beacons AN/APN-91 and -92 (basic design used on *X-15* rocket); 5. Beacon telemetering and missile-borne equipment for ASSA, Ft. Monmouth.

As prime contractor to all three military services, Stavid's 1958 sales were over $11 million . . .

Albert B. Poe
Public Rel. Manager
Stavid Engineering, Inc.
Plainfield, N.J.

*M/R regrets the failure to list Stavid, which obviously should have been included. It was an editorial oversight, not a result of space limitations.—Ed.*

EMPLOYMENT

AERODYNAMICS

The Sandia Corporation has a need for graduates in the field of aerodynamics, aero-thermo dynamics and magneto-hydro dynamics. The work embraces research and development in the fields of space and high-altitude rockets; hypersonic research; magnetic theory; supersonic parachutes; nuclear weapon aerodynamics; and high velocity research apparatus design. Applicants with B.S., M.S., or Ph.D. degrees from accredited colleges and good academic records are requested to write Personnel Department 522, Sandia Corporation, Albuquerque, N.M.

Sandia Corporation, located in Albuquerque, N.M., is engaged in research and development of nuclear weapons and other projects for the AEC. Albuquerque is a modern city of about 225,000; has an excellent climate and many cultural and recreational attractions. Winters are mild, summer nights are cool, and there's plenty of year-around sunshine. Sandia's liberal employee benefits include generous vacations, retirement and insurance plans, and a graduate education assistance program. Paid relocation allowance.

SANDIA CORPORATION
ALBUQUERQUE, NEW MEXICO

## when and where

### SEPTEMBER

**Mitre Corporation,** Symposium on "Tracking Acquisitions and Weapon Control in Track-While-Scan Systems," (classification—SECRET) New England Mutual Hall, Boston, Sept. 29-Oct. 1.

**Institute of Radio Engineers, American Institute of Electrical Engineers,** Eighth Annual Industrial Electronics Symposium, Mellon Institute, Pittsburgh, Sept. 30-Oct. 1.

### OCTOBER

**Institute of the Aeronautical Sciences,** Anglo-American Aeronautical Conference, Hotel Astor, New York, Oct. 5-7.

**Society of Automotive Engineers,** National Aeronautics Meeting, Aircraft Manufacturers Forum and Aircraft Engineering Display, The Ambassador Hotel, Los Angeles, Oct. 5-10.

**Electronics Industries Association Conference,** University of Pennsylvania, Philadelphia, Oct. 6-7.

**Radio Interference Reduction and Electronic Compatibility Conference,** sponsored by the U.S. Army Signal Research and Development Laboratories, Conducted by Armour Research Foundation of Illinois Institute of Technology and Institute of Radio Engineers Professional Group on Radio Frequency Interference, Museum of Science and Industry, Chicago, Oct. 6-8.

**Aeronautical/Astronautical Problems of High Speed Flight Meeting,** sponsored by AFOSR/Aero Sciences Directorate, ONR, OOR, NSF, and Stanford University, Stanford, Calif. Oct. 6-8.

**AFOSR/Solid State Sciences Directorate,** AEC, ONR, NSF, OOR, Stanford Research Institute and several industrial organizations. International Symposium on High Temperature, Asilomar, Calif., Oct. 6-9.

**AFOSR/Propulsion Research Division, Aeronautical Sciences Directorate and Avco-Everett Research Laboratory,** Second Symposium on Advanced Propulsion Concepts, (Classified) Boston, Oct. 7-8.

**Society of Experimental Test Pilots' Symposium,** Pilot's Role in Space Exploration, Beverly Hilton Hotel, Beverly Hills, Oct. 8-10.

**American Institute of Electrical Engineers,** Fall General Meeting, Morrison Hotel, Chicago, Oct. 11-16.

**National Electronics Conference,** sponsored by American Institute of Radio Engineers, Northwestern University, and University of Illinois, Hotel Sherman, Chicago, Oct. 12-14.

**Institute of Aerophysics, University of Toronto,** Decennial Symposium, Toronto, Canada, Oct. 14-16.

**University of Denver,** Conference on Hypervelocity Projection Techniques, Denver, Oct. 20-21.

**American Standards Association,** Tenth National Conference on Standards, Sheraton-Cadillac Hotel, Detroit, Oct. 20-22.

**Society for Experimental Stress Analysis,** 1959 Annual Meeting, Hotel Pick-Fort Shelby, Detroit, Oct. 21-23.

**Armour Research Foundation,** 15th Annual National Conference, Hotel Sherman, Chicago, Oct. 26-30.

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# So We Lag in Space—Who Cares?

The visit of Premier Khrushchev has underscored sharply the inadequacy of the nation's space program. Worse, it has brought home the dangers of our present attitude toward that program.

We have grown accustomed to the present Administration's apathy over the country's space progress in the same way an injured man gets accustomed to pain. He learns to live with it.

It is inevitable that apathy at the top level communicates itself downward; fear or hesitancy carry their own contagion. A timid leader will have timid troops.

Today this Administration's apathy over our space program has seeped down through the space agencies. It has touched Congress and the national press. It is easily visible in the American public. If our leaders show no urgency—why should the man on the street?

Between the flight of *Lunik II,* the arrival of the Soviet Premier and this writing, the United States has attempted nine assorted firings in the missile/space field. Of these, four have been successful, five have been failures. At Edwards AFB the *X-15* successfully accomplished its first powered flight—months behind schedule. It will be months more before the *X-15* carries a man into actual space. Some of these nine efforts, it could be suspected, were scheduled to time with the Khrushchev visit. None remotely approached the Russian upper-stage guidance techniques which made their moon shot possible.

What is holding up our space program? Money. Purely and simply money—and this is a sad thing indeed for the richest country in the world. It is true that the Russians began their program before we did. Time is on their side. But with money you can buy time; any honest scientist in the space/missile field will affirm that to one degree or another.

With money we can buy research, we can buy test vehicles. With money we can pursue multiple avenues of approach in the fields of metals, fuels and guidance. Recently NASA's Dr. T. Keith Glennan said that we must back off and go more slowly in space exploration because our scientific knowledge is lagging behind the program. It has, in fact, lagged for several years and Mr. Khrushchev's words remind us of that fact almost daily.

In certain fields we are not—or were not—behind. In nuclear physics, for instance, the United States led the world in every phase. Now, through that same apathy and an Administration preoccupation with the fear of inflation, we are losing even that leadership. Would you like to wager who will fly the first atomic aircraft or fire the first nuclear rocket?

The great pity of this apathy is not entirely that we may be losing ground militarily, but that we stand also to lose our leadership in our own proud specialty—world commerce and trade.

One of the nation's leading commercial scientists, speaking of the value of space achievements, said recently:

"From a purely commercial point of view a communications satellite would be worth a billion dollars to this country. A weather satellite would be worth billions.

"Whether these satellites have any military value or lead to any military usage is beside the point. They are worth what they cost without military application, but if that comes as an extra dividend, so much the better.

"Judging space exploration by its immediate returns would be like judging the value of Columbus's voyage by how much gold he brought back."

What do we need in this country to arouse the government from its tired preoccupation with elections and bookkeeping? Soviet scientists achieve a signal success by firing a rocket to the moon—a feat we tried and failed to accomplish. A space spokesman damns the achievement with faint praise and remarks that hitting the moon isn't really as difficult as hitting New York from Moscow. Maybe not, but we have a feeling the Russians might be able to do that, too.

A cherub-faced old villain from the Kremlin pays us a visit to brag piously that he doesn't consider the Soviet moon shot a Russian achievement but "our achievement"—"our" meaning the world's. The pronoun in this case sounds suspiciously possessive.

What do we need to bring about an awareness that this country is in grave danger of losing its world position militarily, scientifically and commercially? Factual evidence doesn't do it. Loss of pride doesn't do it. How fateful then will be the next 450-odd days before we have a new Administration—less tired, less preoccupied, less apathetic?

**CLARKE NEWLON**

# FIVE YEARS THAT CONVERTED SPACE INTO A NEW FRONTIER OF FREEDOM

# 1954 1959

IT WAS FIVE YEARS AGO this July that a handful of men gathered in a classroom of a former parochial school in Inglewood, California, to sketch upon the blackboard of history the plans which were to give rise to the greatest single peace-time military effort ever undertaken... the U.S. Air Force Ballistic Missile Program.

Today that program involves the expenditure of nearly two billion dollars a year for the research, development, testing, production, and operational deployment of the Air Force family of missiles—Atlas, Titan, Thor, and Minuteman. These are providing much of mankind's insurance against the holocaust of thermonuclear war.

The Air Force Ballistic Missile Program is now drawing upon human and material resources which represent a cross-section of all America—thousands of scientists, engineers, technicians and others, both civilian and military, along with the countless skills and facilities exemplified by the program's 30 associate contractors, its 200 major sub-contractors, its 200,000 suppliers in 22 industries across the nation.

All these disciplines and productive capacities have been pooled into a dedicated science/industry/government team which has enabled the Air Force Ballistic Missile Program to achieve in five years what even optimists thought would take up to a decade to accomplish.

Five years ago the free world had no functional ballistic missile rocket engines, no guidance systems, no nose cones, no tracking stations, no launching pads, no trained missile squadrons. Today we have moved past the threshold of bringing these toward operational reality.

In this 14th year of the Cold War and second year of the Space Age, the Air Force Ballistic Missile Program is daily becoming more crucial to the ability of free men everywhere to survive. As this program sweeps forward, it is demonstrating anew to proven friend and potential adversary that America's military power, whether on land or sea or under it, in the air or in outer space, is first and last a power for peace—the power to deter aggression by being able to visit overwhelming retaliation upon an aggressor.

IN THIS EFFORT, in which all Americans may take pride, Space Technology Laboratories is also proud of its privilege in performing the functions of systems engineering and technical direction for the Air Force Ballistic Missile Program in close and continuing cooperation with the Air Force Ballistic Missile Division, Ballistic Missiles Center, Strategic Air Command-MIKE, with National Aeronautics and Space Administration and Advance Research Projects Agency in their advanced space probes, with the leading members of the scientific and industrial communities. All have displayed the ability to work in concert and in a spirit of patriotism which traditionally has inspired free men to turn back the threats of tyranny.


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