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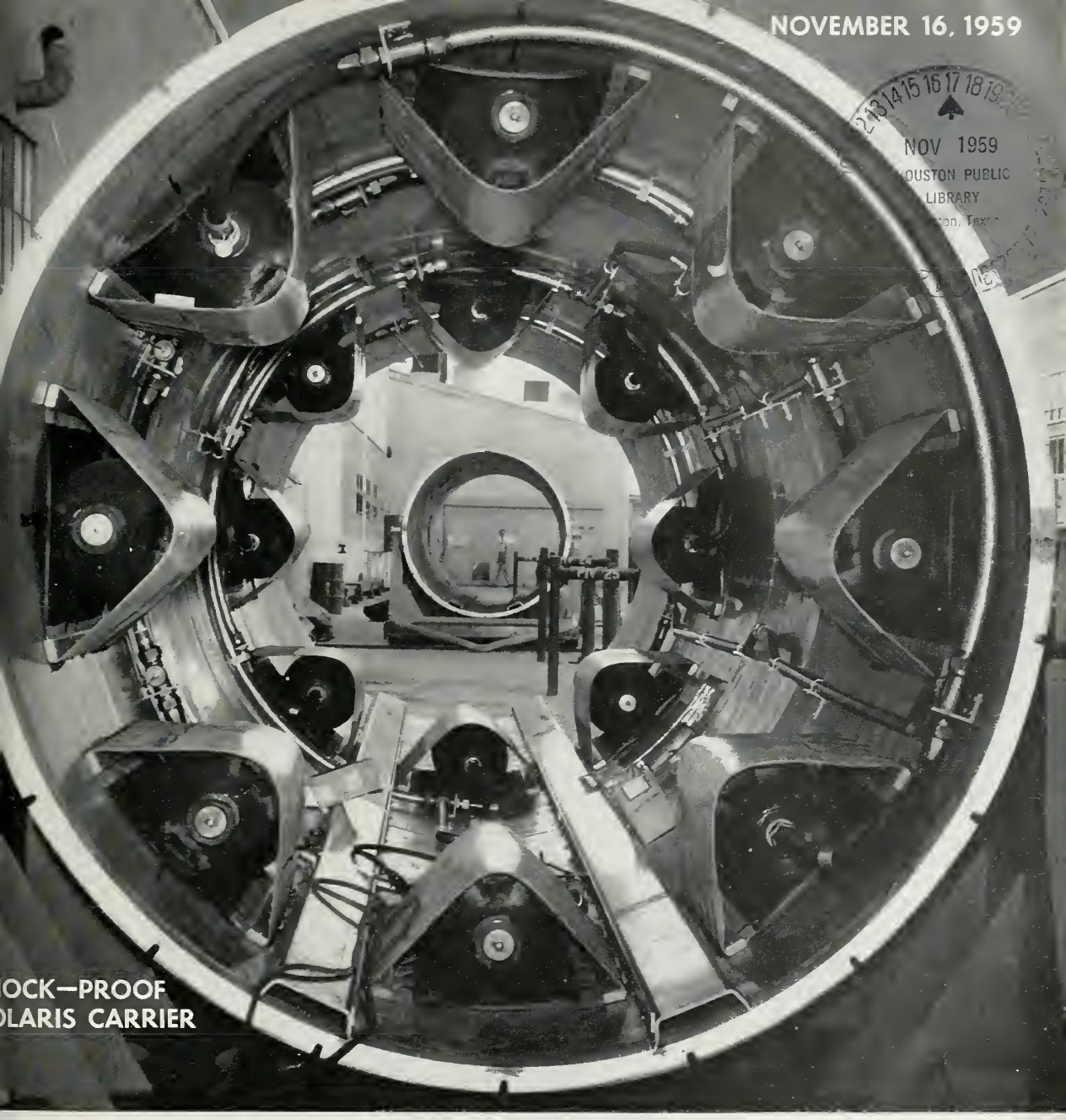

OCK—PROOF
OLARIS CARRIER

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

ADVANCED FUEL MANAGEMENT ...FROM SMI

The requirements of accurately tanking missiles with propellants is but one of the areas of fuel management in which Servomechanisms, Inc. has demonstrated capability. *Propellant utilization* and *thrust control* are other areas in which SMI has developed highly accurate and precise measuring and control systems.

SMI's LOX Tanking Computer, which has been in production for the past year, accurately measures, controls and indicates the level of liquid oxygen in missile tanks. Loading is accomplished rapidly and accurately due to a unique two-mode control system. The first mode permits extremely high pumping rates until about 98% capacity is reached. The second mode then takes over and controls a precise proportioning valve which adds the necessary LOX to fill the tank within 0.1% accuracy. The second mode also provides continuous topping, thus compensating for LOX evaporation losses during standby.

SMI has currently in development, more advanced fuel management systems to meet the increasingly complex requirements of the next generation of missiles and spacecraft.

SMI would welcome the opportunity to discuss and propose solutions to your fuel management problems. Write for descriptive literature.

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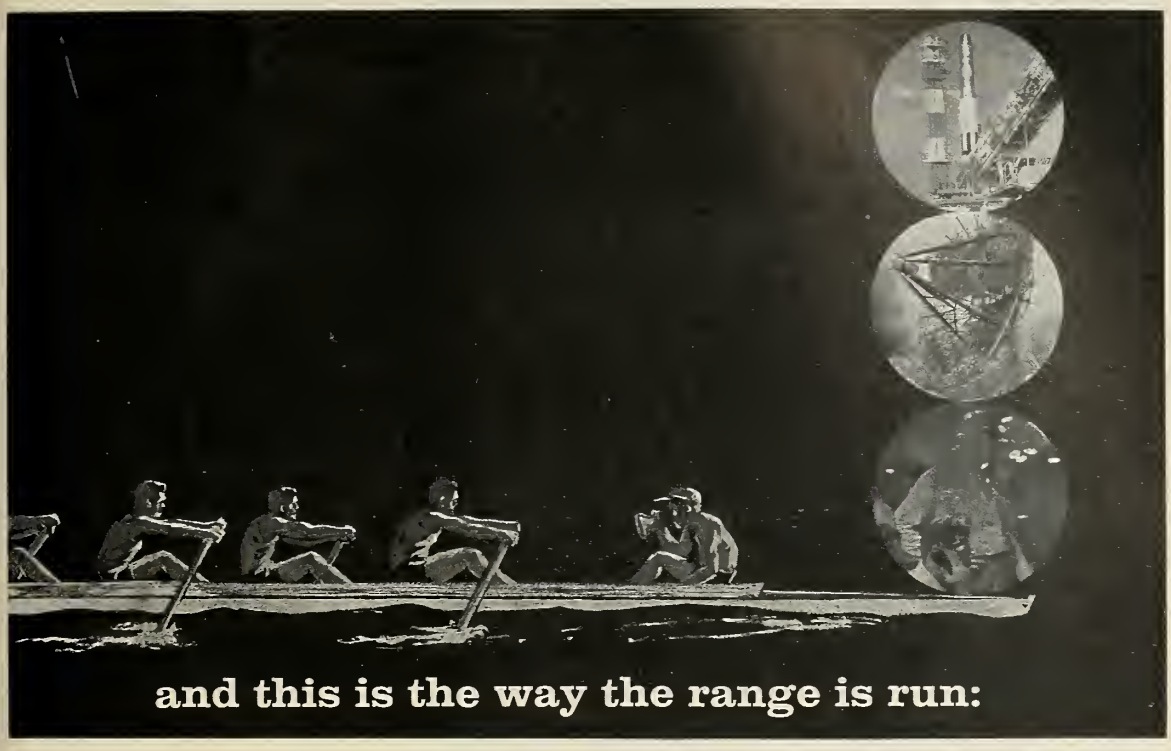

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Management moves men toward common goals. But at Cape Canaveral, where we assist the Air Force in management of the Atlantic Missile Range, common goals are uncommon – even extraordinary.

Here is a management involving unparalleled projects – *Juno, Jupiter, Vanguard, Thor, Atlas, Titan, Polaris;* extending over an incredible area – two continents, twelve islands and one ocean; working toward unprecedented achievements – the development of reliable ballistic missiles and the exploration of space.

For Pan American, this experience has meant the expansion of our unique capability for large-area systems management. For members of our technical staff, it has meant the opportunity to achieve new personal goals, and to develop unusual professional skills, through scientific teamwork, coordination, and management.

Other engineers and scientists, particularly those experienced in the areas of quality control, facilities engineering and electronics, should investigate the uncommon opportunities of a career with Pan Am.

Please address your inquiry to Mr. J. B. APPLEDORN, Director of Technical Employment, Pan American World Airways, Inc., Patrick Air Force Base, Florida, Dept. B-13.

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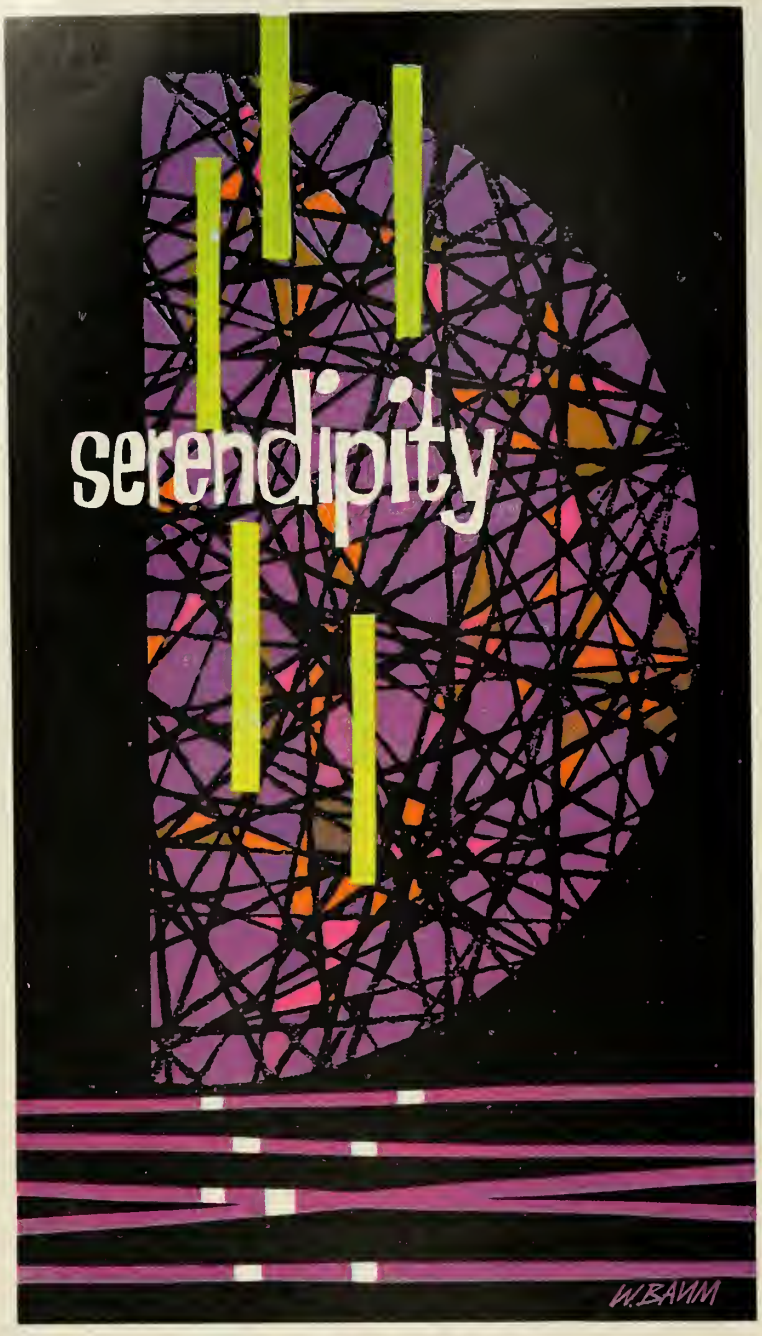

creating new engineering concepts *and discovering solutions to those problems which serendipity has revealed . . . is the task of the professional minds at Martin-Denver. To individuals who possess this creative talent and who seek this stimulation, there is offered an opportunity for outstanding recognition. To participate in this program, inquire immediately of N. M. Pagan, Director of Technical and Scientific Staffing, The Martin Company, P. O. Box 179, (Dept. FF-6), Denver 1, Colorado.*

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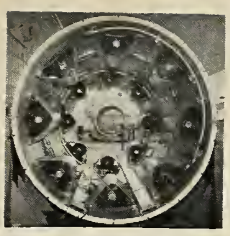
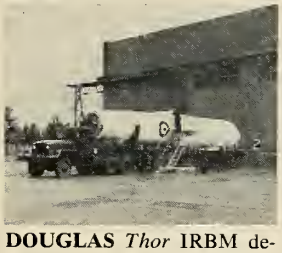


COVER: Prototype of the air suspension system Goodyear has developed for Lockheed's *Polaris* shock-proof shipping container. Spring efficiency goes up to 90%. (See p. 45.)

MISSILE cruiser queen will be nuclear-powered Long Beach, to be commissioned in March—without *Polaris* facilities. A report on what the Navy would like to do with *Polaris* on surface ships begins on p. 12.



DOUGLAS *Thor* IRBM delivered by MATS to England, is prepared for trip to first of four British bases to be equipped with the missile. A first-hand report on a transatlantic trip with *Thor* starts on p. 16.

FINAL subassembly welding of stainless steel deflector for combustion chamber of Thiokol's packaged Guardian I engine. A report on prepackaged liquid propulsion systems starts on p. 24.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

30,800 copies of this issue printed

NOVEMBER 16 HEADLINES

ASTRONAUTICS ENGINEERING

U.S. Reg. Pdg.

MISSILE SUPPORT

U.S. Reg. Pdg.

ASTRIONICS

NEW MISSILE PRODUCTS

THE MISSILE WEEK

U.S. Reg. Pdg.

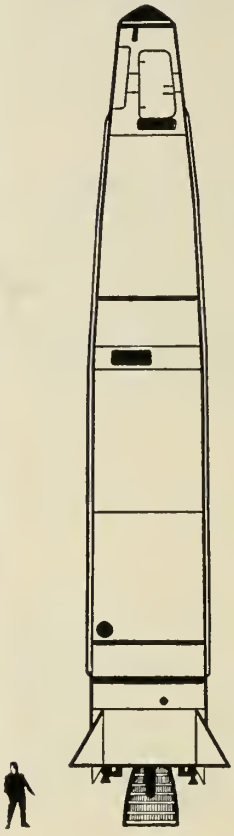
DEPARTMENTS

The man:

. . . a launch-control specialist in a *Thor* SAC squadron. His instruments report each automatic step in the launching procedure of the big IRBM. U.S. Air Force and Royal Air Force missilemen are receiving *Thor* training side-by-side . . . have readied and fired these missiles within a 20-minute count-down.

The missions:

. . . are many—because of the Douglas *Thor's* versatility. As a highly mobile weapon with atomic capability, it sternly warns potential enemies against aggression. As a powerful and reliable booster, it is playing a leading role in our exploration of outer space with satellites and probes.



The missile:

. . . can destroy targets as far as 1500 miles away within minutes after hostile action is detected. Douglas *Thor* missiles were the first intermediate range ballistic missiles to be deployed overseas. The United Kingdom has announced the delivery of the first *Thors*, for operation by Royal Air Force personnel.

Depend on **DOUGLAS**

The Nation's Partner in Defense

Washington Countdown

IN THE PENTAGON

A $46-billion budget . . .
for FY 1961 is the asking price the military services are understood to have come up with as the figure closer to their true needs—$5 billion or more higher than the figure the Administration has told them they could have. The $46 billion includes "economies" forced on the services last year.

• • •

The big Zeus decision . . .
on whether to go into production is expected about Dec. 1. If the answer is yes, more than $1 billion extra must be added to the FY 1961 budget or taken out of some other programs. Even if the decision is no, another $300 million is expected to remain in the new budget for continued R&D on the big **Western Electric** AICBM.

• • •

First grabs . . .
on the ARPA-Army *Saturn* program are reported to have been given the Air Force. But the Air Force top command passed it up because sufficient funding didn't go along with deal. Other Air Force programs would have to be cut to support it.

• • •

Fast transfers . . .
to the Air Force of ARPA's Project *Samos*—the reconnaissance satellite—and Project *Midas*—the early warning satellite—are now expected. They may come in less than two months.

• • •

But much slower ones . . .
are expected in the case of ARPA's Project *Transit*—the navigation satellite—and Project *Courier*—the communications satellite. Neither may take place for a year or two. But when they do the Navy is still scheduled to get *Transit*; the Army, *Courier*.

• • •

Enter Project *Jaguar* . . .
a powerful air-launched sounding rocket designed for the Air Force. The three-stage solid *Jaguars*—two **Thiokol** *Recruits* and a one-fifth-scale **JPL/Sperry** *Sergeant*—will be launched from B-57's first from Holloman AFB, later from Eglin AFB.

Discoverer VIII . . .
is scheduled to be launched in about a month. ARPA will again try to recover an instrument-crammed biomedical capsule from orbit.

• • •

The Cissler report . . .
on possible duplication on U.S. missile ranges probably will be ready before Christmas rather than Thanksgiving. The report is expected to call for reshuffling of some operations on the multi-million dollar ranges.

ON CAPITOL HILL

A rough going over . . .
is seen in store for the NASA budget when it reaches Congress no matter how much cash is in it.

. . . If the Administration asks for only a slim increase, it will be hit with charges of losing the space race to Russia.

. . . If the Administration asks for a big increase, it will be hit with charges that it admits foot-dragging last year.

• • •

The banned book controversy . . .
involving Gen. Thomas Power's attempt to tell the American people how many missiles and bombers they need to survive the Cold War is far from dead. The House Information Subcommittee is still digging into why publication of the SAC commander's book was stopped.

AT NASA

The Thanksgiving Day Menu . . .
on Nov. 26 is definitely scheduled to include the launching of an *Atlas-Able* carrying a moon-orbiting satellite. The planned *Thor-Able* launching with a sun-orbiting satellite is scheduled for two weeks later. NASA's holiday season package also is rumored to include one other shot still to be identified.

• • •

NASA's adopted children . . .
ABMA and JPL are reported to be advocating that they act as a team to survey new industry proposals submitted to the civilian space agency. The two confide they are not happy with the technical judgment of some NASA officials.

AROUND TOWN

An Air Force tracking station in the Aleutian Islands last week reportedly tracked a Russian missile which traveled a full 4800-mile course. According to the report, the Red ICBM came down north of Midway.

The way to know – An ominous shadow over ocean or wasteland... an unidentified "blip" on a radar scope! A challenge from an airborne AN/APX-7 interrogating unit spurts into the ether. In microseconds a reply identifies the potential marauder as friendly. The absence of such a reply alerts the protective and retaliatory might of the nation.

ENGINEERING BEYOND THE EXPECTED

Packard Bell's reputation as a leading designer and foremost producer of IFF (identification, friend or foe) equipment is indicated by the fact that both the AN/APX-7 and the AN/APX-6, which returns the reply, are products of our Technical Products Division. Advanced development, company-sponsored, has recently produced miniaturized IFF modules which operate up to 200°C.

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Industry Countdown

MANUFACTURING

Upwards of $1 billion . . .

for all phases of the *Titan* ICBM program—including hardened bases—may be sought by the Air Force in the FY 1961 budget. Good share of the money would be for improvements in the bird—**AC Spark Plug's** all-inertial guidance, storable, non-cryogenic propellants, uprating of the first-stage engine, and a bigger diameter second stage—to be phased into later squadrons.

• • •

Bigger second stage . . .

would give **Martin's** basic *Titan* design a capability: 1) for larger payloads and longer striking distance; 2) as a larger second stage for *Saturn*, and 3) as a clustered boost or a second stage for a winged re-entry vehicle such as *Dyna-Soar*.

• • •

Prime contractor "pirating" . . .

issue is now in the hands of DOD's Small Business Industry Advisory Committee. The Senate Small Business Military Procurement Subcommittee has handed a report to the DOD group showing "limited examples" where technical information developed by subcontractors is being improperly utilized by primes and higher tier subs.

• • •

Latest *Polaris* birds . . .

are one-third lighter than original models thanks to reduction in weight of inert parts. For his contribution to the weight-cutting program, E. R. Roberts of **Aerojet-General** won the 1959 Hickman Award.

PROPULSION

High-energy solid fuel . . .

that will be as safe to transport as a barrel of kerosene reportedly is under development at **B. F. Goodrich** plants in Brecksville, Ohio, and Rialto, Calif.

• • •

Extra-high mass ratio . . .

space motor (end of scale 94.95 and above) may be test fired shortly by **Grand Central Rocket.** Burning "Nitrolel" (carboxylated butadiene acrylo nitrile), the engine is designed for upper-stage vehicles—soft lunar landings, deep space probes, satellites.

Process for producing . . .

high-boiling hydrogenated polycyclic hydrocarbon high-energy fuels has been patented by **Monsanto Chemical.**

ASTRIONICS

Flying TV camera . . .

will be used to prove out the **Martin** 700-mile *Pershing*. Miniaturized unit—housed in a capsule which is ejected from missile during flight—photographs warhead to impact point. Developed for ABMA by **RCA** and **Chrysler,** the camera will be used for target damage assessment.

• • •

Tubes and transistors . . .

standardization program is underway by the Navy's BuShips. Rapid technical changes and lack of production uniformity—particularly in semiconductors and transistors led the bureau to develop some standard test procedures aimed at eliminating unnecessary evaluation of parts.

• • •

ABMA has successfully . . .

tested production guidance units for a *Jupiter*. Two identical units—one for control and the other for reference—were off-the-shelf and neither was retested or recalibrated after production checkout.

WE HEAR THAT

Nike-Zeus sustainer . . .

will have propellant weight of 7000 pounds . . . Russian rocket engineers are experimenting with hydrogen and fluorine in hopes of using the combination in a 281,000-pound-thrust booster . . . **American Machine & Foundry** reportedly is getting ready to establish a new anti-submarine warfare group . . . New DOD list of top 100 defense contractors will be ready at the end of this month . . . **Rocketdyne** is setting up a new nuclear propulsion engineering subdivision—**Nucleonics** . . . An applied research section to study outer atmospheric conditions affecting space exploration has been created by **Convair** Fort Worth . . .

More About the Missile Week on Page 45.

Operations Research Scientists:

Need time to develop your ideas?

Most scientists engaged in operations research work seem to feel that they cannot do their most productive work when they are constantly fighting unrealistic deadlines.

The operations research programs at System Development Corporation are carefully planned to provide ample time for the development of new ideas that apply to the development of large-scale, computer-based information-processing systems.

The following are just a few examples of the areas in which Operations Research Scientists work at SDC: (1) simulation and operations gaming techniques in problems of control systems; (2) mathematical logic applied to universal computer languages; (3) medical data processing; (4) stochastic modeling of man-machine interactions; (5) logistics; (6) test design for operational computer programs.

Operations Research positions are now open for scientists at several levels of experience. Please send your inquiry to Mr. E. A. Shaw, SDC, 2414 Colorado Avenue, Santa Monica, Calif.

"Application of Computer Simulation to Production System Design," a paper by Allen J. Rowe, is available upon request. Send request to Dr. Rowe at SDC.

SDC

SYSTEM DEVELOPMENT CORPORATION

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In thermoelectrics . . .

Red Breakthrough—Fact or Fiction?

Tass reports Soviet scientists have achieved nearly twice the theoretical top efficiency; reaction of U.S. experts varies widely

by Hal Gettings

LONDON—Thermal efficiencies of 182%, almost twice that theoretically possible, have been reported by Russian scientists. The spectacular—if true—breakthrough was attributed by Tass, official Soviet news agency, to a new thermoelectric device now under research. (Thermoelectricity deals with the phenomena of changing heat directly into electricity, and vise versa.)

The Moscow device reportedly produced in heat form nearly twice as much energy as was put into it in the form of electricity.

Response of U.S. scientists queried by MISSILES AND ROCKETS varied from utter disbelief (". . . the dispatch must have been garbled.") to acceptance of the achievement as not only possible but expected. One English scientist claimed that he had done the same thing eight years ago. At least one patent is in the works in this country for what could prove to be a parallel advancement.

The Tass dispatch claimed, however, that "this wonderful phenomenon never before had been demonstrated experimentally."

• **Simple pump?**—Dr. Stephen Angelo of **Westinghouse,** one of the nation's top authorities on thermoelectricity, is of the opinion that the device could well be no more than a "thermoelectric heat pump." He said it is possible to move a certain number of watts from a lower to a higher temperature—in effect, run a refrigerator backwards—and produce up to twice as much heat as the equivalent electrical power required to operate the device. No violation of thermodynamic laws would be involved.

Others have theorized that the indicated "amplification" might be attributed to a release of part of the nuclear energy within the thermoelectric semiconductor materials. This, however, would involve a change of mass into energy and does not seem particularly logical in this particular instance.

• **Time for reappraisal?**—Another conclusion drawn is that perhaps certain accepted "basic truths" might need to be re-examined in the light of new knowledge. Under the impact of tremendous recent scientific progress, old definitions and limitations may not hold.

It has been apparent for some time that many scientific definitions are in need of clarification, particularly in the fields of energy and conversion. Just how do you measure the inherent energy in a pound of coal, for example? It is well known that a handful of material contains enough energy to drive a ship for thousands of miles. To date, the only method of unlocking a significant amount of this energy has been through nuclear reaction. The common method of burning a fuel releases only a fraction of its potential. Which yardstick do you use?

By the same token, the thermoelectric material undoubtedly contains energy put into it by processing and manufacture. Perhaps some of this energy could be released to provide a gain in efficiency. Experiments are being conducted along similar lines in this country to investigate improving the "figure of merit" of thermoelectric materials.

• **Not taken lightly**—In any case, the scientific consensus is that such Russian announcements almost invariably have proved to be factual. With the possible exception of claims as to the nationality of discoverers of certain basic scientific principles, few, if any, authoritative Soviet technical statements have been disproved.

Russia is conceded to be ahead of any other country in thermoelectric research. They produced several years ago practical low-cost thermoelectric generators to operate small radios and refrigerators for areas outside conventional power sources. Their rapid progress in this field no doubt gave impetus to recent U.S. emphasis on similar research. It would seem logical to evaluate this new advancement on the basis of what its potential contribution could really mean, rather than to dismiss it as merely a juggling of figures.

Mishap To Delay *X-15* Plans

WASHINGTON—It appears that man's first excursion into space aboard a rocket plane will be slowed as a result of the recent accident to the second *X-15* on Nov. 5. It also will force a rearrangement of plans which called for the turnover of plane Number 1 to NASA.

The big question to be solved now is what caused a fuselage crack at what the manufacturer calls an "attachment point." Investigators still have to determine the relationship, if any, between the crack and the explosion which took place in the upper compartment of the lower rocket engine. Indications are that the fuselage damage was not caused on landing.

It's estimated that if there is no more damage than the first investigation disclosed, plane Number 2 could be repaired in six to eight weeks. However, the basic question of why the structural damage occurred to the fuselage and how the explosion and fire started may take longer. This will automatically postpone completion of tests which were to lead to flights out of the atmosphere.

Indications are that the scientists who have been heavily involved in the program will hang out the "go slow sign" to make sure that pilots' lives are not unnecessarily sacrificed and the $100-million program is not washed out. As one man put it, "time isn't that important."

'Second Blow' in Total War . . .

Navy Pushes for Big Fleet of *Polaris*

Urges eventual deployment of hundreds of IRBM's aboard some 24 cruisers as supplement to subs and SAC; new Polaris surface force might include battleships

by James Baar

WASHINGTON—The Navy is pushing for deployment of hundreds of *Polarises* aboard surface warships to give America's retaliatory forces a mobile-based "second blow."

The proposal eventually would call for a fleet of more than two dozen *Polaris* cruisers that would serve as a supplemental or alternate force to the Navy's *Polaris* submarine fleet and the Air Force's SAC.

The Navy contends such a force would:

- Greatly increase the difficulty of any attempt by Russia to deliver a surprise knock-out blow to U.S. retaliatory power thereby increasing American deterrent power.
- Rapidly give the United States a build-up of mobile missile bases that would help defend the nation during the fast-approaching years of the Missile Gap.
- Provide a reservoir of great striking power that could be used to conclude a war that started with an all-out exchange of nuclear weapons.

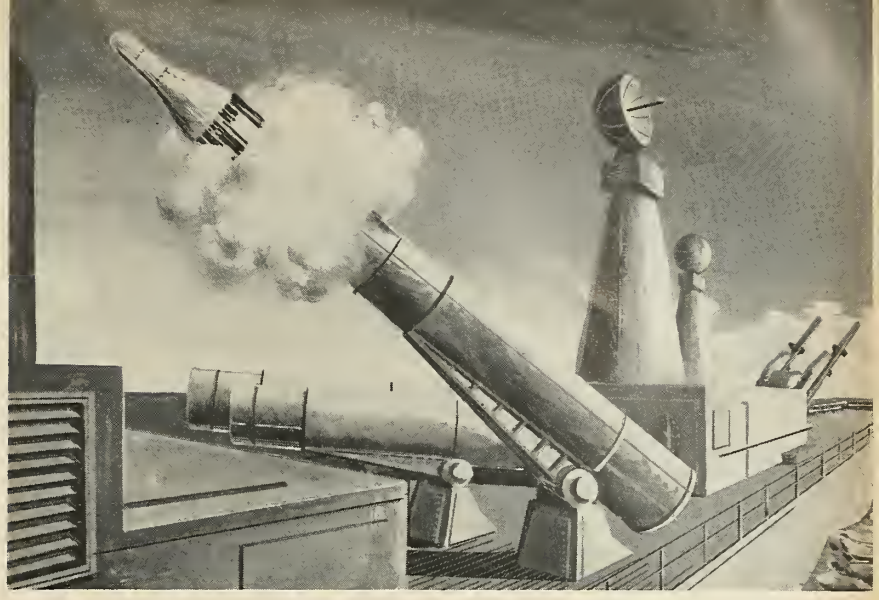
This is the heart of the Navy *Polaris* cruiser plan which has been shelved at least temporarily by the Defense Department since early this year.

Under the plan, the Navy would have had at least one *Polaris*-armed cruiser at sea in 1960 or by mid 1961 at the latest along with the one *Polaris* submarine scheduled to be operational. The cruiser would have been the nuclear-powered Long Beach.

The Navy had ordered that *Polaris*

SURFACE launching of dummy *Polaris* from tube in deck of Test Ship Norton Sound. Ship's list is deliberate.

Cruisers



ALTERNATE method of launching *Polaris* from cruiser is shown in an artist's conception. It might be used on nuclear-powered Long Beach.

launching tubes be installed in the big cruiser while it was under construction at the **Bethlehem Steel Shipyard** at Quincy, Mass. But the Defense Department pulled back the order to review it.

The installation of the tubes and launching equipment will take an extra eight months if the Long Beach is sent to sea without them and is returned to the yards later to be equipped with them.

Speed and availability are two of the Navy's big arguments for putting *Polaris* on surface ships. It contends the plan would greatly increase the rapidity of a build-up of mobile and dispersed U.S. retaliatory forces.

Hardened and mobilized **Boeing** *Minutemen* ICBM's are not expected to begin entering SAC's retaliatory arsenal until about 1962. Meantime, the major U.S. retaliatory force will continue to be manned bombers—many of which may have to be kept on constant airborne alert as Russia's ICBM stockpile rapidly increases—or run the risk of being caught on the ground. The cost of maintaining an airborne alert is expected to run from one to several billion dollars a year.

It is against this background that Navy officials have argued for beginning a *Polaris* cruiser problem as quickly as possible.

However, not a dime for deployment of the **Lockheed** IRBM's on cruisers is expected to show up in the FY 1961 budget. And the Long Beach will be commissioned in March without the launching facilities for them.

Any decision that would authorize deployment of *Polarises* on cruisers isn't expected now until the fall of 1960. Nor are the chances too good that the decision at that time will be in favor of the plan.

Money and the Administration's tight-budget policies are the principal obstacles.

The Navy is having great difficulty in securing funds to push construction of *Polaris* submarines let alone the deployment of *Polarises* on surface ships.

The new budget is expected to provide funds for only three more of the missile-launching submarines instead of the nine that the Navy has advocated. And the Navy considers the *Polaris* cruiser a supplement—not a substitute—for the submarine.

• **Comparatively cheap**—It feels that more funds for both should be added to its budget.

The cost of installing *Polarises* on cruisers is comparatively cheap as modern weapon systems go. All launching and other missile support equipment for 16 *Polarises* can be installed on a cruiser for about $40 million. The cost for eight *Polarises* is about $20 million.

The U.S. missile cruiser fleet—operational and under construction—and its present and scheduled armament. The commissioning dates listed are current estimates.

Cruiser	Missiles	Status
BOSTON	TERRIER	Optl.
CANBERRA	TERRIER	Optl.
GALVESTON	TALOS	Optl.
PROVIDENCE	TERRIER	1/60
LITTLE ROCK	TALOS	3/60
LONG BEACH (nuclear)	TALOS-TERRIER-ASROC	3/60
SPRINGFIELD	TERRIER	3/60
TOPEKA	TERRIER	4/60
OKLAHOMA CITY	TALOS	S/60
ALBANY	TALOS-TARTAR-ASROC	7/61
CHICAGO	TALOS-TARTAR-ASROC	10/61
COLUMBUS	TALOS-TARTAR-ASROC	12/61

These figures are in addition to the approximate $100-million cost for conversion of a cruiser to a missile cruiser. If *Polarises* are installed after the conversion, the cost goes up about 25%.

Initially, Navy officials thought in terms of eight *Polaris* cruisers. That would put the total price tag at about $250 million plus another $400 million for the extra conversions of ships—some of which are planned anyway.

The *Polaris* cruisers would add a new arm to a growing missile Navy that already includes some 80 ships that are operational, authorized or under construction.

The queen of this missile fleet is the 14,000-ton Long Beach. In essence, the $250 million ship is a floating missile base capable of cutting through the world's oceans at about 30 knots.

Unlike the first group of converted missile cruisers, the Long Beach will not carry a gun. Instead, her more than 700-foot deck will be dotted with missile launchers.

Here is her presently-planned armament:

• *Talos*—A twin-rail stern launcher built by the Naval Weapons Plant will fire the more than 65-mile range **Bendix** missiles. The nuclear-tipped *Taloses* can be used against missile-launching aircraft or for long-range heavy bombardment. The Long Beach will carry probably more than four dozen.

• *Terrier*—Two twin-rail **Northern Ordnance** launchers will fire the 10-mile-range **Convair** missiles from the bow and forward area. The Long Beach probably will carry more than 100 *Terriers*. The surface-to-air missiles carry high explosive warheads.

MISSILE CRUISER queen, the nuclear-powered Long Beach, carries (stern to bow) *Taloses, Polarises, Asrocs* **and** *Terriers* **in this graphic artist's conception.**

• *Asroc*—A **Universal Match** launcher almost amidships will fire the new **Minneapolis-Honeywell** anti-sub missiles.

• Torpedoes—Midship port and starboard tubes built by the Naval Operating Plant of Louisville will launch **GE** anti-sub Mark 44 torpedoes.

The *Taloses* will be fed semi-automatically to the launcher by the huge **GE** launching system that stores the missiles ready for action in trays. The *Terriers* will be fed to their launchers by the Northern Ordnance "coke-bottle" launching system that stores the missiles around revolving drums.

The Long Beach magazines that house the *Terrier* and *Talos* launching systems are more than 30 feet deep. They take up much of the stern and forward quarters of the ship.

The *Asrocs* will be stored and fired from the box-like *Asroc* launcher.

Polarises—if installed on the Long Beach—would probably be launched from tubes elevated from a horizontal position on the deck. Three of the 28-foot missiles could be stored in the tubes; five more would be stored nearby.

The alternate method for launching *Polarises* from cruisers is from eight or 16 tubes constructed upright inside the ship's hull. The easiest way to do this is to remove turrets and install the tubes in their place. The tubes will be installed at an angle to prevent any missiles from falling back on the deck.

Installation of tubes below or on the deck is considered an eight-month job as long as space and weight have been taken into consideration in construction or conversion of the ship.

So far, space and weight for *Polarises* are being allowed for on the Long Beach and three heavy cruisers undergoing conversion to missile ships: the Albany, Chicago and Columbus. The last three are scheduled to be operational in late 1961.

The Navy's eight other missile cruisers—three operational and five scheduled to be by mid-1960—have not been constructed with *Polaris* in mind. Their armament is *Terrier, Talos* or *Talos* plus the new **Convair** *Tartar.*

However, the Navy has six other operational cruisers, 31 mothballed cruisers and 10 mothballed battleships to draw from for deployment of *Polarises.* Besides these, the Navy also has considered deployment of *Polarises* aboard its proposed swift new auxiliary ships such as the AOE's—the combined oiler and ammunition ships.

All of these would provide what the Navy wants in a surface IRBM launching platform: speed, mobility and dispersion. But there is no question that the cruiser is looked on as the most likely ship for the job—particularly because of its ability to fill such a wide variety of missions.

As the partly-completed Long Beach lies in her pier at Quincy, you can look down through the deck at the great missile-launching systems and sense the ship's power.

But many Navy officers feel the Long Beach is far more than just a powerful ship. They see it in the years ahead as the possible leader of a great armada that alone might hold the balance of power in an H-bomb-smashed world.

LEFT—Before conversion the cruiser Springfield carries two conventional stern turrets.

RIGHT—After conversion the missile cruiser Boston boasts two *Terrier* **launchers astern.**

by M/R Staff
from Official Translations

Planet-based Radios for Guidance

A Russian scientist has stated that radio navigation for space ships will probably be effected by establishing radio transmitters on the plants of destination or on their satellites.

V. I. Siforov, Chairman of the Central Board of the Popov Scientific Society of Radio Engineering and Electric Communications, and a Corresponding Member of the Academy of Sciences, USSR, predicted in a recent issue of *Moscow News* that the pilot of a future interplanetary ship will tune into a particular waveband—the rest will be done automatically as in modern aviation.

Siforov believes that, in contrast to terrestrial conditions radio navigation transmitting stations will not be motionless but will move along a complex path. Yet the positions of the radio beacons will be known to the astronauts, and their complex courses will be plotted in the course of computing the whereabouts of the spaceship.

Superior Magnetometer?

A Soviet technical paper claims that a D. D. Voyekov has designed an accurate magnetometer employing the Hall effect that is "superior to similar non-Soviet meters."

Basic error is given as ±1.5% +1 gauss in the 100-16,000 gauss range. Temperature range is −30° to +50°C, the temperature influence error not more than ±0.3% per 10°C.

The magnetic pickup of the magnetometer is made from n-type germanium with a specific resistance of 2-3 chm/cm. Dimension of pickup, 2.7 x 2.7 x 0.4 mm^3; sensitivity, approximately 10 microvolts per gauss. Temperature control for increased accuracy is achieved by placing the Hall pickup inside a small brass container equipped with a heating element and a small transistor.

The pickup is heat-insulated from the container's wall but the thermistor has a firm, heat-conduction contact with the element and container. Thus, while variations in the container's temperature are applied directly to the thermistor, they reach the pickup only after considerable delay.

Periodic temperature variations in the ±1.5°C range cannot influence the pickup, since the entire cycle of temperature of the unit is maintained within an accuracy of ±0.1° to ±0.25° C. The NMN-3 is recommended for both laboratory and industrial use. (*Pribory i tekhnika eksperimenta,* No. 4, 1959).

New Research Center

The Kirghiz Academy of Sciences has begun construction of a scientific research center 128 kilometers southwest of Frunze which will be used to study cosmic radiation, radio engineering, high mountain physiology, and astrobotany.

The station, according to the Bucharest, Rumania, publication *"Elore,"* (May 23, 1959) will be on a 10,000-ft. mountain and contain a meteorological station, several laboratories, power plants, apartment houses, clubs, stores and repair shops.

Polyethylene Lag Hit

Y. Krein, writing in *Promyshlenno-ekonomicheskaya Gazeta* (Oct. 4, 1959) claims that Soviet scientific research institutes have been "dragging their feet" for three years in the production of polyethylene at low pressure.

Initially the plan was to build a pilot plant to obtain data and experience for production on a commercial scale in 1960. However, the experimental facilities have not been finished because of defective specifications.

The Soviet writer also states that because of confusion over what agency was responsible, no industry has been assigned to make the gas blowers and high-pressure ventilators, and that the nine horizontal centrifugal machines with fourfold rinsing for the polymerization shop have not been produced.

Radiation Experiment

A special instrument was installed in *Sputnik III* for registering only those electrons with energies of tens of kev, it was reported in a recent Russian technical paper.

The effect of X-rays was excluded by means of fluorescent screens and aluminum foils. Monochromatic electron fluxes were reduced to monochromatic electrons. The reduced energy of the electrons was called "equivalent" energy.

According to the paper, electrons carrying energies of about 10 kev were found at altitudes from 470 to 1880 km above sea level. The intensity of the electrons is higher in the daytime than at night.

Their flux can form different angles with the geomagnetic lines of force and the direction of flux is less than a certain value, particles with low energy are able to penetrate deep into the earth's atmosphere. *(Izvestiya AN SSSR. Seriya geofizicheskaya,* No. 8, 1959.)

Atomic Battery Research

Corresponding Member of the Soviet Academy of Sciences Vladmir Siforov has predicted that Russian space flights to Mars and Venus will be powered by atomic batteries.

The Soviet Union is doing extensive research on semiconductor-operated atomic batteries, according to Siforov, and regards Strontium 90 as the most suitable radioactive material because it can produce a large number of secondary electrons (up to 200,000 per primary electron) in a semiconductor layer.

However, the low magnitude of electric currents and voltages produced by the electron emission requires that numerous primary atomic cells be employed simultaneously to obtain currents and voltages strong enough to run space electronic equipment. *(Norddeutsche Neueste Nachrichten,* Rostock, Germany. Sept. 30, 1959.)

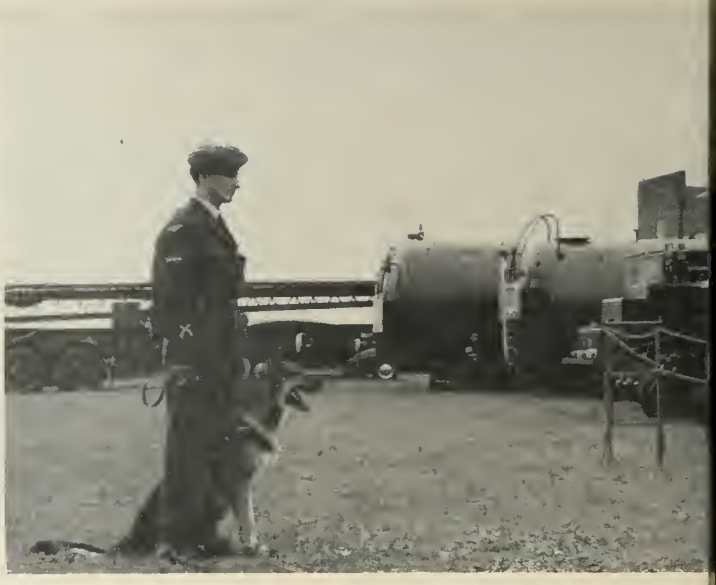
Pulse-Amplitude Analyzer

The Physical Institute of the Armenian Academy of Sciences has developed a pulse-amplitude analyzer in which use is made of logarithmic conversion of pulse amplitudes into duration as a result of which pulses in all the channels are measured with the same relative accuracy.

The Soviet journal *Atomnaya Energiya* (Sept., 1959) stated that the analyzer is intended for use with a 5-strata proportional counter when studying cosmic rays.

Dr. Albert Parry, professor of Russian at Colgate University, has long contributed a monthly column on Soviet Affairs to M/R. Because of the increasing interest in things Russian, we now plan to supplement this coverage wtih more frequent material emanating from the USSR, translated by official sources in this country, and compiled by the M/R editors.

M/R editor is first correspondent to fly Atlantic with big ballistic missiles; guidance units pose trickiest problem of in-flight maintenance



Thors Are Airlifted Gentl

by Donald E. Perry

LONDON—Transporting the *Thor* IRBM and its component parts by C-124 between the U.S. and England is an assignment that MATS must approach with the delicacy of handling eggs or dealing with a temperamental woman.

The C-124 crews have problems and MATS has largely had to write its own standard operating procedures along the way. Although crews run into electrical trouble with some 30% of components shipped, the record of Eastern Transport Air Force's 1607 Air Transport Wing in hauling the big ballistic missiles is impressive.

These and many other things I found out when I became the first newsman to ride one of the C-124 *Thor* carriers between Dover AFB, Delaware, and Lakenheath RAF Station, England, where the big birds are unloaded.

Most often shipment of *Thor* and components is made on a six-hour lead time. Add to this a noise abatement program at Santa Monica (when the C-124's can take off only between 7 A.M. and 8 P.M.) and the inability of the Airheads in Britain to receive shipments except during normal working hours, and you have one of the stickest logistics problems imaginable.

• **Expensive operation**—This is also reflected in operating costs. Airlift of *Thor* comes under the special mission category. Example: For one airplane to fly to the coast from Dover AFB and pick up a *Thor* and transport it to the United Kingdom costs $33,000.

Some 40% of MATS' flying hours are devoted to special missions. The biggest single item is missiles and their support equipment which take up more than 50% of that total.

The big rub is that in special mission operations where there are no regular MATS supply channels the "in commission airplane hour" may sometimes be double the cost of the flying hour, which averages $513 for the C-124.

There are no exact figures on costs to date for shipment of *Thor* and components to the United Kingdom, I was told. However, it can be generally assumed that for every aircraft that carries the bird, at least 10 more are required for component parts. Between two and three aircraft leave Dover on a weekly average usually grossing out at maximum of 185,000 pounds, so in the more than one year's operation of *Thor* airlift, one heck of a lot of tonnage figure can be imagined.

Normal routing from Dover is to Harmon Air Force Base, Newfoundland, with load factor determining whether the flight can be made direct to Britain or via the Azores for refueling.

SAFELY DELIVERED in England, a Douglas *Thor* is readied for trip from airhead at Lakenheath RAF Station to Feltwell, first of four British bases to get the missile.

as Eggs

Engineering-wise, MATS personnel largely has had to rely on contract personnel for in-flight maintenance and servicing of *Thor* components and subassemblies. Trickiest things are guidance units.

• **Protecting gyros**—The **AC Spark Plug** Inertial Measurement System contains two major subassemblies; the inertial platform contains a series of gyros suspended in Floralube, a flotation medium requiring temperature control within a specific range.

To achieve this temperature control an electronic package is installed on the forward face of the shipping pallet. If the generating system should have more than a five-minute power-off, there could be irreparable damage to the AC Spark Plug unit, or—at the least—it could become necessary to recalibrate the individual gyros, conservatively estimated to cost $5000 each.

• **More precautions**—To protect the empty missile tank sections during air transport, **Douglas** recommended a rate of descent between 500 and 1000 feet per minute within the 0 through 20,000-foot altitude range. Maximum rate of descent cannot exceed 2000 feet per minute because of the thin-skinned tankage shell.

EASTAF's 1607 Air Transport Wing has a set of precautions to observe while transporting the inertial system. After starting engines, the outboards must be maintained at 1200 RPM's while taxiing and while waiting for take-off, even though aircraft braking is necessary.

Pilots must wait for level-off before checking the C-124's power operations (pitot heaters, landing lights, etc.). Testing must be restricted to one operation at a time. This is to prevent starving the guidance system heater circuits.

On landing there is a battery back-up which automatically provides the required heat control to the guidance system, until such time as the plane is plugged into ground power.

The power requirement is 28V DC 75 Amps—50 continuous, derived from the C-124 power supply.

• **Going through channels**—Here's the chain of command for airlifting *Thor*. Ballistic Missiles Division Transportation is under Air Materiel Command. Transportation determines airlift requirements. AMC Headquarters goes through Headquarters AF which transmits requirements to Headquarters MATS. MATS gets a monthly tonnage requirement and in turn gives it to Eastern Air Transport Air Force. EASTAF then gives the 1607th Air Transport Wing the yeoman's task of executing requirements.

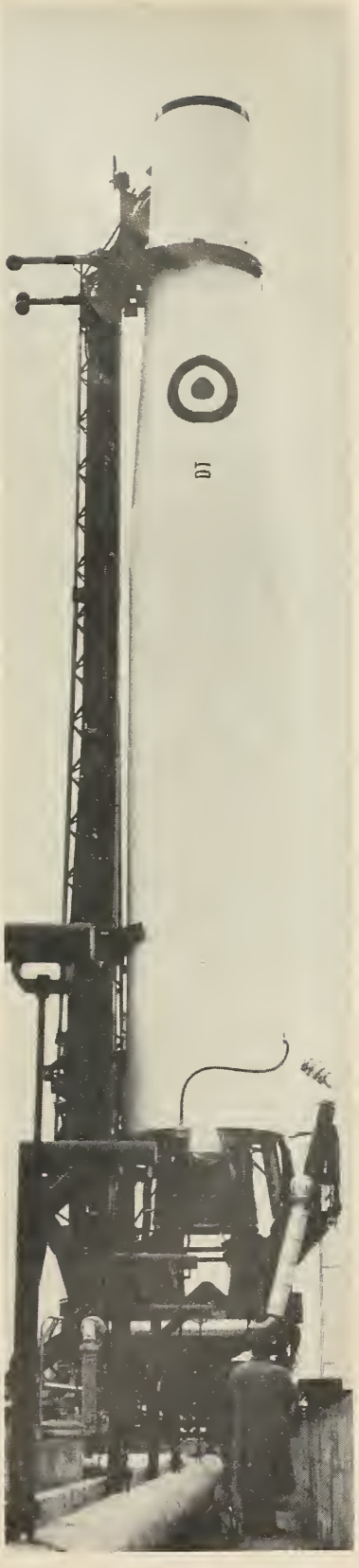
Next Spring, EASTAF will get delivery of the first C-133B—the only air cargo transport in the world capable of carrying the ICBM *Atlas*. The Cargomaster can carry more than 26 tons some 4000 miles at an average speed of 323 MPH. The aircraft features clam-shell doors which open in four directions to allow the huge *Atlas* aboard.

By that time, however, England's IRBM program will be virtually completed.

Feltwell base became missile-equipped early in July. Helmswell was expected to be operational this November, Driffield by December, and a fourth, unnamed base before next July.

Each base (M/R, July 27, p. 11) is of squadron strength—15 missiles. Each base consists of a main site and four satellite sites, each with three missiles. Maintenance and housekeeping facilities and personnel are at the main site. Main site and each satellite are separated by about 20 miles.

But after *Thor* will come *Jupiter* for Italy. Ground work has been laid and MATS—while not envisioning a "snap"-type task—considers that operating procedures are pretty well pat and the *Jupiter* job should be much easier.



***Thor* NOW BEARING British bullseye markings, is raised into launching position. Each base will have 15 birds.**

$60,000,000 bargain? . . .

Polar Launch Site Urged in Canada

Experts point to advantages which would come with building a launching facility at Moosonee—chiefly reduction of radiation hazards

Editors Note: This report on the possibilities of a polar launching site in Canada was prepared for M/R by two Canadian scientists, formerly with the Canadian Government.

OTTAWA—A polar orbit launching site with a range of 1800 to 2500 nautical miles can be built in Canada for only $60 million.

It would have significant advantages over the present polar launching site at Point Mugu, Calif., and over most of the other sites in the world under consideration. A major advantage of a Canadian site—at Moosonee in Ontario—would be the great reduction of the radiation hazards to manned flight; the Van Allen radiation belts diminish to insignificant size in northern regions, and do not exist in the upper polar regions.

For logistic reasons, the rangehead where the launching facilities will be located must be near a railway center, seaport, large airport or a combination of these. It should also be near the industrial centers of Eastern Canada which would supply most of the equipment for a primarily Canadian venture.

The range proper should be a corridor roughly 2500 miles long and 50 miles wide, with little or no population. At intervals of 100-200 miles along the range, interrogation, monitoring and control stations will be situated, and these should have relatively easy access.

They should also be close to the sea or on an island; supply to inland stations in the Sub-Arctic is difficult and extremely expensive, since most equipment has to be airlifted. Launchings will be directed north, away from the populous United States and the equatorial zone, where the radiation layers are so intense.

• **Screening the sites**—A comprehensive map of Canada shows a number of places that might well serve as the site of the rangehead; four that look promising are Moosonee, Churchill and Lynn Lake in Manitoba, and Shefferville, Quebec. There are others, such as Canada's northern railroad centers on the Athabaska and Peace Rivers and at Dawson Creek, but they are all south of relatively populous settlements which might be endangered by falling booster motors and misdirected rockets —and in any case the length of the ranges is too short to be of real interest.

In the case of Shefferville, transportation is necessarily by boat and then rail—a serious disadvantage. In addition, the central part of the range would extend over Frobisher, which might again lead to population hazards. A thousand miles downrange from Shefferville the range passes into Baffin Bay and out of Canadian control.

At Lynn Lake, many of the prospective monitoring posts would have to be inland, and hence difficult and expensive to maintain. Besides, a range from Churchill or Moosonee provides a longer path over sovereign territory than Lynn Lake or Shefferville.

There remains Churchill, which has received much publicity because of rocket firings there during the International Geophysical Year, and Moosonee, which is being heavily developed with an eye to making it Ontario's first salt water port.

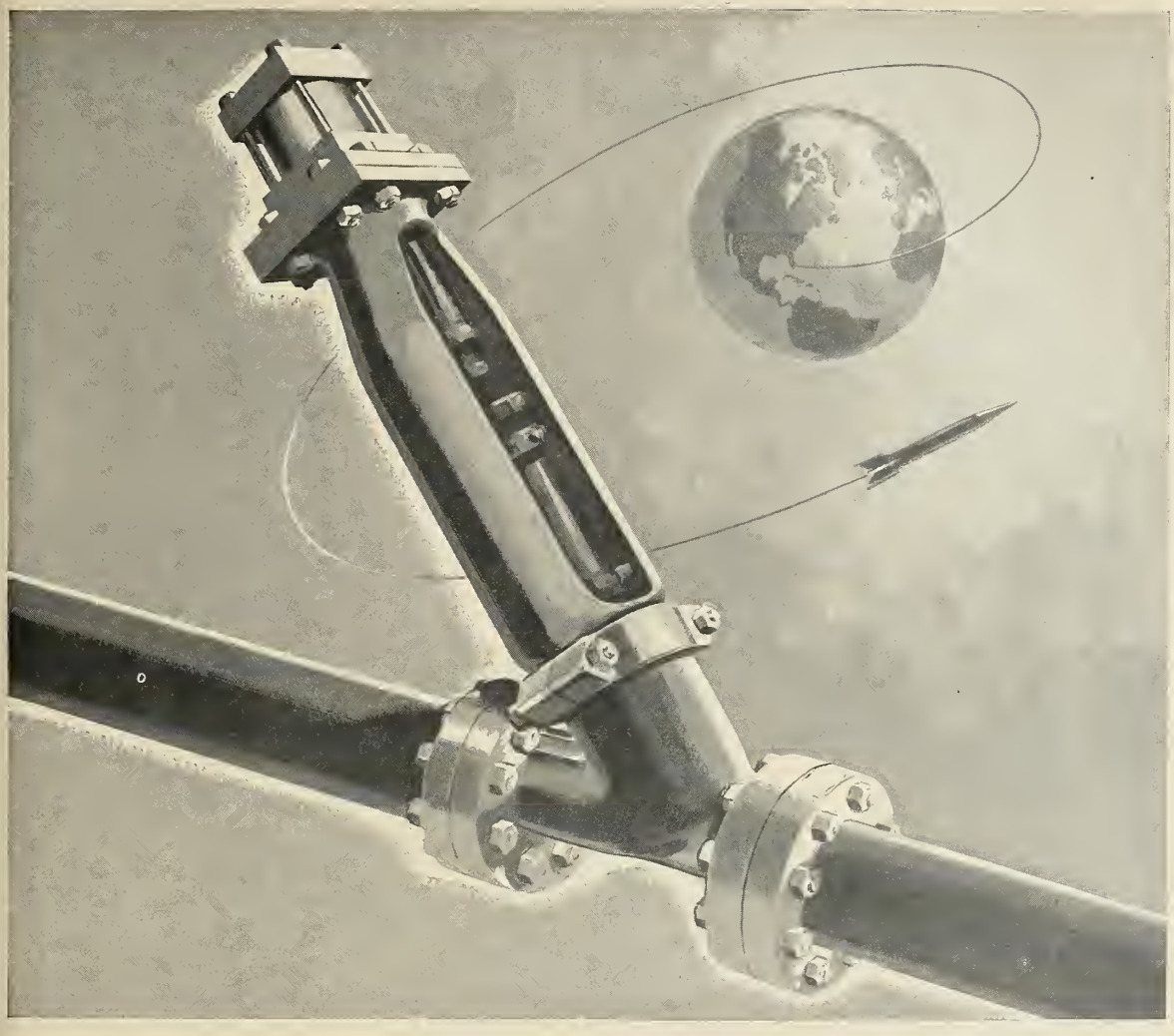
In comparing Moosonee and Churchill, it is necessary to consider a number of factors. Of primary importance is the cost of establishing launching facilities, and here transportation plays a considerable role. Both sites can be served about three months of the year by sea. Churchill is an established seaport while Moosonee is not; nevertheless the cost of establishing harbor facilities at Moosonee would not be charged against rocket site development cost, if present proposals to create a commercial port there go through—as appears very likely.

• **Air and rail connections**—The Ontario government has set aside $5 million to convert Moosonee into a salt water port. In addition, Col. C. E. Reynolds, chairman of the Ontario Northland Transportation Commission, has indicated that an airstrip can be built at Moosonee. Tests have been indicated that gravel to be dredged from shoals in the Moose River would be ideally suited for a base layer for the proposed air strip.

At present, Moosonee has only a private airstrip, used by Austin Airways Limited. According to Austin, the soil is unsuitable for a good airstrip, consisting of one or two feet of overburden on top of clay.

Churchill has a good airfield, which can be used throughout the year, except for a few days during spring break-up. Large aircraft such as the C-133 Cargomaster can be landed there. At both Moosonee and Churchill then, airport facilities will be satisfactory in the near future.

Churchill is the terminal of a Canadian National Railway line from Le Pas, with a direct connection to Winnipeg and Regina. Moosonee is the terminal of the Ontario Northland Railroad from Cochrane that connects directly to Toronto. Since most technical equipment is likely to come from the industrial Centre of the Eastern Provinces, Moosonee, which is 186 miles north of Cochrane and 668 miles north of Toronto, has the advantage of being some 2000 railroad miles nearer



Headed for History...on Schedule

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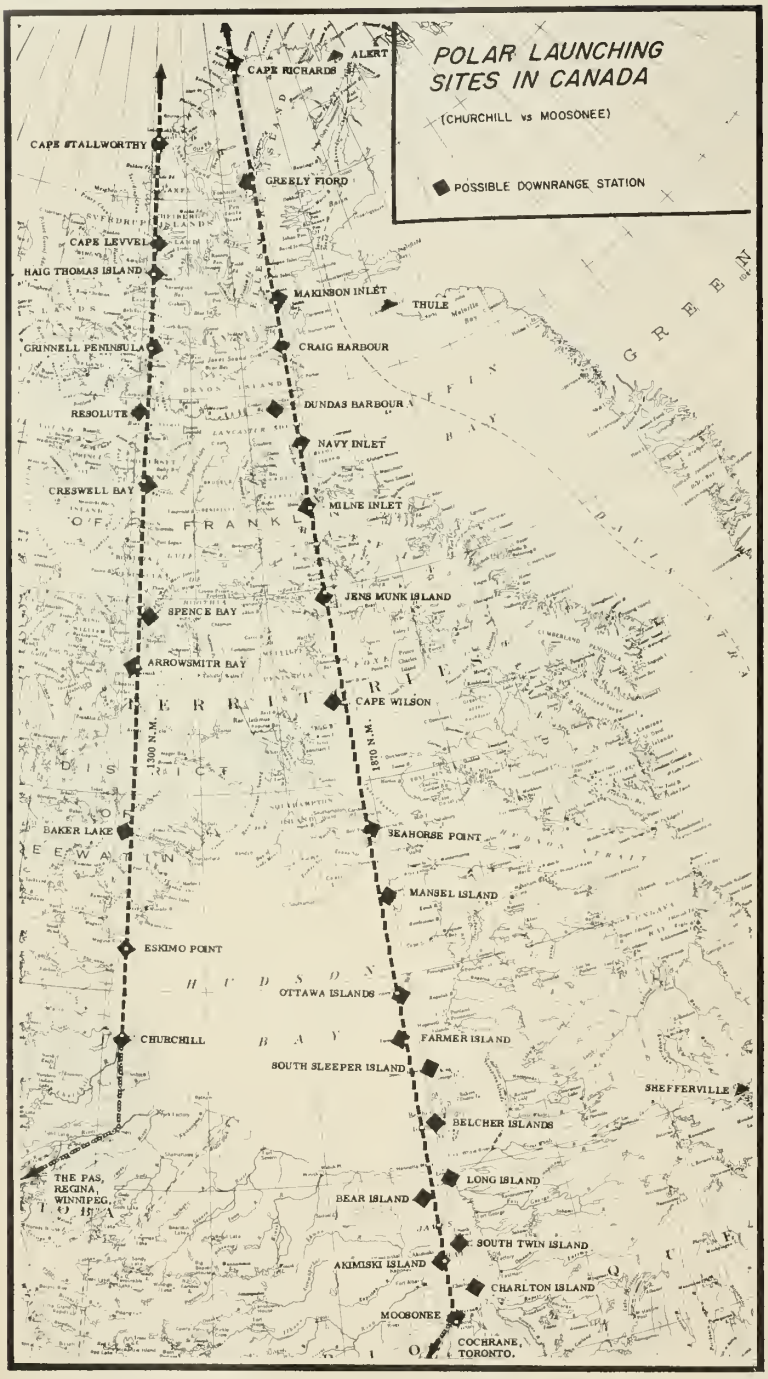
rangehead would mean flight of 1870 n.m. over Canada . . .



VAST DISTANCES offered by both suggested Canadian launching sites are indicated on this map showing possible downrange stations. The Moosonee rangehead would provide 1870 nautical miles over Canadian sovereign territory; a Churchill rangehead would mean 1300 miles across Canada.

to the sources of supply.

• **Starting from scratch**—Contrary to popular belief, the existing rocket launching pad support at Churchill is of no value in the construction of launching facilities for long-range rockets. A major facility would be altogether different.

It would be necessary therefore to construct such a facility at either of these two places essentially from scratch.

During the construction, as in subsequent operation, climate plays an important part. Climatic observations show that Moosonee is, on the average 15°F, warmer than Churchill throughout the year. On the average Moosonee also experiences above-freezing weather for seven months of the year, in comparison to four months for Churchill. Moreover, the extreme January frost conditions common to Churchill are rare at Moosonee. There is adequate housing both at Churchill and Moosonee to accommodate construction crews during the early phases of the development.

In summary, supply costs for Moosonee should be smaller than those for Churchill, although the actual difference is unlikely to be great. Construction costs are likely to be significantly less for Moosonee because of the higher temperatures and the lack of permafrost.

• **Looking down range**—The second factor is the construction of downrange facilities. The small islands in Hudson Bay and the larger islands of the Canadian Archipelago farther north make ideal locations for radio control, monitoring and interrogative stations for a Moosonee range. Churchill is also well provided in this sense, except for an important length, starting some 125 nautical miles downrange and extending 525 nautical miles, from Eskimo Point to Arrowsmith Bay. This length represents the main burning part of prospective rocket launchings, but still, it could be monitored easily from the end points and perhaps from Baker Lake. Other monitoring stations would introduce the difficulty and expense of inland siting. The position of Eskimo Point, Baker Lake and Resolute downrange from Churchill is a mixed blessing as they are relatively populous.

• **Range over Canada**—A third factor of importance in site comparison is the length or range within Canadian sovereign territory. The Moosonee rangehead is about 1870 nautical miles from Cape Richards on Ellesmere Island along the same Meridian, or geographical north-south line. The Churchill rangehead is 1300 nautical miles from Cape Stallworthy on Heiberg Island.

Under typical conditions final

rocket burnout may be expected to occur some 600 to 1500 nautical miles downrange, depending on the length of coasting before the final stage is fired. If an earth satellite vehicle were being launched, a further 1000 nautical miles of path length would be monitored, so that future behavior of the satellite could be adequately predicted.

For our purpose, a 1300-nautical-mile range is marginal, while an 1870 nautical-mile-range represents a considerable improvement. Of course, a 2500-n.m. range would be better if one were available, and we will indicate later how this might be obtained.

Consideration must also be given to the operation of the launching site once it has been constructed. In this connection, the majority of the work involved in launching rockets lies in transportation of the rockets between storage depots and the ramp, installation and checking. This is outdoor work and would be easier in temperate climate conditions. Building of permanent homes for the operating personnel is also less expensive under such conditions. It appears that Moosonee is preferable to Churchill, and in general, other potential locations across Canada.

• **Drawbacks elsewhere**—At the present time, the Western nations have available only one polar orbit launching site, located at Point Mugu in California. There is no sovereign monitoring for this site at all, all downrange activities being undertaken by picket ships in the open sea. Point Mugu also suffers the severe disadvantage that it launches rocket vehicles into the equatorial zone, where considerable dangerous radiation is trapped by the earth's magnetic field, as previously mentioned.

Examining site possibilities elsewhere in the world, it becomes evident that only Australia could provide an alternate range. An Australian polar range would have a sovereign path between 1000 and 1200 nautical miles in length, with the rangehead in the Northern Territory, near the coast. Launchings would be south over Antarctic regions, and downrange facilities could possibly be extended 1700 nautical miles out into the Pacific Ocean by means of picket ships. There is the disadvantage that supply to downrange stations, located in the central Australian desert, would involve considerable expense.

A range in South America would also be of interest to the United States, but the site would have to be carefully chosen to reduce hazards to the population, and it would probably be a major political undertaking. An African range does not seem possible at all due to the hazard to population. Any range of the length we have mentioned constructed in a north-south direction in Africa would inevitably pass over densely populated areas. Again there are political difficulties, because the range would not be confined within one country.

At Moosonee a rangehead could be constructed that would permit the use of a range extending over 1870 nautical miles over Hudson's Bay and the northern islands—and might conceivably be maintained for a further 500 to 1500 nautical miles from floating ice islands in the Arctic Ocean.

The area is suitable for construction. A few miles down the river from James Bay, the shoulders of land along the river rise above the muskeg and several square miles of drain land are available for launching facilities. The community itself, on the left bank of the Moose River, opposite Moose Factory, is 15 miles south of James Bay and would be south of the launching site, out of range of any potential danger, but immediately accessible.

• **Requirements and cost**—What about the magnitude of the facilities required for the rocket range and the cost of the project?

The basic requirements for launching facilities are as follows:

• At least two launching ramps, with a blockhouse protected against the lethal radius of rocket fuel explosion.

• Weather shelters for the readied rockets, which, with the maintenance and servicing platform, ride on rails so that everything can be rapidly withdrawn from the rocket before firing.

• Microwave and cable communications within the launching area. A storage depot, including an air conditioned room for maintenance of electronic equipment.

• A liquid oxygen generator and central fuel storage area.

• A power generator, probably diesel, of about 100 kilowatts capacity. A very high capacity digital computer for the setting of guidance systems, and general data handling.

• Two or three precision tracking radars on an accurate base line at the launching area.

• Adequate meteorological facilities for weather prediction.

• Housing for 150-200 men, the basic staff of the base. The approximate real estate would be about one square mile. We estimate the basic cost at about $30 million.

The requirement at each downrange station is roughly as follows:

• One precision tracking radar.

• One or two optical tracking instruments.

• One or two cine-theodolites, for tracing.

• One multi-channel telemetry receiver, microwave, telephone or ultra-high-frequency communication to the central launching area.

• Meteorological facilities.

• Housing for some 25 men.

The cost of each downrange station would be about $2 million. About 10 to 15 such stations will be required.

The total basic cost for the launching facilities and downrange monitoring stations comes to about $60 million. That is not a great deal of money in this day and age for what we would be buying—a unique rocket facility for the Western world, that could be emulated only, perhaps, in Australia. The rocket range would be a considerable contribution to the Northern development of Canada, as well as a major contribution to Western missile and rocket facilities.

EIA Gets 100 Millionth Packaged Circuit Unit

WASHINGTON—The 100 millionth "packaged electronic circuit" PEC was presented to the Electronic Industries Association here last week. The presentation, symbolizing 15 years progress in miniaturization, was made by W. S. Parsons, president of **Centralab**, to David R. Hull, president of EIA. Parsons predicted production of the next million units within 4½ years.

A PEC unit is a complete electronic sub-assembly made up of capacitors, resistors, inductors, and wiring printed and bonded to a ceramic base plate. The resulting sealed unit is extremely thin, with essentially only two dimensions. A four-stage amplifier so constructed has a density of over 500,000 components per cubic foot. The technique grew out of Centralab's World War II work on radio proximity fuzes.

Hull, in accepting the circuit—which will eventually be part of a Smithsonian electronic exhibit—said miniaturization can take much credit for the great progress of electronics. He said "the significance of this development to the Space Age is self-evident. Without packaged circuitry and other routes to miniaturization, the periphery of space would still lie beyond the reach of man. But for these developments, it is clear that the instruments upon which we today are totally dependent in space exploration still would be earth-bound, awaiting rocket engines far more powerful than any we have yet been able to produce."

It was pointed out that the vast amount of electronic equipment needed in the future would require more old-type soldered connections than could be produced by all the people in North America.

How A Small Firm Meets Space Age

BALTIMORE—The sudden arrival of the Space Era, imposing demands for special skills in unexpected ways, has caused many small companies to undergo radical shifts in product emphasis.

A typical example is **Flight Refueling, Inc.** of Baltimore. Until two years ago, almost all of this company's sales were in the area of aerial refueling. Today, it is supplying such market as missile booster and disconnect valves, nuclear reactor valves and disconnects, flexible fittings for nuclear submarines, and special subcontract work on rocket bodies and electronic components.

The company is still in a transitional phase, however, and these new lines have not yet been built up to healthy proportions. Diversification now accounts for 30% of sales (compared with 10% in calendar 1958). The company says that it will in time account for a far greater proportion of business.

Much of the diversification is in the field of fluid flow. Understanding of how gasoline moves in an aerial refueling system has helped Flight Refueling's engineers solve flow problems encountered with liquid rocket fuels and reactor-generated steam.

• **Precision specialists** — A small company, Flight Refueling is not engineered or equipped for mass production of relatively rough tolerance pieces. Rather, the concern is making use of its machinists' skills and experience in precision work under government-certified quality control procedures.

Some typical jobs done recently in the missile field include: LOX and fuel servicing nozzles and adapters for the **Douglas** *Thor;* small stainless steel solid-fuel retro rocket cases used on several missiles; Dural booster disconnect valves for a classified missile program; consultation for **Martin, Denver,** on fluid flow problems in laying out *Titan* launching sites, and design study work on an entirely new system of missile handling.

Like many other small companies, Flight Refueling has contributed to some of the developments on its initial subcontracts, as well as initiating its own independent research and development programs in the new fields.

• **Picking a job**—In diversifying, executives must think long and hard about each bid opportunity lest they fritter away company resources. In aerial refueling, the market was fairly narrow and there was little question when and where to bid. This is not the case, however, with the new and diversified markets, many of which hold great promise for the company's technical team, but are somewhat of a mystery to the company's business and sales organization. The "digging out" of most promising prospects to determine those best adapted to the company's facilities, engineering talent and manufacturing skill is perhaps the most difficult problem which faces the management of the small company. Time, effort and money wasted on projects of limited future can, indeed, nullify much good effort toward diversification.

This situation is further complicated by the involved procurement requirements for defense products which often places the small engineering firm at a distinct disadvantage in competitive bidding.

"Perhaps the fairest method for the small company bidding on development projects," says William F. Whitesides, Flight Refueling's Engineering Manager, "is that used by a few of the larger companies. These companies request technical proposals without price on the first round of bidding. Then when the best technical solutions to the problem are determined by evaluation, they ask those two or three companies which have submitted the best technical proposals to submit priced bids for further competitive evaluation."

West Germans Uninterested in Moon Shots

by a M/R Correspondent

MUNICH—The recent agreement of the Council of the Western European Union to permit West Germany to manufacture certain antiaircraft missiles has not found enthusiastic approval among West German experts.

"We do not have any desire to help develop deadly weapons, even if we are permitted to do so! said a noted scientist who does not want his name revealed. "We have great plans—but only with small rockets and missiles and for pure scientific purposes. We do not even want to shoot for the moon!"

Among the scientists presently working in Germany are such well-known men as Professor Herman Oberth, the "Father of the Space Age." Last year he returned from the U.S., where he had been working with ABMA, to his home near Nuremberg.

The town of Stuttgart is the home of Professor Dr. Eugen Sanger and his physicist-wife, Dr. Irene Bredt. Sanger is the head of the "Research Institute for Jet-Propulsion" there. He is better known as the originator of the "Antipodal-Glide-Bomber" and the "Photon-Rocket." The latter theory, published in 1955, is believed to be the ultimate goal in space flight. Exhaust velocity of a photon-rocket would be equal to the velocity of light in a vacuum.

•**Substantial activity**—There are two astronautical organizations presently working very actively in West Germany. Both belong to the International Astronautical Federation whose new president is Russia's professor Sedov. The "German Society for Rocket-Technology and Spacetravel," headed by Prof. Sanger, and the "German Rocket-Society," under its president Dr. Ing. A. Staats.

The latter group puts main emphasis on experiments on a practical scale; the first group under Prof. Sanger is mainly engaged in theoretical research. Both groups have one common problem: a meager budget.

It has been possible, mostly through private contributions, to erect a new static test-stand near the town of Wildeshausen. First tests with rocket-motors developing a thrust up to 20,000 lbs. will start next spring.

A. L. Feldman

Al Feldman is thirty-one. A Cornell BSME, he joined Aerojet as a development engineer in 1954. His present job: Head, Propulsion Systems Department, Liquid Rocket Plant, Sacramento. The assignment: design and development of rocket engines for the TITAN missile.

His talent for careful analysis and willingness to meet the toughest problems have brought Al Feldman recognition and responsibility. But his progress at Aerojet is not unique. We'd welcome the chance to discuss similar opportunities with *you*. Send your resume to: Director of Scientific and Engineering Personnel, Box 296J—Azusa, California, or, Box 1947J—Sacramento, California.

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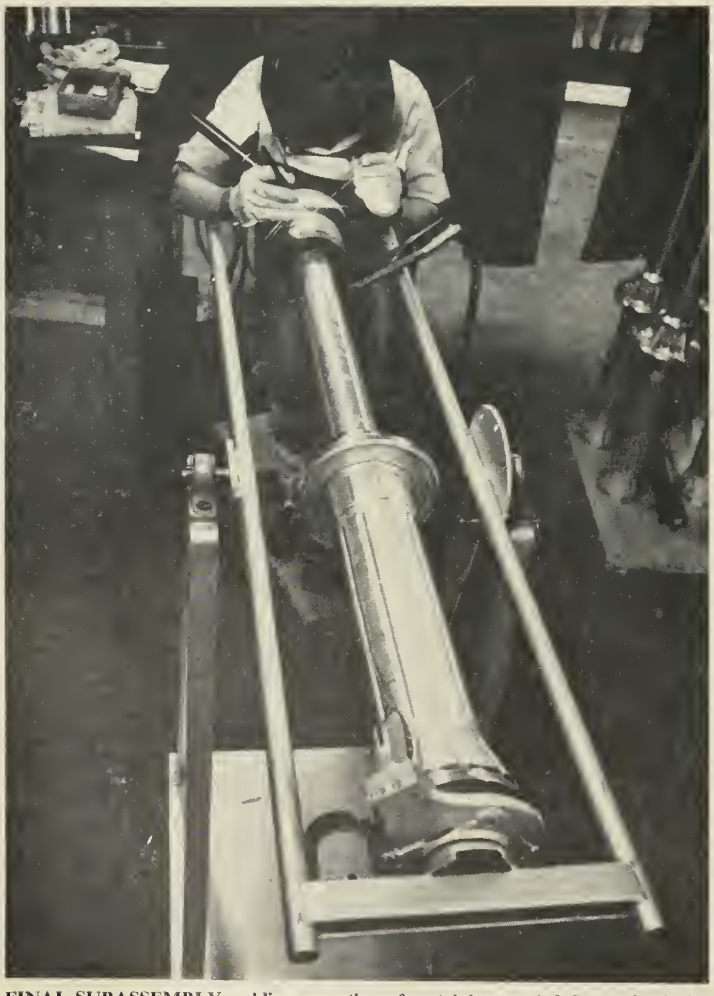
Will *Titan* Switch To Storable Fuels?

Prepackaged liquid systems concept profits from advances in storable fuels and oxidizers; encapsulation techniques may be applicable



FINAL SUBASSEMBLY welding operation of a stainless steel deflector for Thiokol Chemical Corporation's Guardian I packageable engine combustion chamber.

by John Judge

WASHINGTON—Storable liquid propellants have developed to the point where they are threatening areas now exclusively occupied by cryogenics and solids.

The technology is such that **Aerojet-General** is currently engaged in research and development involving the feasibility of converting the high-thrust *Titan* engines to storable fuels.

The advances in these power sources are directly proportional to the progress in prepackaged engines, since the "canned" engine is only as good as its propellant.

"Canned" units—in which the liquid propellant, oxidizer and pressurizing medium are sealed into a tankage shell which in turn, is integral with the rocket thrust chamber—are rapidly approaching maturity.

In essence, the high performance characteristics of liquids and the reliability, storability and handling ease of solids are combined in the prepackaged engines.

• **An old idea**—The concept of canned units is not new. German engineers were entertaining the idea at the end of the Second World War. But the early interest was somewhat discouraged by the comparatively low levels of energy available in storable liquids. Today, however, with all the advances in the chemistry of various compounds, the activity has increased tremendously.

Basically, a prepackaged engine consists of two propellant tanks, a pressurizing medium and a thrust chamber. Many variations of this configuration are possible. For instance, an experimental engine developed by the Naval Ordnance Test Station at China Lake, employs a burst diaphragm method to mix the propellants in the chamber. The trend is toward simplicity, both in design and operation.

The propellant combinations are forced under pressure into the reaction chamber where they ignite on contact if hypergolic, or some small initiator is used if they are not. The pressure medium can be stored gas, a small simple solid-propellant gas generator or a liquid chemical type. The pressure medium must be small, self-starting and provide constant or controllable generation throughout its operation.

The components must be able to withstand all storage, handling and environmental requirements.

• **Basic advantages**—The advantages in the prepacked concept evolve from the system's ability to combine the best features of both the liquid and solid engines in one simple device.

Such propulsion units are instantly ready for firing and capable of long-term storage without ill effect; they reduce support equipment to a minimum, and because of the simplicity of the device, its reliability factor is excellent.

In addition, canned units may be factory-adjusted for different missions. Blending of various fuels and oxidizers provides the optimum combination for any given job. This also holds true for environmental requirements imposed by the climatic conditions at any given launch site.

Many propellant combinations are hypergolic, thus simplifying the starting and restart problems. The entire powerplant when ready for firing is completely safe, since the propellants are inert until mixed for reaction.

Finally, the entire engine lends itself to comparatively easy scaling operations. The size range is almost unlimited.

• **Future expansion**—Aerojet confidently predicts that by 1961, it will have storable systems which will exceed the I_{sp} of most of the present day cryogenics with the exception of the hydrogen-fluorine system. The theoretical I_{sp} of the current storables is in the 275 to 290 second range (1000 psi at sea level) and Aerojet expects to increase the vacuum I_{sp} from the present 315 seconds to 360 seconds.

Thiokol is also on record as a cryogenic competitor. Its packaged Guardian units already power the Navy's *Sparrow III* and *Bullpup* missiles. **Reaction Motors'** Guardian series have been scaled up experimentally to deliver 50,000 lbs. thrust. Company spokesmen point out that none of the inherent advantages of the smaller units were lost in the scaling operation.

Both of these companies have been working with the prepackaged concept for a long time.

There is evidence that **Rocketdyne's** activity in this area is considerable. Research is underway toward tailored mixtures for specific applications and new metallic and non-metallic materials are being developed for use with corrosive liquids.

Much of the effort in packaged systems is classified, since the basic concept particularly appeals to the military. Aerojet is devoting considerable time to design considerations, in thrust chambers, nozzle configurations, injector design and materials of construction. Thiokol is also involved in enlarging the Guardian family; it can be assumed that others are pursuing such avenues.

• **Encapsulation proposed**—A serious problem in prepackaged engine development is that the tank materials must be compatible with the propellant combinations. Many compounds that could be used as oxidizers are extremely reactive and unstable. A suggested means of incorporating these substances into fuel systems is to encapsulate them in small pellets instead of containing them in large tanks. The possible uses of capsules in rocket propulsion are obvious: they could contain oxidizers, dampers or exotic additives, remaining inactive and protected until the instant of use.

Scientists at the **Southwest Research Institute** point out that another concept in prepackaged engines could be based on encapsulation. Such an engine would change from a liquid to a free-flowing solid system, the liquids being encased in thin, uniform, continuous films.

Recently, the Institute's Department of Chemistry successfully metal-coated a liquid-containing capsule. The laboratory method involved freezing the capsule and dipping it in a bath of a low-melting metal. Although the technique was proven feasible, a great deal of research is necessary before such capsules could be manufactured in quantity.

• **Propellant Combinations**—The heart of the prepackaged engine is the storable propellant. With the exception of ammonia and hydrogen, the known energetically-useful liquid fuels are generally stable under ambient conditions. The oxidizer is the problem child. Elemental fluorine and oxygen are definitely the highest performing oxidizers known to man. All of the other oxidizers, solid or liquid are inherently inferior because of the available energy loss involved in combining these oxidizing elements into a molecular structure containing elements of lower oxidizing potential. But, obviously, cryogenics are not easily stored.

Apparently no single oxidizer or fuel exists which can be designated as the best propellant. No single propellant system can satisfy all of the requirements for all conceivable missions. Therefore while the prepackage concept is adaptable to 99% of present and anticipated propulsion needs, the fuel and oxidizer combinations may very well differ from unit to unit.

Considerable improvements have been made in storable oxidizers. The most familiar compounds are the modified nitric acids. And of these, the standard is inhibited red fuming nitric acid. A propellant consisting of unsymmetrical dimethylhydrazine and IRFNA has been stored for as long as three years at a temperature of 165°F. Nitrogen dioxide provides a higher performance level. Others in use include nitrogen tetroxide and hydrogen peroxide.

Chlorine trifluoride seems to be up for future investigation, primarily because it is about 30% denser than the conventional oxidizers. In terms of performance, density, hyperglocity and low freezing point, the trifluoride is an excellent oxidizer when used with amine or hydrazine base fuels.

Propellant combinations of possible future interest for canned systems are under development. I_{sp} of 290 to 300 is thought to be possible with a nitrogen tetroxide-lithium borohydride system, although the borohydride would have to be liquefied somehow. High density combinations such as aluminum borohydride-bromine pentafluoride yield a calculated density specific impulse of 450 seconds.

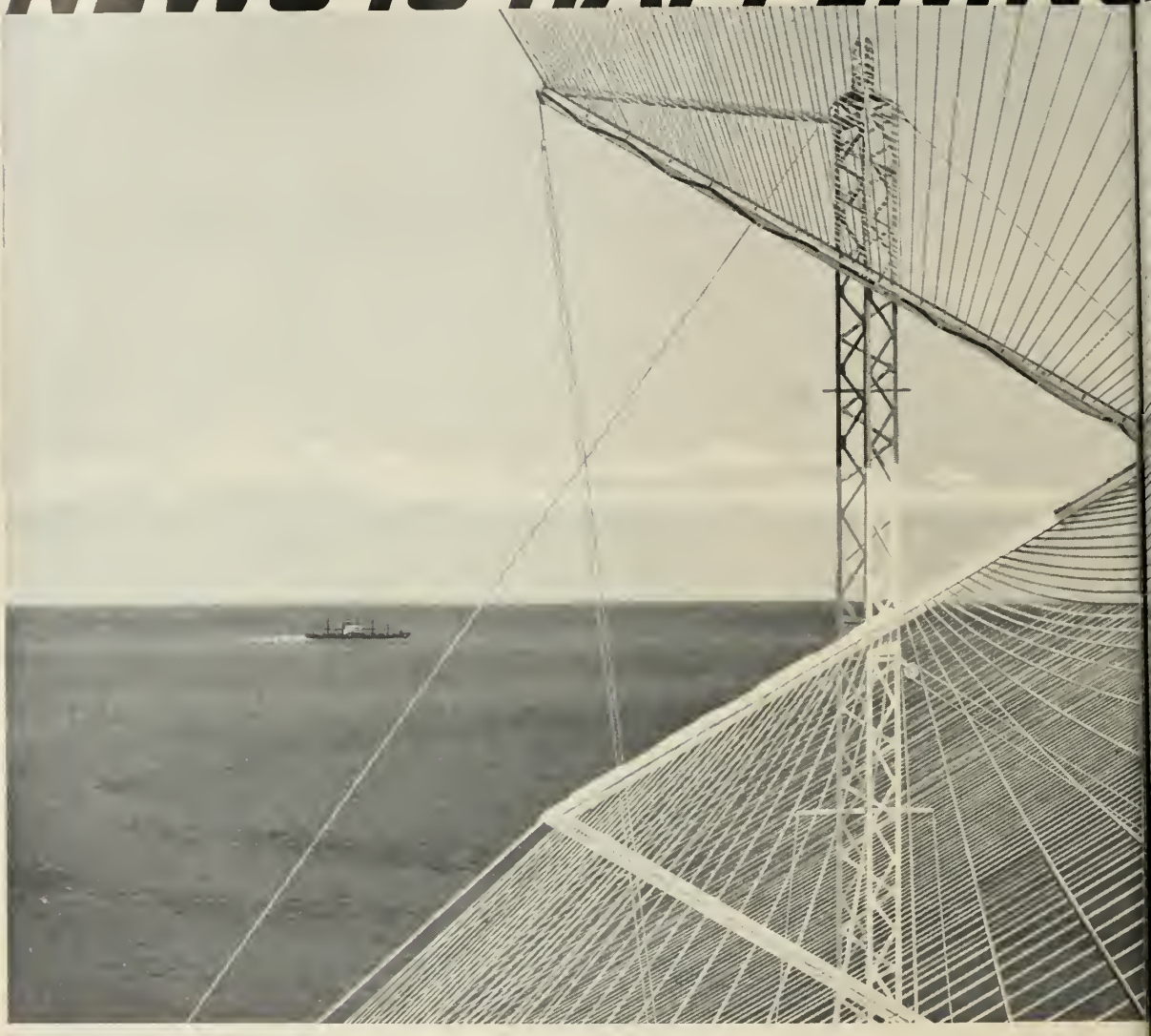
The application of the canned engine concept to ICBM and IRBM systems is an ideal one because of the instant readiness and high performance characteristics. Further, upper stages might effectively utilize a small packaged unit as a precise means of thrust vectoring. Since the engines could be easily shut off and restarted, the exact orbit might be plotted on the ground and the unit them turned on to achieve the mission.

Some space probe missions can be handled efficiently with the packaged engine, but the more difficult aspects such as soft lunar landings and deep space probes will still depend on the cryogenic systems.

Another interesting thought is the possibility of placing canned units in precise orbits. Then a system resembling the pony express concept—periodically replacing tired horses with fresh ones—could be utilized for the completion of advanced space missions.

The feeling is that the packaged engine may well be America's first all-around, off-the-shelf, high-performance thrust system within the very near future.

NEWS IS HAPPENIN



PAGE COMMUNICATIONS, LEADERS IN WORLD-WIDE TELECOMMUNICATIONS, USES "MOON MESSAGE" TECHNIQUES TO LINK THE FREE WORLD

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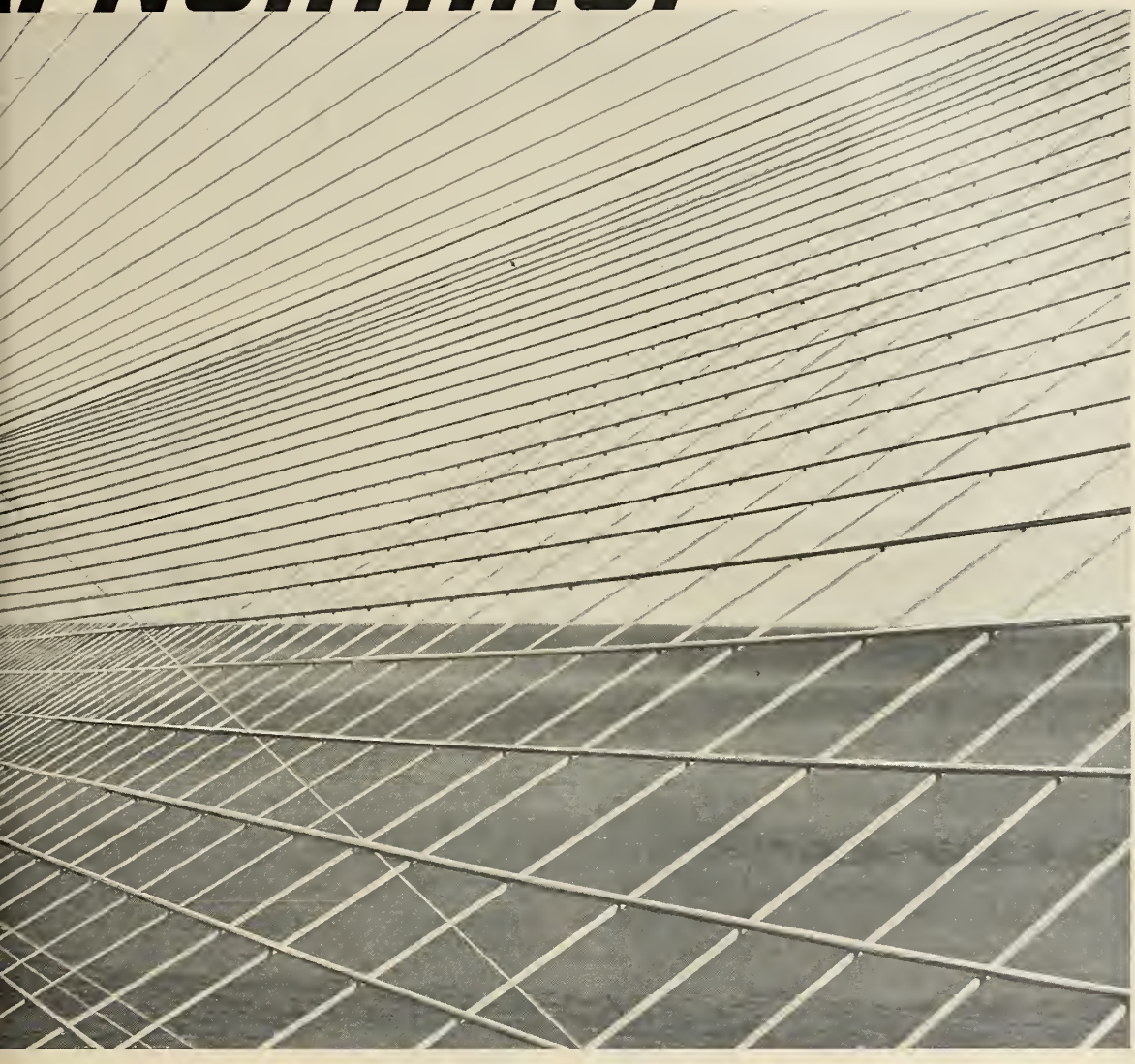
Page serves our Armed Forces on DEW Line and Pacific Missile Range. Page and its affiliate, Edison-Page in Italy, advance the arts of radio, television, navigational aids, telemetry and wave propagation. As a subsidiary of Northrop Corporation, Page typifies Northrop's continuing goal: maximum answers to the problems of present and future defense—at minimum cost.

NORTHROP CORPORATION *Beverly Hills, California*

AT NORTHROP

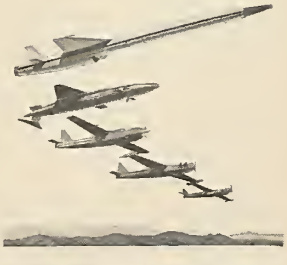


NEWS FROM OTHER MEMBERS OF THE NORTHROP FAMILY

ORAIR, outstanding creator of apon systems including related frames, is now producing the ark SM-62 missile, the T-38 lon trainer, and the multi- rpose N-156F Freedom Fighter.

NORTRONICS makes news with America's two most advanced inertial and astronertial guidance systems – LINS and A-5 – is 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.



RADIOPLANE, foremost producer of multi-purpose drones and recovery systems, is delivering unmanned aircraft that train men, evaluate weapon systems, and fly photo surveillance missions.

Transporting Big Boosters by Water

Plant-to-launch pad logistics is essential preliminary design consideration for multi-meg rockets; land, air travel is limited

DOWNEY, CALIF.—Designers of big rocket boosters for space vehicles have a problem as prosaic as the do-it-yourselfer building a 40-foot yacht in the cellar. How do you get it to the launch pad without taking the house apart?

This is a question which must be resolved before construction starts—very definite limitations exist in the various types of air and land transportation.

Only ships and barges offer no restrictions as carriers of oversize space vehicles. But, because there is a considerable problem in metropolitan areas in moving a 22-foot diameter booster even a short distance overland, suggestions are being advanced to locate the manufacturing plant near navigable waters.

This preliminary design consideration must be taken into account for the Nation's two big boosters—ABMA's *Saturn* cluster of eight **Rocketdyne** H-1 liquid engines and NASA's F-1 (formerly called *Nova*) also being developed by Rocketdyne—now in the program stage. Both these boosters will have about 1.5 million pounds thrust. *Saturn* will have an overall diameter of more than 20 feet and the exit nozzle of the F-1 alone will be larger than 12 feet in diameter. The booster propellant tanks for the F-1 are expected to create a number of logistic problems. And if liquid hydrogen is used, the tanks will be even bigger.

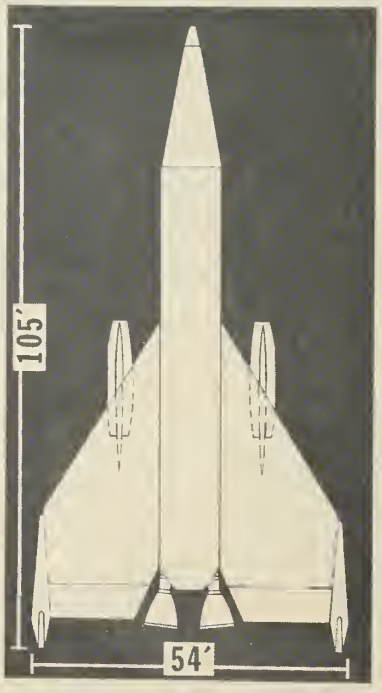
There are several other concepts being advanced for multi-meg-thrust boosters, including ones by **Aerojet-General** and **Thiokol,** which also must take into account the plant-to-launch transport problem.

A definitive study of the availability of transport has been made by Louis J. Walkover and H. L. Woodlief, Jr., both of **North American Aviation's** Missile Division. Their report, available to industry and government, is a compilation of all the standard means of transport via land, sea and air, and delineates their various physical and legal limits.

• **Flyable manned boosters?**—Ideally, the transport problem could be met with the least difficulty if the oversize booster could be flown to its destination by a pilot—the same as giant SAC bombers. Or if the booster is assembled at the launch site.

In the case of *Saturn*, which is being assembled and tested at Huntsville, Ala., it is proposed to put the big booster aboard a barge and tow it via river and the ocean to Cape Canaveral for launching. It has also been proposed to airlift the booster with a dirigible or blimp.

Walkover and Woodlief point out, however, that a lighter-than-air blimp large enough to carry a big booster would have to be developed first. And the science of dirigible building is 20 years out-of-date. They also point out that the development problem would apply to a helicopter. One that has been proposed to lift an 80,000-pound payload would have a range of only 100 to 150 miles without refueling.



HUGE MANNED recoverable booster would be moved by water or possibly flown from plant to launching site.

There are other forms of aircraft which might be useful, but they also would require development first. One type would be a conventional fixed-wing aircraft without a fuselage, in the true sense, which would carry the cargo in a pod suspended from the wing. Another approach would be to enlarge a conventional air cargo plane to handle big objects.

The largest available cargo plane today—the **Douglas** C-133A— can just accommodate the 10-foot diameter *Atlas* ICBM. So any booster of larger dimension must be transported by another means.

• **High transport costs**—Highway and rail transport are almost as restrictive as air transport. The study found that right-of-way railroad and highway clearances—even in cases where special routes and special permission was obtained—are limited to loads of a maximum 13 feet in diameter. Normal maximum diameter for highways is 8 feet, for railways 10 feet.

No matter how the transport problem is tackled, the report finds that it invariably will be expensive for boosters of 20-foot diameter or more because of the special handling involved.

Along the highways, special trailers would be required to carry the vehicle. And, aside from multifarious state highway laws (one state permits *Atlas* on its highways only from 10 a.m. to 4 p.m. weekdays and not at all on weekends) which complicate movement, there would be added expense in relocating power and telephone lines along the route, as well as traffic signs,

signal lights and trolley cables.

While truck transport in the West often appears feasible for oversize loads, it gets less attractive in the Eastern part of the country because of older highways, underpasses, towns and more numerous rivers to be crossed.

• **Ocean carriers**—Large ocean ships are satisfactory for shipping oversize airframes from one coastline to another or to the Great Lakes. Ocean-going commercial ships can carry large bodies as deck cargo lashed to the upper deck or as hold cargo stowed vertically down the cargo hatches. Special-purpose Navy ships such as LST's and LSD's can also carry large airframe bodies. Ships that could be used to transport oversize airframe bodies also include C-series cargo ships. Mariner cargo ships, T2-SE tankers, and Navy aircraft carriers and seaplane tenders.

Sea barges can carry large bodies and could possibly be towed directly into the inland waterway system without a transfer.

Some of the problems in ocean shipping are a little different from those in other means of transport. The cargo must be well protected from the sea if it is carried on deck. And the loading of the cargo on and off the ship requires overhead cranes and accurate positioning within confined spaces that could do additional damage en route.

Shipment of cargo by water carrier may be handled in several ways. The first way could be the use of commercial marine carriers that operate between specified ports or stations in the same way as a railroad. The disadvantage of using a common carrier is that they seldom go to the exact place desired.

An example of this can be found in water delivery of an oversize body to AFMTC, Florida. None of the commercial carriers makes scheduled stops at Port Canaveral. The closest regular stop is Charleston, S.C., at normal intervals of 1 to 4 weeks. A few lines will stop at Jacksonville, Fla., if given advance notice and special inducement pay.

In any case of this type, the cargo would have to be transferred to a barge and towed to Port Canaveral. There is the possibility that a carrier can be prevailed upon to stop and unload at Port Canaveral at the expense of an inducement fee.

The second means of ocean-going transport is via one of the ships of MSTS (Military Sea Transport Service). This service was established in 1949 for the control, operation, and administration of ocean transport of cargo, and personnel for the Department of Defense.

The operations involve the movement by sea of, and logistic support for, the Army, Navy, and Air Force outside the United States. DOD will authorize MSTS to support other agencies of the Government and to plan and negotiate for use of commercial shipping when necessary. Without the help of the commercial shipping industry, MSTS could not meet its commitments. Privately owned ships of the U.S. Merchant Marine carry over 70% of the military cargo. The MSTS fleet is made up of transports, cargo vessels, aircraft carriers, tankers, LST's, and various types of specialized ships. There are no LSD's in this fleet at the present time.

The MSTS is operated along the lines of a commercial business and its operating cost per ship is considerably below that for a similar ship manned by Navy personnel in fleet service. One of the reasons for the higher cost of a Navy ship is that the number of Navy personnel required aboard a typical VC-2 type (Victory) ship is about 250 as compared to approximately 50 men when the ship is in service with MSTS. Following are approximate operating costs for a complete ship in MSTS service, but do not include any loading or unloading costs.

	Cost Per Day
LST	$2250 per day
LSM	$1025 per day
AKL	$1500 per day
APZ	$2700 per day
C4	$3500 per day

The crews of the MSTS ships are civil service employees and not subject to a strike as are those crews aboard commercial ships. This fact could be important when the shipping time of a cargo is critical. There is an MSTS office in San Pedro, Calif., where additional information may be obtained concerning this transport service.

It was the consensus of persons contacted on the subject, that obtaining a regular Navy ship and its crew would be very difficult and undesirable for the transport of special cargo of the type considered in the report.

• **Cheaper by water**—In practically all cases, ships are loaded in this country by self-contained booms and hoisting equipment. In most foreign ports dockside cranes and overhead hoists are used for loading and unloading. Oversize loads would have to be hoisted on and off a conventional type ship.

Because of size and/or weight of cargo, it might be necessary to employ a dockside crane or possibly a floating crane along-side the ship to load and unload. Cargo does not have to be transported directly to a dock alongside the ship for loading—although this is most desirable—but instead may be loaded into a barge or lighter at one dock and moved across a harbor to the ship at its berth where it is hoisted aboard over the farside.

Oversize cargoes and heavy lifts have a higher tariff rate and require more insurance, boosting shipping costs. Even so, a large airframe body can be shipped much cheaper by water than any other means. Shipping costs may be obtained directly from the carriers involved in some cases. In other instances, estimates may be made by consulting the Freight Tariff Manuals published by Harry S. Brown, Agent, New York City.

Information on dimensions and crew complement for any Navy vessel can be obtained from the "Booklet for General Plans" for that particular ship and is available from any Naval Shipyard through the Navy Plant Representative at North American Aviation. Commercial-type ship information can be obtained from the Federal Maritime Administration, Washington 25, D.C. and from commercial carriers who have the various types of ships in service.

Transport Logistics

AIR TRANSPORT	SURFACE TRANSPORT	WATER TRANSPORT
INTERNAL CARRY	8 FEET DIAMETER	ONLY SIZE LIMITATIONS FOR WATER TRANSPORT ARE REQUIREMENTS FOR LOCAL ROAD TRANSFER FROM FACTORY TO PORT AND FROM PORT OF DEBARKATION TO LAUNCH SITE
C-133 AIRCRAFT	NORMAL RAIL AND MAX. ROAD TRANSPORT MODES	
10 FT. MAXIMUM TANK DIAMETER ON SPECIAL LOW BED TRAILER	10 FEET DIAMETER	SHIPS CAN CARRY 22 FT. AND LARGER DIAMETER TANKS
	MAXIMUM RAIL TRANSPORT MODE	
EXTERNAL CARRY	ROAD TRANSPORT REQUIRES SPECIAL PERMIT (WIDTH DEVIATION) AND SPECIAL LOW BED TRAILER	HARBOR AREA TRANSPORT
POD MOUNTING		17 FEET DIAMETER
HELICOPTER	13 FEET DIAMETER	RAISING OF MINIMUM NUMBER OF OVERHEAD WIRES
LIGHTER THAN AIR	ROAD TRANSPORT WITH PERMIT (HEIGHT AND WIDTH DEVIATION) SPECIAL LOW BED TRAILER AND SELECTED ROUTING	22 FEET DIAMETER
	RAIL TRANSPORT WITH SELECTED ROUTING	RELOCATING OF ALL OVERHEAD WIRES

Analogue, Digital Computers Wedded

by G. V. E. Thompson

LONDON—A hybrid system combining the high-speed and flexible programming of the analogue computer with the accuracy and speed of data-processing of the digital computer has been developed for missile homing investigations.

This automatic computer was described by J. G. Thomason of **Imperial Chemical Industries'** Central Instrument Laboratory, Reading, in a paper given recently to the Society of Instrument Technology.

This development arose out of an analogue computer investigation into guided missile system performance, made at the Royal Radar Establishment. During the investigation it was noticed that operation of the computer and subsequent reduction of the data were making excessive demands on labour which might have been employed on more creative tasks, particularly when effects of noise in a missile system were being studied. This involved making many repeated runs on the computer to obtain statistical results.

To overcome this, a project to fit an "automatic operator" and "automatic clerk" to the analogue computer was undertaken. In the system finally achieved, the analogue computer runs and resets its parameters in response to an input program punched on conventional 5-hole paper tape. Results are encoded and punched on an output tape, which is fed to the digital computer. This reads the tape and prints out tabulated reduced data. It can also operate a graph plotter if necessary.

Instructions for the analogue computer are read on a Creed tape reader converted for parallel operation and feeding the usual relay tree producing a 24V pulse on one of 32 terminals. These are conveniently named as in teleprinter practice, so that programming is reduced to punching letters.

The computer, developed in Thomason's laboratory, does not use standard commercial units. The operational amplifier in the analogue configuration is a non-drift-corrected 4-valve DC amplifier with a gain of about 12,000. Drift is cancelled by a separate zeroing unit using a motor-driven potentiometer to set the bias between runs. The divider circuit incorporates a cam-corrected potentiometer for each plane. The delay is continuously variable from 100 microsec. to 1 sec. in four switched decade ranges.

Summation, integration and limiting are conventional. A feedback method of obtaining quadratic-lag transfer functions is used in preference to complex single-amplifier configurations in order to achieve independence of control of frequency and damping.

The analogue-to-digital converter is of the conventional stepping-switch type working in binary code. Provision is made for accepting two analogue inputs and converting these in sequence.

The space and three of the four format instructions provided for teleprinter purposes are used to program the computer operations. One character is used to make the computer repeat the run the number of times that has been set on the run counter dial, to obtain statistical results. No more tape is read until this number of runs has been made. From 10 to 110 runs, in steps of 10, may be made. Indicators are provided for showing the number of runs already performed in a 'count' sequence, and the total number of runs.

Another character facilitates unattended running. When placed at the end of the program tape it cuts off the main supply to the whole computer. A time switch is also incorporated so that the machine warms itself up for an hour in the morning before it is needed.

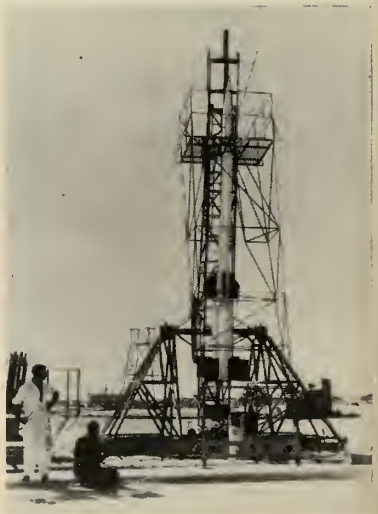
A special lightweight, high-performance, stabilized power unit has been designed. Its output is +300V 0-100mA; −300V 10-100mA; and −960V 1mA (not stabilized).

All timing is referred to the divider potentiometer. The timing potentiometer has a large angle of operation to overlap the divider potentiometer, and there are six comparators, one spare and five giving the timing for pre-beginning (release clamp circuits), missile stimulus in (preset), target stimulus in (preset), end of run (measure miss-distance), and post-end of run (operate clamp circuits).

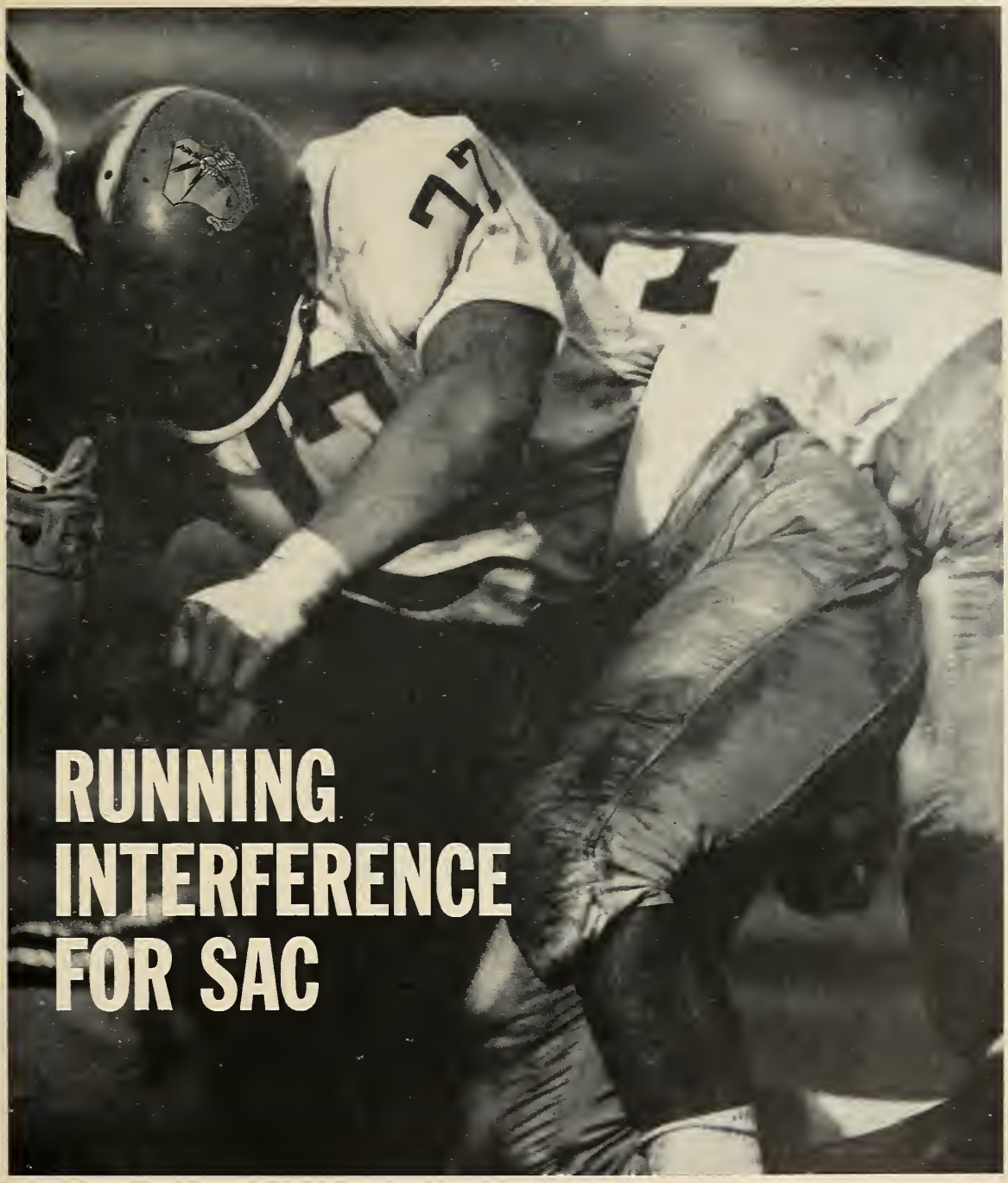
Miss distance is given by the voltage representing displacement error at the instant engagement ends. The charge is stored on a distrene-film capacitor with voltage indicated by a low grid current precision cathode follower driving a centre-zero milliameter.

The noise generator takes non-white noise from a thyraton and uses a mechanical relay modulator to select part of the noise spectrum which is fairly level.

AUSTRALIAN-built *Long Tom* rocket on launcher at Woomera. It is 27 feet long and weighs nearly one ton.



ANOTHER two-stager, also Australian-built and used at Woomera, is the 21-ft.-long *Aeolus*, weighing a half-ton.



RUNNING INTERFERENCE FOR SAC

Now SAC's B-52G has a pair of hard-running teammates... the GAM-77 Hound Dog air-to-surface missiles. They can lunge into action at supersonic speeds to clear a path for the bomber by knocking out ground-defense centers hundreds of miles away. A pair of Hound Dogs carried under the wings of the Boeing B-52 increases the bomber's striking power ... gives it a triple-punch capability. Successful test launches of the jet-powered missiles are being made on schedule over the Atlantic missile range. The system will be deployed by 1960 under the present accelerated development program.

The Missile Division of North American Aviation is weapon system contractor for the GAM-77.

MISSILE DIVISION

NORTH AMERICAN AVIATION, INC., DOWNEY, CALIFORNIA

'Lunar Suit' Proposed for Astronauts

Martin Co. design provides environmental controls, communications capability and sensing equipment for emergencies expected on moon

BALTIMORE—Electronics will play a major part in the uniform of a well-dressed lunar explorer. His protective suit will contain at least three complete electronic subsystems—for environmental control, communications, and emergency sensing. Essentially, the suit must provide the wearer with the same environment he now enjoys on earth.

Such a proposed "lunar suit" was described here during the recent IRE Aeronautical and Navigational Electronics Conference by three **Martin-Baltimore** engineers: F. J. Conley, R. K. Cassatt, and M. A. Grodsky. They pointed out that in order to survive on the moon, man must be protected from the hostile environment and yet be able to communicate and move about.

That the moon's environment is hostile is not questioned; but the extent and exact nature of these dangers are not known. Equipment design today must be predicated on existing knowledge and intelligent estimates. According to the Martin scientists, many of the hazards to man's ability to live and operate on the moon can be reasonably assumed. Among them are:

• **Cosmic radiation**—Although little information is available on this subject, it is known that primary cosmic rays are very energetic and dangerous secondary radiations can also be present. Such radiations undoubtedly are present on the atmosphereless moon.

• **Van Allen radiation**—Preliminary satellite test results indicate the possibility of high-intensity radiation in the area of the moon. Levels can only be guessed at, but the intensities may be dangerous.

• **Meteorites**—Damage may be inflicted on a man and equipment by meteorites or dust particles. Large particles may penetrate the protective covering of a space suit and equipment packages; small particles could produce erosive action on optical and solar battery surfaces.

PILOT'S HELMET equipped with a miniaturized radio transmitter is shown by Martin Co. engineer Francis J. Conley.

In spite of the theory that meteorite impacts on the moon may range up to about 160 per hour per square meter, however, it is not certain that they will cause serious problems. *Vanguard I* has been in orbit for over one and one-half years and has suffered no detectable damage. Other satellite evidence indicates relatively small damage by meteorites.

• **Temperature**—Surface temperatures of the moon may range from +215°F during the lunar day to −243°F during the night.

• **Atmospheric pressure**—Based on radio telescopic observation, atmospheric density of the moon is in the order of 2-6 x 10^{-13} earth atmospheres. The upper limit is usually considered to be about 10^{-7} atmospheres.

• **Solar radiation**—The solar radiation level on the moon's surface has been estimated to be well within man's tolerable limits.

• **Magnetic field**—The magnetic field surrounding the moon is in the order of 0.14 x 10^{-5} gauss. Based on these expected environmental conditions, protective and operational measures would depend to a large extent on reliable miniaturized electronic equipment.

• **Space environmental control**—The space explorer must be maintained in an environment very near that of earth. This can be done with electronic control and sensing devices not too different from those presently used in high-speed jet aircraft and high-altitude balloons.

Temperature can be held within tolerable limits with an electrically heated suit. Thermistors could be used as temperature-sensors. Individual circuits for each portion of the body would compensate for the wide temperature variance between the man's head and feet during the lunar day.

The pressure within the suit must also remain constant. A suit pressure of 5 psi would give a satisfactory equivalent earth altitude of 27,000 feet.

Electronic sampling and sensing devices would monitor carbon-dioxide, oxygen content, and other trace gases to ensure that the chemical recycling filters operated properly.

Under certain conditions, current operational pressure suits allow the wearer's breath to condense on the inside of the face plate. Electrically heated double-walled facepieces would be necessary to prevent fogging and frosting.

Estimates indicate that there is 30% more light on the moon than on earth. In addition, since there is no

diffusing atmosphere. transitions from high to low light levels would be severe. A device to limit the intensity of light entering the face place would be needed to prevent retinal burning. It would have to be operated by the light source itself; as intensity increased, a sensing unit would actuate a protective shield of shutters or polaroid lenses.

• **Communication equipment**—Exploration parties on the moon will require radio for communication between individuals and their vehicle or home base. A UHF line-of-sight link will be used for its noise-free characteristics, proven reliability, and small antenna sizes.

For more efficient communication, the system should emulate, as far as possible, human voice characteristics. Signal strength should be proportional to oral volume, with range limited to points normally reached on earth by a shout. Antenna radiation patterns would resemble normal voice propagation (forward and directional). A switching arrangement would permit omnidirectional full-power transmission during an emergency. Radio equipment must be miniaturized, efficient, and reliable, with power outputs in the order of 600 mw.

• **Emergency sensing equipment**—Since the slightest malfunction could cause serious injury or death, all environmental and communication subsystems must be adequately monitored. As an example. in the case of oxygen failure, a man's system undergoes certain characteristic changes which can be electronically sensed and a warning activated. Repairs or adjustments can be made before serious injury occurs.

All the system indicators, functional switches, and controls must be within easy reach, with a miniaturized control panel mounted on the forearm or top thigh of the suit. The electrical wiring bundle could be molded into the suit's fabric outer layer to prevent damage, and terminate in a quick-disconnect which would plug into the back support-pack.

There is a possibility of exposure to a meteor shower that could puncture the space suit or damage the equipment. Consequently, a device mounted on the suit or helmet to record the impact of particles would be necessary. The frequency of hits would warn of an oncoming meteorite shower and allow the man to return to base or seek natural shelter.

These and other considerations presented in the paper, although speculative to a degree, pose no formidable problems to the design of a protective suit for a man on the moon. The equipment specified is all well within the present state of the electronics art.

A SPECIAL KIND OF POSITION
FOR SPECIAL KIND OF MEN

To help meet the urgent and continuing problems of national security, RCA has created an Advanced Military Systems Department at Princeton, New Jersey. There, in an atmosphere of complete intellectual freedom, men of a very special kind are engaged in highly sophisticated analysis and study of our national defenses—present and future—and how they can be made most effective to meet any future enemy capability.

THE POSITION—Studies conducted by the RCA Advanced Military Systems Department are of the broadest scope and cover such diverse areas as physical and engineering sciences, military science, economics and geophysics. Accordingly, each member of the technical staff may select his own area of work. The only requirement: results must have a direct application to problems of national defense.

Each staff member is provided with every opportunity, facility and detail of environment to use his creative and analytical skills to maximum advantage and at the highest level. He has no responsibility for administrative details. He can call in any specialists he may need. He has full access to all available information—military, academic and industrial. Furthermore, specialized research projects and laboratory work can be carried out at his request by other departments of RCA.

THE MEN—The men who form the technical staff are a group of mature scientists and engineers. They are accustomed to responsible positions in industrial research, advanced development, or systems planning. Most of them have an extensive background in the broad fields of electronics, vehicle dynamics (space, marine or terrestrial), physics (astro, nuclear, or plasma), or operations research (military science). All are men who enjoy seeing the fruits of their work have a far-reaching effect on the defenses of the country.

THE LOCATION—Princeton offers unique civic, cultural and educational advantages. The RCA Advanced Military Systems Department itself occupies a new, air-conditioned building on the quiet, spacious grounds of RCA's David Sarnoff Research Center.

INQUIRIES ARE INVITED—If you are interested in learning more about this far-reaching program and the unusual opportunities it offers to qualified men, write:

Dr. N. I. Korman, Director
Advanced Military Systems, Dept. AM-1K
RADIO CORPORATION OF AMERICA
Princeton, New Jersey

EQUAL JOB OPPORTUNITY For All Qualified Applicants

RCA

RADIO CORPORATION of AMERICA

Please Credit RAF

To the Editor:

I have seen in M/R Oct. 12, page 43 ("More About the Missile Week") an item datelined "Cape Canaveral" reporting that the Air Force successfully launched three big missiles in 14 hours. Reading further, it seems that a Royal Air Force crew launched one of the three.

Presumably your printer dropped an "s" from Air Force.

While we appreciate that the U.S. Air Force makes every effort to launch missiles successfully, in the interests of our morale it is requested that you do not assume that the Royal Air Force is a part of the U.S. Air Force.

C. F. Hobbs
Bytown Inn
O'Connor & Albert Sts.
Ottawa, Ontario
Canada.

M/R dropped language, made no such assumption.—Ed.

Telemetry Revisited

To the Editor:

Your article "What's Wrong in Telemetry?" (M/R 10/5/59) was most interesting. I cannot help but wonder, however, why no mention of **Data-Control Systems, Inc.?** Of 24 companies named, it is our belief we shipped more telemetry equipment the past calendar year than sixteen of them. You cite the *Minuteman* PCM contract but fail to mention that DCS received the FM/FM ground telemetry contract for the missile.

Further, you refer directly to our company's recently announced development of a "Frequency Translation System."

Further, at the recent telemetry show in San Francisco, DCS exhibited the first truly operational solid-state, high-performance discriminator.

Further, our personnel will author a significant portion of a definitive handbook on telemetry now being prepared by a major publisher.

Further, I am sure members of our engineering department would make anyone's "Who's Who" of telemetry equipment designers . . .

Further, we are one of the few companies to offer a complete line of ground and airborne equipment. We also conceive, fabricate and install complete airborne and ground systems.

We think we at least rate a mention.

Robert J. Jeffries, President
Data-Controls Systems, Inc. and
over 250 chagrined employees.

To the Editor:

We at **Texas Instruments** heartily concur with the remark in the "What's Wrong in Telemetry?" article, stating: "Boiled down, it simply means that one doesn't always know what either of the other two are doing." Except that we would expand this state of confusion to include harassed editors. Though not mentioned in this round-up article, TI is certainly a mainstay of the telemetry business. Consider, as an indication, the following systems being built for the missile industry by TI: **Boeing:** *Bomarc A,* Model "C" 45-channel PDM/FM/FM telemetry system. First transistorized telemetry system in quantity production—anywhere. **Temco:** *Corvus,* 90-channel PDM/FM/FM telemetry system transistorized except for SCO's and transmitter final stages. **McDonnell:** *SR138,* modified *Bomarc* system, PDM/FM/FM. **Convair:** *Centaur,* FM/FM, telemetary systems. Extreme reliability requirements. Completely transistorized except for power stages of transmitters.

In addition to complete systems, TI is supplying important subsystems on the following: **Martin-Denver:** *Titan,* complete signal conditioner system. **Martin-Orlando:** *Pershing,* signal conditioners. **Boeing:** *Minuteman,* 90-channel, low-level PDM system. **McDonnell-Collins:** *Mercury,* RF package (two transmitters and two power supplies).

And supporting these activities in systems and subsystems, TI has an aggressive components and equipments development program under way. Products of this program now in use are transmitters, SCO's PDM keyers, solid-state commutators, all types of signal conditioners, transistorized choppers, etc. Other programs nearing completion or awaiting appropriate applications are low-level electronic commutators, investigations of practical high-frequency equipments, digital (PCM) telemetry systems and equipments, and deep space tracking, navigation and communications equipments.

We appreciate the problems of achieving completeness in any editorial "round-up" type feature.

R. J. Mitchell
Data Presentation Manager
Apparatus Division
Texas Instruments

To the Editor:

In reading your article titled "What's Wrong in Telemetry," we were a bit disappointed to see that **Dorsett Laboratories, Inc.,** of Norman, Okla., was not listed among the Who's Who in the Telemetry Field.

We don't claim to be a pioneer in the telemetry systems and components business, but the past few years have proven us to be a strong contender. Our experience ranges from balloons to the *Mercury* capsule.

Two recent accomplishments of possible interest to your readers are: Dorsett was chosen to supply telemetry systems for experimental **Ryan** Q-2C drones, as well as the production Q-2C drone. These systems were specified to meet the rugged MIL-E-5272 environmental specification. And, also, the fact that at least three firings of the NRL *Nike-Asp* sounding rocket will be made with a 3-lb., 8 channel system, built by Dorsett in a cylindrical configuration using transistorized subcarriers and featuring 2 watts output.

We're very much in the airborne telemetry business.

D. M. Klotz
Sales Promotion Manager
Dorsett Laboratories, Inc.

To the Editor:

In your article "What's Wrong In Telemetry?" there is no mention of **Arnoux Corporation** as a supplier of telemetering equipment. I am sure this is simply an oversight on your part, for Arnoux is a major producer of both instrumentation systems and telemetering components . . .

Two years ago, Arnoux entered the decommutation equipment field with TDS, a PAM-PDM Decom. Since that time, we have sold more decommutation equipment than all other manufacturers combined. I don't want this to be a sales pitch, but the reasons, briefly, are reliability, small size, less power consumption, less heat generation, greater versatility, ease of operation and others. The major ballistic missile and space programs are all using the TDS.

Lester Cole
Advertising Manager
Arnoux Corporation

'Selling' Missile Spending

To the Editor:

In the past (and present) issues of your fine magazine, you have editorially lamented the state of our missile program. In these editorials, you have brought forth the following facts:

The Administration lacks the necessary leadership at this time to provide a vigorous missile program.

One reason for this is that the necessary agencies lack the necessary funds to institute a crash program.

The above is due to the fact that such funding would unbalance our national budget.

The administration wants a balanced budget.

You imply (and I agree) that the reason a balanced budget is so desirable at this time is that 1960 is an election year, and the fact that the present Administration can point to a balanced budget seems to be a method of gaining votes for the upcoming candidates. Because of this, it would seem that the converse would be true; an un-

balanced budget at this time would produce less votes.

Because of this attitude in Washington, we are told that many industrial leaders are resigning themselves to a period of relative inactivity until after the 1960 election.

Problem immediately evident: What can be done to rectify the situation?

You have stated the answer to the problem of "what-can-be-done-about-our-lack-of-funds?" by saying "We must get more funds."

You don't say how, other than that they must be provided for.

This solution is somewhat like the solution once given by a doctor to one of his patients. The patient complained to the doctor that after he woke up in the morning he would have a terrible headache that would last for an hour, then vanish. The doctor told him to sleep an extra hour.

Both these "solutions" are not solutions, but evasions. Or, in the case of the missiles, perhaps it would be better to state the question and the answer of funds are both too fundamental. The question should be: "what can we do to convince those responsible that the allocations of necessary funds are necessary and much more important than a balanced budget?" This shift in emphasis is important. We know the answer of where to get the funds, the question now becomes one of *how* to get the money.

The answer is to use the same instrument that is hampering the outlay of the necessary appropriations to help us get them.

The instrument that has prevented proper funding is the fear that an unbalanced budget will lose votes. What is necessary to do, therefore, is to demonstrate that a huskier missile program will gain more votes than a balanced budget. This is strictly a job of salesmanship.

It can be accomplished on two levels. One level is that which can be performed by every citizen, namely writing one's congressman, the President, etc. The other is a united industrial lobby to the same effect, favoring nobody, but pointing out the necessity of an agressive missile program.

Then, a final thing can be done: public education, industry-sponsored. The other week, *The Biography of a Missile* was presented coast-to-coast. If something similar was done over a nationwide TV net, or through a released motion picture, explaining our crying need for a united, agressive, long-range missile program, it would help bring pressure to bear in Washington for a slightly unbalanced budget at this time to insure we *have* a budget to balance a number of years hence.

Stephen A. Kallis, Jr.
447 Manning Blvd.,
Albany, N.Y.

THE GRAND CENTRAL REPORT

Grand Central Rocket Co.'s recent contribution to case bondable, high impulse propellants contains ammonium perchlorate and powdered aluminum in a tailor-made synthetic rubber based on butadiene and acrylonitrile.

This rubber has excellent physical characteristics over a wide range of temperature even when filled with a high proportion—over 80%—of oxidizer and metal fuels. The propellant itself maintains nearly the same combustion properties over a wide range of temperature. It has been loaded into multi-ton rocket motors to give an inherently reliable, intrinsically simple propulsion system for an important defensive weapon.

Grand Central Rocket's propellant research is continuing along short, medium, and long-range paths aimed at higher propellant specific impulse and density. The primary objective is to provide the advanced rocket and missile designer *on schedule* with reliable, case bondable propellants which will meet or exceed his requirements.

Whereas present-day solid propellants deliver a specific impulse of not much better than 240-245 lbf-sec/lbm, many of those which will be used operationally three to five years hence must deliver 255-265 lbf-sec/lbm. Beyond this, to meet requirements for manned escape vehicles of the next decade, Grand Central Rocket plans to have propellant systems *delivering up to 280 lbf-sec/lbm or better.* Judicious combinations of new liquid oxidizers as well as new solid fuels may be used to achieve this goal along with the needed thrust control.

To further this effort, Grand Central Rocket Co. will draw on the results of Advanced Research Project Agency contractors as well as on the research of its corporate affiliates, Food Machinery and Chemical, Tennessee Gas Transmission, Petro-Tex, American Potash and Chemical Corp., and National Distillers.

At the same time research efforts will continue on reducing the proportion of inert rocket components by improving the designs of propellant charges, nozzles, and cases.

Albert T. Camp

A. T. Camp, Assistant Vice President
and Director of Research

(If you have the qualifications that a fast-moving space propulsion team needs, contact our Director, Personnel. Openings now for chemists and engineers.)

Grand Central Rocket Co.

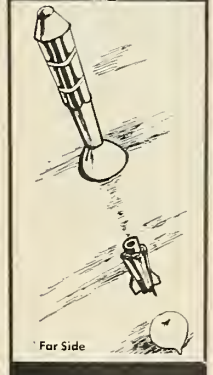
An Affiliate of Tennessee Gas Transmission Company
And Food Machinery and Chemical Corporation

P. O. Box 111 Telephone: PYramid 3-2211
REDLANDS, CALIFORNIA


Mercury


Terminal Stage, NASA


Explorer III and IV


Far Side


Vanguard


Nike-Zeus


Test Sled

Gen. Donald L. Putt, president of United Research Corp., was named 1960 president of the Institute of the Aeronautical Sciences at its recent national meeting.

General Putt, who retired in 1958 after 30 years' service in the Air Force, has held positions ranging from test pilot to Chief of Staff, USAF. At one time he was commander of the Air Research and Development Command, USAF. Following his retirement, he served as special assistant to **Dr. Theodore von Karman,** director of the National Academy of Sciences.

United Research Corp., a subsidiary of United Aircraft Corporation, is engaged in research and development in the fields of rockets and advanced propulsion systems and solid and liquid propellants. At the same time Putt became its president in 1958, he took on the duties of chairman of the Scientific Advisory Board to the AF Chief of Staff. He was also a member of the National Advisory Committee for Aeronautics for nine years.


RICHARDSON

Hughes Aircraft Company announces that **Iden F. Richardson** will be the new manager of the Hughes Products Group at Newport Beach and Costa Mesa, Calif. Richardson previously served for 23 years at Bendix Aviation Corp., where he last held the position of general manager of the Kansas City division. He holds a bachelor's degree in engineering from Purdue University and a master's in business administration from Harvard.

Richardson will replace **Raymond B. Parkhurst,** who held the position while the two manufacturing facilities were being completed. Parkhurst will resume his duties as vice president-manufacturing.

Harold R. Boyer has been elected a General Motors Corp. vice-president and General Manager of the Defense Systems Division, by the GM board of directors. Director of Military Products for GM since April, he joined the corporation in 1925 as a works engineer for Pontiac Motor Division.

From 1930 to 1940, Boyer was president and general manager of the Allen Corporation, Detroit. Before rejoining GM in 1943, he served as Chief of the Aircraft Manufacturing Branch of the War Production Board. He also served the government in 1951 and early 1952 as Chief of Aircraft Production for the Defense Production Administration.

Dr. Bernald Litman has been assigned director of the Flight Test Program for the first flight tests of the all-inertial guidance system in the Air Force *Atlas* ICBM produced by the American Bosch Arma Corp. The tests are scheduled for sometime in 1960 at Cape Canaveral.

Dr. Charles D. Bock, director of the Technical Staff in Engineering Operations, Operations, Arma Missile Guidance Department, has been assigned the responsibility for in-plant technical decisions required by the Flight Test Program.

Dr. Anthony D. Kurtz, former Director of Research of the Semiconductor Division of Minneapolis Honeywell Regulator Co., has been appointed General Manager and Executive Vice-President of Kulite Semiconductor Products, Inc.


KURTZ

In his new position, Dr. Kurtz will be responsible for research, development and production activities in semiconductor materials and devices. He received his B.S., M.S., and Sc.D. degrees from the Massachusetts Institute of Technology in the fields of physics and physical metallurgy.

He is a member of the American Physical Society, The Institute of Radio Engineers and the American Society of Metals, and has published numerous articles on solid-state physics and semiconductors.

Dr. Frank H. Shelton has joined Kaman Nuclear, a division of the Kaman Aircraft Corporation. He was formerly Technical Director of the Department of Defense Atomic Support Agency for four years. In this position, he coordinated the Pentagon's programs on the nuclear weapons tests in Nevada and the Pacific, directed its world-wide fallout activities, and was the scientific director of the Argus nuclear weapons tests in the South Atlantic in the summer of 1958.


SHELTON

Included in his experience are three years at Sandia Corporation's Nuclear Weapons Effects Division. He has also engaged in research pertaining to nuclear reactors, studies of various high temperature alloys, and cosmic ray research.

Dr. Shelton received his B.S., M.S. and Ph.D. degrees in physics from the California Institute of Technology.

Theodore J. Smith has been named Packard Bell Computer Corp.'s sales manager. Smith is a Maryland University graduate in engineering. Before joining Packard Bell Computer, he served as chief applications engineer for the Nuclear Division of American Electronics, Los Angeles, and assistant to the vice-president for engineering at Gilfillan, Inc.

Dr. Lloyd P. Smith, former president of Avco Research and Advanced Development Division and a director of Avco Corp., has joined Aeronutronic, a division of Ford Motor Co., as director of Research Operations.

He is also a member of the Advisory Committee on Grants, Research Corp., of New York City; Advisory Council, Fund for Peaceful Atomic Development, and Advisory Committee on Solid State Physics, Office of Naval Research. He is chairman of the Advisory Council of the Electrical Engineering Department; Princeton University, chairman of the Corporation Committee, Cornell University; chairman, Advisory Panel for Physics, National Science Foundation; and a member of the Research Division of the American Ordnance Association and Chairman of the Physics Section.

Robert A. Franklin, author of numerous scientific papers on electronic and nuclear subjects, has been appointed Manager of Engineering of Stromberg-Carlson-San Diego, a division of General Dynamics Corporation.


FRANKLIN

An engineering graduate of University of Washington, he also received an M.S. from the University of California. His business experience includes: staff engineer for the Submarine Signal Co.; chief of the radar section of the U.S. Navy Electronics Laboratory in San Diego; establisher of the Franklin Engineering Co., and technical advisor to the Air Force Special Weapons Center at Albuquerque. He held the position of regional manager of Radiation, Inc. Albuquerque, until his appointment at Stromberg-Carlson.

Hobart E. Switzer, has been appointed to the position of Director of Manufacturing of Interstate Engineering Corporation's Missile Division, Anaheim, California. **James R. Day,** who was associated with the late **Major E. H. Armstrong** in the development of wide-band frequency modulation, has been elected a director of Radio Engineering Laboratories, Inc., communications subsidiary of Dynamics Corporation of America.

Robert F. Halligan has been named executive vice-president and general manager of The Hallicrafters Company. **Ivar C. Peterson,** will assist the president of Lear, Inc. in directing and supervising technical planning.

propulsion engineering . . .

By JAY HOLMES

Two electrical propulsion schemes . . .
now show promise of being ready for use by the time we need them—when we develop reliable boosters for manned space vehicles and satellites weighing 10,000 pounds and up. Both ion and arc-jet (also called plasma jet) rockets are low-thrust, lightweight long-duration systems far superior to chemical and nuclear propulsion for maneuvering in space.

But the two fill different missions . . .
The ion rocket, although its specific impulse is higher, has a much lower thrust-to-weight ratio. The arc-jet has a lower I_{sp} and a higher thrust-weight ratio. Thus the arc jet occupies a position between the ion rocket and the conventional systems.

Plasmadyne Corp. plans soon to build flyable arc-jet motor with a thrust of about 20 lbs. and I_{sp} of 1500 to 2000 seconds. There is hope that a nuclear powerplant may be available by 1965 to make possible an arc-jet system with thrust-weight ratio of 4 or 5 x 10^{-4}.

Ten days to two weeks . . .
would be needed for an arc-jet propelled moon trip. This is the time needed to lift from a 110-mile earth orbit. With suitable guidance, the arc jet could maneuver the vehicle into a moon orbit and return. But it would have too little thrust to be used for a soft landing.

Because its thrust is higher than an ion rocket, the arc jet also might be preferred for powering a manned satellite to a higher orbit. The maneuver would take less time, which might be limited by supplies of food, water and air.

Ion propulsion is preferred for longer missions . . .
such as the trip to Mars. On a trip that might take almost a year it makes relatively little difference whether the total work is performed rapidly with a high thrust or slowly with a low thrust.

For example, if we do all the work in a few seconds by burning a high-thrust final-stage chemical rocket, the trip to Mars might take 240 days, assuming specific impulse of 400 seconds. But the payload fraction would be less than 25%.

The trip would last 10 or 20 days longer . . .
with an arc jet, specific impulse 1500-2000 seconds. But the payload fraction rises to about 30%.

Now let's see what happens when we switch to ion propulsion. Specific impulse increases to 4000 seconds. However, the thrust drops sharply. The most powerful ion engine now in existence generates only 2 lb. The length of the trip to Mars by ion propulsion may be 300 days. But now we have a payload fraction of more than 50%. Obviously, it may often be worthwhile to make the trip a little longer and get the big payload increase that goes with it.

Shifting orbits for unmanned satellites . . .
is another mission for ion propulsion, even though the arc jet can do it faster. Here, it may not be important that several weeks are required to lift a 110-mile satellite to a 24-hour orbit. The important factor may be the lighter weight and higher specific impulse of the ion system. This may also be true of shipping freight to a moon base.

Both ion and arc-jet propulsion . . .
can be available soon. T. M. Littman of **Rocketdyne** predicts that the first-generation ion engine will be ready for flight test in two or three years. The arc jet will follow soon behind. Both have great potential. But both are limited by a bugaboo that hampers every propulsion system in existence—the availability of materials that will withstand the high temperatures involved.

Come back next week for a few possible answers to this problem. The entire Nov. 23 issue of M/R will be devoted to Space Age materials.

reviews

MATERIALS IN SPACE ENVIRONMENT: PROCEEDINGS OF THE FIFTH SAGAMORE ORDINANCE MATERIALS RESEARCH CONFERENCE, Office of Ordnance Research, U.S. Army, Sept. 1958. Order PB 151900 from OTS, U.S. Dept. of Commerce Washington D.C. 276 pp. $4.

This conference, held in September 1958, dealt with the problems of materials in the space environments encountered by space vehicles or orbiting satellites.

Participants were government, industry, and university representatives, all connected with some phase of metallurgical research or applications related to the field. Space environment phenomena were considered along with their effects on materials.

The report contains 18 papers, some formal lectures, others transcripts of informal discussions.

General subjects covered are: "Space Environment and Vehicle Requirements," "Physics of Space Vacuum and Effects on Materials"; "Thermal Problems under Orbiting Conditions"; "Radiation and Radiation Effects in Outer Space"; "Meteorites and Cosmic Dust in Space"; and "Implications of Space Environment for Material Development."

THE SERVO ENGINEER'S HANDBOOK, Daystrom Transicoil, Division of Daystrom Inc., Worcester, Pennsylvania. 128 pp. $3.

Devoted exclusively to servo components, the book deals with the individual components—how to use them, how not to make them. Although the basic theory is presented, the overall treatment is practical rather than classical.

The contents include: Introduction to servomechanisms, Servo Motors, Rate Generators, Synchros, Gear Trains, Servo Amplifiers, Servo-System Engineering and Environmental Testing.

STUDY OF THE WELDABILITY OF ALUMINUM CASTING ALLOYS WITH 5086 WROUGHT ALUMINUM ALLOY, M. S. Orysh and I. G. Betz, Frankfort Arsenal, U.S. Army. Order PB 151307 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 55 pp. $1.50.

This study was conducted to determine the weldability of the 5086 alloy to selected cast aluminum alloys. Inert gas shielded metal-arc welding was used.

The study demonstrated that thin weldments, welded without a backing strip, are more apt to have very poor joint strip efficiency because of lack of fusion. An experimental perforated weld test used with grid lines proved to be a useful tool for determining weld ductility.

The moderate strength, good formability, excellent resistance to general and stress corrosion, and weldability of 5086 wrought aluminum alloy sheet make the material promising for use as skin for ballistic missiles, the study showed.

RAMJET LEADERSHIP—Ken Hisey (left), Superintendent, Propulsion Shops, discusses some of the finer points of one of the many Marquardt engines with Frank McGuire of the editorial staff of Missiles and Rockets magazine. The pioneering of higher performance ramjet engines by Marquardt has vastly increased the defense area of the advanced Bomarc missile.

WHO READS MISSILES AND

Well, for instance . . . TOP ENGINEERS AT MARQUARDT

Accelerated developments in air-space research . . . advanced power systems . . . manufacturing . . . space-age training . . . and research rocketry have made The Marquardt Corporation one of the foremost leaders in the field of astronautics.

The Marquardt ramjet engines, for example, have been actually flight tested at speeds well over Mach 4 at an altitude of 80,000 feet. Continuous ground cell endurance tests have been successfully conducted to simulate even greater altitudes and higher speeds. In addition to the development and production of propulsion systems that will operate at supersonic speeds, Marquardt has also been a leader in the development and application of high temperature metals and reinforced refractory ceramic coatings for future missiles.

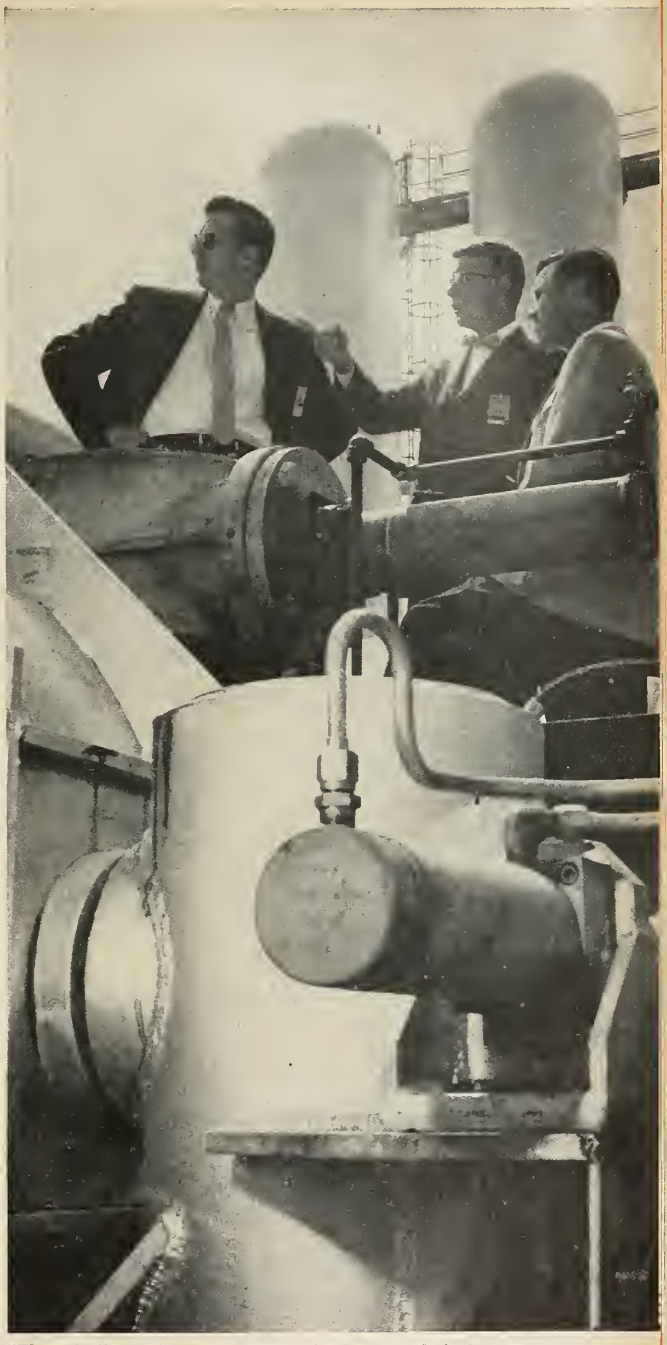
Precision controls and rotating accessories for space vehicles are still another facet of The Marquardt Corporation. A few of these are . . . precision controls for ramjet engines . . . rotating accessories for pneumatic servo actuators . . . and air inlet controls for North American Aviation's "Hound Dog" air-to-surface missile. New and superior production line techniques have been installed at Marquardt's Ogden Division to more than double the production capacity of Bomarc ramjet engines—yet with 100% reliability.

Marquardt is also taking a giant step into tomorrow with ASTRO—Air-Space Travel Research Organization. ASTRO has its own aerodynamic test facilities that are capable of approaching the speed of Mach 12 and temperature tests at approximately Mach 7 (3700° Fahrenheit). Also included in Marquardt's

"Development of products in today's space age is a complex business requiring vast engineering and scientific technology. Additionally, information concerning latest developments in our industry is essential. Missiles and Rockets helps us keep pace in this rapidly expanding market." Don L. Walter, Marquardt Vice President, Power Systems Group.

"Today's missile engineers are comparative youngsters with an unending thirst for knowledge of the entire astronautics market. Missiles and Rockets gives us a total, uncluttered picture of what's going on in this field from week to week!" John Widell (left), Project Engineer, Propulsion Engineering.

"If you want pears, you don't order fruit salad. The same holds true in astronautics. We prefer Missiles and Rockets magazine because it deals with astronautics and astronautics *exclusively*." Dick DeSantis (right), Supervisor of Numerical Analysis Section.



"The missile engineer must have frequent, technical news concerning the industry. That's why the *weekly* issues of Missiles and Rockets are so important to us. Month old news is of little value when yesterday's developments could easily be obsolete tomorrow." Leigh Dunn (right), Director, Test Section.

ROCKETS?

diversified activities is the manufacture of ground support and handling equipment for missiles . . . systems engineering and equipment for data display . . . development and production of rocket systems . . . specialized solid rocket motors and components for space and missile systems. Marquardt recently established a Nuclear Systems Division in the Power Systems Group. Project Pluto is one of their major programs—aimed at the development of a nuclear ramjet engine.

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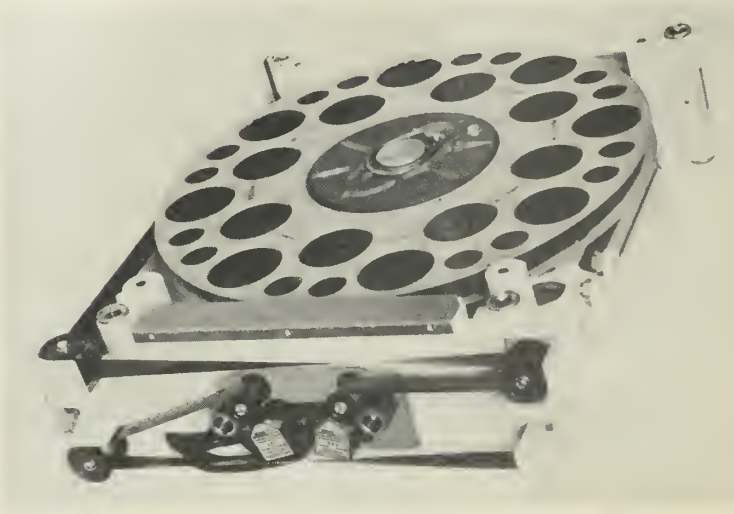


Unit to Record Astronaut's Voice

A 12 lb. tape recorder (including 4800 feet of magnetic tape) will record the environment of the nation's first manned orbital space flight, the physiological effects on the astronaut making the historic flight, and his voice comments.

The **Datalab Division** of **Consolidated Electrodynamics Corporation** has revealed details of the satellite magnetic tape recorder that it designed, developed and manufactured under a $135,480 contract award from **McDonnell Aircraft Corp.**, capsule contractor for the National Aeronautics and Space Administration's Project *Mercury*.

Besides the voice commentary of the Astronaut in the space capsule and phenomena detected by sensitive pickups taped to his body, the tiny data acquisition system will also monitor such environmental conditions as temperatures, pressures, acceleration and shock.

Design goals of the magnetic tape recorder were to achieve a combination of minimum size, minimum weight, minimum power consumption and high reliability. Datalab engineers delivered a unit that weighs only 9 lbs. without tape, measures only 11 x 13 x 3-5/8 inches complete with electronics, requires less than eight watts of power, and has excellent characteristics of performance and reliability.

To provide the smallest volume the recorder has been designed with takeup and supply reels on opposite sides of the main casting. Associated record electronics, drive motor, and integral gear trains are mounted on the central casting between the two reels.

Power consumption was minimized by the use of specially designed "wraparound" dual capstans. The tape wraps around 270° of the capstan to obtain driving friction, eliminating the customary solenoid-actuated pinch rollers. Elimination of pinch rollers components reduced weight; precise tape tracking was obtained by the absence of pinch roller tape deformation.

The two record heads are mounted on a precision plate assembly on the side edge of the main casting. Tape passes over them as it moves from one side to the other. A slight speed differential between the takeup and supply capstans maintains a constant tension on the tape as it moves across the two heads.

The recorder designed for the *Mercury* project will have a tape speed of 1 7 8 inches per second. A kit can convert the speed to 15 ips if desired. The system will make possible eight hours of continuous recording on the .65-mil tensilized Mylar tape of ½" width.

On the magnetic tape will be one channel of voice communication from the pilot and up to six channels of multiplexed analog data from appropriate record amplifiers. Other electronics include a bias oscillator for analog recording.

At 1 7 8 ips the wow and flutter of the tape recorder will be less than 1% peak-to-peak between DC and 500 cycles per second.

In selecting materials from which to build the magnetic tape recorder engineers had two criteria. The materials had to be as light as possible, and had to be inorganic to preserve the precious supply of oxygen aboard the space capsule. The main casting is a magnesium alloy of thin section design. Magnesium reels combine rigidity with light weight. Special paint, insulation and drive belt materials were used. Drive belts are of especially compounded silicone rubber.

The tape recorder will be required to operate in the varying conditions of launch, orbit, and re-entry. The operational environmental specifications are temperature range, −15 to +200°F; vibration, ±10 g from 5 to 2000 cps; continuous acceleration, ±6 g's in all axes; and shock to 100 g.

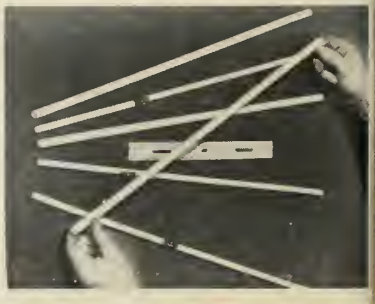
Tapes produced on the airborne recorder will be played back on a standard reproducer using a special adapter supplied with the recorder for matching the hubs to standard NSRTB reel hubs. Engineers will have for their study a complete analog record of all phenomena that occurred on the historic flight.

Consolidated Electrodynamics Corp.
360 Sierra Madre Villa
Pasadena, Calif.

Ceramic Tubing Resists Shock, Ultra-High Temps

Beryllium oxide ceramic tubing in lengths to 24 inches, highly resistant to elevated temperatures and to thermal shock, is available from **National Beryllia Corp.**

Berlox beryllium oxide tubing is supplied with both ends open or with one end closed, for insulation and protection of thermocouples and other sensing and measuring elements for use at extremely high temperatures or where heavy radiation is encountered. Berlox tubing is also used to introduce materials to, or draw samples from,



areas where temperatures are very high or corrosive conditions are extreme.

Properties of Berlox tubing include melting point of 4650°F, greater strength above 2000°F than any other

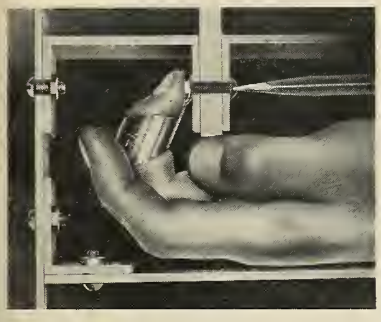
known ceramic, high hardness and abrasion resistance, high electrical resistivity combined with high thermal conductivity, and immunity to heavy doses of radiation. The exclusive high-fired surface is permanently dust-free, thus eliminating toxicity problems. Because of high density, the tubing is essentially gas-tight.

Round, single-bore tubing is available from stock in lengths to 21 inches, and to 24 inches on special order. Standard sizes are 5 (ID) x 7 (OD) mm, 1/4 x 3/8 in., 3/8 x 1/2 in., and 7/16 x 11/16 in. Special insulator tubing, round or oval, is available in stock lengths of 6 and 12 in., with single or twin bore, in sizes from 5/64 to 3/16 in. OD and bores from 3/64 in., Berlox tubing custom-made to non-standard lengths, diameters and bores is available on 4-to-6-week delivery.

National Beryllia Corp.
4501 Dell Ave.
North Bergen, N.J.

Finger Tool Reaches Remote Working Areas

A finger tool design that enables the user to reach into snug, narrow, remote or hidden working areas—to "Touch 'n Hold" a nut or bolt in a



true fixed position for assembly or disassembly—is available from the **Beaver Tool Co.**

The "Touch 'n Hold" tool is a wrench which is worn like a ring on the finger without restricting the free motion of the hands or fingers. It is adjustable to fit different size fingers. These finger wrenches are supplied in the most popular Hex Head nut sizes.

Beaver Tool Co.
Box 256
Huntington Station, N.Y.

Small Unit Does 100,000 Calculations Per Minute

A small transistorized scientific computer which can perform more than 100,000 calculations a minute was announced today by the **Data Processing Division** of **International Business Machines Corporation.**

Requiring little more space than the average desk or drafting table, the new IBM 1620 Data Processing System operates under the direction of an internally stored program of instructions. It can perform complex engineering and scientific computations on a continuous or production basis.

Advanced features incorporated in this compact but powerful computer include 20,000 digits of magnetic core storage with variable field length and immediate accessibility, and paper tape and electric typewriter input and output. The availability of two advanced programming systems and a comprehensive library of mathematical and statistical routines simplifies programming for the 1620. Specific programs for the petroleum industry, public utilities, civil engineering, and optical firms will be available.

International Business Machines
Data Processing Div.
112 East Post Road
White Plains, N.Y.

Glass-Epoxy Laminate Takes High Temperatures

A new glass-base, epoxy-resin laminated plastic for use in both normal and elevated temperature applications has been announced by **Taylor Fibre Co.**

Designated as grade GEC-111, the new laminate meets the specifications for NEMA grade G-11 and military grade NIL-P-18177B-Type GEB. A one-eighth inch thick sheet of GEC-111 retains at least 68% of its flexural strength after one hour exposure at 300°F, thus exceeding the military specification of 50% strength retention under those conditions.

The ability to retain strength at elevated temperatures makes GEC-111 particularly suitable for use as the base material for copper-clad laminated plastics. Printed circuit boards made from GEC-111 copper-clad laminates will not distort when placed in solder baths.

The material's excellent strength retention also suits it for use wherever high ambient temperatures are encountered such as might occur in miniaturized, enclosed components. Its maximum heat resistance for continuous use is 350°F.

As is characteristic of other glass-epoxy laminated plastics, GEC-111 combines extremely high flexural, impact and bonding strength with low moisture absorption and excellent chemical resistance. Because of its low moisture absorption it exhibits low dielectric losses and good insulation resistance even during exposure to high humidity.

Taylor's Grade GEC-111 is furnished in sheets only in a thickness range of .010 to 1 inch inclusive. Sheets up to 3/32-inch thick may be cold punched. The copper-clad laminate is supplied either with rolled copper foil (GEC-111R) or with electrolytically deposited foil (GEC-111E). The bond strength of copper foil to the base is from 8 to 10 pounds per inch of foil width, depending upon the type and thickness of foil.

Taylor Fibre Co.
Norristown, Pa.

Coating Provides Temp Control for Space Units

A team of **Bausch & Lomb** scientists has delevoped a thin film coating which provides a means of temperature control for the electronic system of satellites. The coating, which covers the satellite's solar batteries, reradiates heat into space. It provides an external cooling system which reduces the equilibrium temperature of the satellite operating in the presence of high-intensity sunlight encountered at great altitudes.

Intense heat from the sun not only reduces the efficiency of electronic gear for radio transmission from satellites operating in outer space, but may even melt the solder fittings which link the batteries together, thus ending all further radio contact. Basic research on the coating was conducted by Dr. J. F. Hall, Jr., Project Physicist in the B&L Vacuum Coating Department.

Silicon solar cells are often used as an electrical power source for satellites and other space vehicles. The solar cells are fitted to a large portion of the external surface of the satellite, and absorb most of the sun's energy which falls upon them. Only about 10% of this energy can be used to produce electrical power; the remaining radiation basically heats only the battery cells and the satellite itself. Under these conditions, the only effective means of "cooling" the solar batteries is by reradiating the sun's energy back into space, after it hits the satellite.

The thin film, which was developed

to provide this unique cooling system, was a direct result of a request from the Astro-Electronic Products Division, **Radio Corporation of America,** to produce a satisfactory means of providing a temperature control for the satellite's covering of batteries. Dr. A. F. Turner, head of the B&L Vacuum Coating Department, coordinated the research and development program within the specifications.

Working on the data provided by Dr. Turner, Dr. Hull and R. E. Peo developed a film coating composed of magnesium fluoride and silicon monoxide. The coating, which is less than 2.5 microns thick (approximately one ten thousandth of an inch), keeps the solar batteries "cool" by reradiating the long wavelength "heat rays" away from the satellite. At the same time, the film coating allows the cells to absorb the shorter radiation necessary to produce electrical energy.

Turner and Hall point out that the effective protection which this new coating now supplies may mean the difference between losing radio contact with the satellite after a few hours or days, and having radio reception remain intact, theoretically, for as long as the satellite itself remains in orbit.

Bausch & Lomb Optical Co.
Rochester 2, N.Y.

Tiny Rate Gyro Made For Research Rockets

A new gyro for high-altitude rocket research has been announced by **Humphrey, Inc.** The gyro, known as model RG24-0103, is only 1 5/8" in diameter and 3½" long, including the **Bendix** connector.

Despite its extremely small size, it

has a DC motor and potentiometer pickoff. This is said to be the smallest precision DC gyro with pot pickoff ever made for high-altitude use.

The new Humphrey instrument is hermetically sealed in a steel case. It withstands rugged environmental conditions, such as temperature from –65° to +180°F, unlimited altitude, vibration of .06 DA to 10 g, whichever is limiting, 10 to 2000 cps, shock of 75 g for 6 to 12 milliseconds on any axis. The gyro can be provided with output potentiometer values to meet any of the usual requirements. The motor runs on 28V DC, 150 ma maximum running current.

Humphrey, Inc.
2805 Canon Street
San Diego 6, Calif.

Bleeder Cloth, Parting Film Duties Combined

A combination bleeder cloth and parting film is now in volume production at **Narmco Resins & Coatings Company.**

The new material, labeled Ventcloth by the manufacturer, combines the function of a parting agent (such as cellophane, polyvinyl alcohol, silicone or wax) with that of a bleeder cloth. The latter is required in vacuum-bag molding operations whenever a large laminate area is being cured and there is a chance that the vacuum will not draw out all of the air across the entire surface. The parting agent, in turn, is used to prevent the cured laminate from adhering to the bleeder cloth or the vacuum bag itself.

The new cloth consists of a woven glass fabric impregnated with a parting agent. It is laid directly over the final laminate layer just before the vacuum bag is used to cover the assembly. As vacuum is drawn, air trapped under the bag surface escapes through the porous material layer. The Ventcloth remains porous and open throughout the cure cycle, ensuring laminates that are virtually void- and air-free. Moreover, since all air is removed, it insures that full atmospheric pressure will be applied to all parts of the laminate. Shop experience indicates that this will increase resin flow by as much as 15%, resulting in a more dense and uniform laminate structure.

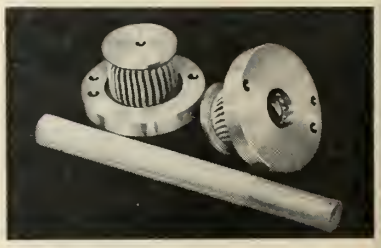
Narmco Resins & Coatings Company
600 Victoria Street
Costa Mesa, Calif.

Filter Called World's Tiniest with Relief Valve

The world's smallest precision filter with a relief valve is currently being manufactured by **Aircraft Porous Media, Inc.,** the company says. The unit, which weighs only 1.18 oz., is rated at 2 microns, and at 15 microns absolute.

The filter is designed to operate at 0.3 gpm under normal conditions, and at 0.8 gpm under intermittent surge. It has a temperature range of −65°F to 275°F. Relief valve cracking pressure is 150± 15 psi. Materials used are all stainless steel.

Originally designed for use on a



pump for hydraulic oil (MIL-H-5606), the filter can be used with other fluids, including corrosives, and with gases. The filter element is made of corrugated SUPRAMESH.

Aircraft Porous Media, Inc.
Glen Cove, N.Y.

ROCKET CONTROLS ENGINEERS

1) For development and analytical design of valves and controls for rocket engine systems. Develop specification requirements for components covering design, test and development. Prepare data for proposals. BS in ME or AE and 3-7 years experience with hydraulic pneumatic devices and systems.

2) For dynamic analysis of mechanical systems associated with rocket propulsion. Mathematical descriptions of controlled rocket components with regard to systems stability. Interpretation of designs for controlling rocket components. Analogue simulation of systems. Supervision of above area. BS, ME or EE. Experience in servo systems analysis and techniques.

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If you are a qualified engineer or scientist, we urge your prompt inquiry on the attached Professional Employment Inquiry form. Interviews in your area will be arranged for qualified applicants.

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CONVAIR DIVISION OF

GENERAL DYNAMICS CORPORATION

POMONA, CALIFORNIA

——more about the missile week——

• **Wallops Island, Va.**—An Army research rocket—the five-stage *"Strongarm"*—probed 1050 miles into the upper atmosphere Nov. 10. The vehicle, composed of an *Honest John,* two *Nike-Ajax* boosters, a modified *Recruit* and a scaled-down *Sergeant,* put up an instrumented nose cone which gathered ionization data to be utilized in the ICBM and *Nike-Zeus* anti-ICBM programs.

• **Vandenberg AFB**—An electrical system malfunction caused the fourth straight failure Nov. 8 in Air Force attempts to recover an instrumented capsule from a polar-orbiting *Discoverer VII* satellite. The malfunction cut off power to actuate the separation sequence as well as to the vehicle stabilizer.

• **Washington**—Appointment of Dr. Charles L. Critchfield to head ARPA is being investigated by the House Military Government Operations Subcommittee on grounds of possible conflict-of-interest. It was disclosed that Critchfield would continue to draw a $35,000-a-year salary from **Convair** while serving in the Pentagon post without compensation (WOC). The subcommittee plans to look into all DOD WOC personnel, including hundreds of consultants, as well.

• **Huntsville**—A training program for troops who may eventually man the *Nike-Zeus* AICBM is being developed at the Ordnance Guided Missile School. Representatives of 21 Army agencies and the contracting team headed by **Western Electric** have held three secret sessions.

• **Washington**—Missile industries in the news: **Telecomputing Corp.,** Los Angeles has purchased for more than $2 million the **Monrovia Aviation Corp.,** a wholly-owned subsidiary of **Carrier Corp. Minneapolis-Honeywell Regulator Co.**'s semiconductor division will build a $1 million R&D center at Riviera Beach, Fla. . . . **Minneapolis-Moline Co.** has acquired **Hymac Electronics,** Culver City, Calif.

• **Des Moines**—The Army disclosed that Baker, the 1-lb. rhesus monkey which survived a *Pioneer IV* shot May 28 to an altitude of 360 miles, is expecting a baby. Arrival date unspecified.

• **Washington**—Contract for joint Army-Navy-Air Force Power Information Center probably will be let in January. The center, to be established by Interservice Group for Flight Vehicle Power, will act as coordinator for all technical information concerning R&D in power and energy sources (exclusive of propulsion). Primary concern is energy conversion for space—thermoelectrics, thermionics, fuel cells, etc. (Mission and organization of Interservice Group as well as a comprehensive survey of government agencies involved in this work will appear in the Nov. 30 M/R.)

• **New York—General Dynamics Corp.** reports nine-month net profits to Sept. 30 of $16.8 million on sales of $1.2 billion compared to a net of $28.7 million on $1.2 billion sales for the like 1958 period. Write-off of the Convair 880 jet transport program was attributed to the decline.

• **Seattle—Boeing Airplane** reports nine-month sales of $1.1 billion and net earnings of $8 million and predicts an improvement in earnings during the final quarter. Its Sept. 30 backlog stood at $2.2 billion.

• **Burbank, Calif.**—A net for the nine months ended Sept. 30 of $6.2 million was reported by **Lockheed Aircraft Corp.** on sales of $939 million. Almost two-fifths of sales were from missile and space work.

Mergers & Expansions

For an exchange of stock, **Fairfield Engineer Corp.,** Springdale, Conn., has acquired **Cove Industries Inc.,** Norwalk, Conn. Fairfield makes magnetic amplifiers . . . **Del Mar Engineering Laboratories,** Beverly Hills, Calif., has purchased **Electromation** of Santa Monica and will operate the company as a subsidiary for development of missile subsystems . . . **Litton Industries** now has a majority interest in **Svenska Dataregister,** Stockholm cash register maker . . . **Universal Controls'** subsidiary—**C. P. Clare & Co.**—is doubling its relay and switch production space at Chicago . . . At Zug, Switzerland, **Varian Associates** has formed a European subsidiary. A research and applications laboratory will be maintained at Zurich . . . **Capehart Corp.,** which recently acquired **Dynamic Electronics,** is re-activating its military-industrial division . . . and **Infrared Industries,** Waltham, Mass., has formed a new photoconductor and a new controls division.

About the Cover

En route to service aboard fleet ballistic missile submarines and in storage, *Polaris* missiles are protected against shock and vibration by an air-suspension system. A prototype of the shipping container developed by **Goodyear Aircraft's Arizona Division** on the cover of this week's issue of M/R shows the system of log-type spring units to hold *Polaris* with a "soft touch."

Polaris container designs have a high energy absorption factor with sprig efficiencies reportedly as high as 85%. Goodyear says when containers are subjected to 30 g's impact, air suspension attenuates the loading on missile to 4 g's.

Next Week's Special Issue

Next week, MISSILES AND ROCKETS *presents a historic first—a symposium on needs now and over the next decade in materials for the Space Age.*

Staff-written articles will outline major problem areas in research, high-temperature and high-strength structures. For additional information, M/R went to the men who know material needs best—those who are developing materials for the prime and propulsion contractors on America's most important missile and space vehicle systems. A special section, entitled "Missile Makers Speak," will include statements on materials by spokesmen for 12 major contractors.

Will these needs be met? M/R asked this of material suppliers. In a second special section, "Missile Suppliers Speak," top engineers for 45 companies state their views on such topics as refractory metals, ceramics, plastics, coatings, and metal working. In the latter category will be statements on welding, forging, deep drawing, spinning, turning, casting and hollow-core construction. And there will be an article on an exciting new process—explosive forming—by a top expert, Dr. John S. Rinehart of the Colorado School of Mines.

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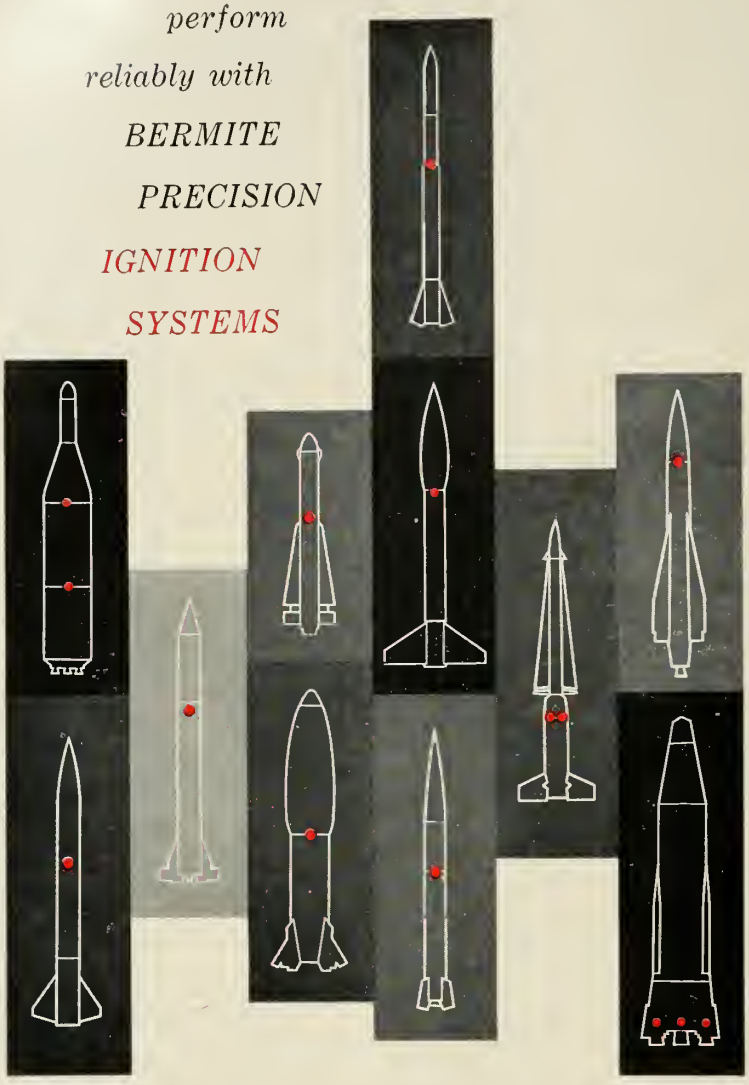


Bermite's leadership in ignition systems has been brought about by basic and applied research programs, development of specific systems to meet special customer needs, and production of the largest volume of reliable and qualified igniters for the missile industry.

In addition, Bermite produces safety and arming devices, squibs, ignition materials and unique inert components found in reliable missile systems and JATO units.

Explosive engineers interested in sophisticated projects may submit resumes to the Research and Development director, or at the Washington area office, 914 North Chambliss Street, Alexandria, Virginia.

BERMITE —built ordnance is better built through research, development and production.

Bermite Powder Company

22116 West Soledad Canyon Road, Saugus, California

—reviews—

PERARYLATED SILANES: A CLASS OF STABLE ORGANIC MOLECULE, L. Spialter and C. W. Harris, WADC. Order PB 151860 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 22 pp. $.75.

Air Force chemists predict production of many new materials from perarylated silanes, a new organic system notable for its size, versatility, radiation and heat stability. But, the researchers say, much developmental work remains to be done.

The perarylated silanes comprise a class of molecules which contains hundreds of thousands of members constructed by combining silicon atoms and aromatic groups into various molecular arrangements. Some types have shown unusually high resistance to radiation, oxidation and high temperature (to 600C).

Their versatility may lead to use in lubricants, hydraulic fluids, insulators or dielectric materials, and radiation-detection materials. The possible production of new stable elastomers and plastics from polysilarylene polymers is promising. Chemical derivatives of these types may lead to new adhesives and synthetic fibers.

Air Force chemists call for stepped-up developmental efforts in such areas as the preparation of new molecular species, polymers in particular. New chemical derivatives and special equipment are needed to iron out shortcomings of molecules now available.

SUPERSONIC WIND-TUNNEL TESTS OF RING-WING CONFIGURATIONS, L. H. Schindel, M.I.T. for WADC. Order PB 151754 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 108 pp. $2.50.

In this study, supersonic wind tunnel measurements were made of aerodynamic forces and moments on ring-wing configurations. This has been considered a natural shape for a tube launched missile.

The main result was an indication that the combination of linearized and slender body theories is not adequate to design a ring-wing vehicle with zero wave drag.

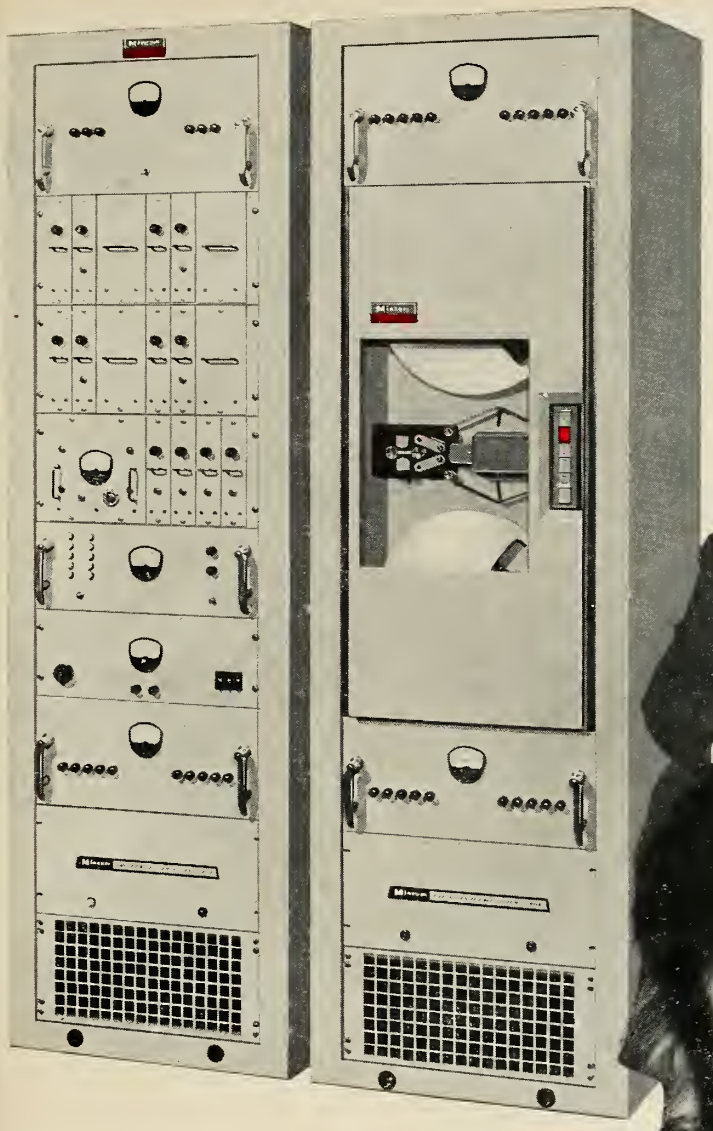
Other tests provided data on tandem ring-wings and on the lifting effectiveness of support struts. In addition, some experimental results were compiled on the area ratio required to start supersonic flow in the annular region between wing and body.

Although no new contributions are made to ring-wing theory, the illustrated report does contain an extensive review of its state of the art.

THE OPTICAL INDUSTRY DIRECTORY, The Optical Publishing Company, Lennox, Mass. 254 pp. $5.

The 1959 issue of the Directory lists some 400 items pertinent to the industry —instruments, components, raw materials, and services.

Also listed is information concerning 1200 American company sources capable of furnishing these items and a complete catalog of all corrected lenses, both domestic and foreign.



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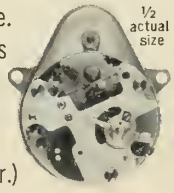

THE AWH HAYDON COMPANY
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contracts

AIR FORCE

Boeing Airplane Company was chosen to build the *Dyna-Soar* manned space glider and **The Martin Company** to produce rocket boosters to power the vehicle.

No estimate of the eventual cost of *Dyna-Soar* was announced, but the Air Force said it had $53,000,000 available for the project in the current fiscal year ending next June 30.

The dual selection ended a lengthy contest between contractor teams headed by Boeing and Martin. (See story on page 49.)

Allison Division of General Motors has received a contract for the design, fabrication and performance testing of an earth satellite powerplant. Amount not disclosed.

$2,000,068—**Collins Radio Co.**, Dallas, Texas, for providing a microwave communication system.

$709,930—**ACF Industries, Inc.**, Riverdale, Md., for a KC-135A and MB-26 flight simulator, spare parts, test equipment, special tools, installation services and data.

$624,653—**United States Steel Corp., Consolidated Western Steel Div.**, Los Angeles, for design and construction of equipment for an inertia measuring platform.

$217,301—**Sylvania Electric Products, Inc.**, N.Y., for various electron tubes. (Two contracts.)

$203,340—**Tung-Sol Electric, Inc.**, Newark, N.J., for various electron tubes. (Three contracts.)

$190,100—Cornell University, Ithaca, N.Y., for continued research in "Theory and Application of Precision X-Ray Spectroscopy in the Study of Solids."

$181,601—**Boeing Airplane Co.**, Pilotless Aircraft Div., Seattle, for reproducible copy and negatives applicable to the *IM-99A* missile. (Three contracts.)

$104,426—**Collins Radio Co.**, Dallas, for contractual maintenance and operation of microwave system.

$81,745—**Radio Corp. of America**, Harrison, N.J., for electron tubes. (Two contracts.)

$71,523—**Westinghouse Electric Corp.**, Elmira, N.Y., for electron tubes.

$40,921—**Bruno-New York Industries Corp.**, N.Y., for simulator-antenna position, maintenance handbook data and engineering data.

$40,658—**Raytheon Manufacturing Co.**, Waltham, Mass., for receivers, three items, various quantities.

$38,600—Wayne State University, Detroit, Mich., for research.

$28,309—**Southwest Research Institute**, San Antonio, Tex., for continuation of research and reports on radiation-induced free radicals in chemical and biological systems.

$27,937—**Allen B. Du Mont Laboratories, Inc.**, Clifton, N.J., for electron tubes.

$27,422—**Radiant Manufacturing Corp.**, Morton Grove, Ill., for 930 portable screen projection BM-10.

$27,000—**Bomarc Laboratories, Inc.**, Beverly, Mass., for various electron tubes.

NASA

$207,000—**Electronic Engineering Company**, Santa Ana, Calif., for radar data handling equipment at Wallops Island, Va., rocket test station.

$100,000—**C.E.I.R., Inc.**, Arlington, Va., for computing services.

$30,735—**Precision Instrument Co.**, San Carlos, Calif., for record reproducing system

MISCELLANEOUS

$300,000—**Polarad Electronics Corp.**, for special microwave receivers with extremely precise calibration. Subcontract from **Western Development Laboratories-Philco Corp.**

NAVY

$3,000,000—**Carrier Corp.**, Syracuse, N.Y., for production of steam-activator absorption cooling equipment for nuclear submarines.

$122,563—**Consolidated Electrodynamics Corp.**, Washington, D.C., for recording oscillograph.

ARMY

$2,430,000—**Samuel N. Zarpas, Inc.**, and **Fullerton Construction Co.** (joint venture) Detroit, Mich., for construction of *Bomarc* facilities at Travis AFB.

$2,200,000—**Ralph M. Parsons Co.**, Los Angeles, for construction of *Titan* test launch facilities at Vandenberg AFB.

$700,000—**The Siegler Corp.**, Hallamore Electronics Div., for special test equipment for the *Sergeant* missile. Subcontract from **Sperry Utah Engineering Laboratory.**

$500,000—**Chrysler Corporation**, Detroit, for modification work on the *Redstone* missile for space application.

$250,000—**Philco Corp.**, Philadelphia, Pa., for *Courier* communication satellite.

$235,000—**North American Aviation, Inc., Rocketdyne Div.**, Canoga Park, Calif., for design and development of a motor.

$219,264—**Raytheon Corporation**, Andover, Mass., for repair parts for the *Hawk* missile system.

$160,834—**Western Electric Co.**, N.Y., for *Nike* spare parts and components.

$140,640—**Askania-Werke**, Bethesda, Md., for cinetheodolites with tool kits and aided tracking drive systems.

$133,778—**J. W. Fecker, Div. of American Optical Co.**, Pittsburgh, Pa., for design and construction of 16 lens internal leveling system and target focusing for cinetheodolites.

$104,280—**Resdel Engineering Corp.**, Pasadena, Calif., for receivers, oscillators, schematics.

$89,130—**Emerson Electric Manufacturing Company**, St. Louis, for *Honest John* M2A1 pedestal assemblies with electrical installation and batteries.

$49,490—**Hughes Aircraft Co.**, Culver City, Calif., for study of radiation on missile components.

$48,266—**Radiation Electronics Corp.**, Skokie, Ill., for thermal imaging systems.

$46,467—**Surprenant Manufacturing Co.**, Clinton, Mass., for research and development design, in development and fabrication of prototypes of improved multiconductor cable and connectors.

$29,775—**Bourns, Inc.**, Riverside, Calif., for pressure transducers.

Dyna-Soar Puts AF Back In Space

by James Baar

WASHINGTON—The Air Force has soared back into the national space program in a big way with its decision to go ahead with development of the multi-billion dollar *Dyna-Soar* space bomber program.

At the same time, the Air Force dealt a hard blow to the "company team" concept of weapon systems development by personally assuming the prime contractor's role of weapon systems manager for *Dyna-Soar*.

Each of the only two competing primes—**Boeing** and **Martin**—received major parts of the program while members of their respective company teams must now compete independently for contracts to develop major subsystems and components.

Boeing was considered to have received the biggest slice of the program. It will develop the boost-glide vehicle and will be responsible along with the Wright Air Development Division for the integration of vehicle subsystems, the vehicle and the booster, assembly and testing.

Martin will develop the boosters. These are expected to be only slightly modified *Titan* vehicles in the very early stages of the program. Later, the booster may be clusters of four *Titans* providing some 1.2-million pounds of thrust. An alternative—or intermediate step—could be expanding *Titan's* first stage from a 10-foot diameter to 12-feet.

Both **Boeing** and **Martin** received authority to select—subject to Air Force approval—the subcontractors for their share of the program.

However, the Air Force made clear that overall responsibility for management and integration of systems will remain directly in the hands of the Wright Air Development Division.

The Air Force gave no official indication how much cash it was ready to pour into *Dyna-Soar*. It said only that the program has $53 million through FY 1960.

However, the initial development program is expected to cost at least $1 billion—not including the manufacture of any significant number of operational vehicles.

• **Big step forward**—The *Dyna-Soar* program now being launched by the Air Force is a major step beyond the original program that was under consideration as late as last summer.

That program aimed at development of a boost-glide spacecraft that would serve as a laboratory for gathering data that eventually would lead to building maneuverable-recoverable military space ships.

The Air Force decided that developments have already made such a research program unnecessary. It directed that **Boeing** and **Martin** come in with a usable military vehicle, as well as a research craft, instead. It also directed that the vehicle be designed so that it could make use of available boosters, at least in its early stages, rather than call for development of new models.

The *Dyna-Soar I* which will be developed is the result.

Predicted in June

MISSILES AND ROCKETS **reported on July 13 that "all signs continue to point to Boeing as winner of the** *Dyna-Soar* **contract despite Air Force decision to delay making awards." Two weeks earlier, M/R had said Boeing received technical approval from the Air Force and was victor in the design competition.**

The *Dyna-Soar* winged space ship with its pilot will be boosted into space at speeds approaching 14,000 miles an hour. By dipping in and out of the edge of the atmosphere, the space ship will be capable of traveling around the earth and landing at a selected site.

It will be capable of conducting reconnaissance, and bombing missions anywhere on earth. It also may be used to intercept enemy satellites and spacecraft.

Dyna-Soar II, which will be developed in the second phase of the program, is expected to be capable of deep space missions. It would have propulsion power to "jump" from orbit to orbit.

The Air Force has announced no schedule for the program. However, the first vehicles probably could be ready for launching within three years. *Dyna-Soars* probably could be operational in five. Much depends on the level of funding.

The first step in the program will be the development of a glider capable of safely bringing a man back to a normal landing after traveling at hypersonic speeds.

Later, unmanned and manned gliders will be launched down the Atlantic Missile Range to explore technical problems of flight at near-orbital speeds. One of the key problems that must be licked is the tremendous heating that the glider's leading edges will undergo in such flights.

The Air Force decision to go ahead with the program, which dates from the Saenger concept first put forth in the 1930's, appeared to be a sharp reversal of the recent Administration trend to take the armed forces out of space.

Only last month the Administration announced the switch of the *Saturn* 1.5-million-pound-thrust clustered booster from ARPA to NASA subject to congressional approval. The switch left the Air Force without a going lunar space program.

The *Dyna-Soar* program changes all that very much.

Dyna-Soar Contracting Teams

PRIME CONTRACTOR

BOEING AIRPLANE CO., SEATTLE,
Flight vehicle and ground support

MARTIN CO., BALTIMORE DIVISION,
System integration

SUBCONTRACTORS

GENERAL ELECTRIC:
Guidance and tracking system, including airborne components

NORTH AMERICAN AVIATION, AUTONETICS DIV.:
Inertial guidance and flight control

CHANCE VOUGHT:
Flight capsule, including escape

SUNDSTRAND AVIATION DIVISION:
Secondary power

RCA:
a) (Second-tier subcontractor not selected.) Air-ground communications subsystem b) (Second-tier subcontractor not selected) Ground communications

CONVAIR OR MARTIN:
Boosters

HERCULES POWDER CO.:
Separation rockets

RAMO-WOOLDRIDGE, RCA:
System studies

GOODYEAR AIRCRAFT CORP.:
Navigation system studies

BELL AIRCRAFT CORP., BUFFALO, N.Y.:
Airframe, airframe subsystems (except hydraulic and electrical), flight control

AMERICAN MACHINE & FOUNDRY CORP.:
Heavy ground handling and launching equipment

BENDIX AVIATION CORP.:
Hydraulic and electrical subsystems; telemetry, and short-range communications systems

GOODYEAR AIRCRAFT CORP.:
Pilot escape system; radar studies

MINNEAPOLIS-HONEYWELL REGULATOR CO.:
Aircraft navigation system; inertial guidance and computer studies

MARTIN CO., DENVER DIVISION:
Boosters

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west coast industry . . .

By FRANK G. McGUIRE

It is doubtful that **Rocketdyne's** E-1 engine will ever fly.

It is a well-designed, powerful engine (400,000 lbs.) using the latest design techniques, but there are a number of factors against the E-1, not the least of which is the current budget-balancing attitude. The E-1 was developed under an Air Force contract to provide answers to many problems of large, high-thrust liquid rocket engines. There is no vehicle for it; there would be a great reluctance to divert funds from other large-engine projects (F-1 and *Saturn*) in support of its further development, and unless public pressure demands otherwise, it will remain an interesting research tool.

The scanty photo caption released with the E-1 held a significant statement: "At the present time, the engine is not scheduled for any specific vehicle." Building a vehicle for the E-1—and doing a good job—would take time, and more money than the government would be willing to spend. It would be necessary to establish a requirement, obtain funding, review proposals, let contracts, and go through the testing and development phases . . . extensive, for such a necessarily-large vehicle. Past history of our rocket programs tells us that constant re-evaluation and re-justification would be required . . . with many people calling for the ax, as has been experienced in our *Saturn* program.

This Administration's record of crash-stretchout-crash programs, dictated by Soviet space achievements, belies any hope that the Rocketdyne engine will ever power a U.S. space vehicle. Nevertheless, it has proven immensely useful in providing data for the F-1, Rocketdyne's 1.5-million-pound-thrust engine for NASA. Nevertheless, with two large, high-thrust projects now underway, we would be very surprised if DOD, Congress, and NASA could all be permanently convinced that the E-1 should be continued into operational status, with all that this entails.

Two innovations at Northrop . . .

may set trends throughout the industry in employe-relations. The company has endeared itself to many by its holiday schedule plan, which calls for an uninterrupted 11-day holiday for employes, from December 23rd to January 4th. The other action calls for a cash award to **Northrop** employes referring eligible engineers to the company for hiring. If the referral is hired in an eligible classification, the employe gets $100.

Spacelabs, Inc., life-support specialists . . .

have established headquarters at Tarzana in the San Fernando Valley. The firm expects to do $200,000 in business during 1960, and $750,000 during 1961. **Spacelabs** will be one of the few companies in the country specializing in equipment designed to support life in space vehicles. Founders were formerly with **Sundstrand-Turbo**.

Hughes Aircraft got unexpected results . . .

by sponsoring a school-children's summer science project with Cal-Tech. The course was intended to provide basic education in determining orbits of astronomical bodies. Instead, the students discovered a 350,000-mile miscalculation in the orbit of one of the minor planets!

Computer Control Co. has cut prices . . .

on many of its electronics components. Ascribed to increased sales and improved manufacturing facilities, the cuts take effect immediately.

Lockheed-Marietta will engineer nuclear rocket . . .

under a negotiated contract with NASA. Seven firms submitted bids, and of the seven, **Lockheed** was chosen for negotiation of a contract calling for basic engineering work on the nuclear rocket system.

Hufford Corp. will build world's largest . . .

machine tool, a 120" diameter spin forge. The largest to date has been a 96" diameter spin forge built for Lockheed. The 120" diameter tool will be built with **Hufford's** own funds, and will be used by the company in its operations.

—when and where—

National Academy of Sciences, Autumn Meeting, Indiana University Memorial Union, Bloomington, Nov. 16-18.

University of Michigan, Fifth Annual Conference on Magnetism and Magnetic Materials, Sheraton-Cadillac Hotel, Detroit, Nov. 16-19.

American Rocket Society, 14th Annual Meeting, Sheraton-Park Hotel, Washington, D.C., Nov. 16-20.

American Society of Mechanical Engineers, Fifth International Automation Exposition and Congress, New York City, Nov. 16-20.

Instruments Division, Philips Electronics, Fifth Norelco Electron Microscope School, Hotel Victoria, New York City, Nov. 16-20.

National Aviation Trades Association, 20th Annual Convention, Hotel Montelone, New Orleans, Nov. 16-20.

Society of Aircraft Materials and Process Engineers, Eastern Division, Fall Meeting, Sheraton Carlton Hotel, Washington, D.C., Nov. 17.

Institute of the Aeronautical Sciences, National Turbine-Powered Air Transportation Meeting, Fairmont Hotel, San Francisco, Nov. 17-18.

Institute of Radio Engineers, 1959 Northeast Electronics Research and Engineering Meeting, Boston Commonwealth Armory, Boston, Nov. 17-19.

Ninth Aircraft Hydraulics Conference, sponsored by Vickers, Inc., Div. Sperry Rand Corp., Park Shelton Hotel, Detroit, Nov. 18-20.

DECEMBER

AFOSR/Physics Division, Physical Sciences Directorate and NAS/NRC, Conference on Problems Related to Interplanetary Matter, Northwestern University, Evanston, Ill. (Dates still not firm).

Rocket and Missile Symposium, USAF Arnold Engineering Development Center and ARO, Inc., Arnold Air Force Station, Tullahoma, Tenn., Dec. 1-2.

Eastern Joint Computer Conference, Statler Hilton Hotel, Boston, Dec. 1-3.

National Conference on Application of Electrical Insulation, Sheraton-Park and Shoreham Hotels, Washington, D.C., Dec. 6-8.

American Institute of Chemical Engineers, 52nd Annual Meeting, Sheraton-Palace Hotel, San Francisco, Dec. 6-9.

American Management Association, Briefing Session on the Defense Market, Ambassador Hotel, Los Angeles, Dec. 7-9.

First Aerospace Finishing Symposium, sponsored by Southwest Society of Aircraft Materials and Process Engineers, and Dallas-Ft. Worth Branch of American Electroplater's Society, Hotel Texas, Fort Worth, Dec. 8-9.

Institute of Environmental Sciences, New York Metropolitan Chapter, Technical Symposium and Product Exhibition, Henry Hudson Hotel, New York, Dec. 10-11.

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Vital Newcomers of the Space Age

As a sign of the times in which we live, thousands of new companies have been and are being formed throughout this country. They are the results of the Space Age, if you want to call it that, or at any rate of this advanced stage of the world's industrial revolution. They are the products of specialized techniques which have grown to meet specialized needs.

Many of these firms have arisen to answer requirements engendered by fantastically rapid technological advances; some are the results of military requirements, some of space exploration, and some simply of the different way in which we now live.

They deal in items ranging from auxiliary power units through bearings, capacitors, computers, diodes, fluorine, guided missile telemetering, infrared, kilovoltmeters, modulators, nozzles, plasma, radar, shields, test equipment, valves, wind tunnels—to X-ray plotters and yokes—items which run into the thousands.

The men who organized most of these companies are young—frequently under thirty. So are the men and women they hire. The techniques and methods of operation are formulated as they go along. Most of the employees are trained either on the job or in special classes set up by the company, because the fields are so new no experience exists.

Take Company A. It was formed in 1954 with just over $20,000 capital to take on a contract which was about to go by default because no one else could, or wanted to, tackle it. Company A became specialists in the computing field, developed the idea of selling computing service to industry (and government), now do $3 million business a year. Their stock has gone from $6 to $50 a share. They are expanding into a chain which will reach across the nation.

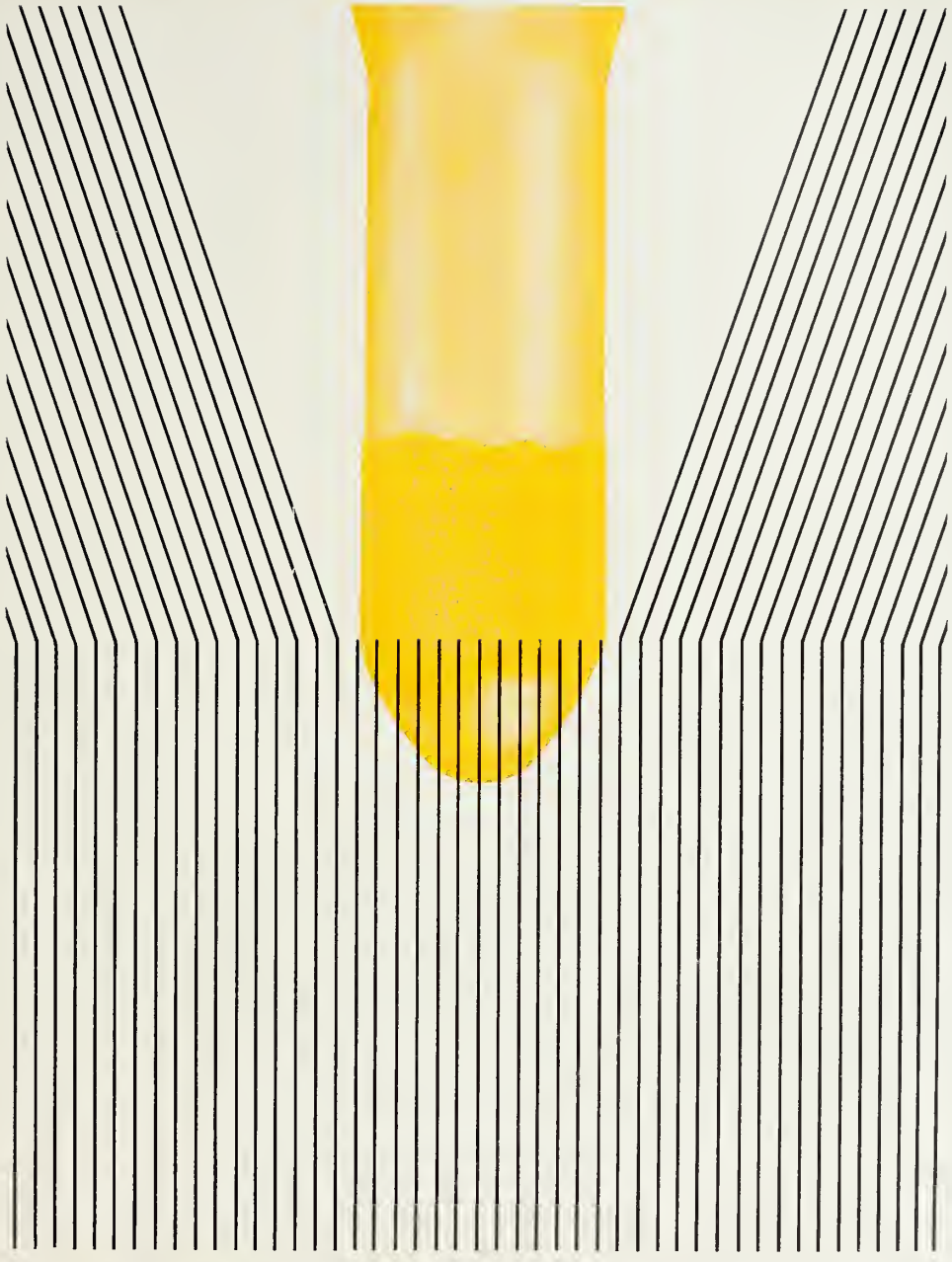
Take Company B, a company formed in 1956 with nine people to fill a need of the age—to build simulators to train ground radar operators. The company now has 248 employees and a backlog of $3.5 million.

Or Company C, now a veteran of nine years of dealing in space electronics, with inevitable by-products for peacetime civilian uses. In just the past year this company's payroll rose from some 780 employees to 1150, while the backlog of orders climbed from $5.4 million to $14.4 million.

These companies and others like them are both in competition with and in support of the business giants which have long ruled our industrial world. As a subcontractor for the big primes, the little man necessarily picks up some of the big company techniques and secrets. But mostly he develops his own. He accumulates his own patents and his proprietary rights. He guards them jealously—to the point of seeking congressional investigations of pirating.

He is a product of the age—or perhaps he has helped produce the age. In either case he is a vitally important newcomer to the world's industrial scene, important for his collective size but more important for the collective skills and ingenuity and the contributions he makes toward solving today's unprecedented demand for products and methods undreamed of just a few years back.

CLARKE NEWLON



Avco cools a nose cone—at 12,000°F. — To bring a space vehicle safely through the 12,000-degree heat of atmospheric re-entry, Avco scientists have developed radically new "space age materials." One of these, a ceramic structure termed Avcoite, made history as it returned this country's first successfully recovered ICBM nose cone. Today, materials research at Avco continues in new and bold directions, ranging from heat-resistant rocket nozzles to lightweight space structures.

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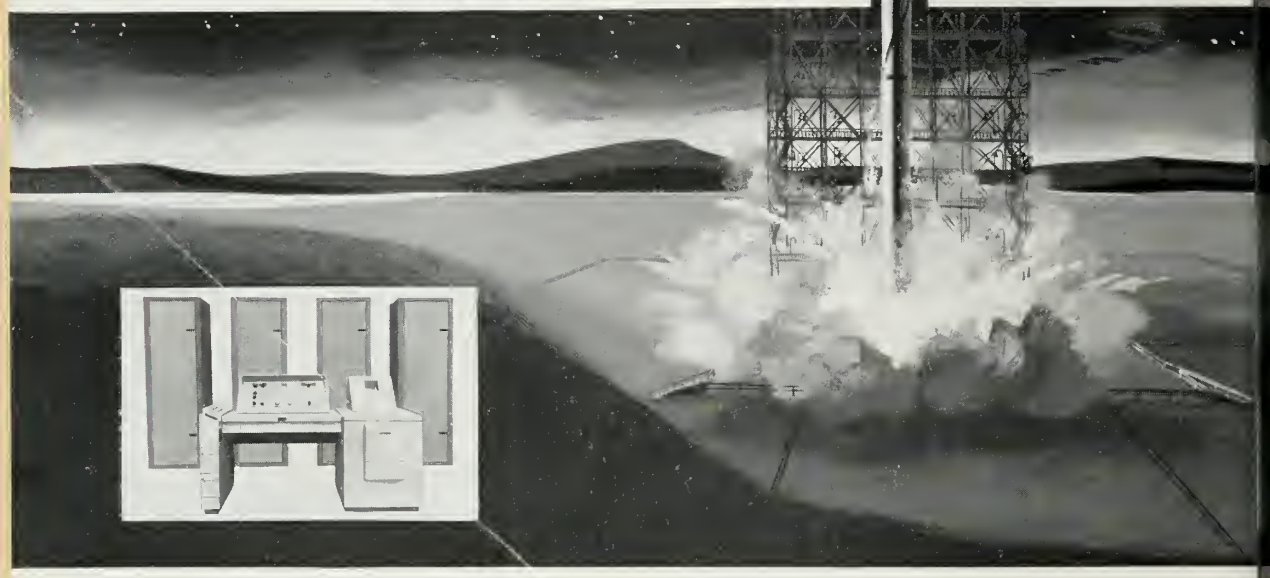

APCHE (Automatic Programmed Checkout Equipment) is a solid-state, universal, high-speed, highly reliable, compact general-purpose tester designed especially for automatic checkout of aircraft, missile and space systems and their supporting systems. In its various versions (differing in input media, size and weight) APCHE installations may be fixed, mobile, airborne or submarineborne. APCHE was designed and is being produced as a part of RCA's ground support electronics subcontract from the Convair (Astronautics) Division of General Dynamics Corporation, prime contractor for the ATLAS Intercontinental Ballistic Missile.

The system being supplied to Convair for the ATLAS Program includes a console and four rack cabinets providing both analog and discrete test functions with a resulting printed and GO-NO GO indication. As a product of RCA's Missile Electronics and Controls Department, Burlington, Massachusetts, APCHE is one of the latest RCA developments in the field of military weapon readiness equipments.

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