NOVEMBER 21, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

oading Missiles on George Washington

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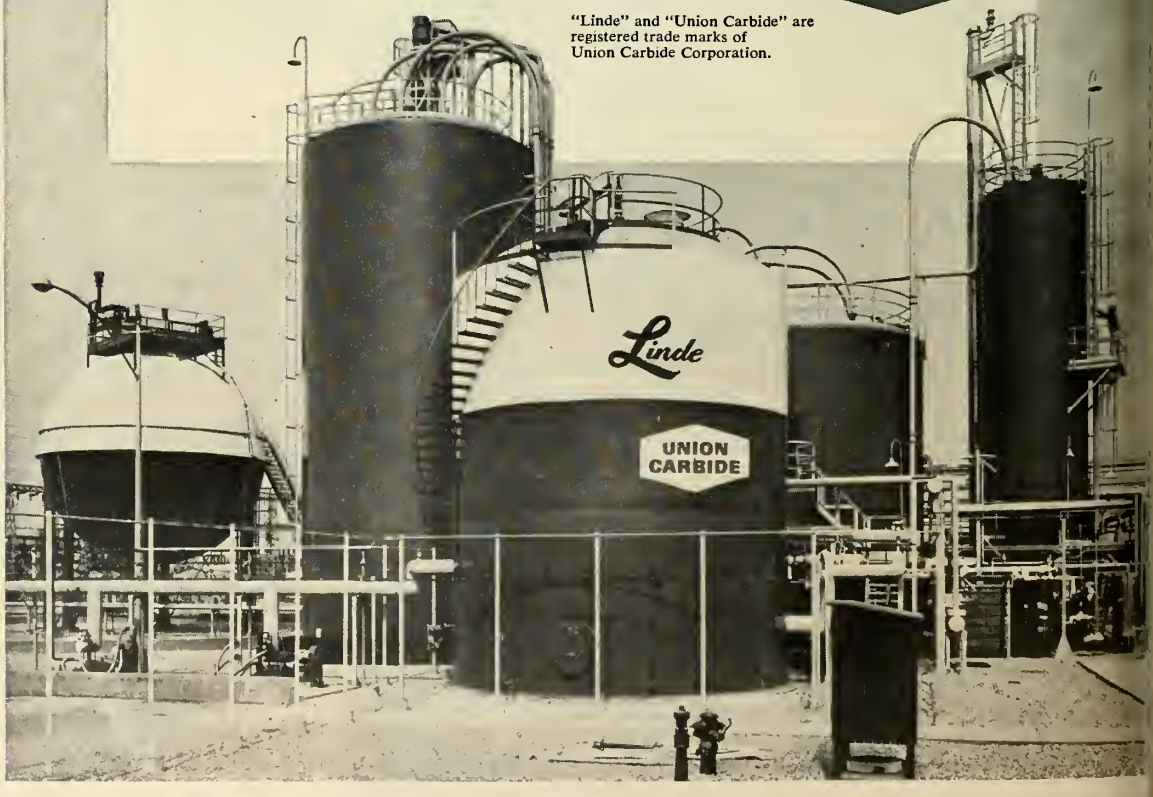

THE MISSILE / SPACE WEEKLY

missiles and rockets

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THE COVER

USS George Washington receives one of its combat-ready Polaris missiles at night during round-the-clock loading before sailing out to go on station. See story on p. 10.

NOVEMBER 21 HEADLINES

SPECIAL REPORT: PMR DOWNRANGE

ELECTRONICS

PROPULSION ENGINEERING

SPACE MEDICINE

ADVANCED MATERIALS

INTERNATIONAL

DEPARTMENTS

31,876 copies this issue

Computer-listed master catalog of engine parts reduces production lead time at Rocketdyne.

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Behind the thundering performance of Rocketdyne's engines, a significant reduction in the cost of power for America's missiles has been quietly achieved. Today, Rocketdyne engineering skill and efficient production methods make it possible to power two missiles for the cost of one in 1957.

Rocketdyne, the pioneer in rocket science, was first with power for America's long range ballistic missiles—first with power for outer space. In establishing this technological leadership, Rocketdyne developed new management concepts at every level of operation, from early design through final testing. The result is outstanding technical achievement at the lowest possible cost.

In data processing alone, advanced techniques are saving engineers hundreds of hours of experimentation and testing and have contributed to a 37 percent reduction in Atlas engine costs for the Air Force. An intracompany communications network links test stands and research laboratories in Missouri, Texas and California; gives management the daily status of every program—whether it's on schedule, what parts are in short supply, how the production line is performing.

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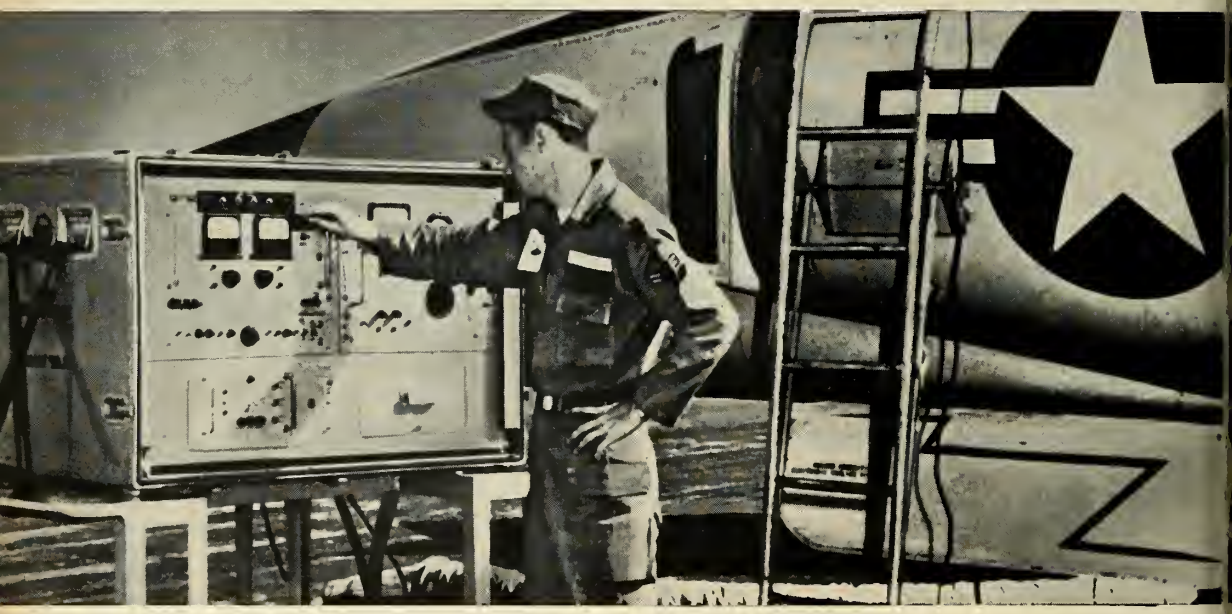
DATS

(Dynamic Accuracy Test System)



Flight-line checkout by DATS (Dynamic Accuracy Test System) tells the interceptor commander whether his aircraft and weapon control systems are completely ready for a successful mission. As a result of field evaluation tests, showing the effectiveness of DATS in improving weapon control performance, RCA has been awarded an Air Force production contract. Developed by RCA's Airborne Systems Division, Defense Electronic Products, Camden, New Jersey, DATS is a new approach to the evaluation of system readiness.

It makes certain that only aircraft with properly operating weapon control systems are sent on missions. Based on a building-block design employing the highest reliability factors, a mechanical programming device and self-test capability, DATS utilizes a series of synthesized attack runs typical of mission conditions. DATS could be made applicable to many interceptor types of aircraft.

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The Countdown

WASHINGTON

Dissidents Return?

President-elect Kennedy is expected to call on some Eisenhower Administration dissidents to help throw the defense/space effort into higher gear. Among those who may return, perhaps on a presidential advisory basis, are former Army Generals Taylor, Gavin and Medaris. Trevor Gardner, the former Air Force Missileman, also could get an invitation to a DOD post.

One-upping the Russians

Big problem facing Kennedy after Jan. 20 is making good his campaign promise to put the United States ahead of Russia in space. His desire to seize the initiative can only be translated into a greatly-expanded man-in-space effort, more money to accelerate large rocket booster programs. With manned spacecraft more than four years away, the new administration can be expected to draw a bead on the moon and try to beat the Russians to a lunar soft-landing.

Supplementary Defense

Breakdown of the $2 billion to $3 billion supplementary defense budget Kennedy is expected to hand Congress in January could look something like this:

–$600 million to put *Polaris* submarine program on a "keel-a-month" plan.

–$500 million for the Strategic Air Command's air alert.

–$500 million to speed up *Minuteman* and *Titan* base building.

–$400 million to let the Army modernize and buy some of the new missiles it has been developing.

–Possibly a "substantial" downpayment for putting *Nike-Zeus* into production.

NASA Repeater Satellite

Look for an active repeater communications satellite contract to be let soon by NASA. Action on a privately-owned satellite, however, must wait until the FCC decides on an AT&T application for a microwave channel.

On Capitol Hill

All congressional investigations into the nation's space program—including the *Mercury* project—will be kept on the back-burner until after Kennedy takes office. Some of the items currently under scrutiny include possible duplication of moon-mapping (Army, AF, NASA, and the Interior Dept. are all in the act) and some Navy complaints that the AF is giving it short shrift on launch schedules for next spring.

INDUSTRY

SAINT Contract Due

Award of a contract for a prototype *SAINT* test vehicle probably will be made by the AF Ballistic Missile Division before the end of the year. About three dozen bidders are in the competition for the satellite to inspect and destroy hostile spaceware.

Minuteman Production

Growing size of the *Minuteman* ICBM program is indicated in the huge $30-million AF Plant 78 being built at Tremonton, Utah, to produce first-stage motors. Thiokol will operate the plant.

Test Stands for the F-1

Two test stands for static-firing Rocketdyne's 1.5-million-lb.-thrust engine are almost ready at Edwards AFB. Test stand 1a is designed to hold the engine under full power. . . . At Sunnyvale, Calif., Lockheed is getting ready to add a $4-million engineering laboratory for its Missile and Space Division. Lockheed says the move will be accompanied by a "significant rise" in employment.

High Cost Payloads

Scanning the horizon to 1970, JPL scientists figure that the scientific instruments needed for exploratory work on other planets will cost more than the launch vehicles to get them there. The expensive items: remote control devices.

In From Space

MIT is joining the growing list of contractors in the AF-ARPA *Defender* program. The Institute's Lincoln Laboratory will research problems relating to both ballistic missile defense and location of and communication with, re-entering space vehicles. Field experiments are being conducted with NASA's Wallops Island, Va., station.

INTERNATIONAL

Skybolts for Victors?

Handley Page denies that its Victor bomber can't carry the *Skybolt*, contending that the Victor I already has flown with the equivalent weight and drag of two *Skybolts* under its wings. The company says the bomber could be fitted with an ALBM made in Britain, if the *Skybolt* goes only on Vulcan Bombers.

Blue Water: Secret Sell?

Rumors are circulating in London that the British War Office is secretly sending a *Blue Water* tactical missile to the U.S. in hopes of getting a $140-million order from the U.S. Army. The missile is being offered as a substitute for *Sergeant*. Unless America buys the *Blue Water*, observers feel it unlikely that the rocket will be bought by the British because of the high cost of producing it in limited numbers.

Red Astronaut

The vice president of the Soviet Academy of Medicine, V. Timakov, reports that the first Russian astronaut has been selected. He is a jet pilot, smaller than average in size, who has been dividing his time between learning new sciences, handling complex instrumentation and physical training.

Overseas Pipeline

The RAF is said to be trying to wrest operational control of the *Thunderbird* air defense missile from the Army. That contract for an advanced Mark I *Thunderbird*, incidentally, is reported to be worth $56 million to English Electric . . . Nord's CT 41 target drone is under consideration for NATO use . . . Eight European nations are meeting in Geneva Nov. 28 to discuss creation of a common space research center . . . The Indian government is thinking about buying *British Bloodhounds* and U.S. *Sidewinders*.

PATRICK HENRY later this year will become second FBM sub to go on station.

'Most Significant . . .'

Polaris Sub Sails to Gua

Triumphant departure of George Washington changes wo power picture; Navy to press for bigger fleet

by James Baar and William E. Howard

CHARLESTON, S.C.—Arrival of the *Polaris*-launching submarine George Washington sometime this week beneath the ocean's surface somewhere within range of the Soviet Empire is a major event of twofold significance:

–It introduces a mighty, new element—the hidden, mobile missile base—into the complex equation of the world balance of power.

–It opens a renewed drive by the Navy for authority to construct a two-ocean, five-squadron fleet of *Polaris* submarines.

The George Washington with her 16 H-bomb-tipped missiles sailed from the Charleston *Polaris* Depot at a few minutes after noon on Nov. 15. She was expected to reach her station in about 10 days.

The Patrick Henry—second of the *Polaris* fleet—is scheduled to join the nation's strategic forces in less than six weeks. She is expected to begin taking on *Polarises* at Charleston about the end of the month or early December.

Three more *Polaris* submarines—the Theodore Roosevelt, Robert E. Lee and Abraham Lincoln—will follow during 1961, putting a possible total of 80 1400-mile-range missiles around the periphery of the Soviet land mass.

An operational command post for the *Polaris* fleet has been in operation at Norfolk Naval Base since October under the command of Adm. Robert L. Dennison, commander-in-chief of the Atlantic. The post was established by Vice Adm. Elton W. Grenfell, commander of the Atlantic Submarine Fleet.

Here would come the order from the Joint Chiefs of Staff to launch *Polaris* missiles.

• **Only beginning**—At present, the Navy has authorization and funds for the construction of 14 *Polaris* nuclear-powered submarines and purchase of long-lead time items for five more. This is less than half the 45 submarines that the Navy feels the nation should build, at a total cost including R&D of about $9 billion.

The Navy is expected to push for 12 *Polaris* submarines in the FY '6 budget of the Kennedy Administratio and possibly four more in the expecte FY '61 supplemental. Moreover, th Navy probably will ask for more R& money to press work on the A3—th 2500-mile range *Super Polaris*.

The authorization of a doze subs—one keel would be laid a mon —would cost an estimated $1.3 billio The authorization of four more wou cost about $600 million.

A 45-ship *Polaris* fleet would enab the Navy to deploy five nine-sh squadrons. A high-ranking Nav source says three probably would o erate in the Atlantic and two in th Pacific.

• **Two-month submersion**—Oper tional plans of the George Washingto were closely guarded. However, a fe facts about her orders were indicate before the great undersea ship-of-th line sailed.

More than 60 miles off the Ea Coast of North America she close her hatches and submerged with 1 plan to surface for two months. The following a secret course, she heade for the European littoral. For tw months she will lurk somewhere in th cold wastes of the North Atlantic, th Arctic and possibly other ocean are from which her missiles with the range of 1400 statute miles could strik deep into European Russia.

Sometime before mid-January aft the Patrick Henry has been deploye the George Washington will turn ar head for home. She will be resupplied New London, the ship will be turne over by her Blue Crew to her Go Crew and once again she will head fo an unknown station.

The *Polaris* Sub Tender Proteus w service the George Washington at Ne London before sailing for Holy Loch Scotland. Patrick Henry will be the fir *Polaris* sub to be serviced at Ho Loch.

• **12-hour shifts**—The Georg Washington arrived at the isolate Charleston *Polaris* Depot 16 miles u the Cooper River from the Atlant shortly after Nov. 1. The nuclea tipped missiles were loaded onboard about a week—half the time expecte

eace

However, up to the last day, the sub's crew of more than 100 officers and men continued to load supplies ranging from delicate guidance components to lettuce.

The day before she sailed, with supplies still piled on the pier, the Navy demonstrated how the missiles were loaded from their special double containers into the sub's great launching tubes. But the missiles had long since been slowly slid into the tubes, checked out and accepted by the George Washington's skipper, Cmdr. James Osborn.

Osborn and his crew had been working 12-hour shifts for two weeks to prepare for sailing. The pace the weeks before at New London and Cape Canaveral had been much the same.

At 11 o'clock of the day they sailed the pier was clear of cartons and was lined with the officers and men of the Navy Weapons Depot. A band played briskly in the warm sunshine. Osborn and his officers and two thirds of his crew stood at attention on the George Washington's deck.

• **Most significant journey**—Admiral Grenfell presented the crew with the Navy Unit Commendation Ribbon. He presented Osborn with the Legion of Merit. Then there were speeches.

"This is the ship and the crew who may indeed be the one military system capable of guaranteeing peace in the world—for it is this ship and her crew and those following who can really provide a retaliatory capability as well as a deterrent," Grenfell said.

Adm. Arleigh Burke, Chief of Naval Operations, talked to the crew by radio from the Robert E. Lee, which was cruising in the Atlantic with the Joint Chiefs of Staff.

"I wish you the best of luck in the most significant journey that any man-of-war has ever taken," he said.

Then the great 6000-ton submarine was edged from the pier by two tugs. Once in the middle of the Cooper River her nuclear-powered screw began to churn the placid water.

As the band played "Anchors Aweigh," the George Washington moved slowly away from the shore with Osborn in the sail jauntily smoking a cigar. In a few minutes she headed down the river until she was only a dark silhouette.

Out in the Atlantic Destroyers swept the sea for Soviet subs. The fleet's new queen of war, the most powerful ship ever built, was about to take command.

Navy Defends Holy Loch

The Navy this week hit back at critics of its decision to establish an advance *Polaris* base a Holy Loch in Scotland.

The essence of the Navy's argument given both publicly and privately is that the Holy Loch base can hardly be called a base at all in the usual sense of the word because it will be mobile.

The calm water of the Scottish loch will be used only as an anchorage for the Submarine Tender Proteus and a floating drydock which could be located anywhere. The real *Polaris* bases—the nuclear-powered submarines and their H-bomb warheads—will be at sea.

Rear Adm. Kenmore McManes, commandant of the 6th Naval District and Charleston Naval Base, said at a luncheon before the George Washington sailed:

"We are not—repeat not—establishing a base in Scotland. What we are doing is sending over a tender. When you think of a base the public generally thinks of something like New London or Charleston."

• **"We're not vital"**—Capt. Richard B. Lanning, commander of the Proteus, elaborated on the role of his ship while sitting aboard her in Charleston harbor.

"We would like to think we are absolutely vital to the *Polaris* system, but we're not," he said. "They don't need us. They could come home. We're saving transit time."

As to the choice of Holy Loch, Lanning said:

"We don't have any umbilical cord at all. We have a few piers that we can use if we want. A number of our men will live ashore with their families. But we can go anywhere. It's a matter of convenience, not necessity. We're not a fixed base."

Overseas, the uproar over the proposed *Polaris* base appeared more and more to be a political football that the left-wing Laborite groups and supporters of the Campaign for Nuclear Disarmament sought to keep in motion to press their drive for unilateral disarming of Britain.

As the highly-respected *Economist* put it: "The Campaign for Nuclear Disarmament, as it happened, was in need of a juicy bone of this kind to gnaw at the present time."

• **Factors in favor**—However, supporters of the Government's position in favor of the base appeared to be carrying the day.

One reason was the shooting down of the contention that the presence of the Proteus and a *Polaris* submarine on occasion would make Holy Loch a target for Soviet missiles.

Supporters of the base pointed out that Holy Loch already was a target since the Royal Navy's Third Submarine Flotilla and the British Tender Adamant are stationed only 25 miles away in Gareloch. The Clyde Valley is a heavy industrial center, and other military targets are located in the area.

Economics is also a factor favoring acceptance of the base. The area has one of the highest unemployment rates in Great Britain.

• **Useful Proteus**—Present Navy plans call for the arrival of the Proteus in Holy Loch sometime in February. The *Polaris*-launching submarine Patrick Henry—second of the *Polaris* fleet—will be her first customer.

The 18,500-ton Proteus and her crew of 895 officers and men is capable of providing a *Polaris* submarine with extensive servicing.

The submarines can be completely resupplied with food, spare parts and other supplies including the replacement of any *Polaris* missiles that may have developed breakdowns beyond the ability of the sub crews to correct. Twenty spares can be carried aboard the tender.

The Proteus shops are capable of performing extensive work on missiles and on the submarines themselves including the replacement of modules inside the sub's nuclear cores. They can also work on nuclear warheads.

The Proteus is specifically assigned to servicing the nine ships of the first *Polaris* squadron—Subron 14. However, as Lanning put it:

"If another nuclear sub came by, of course we'd help out if we could. If a seaplane came by and asked if we had any extra ice cream, we'd provide that, too."

PMR May Stretch to Indian Ocean

Range ships by next spring will be ready to extend tracking capability to Indian Ocean, if necessary; facilities added in Philippines

by Frank G. McGuire

WAKE ISLAND—The Navy may extend the Pacific Missile Range to the Indian Ocean from its present terminals here and at Eniwetok sometime next year.

A splash net in the Indian Ocean would give the range the capability of handling training shots of the *Titan* ICBM, in addition to its tracking role in the *Dyna-Soar* program. By spring, three PMR range ships will be equipped with SILS (Shipboard Impact Locator System) to extend the net, if required, to meet with the tracking and communications network of the Atlantic Missile Range at parallel 90° West.

Range capabilities are being expanded with the recent addition of MILS (Missile Impact Locator Systems) stations, instrumented aircraft, and *Transit* tracking stations in the Philippines and elsewhere.

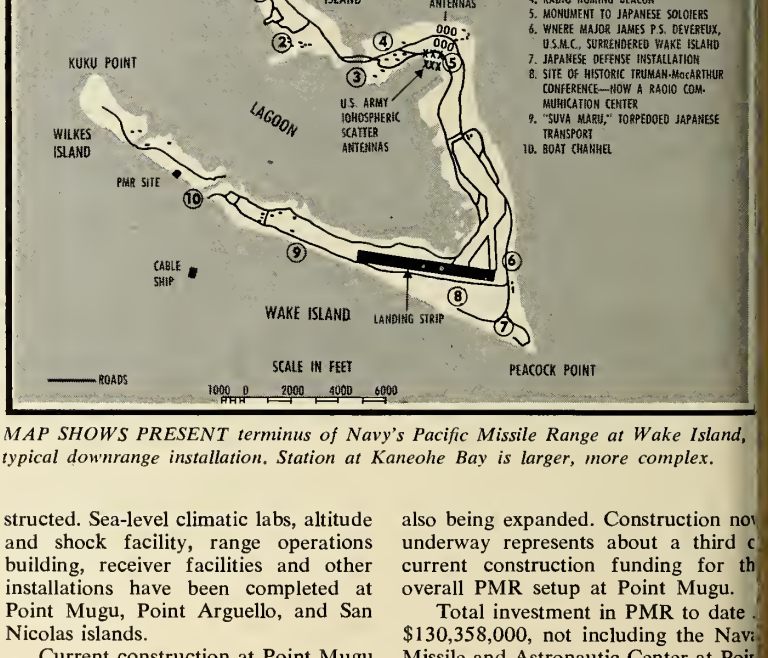
• **Grandstand seats for re-entry**—At present, PMR terminates at this wishbone-shaped trio of coral islets barely clearing the surface of the Pacific at 19°15′ N. latitude and 166°37′ E. longitude. The island's three square miles of land surface have 20 miles of shoreline.

The PMR installation itself is on the south shore of Wilkes Island, the least used portion of the atoll.

Tower operators in the airport control center have reported seeing reentering *Atlas* vehicles plunge into the sea. They describe the colors of reentry as "brilliant." The vehicle separates into two packages just before water impact, they say, and one package explodes while the other enters the water intact.

The explosion undoubtedly signifies a successful arming and fuzing operation, while the second package carries SOFAR bombs.

• **Building investment**—During the fiscal year ending June 30, PMR completed military construction totalling $15 million. This includes missile impact locator system buildings at Kaneohe, Eniwetok, Midway and Wake Island. In addition, runways for support aircraft at Point Mugu PMR headquarters and other facilities were constructed. Sea-level climatic labs, altitude and shock facility, range operations building, receiver facilities and other installations have been completed at Point Mugu, Point Arguello, and San Nicolas islands.



MAP SHOWS PRESENT terminus of Navy's Pacific Missile Range at Wake Island, typical downrange installation. Station at Kaneohe Bay is larger, more complex.

Current construction at Point Mugu for PMR consists of 15 major projects with a combined cost of over $7.5 million. Heading the list is a missile projects building for work on the *Eagle* missile system and an airborne tactical data system. The meteorological building is being expanded to boost current range capability in support of *Tiros* and other satellites. Frequency control buildings, instrumentation, photo installations, calibration and hangars are also being expanded. Construction now underway represents about a third of current construction funding for the overall PMR setup at Point Mugu.

Total investment in PMR to date is $130,358,000, not including the Naval Missile and Astronautic Center at Point Mugu or the Naval Air Station there. Estimated expenditure for Fiscal 1962 is about $50 million, according to Navy figures.

Future plans call for building instrumentation sites at a number of islands. These would very likely include Manus and Christmas Island. Manus is east of New Guinea and Christmas is northwest of Australia.

Installation of the missile impact locator system (MILS) at Eniwetok was completed recently, and the MILS unit at Midway is expected to be finished shortly. Neither is expected to be completely operational before the end of the year, however. The MILS system used at the downrange stations was developed by Bell Laboratories, manufactured and installed by Western Electric, and is operated and maintained by Bendix Corporation.

First on the Scene

MISSILES AND ROCKETS *Correspondent Frank G. McGuire is the first reporter sent by any publication to visit PMR's downrange facilities and send back a first-hand story.*

PMR Capital: (Cumulative in millions of dollars)

Fiscal Year—	1957	58	59	60	61
Land	$ 3.8	2.7	3.2	3.2	3.2
Facilities	34.9	35.0	35.0	65.0	110.0
Equipment	30.2	31.7	46.4	53.0	109.0
Total	68.9	69.4	84.6	121.2	222.2

• **Air support**—Projects for rapid ata acquisition and reduction are also nder way at Point Mugu. Three WV-2 ircraft have just been modified to act s airborne multi-purpose range instru- ientation carriers anywhere along the ystem. These Lockheed Constellations rovide PMR with frequency monitor- ig and interference control, airborne IC, telemetry data recording with mited real-time readout, and terminal npact data on ballistic missiles and tellite instrument capsules.

In addition to the three Constella- ons, a Lockheed Electra has been odified for telemetry duty, carrying quipment in what was formerly the nter seat section on the former apital Airline plane. In addition to he internal gear, a special radome was stalled for antennas on the upper uselage.

• **Wake's set-up**—Typical of PMR ownrange installations is the complex ere at Wake Island. The visible "com- lex" consists of one small concrete- lock building about 30 x 8 ft. in size, ontaining an instrumentation room, a ommunications room, and various ad- inistrative and support offices. There a small power house near the air- onditioned main building. Three to ve permanent civilian personnel man he station.

The MILS setup includes two major ubsystems: the SOFAR (sound fixing nd ranging) and Splash Detection Sys- ms. SOFAR itself consists of two ets, the broad ocean area net and the iniature SOFAR net for great accu- acy in a smaller area.

SOFAR depends on subsurface ex- losions to make a fix on a missile im- act. Small bombs are set off 2500 feet nderwater by the re-entry vehicle's ecovery package when it strikes the ean surface, providing SOFAR with he necessary explosion. The broad ean area system has great range, but cks the extreme accuracy of the mini- ure SOFAR net.

SOFAR operates on the triangula- on principle, with stations at Wake, idway and Eniwetok islands compar- g data for a precise fix. As of now, ere are four pairs of hydrophones in e SOFAR net at Wake.

• **Helped spot Red rockets**—The lash detection system records the cation of an object striking the ocean rface. PMR did not give the range of e system, but it is known that such MR equipment aided in pinpointing e impact location of Soviet rocket ots into the Pacific.

Hydrophones are located off Wake two patterns, the four pairs men- ned for the SOFAR setup, and an- her set of six in the splash net. These e patterned in a pentagon, with the xth sensor in the center. Distances in- volved were not disclosed. The signals from both nets in the MILS system are transmitted by cable to the shore station, where they are recorded, timed and correlated.

No airborne telemetry is included at present in the Wake/Midway/Eniwetok complex, all instrumentation being underwater. Seven channels of hydrophone telemetry are handled by the three tape recording racks at the shore installation. About 10 racks of equipment, including the three tape recording units, are at the site, consisting of WWV receiver, a secondary time standard, oscillographs, oscilloscopes, and other equipment. There is also a separate communications room in the small building. One voice and one teletype circuit, both furnished by the Federal Aviation Agency and designed by Collins Radio, handle communications between Wake and the PMR main downrange station at Kaneohe Bay on Oahu in the Hawaiian Islands.

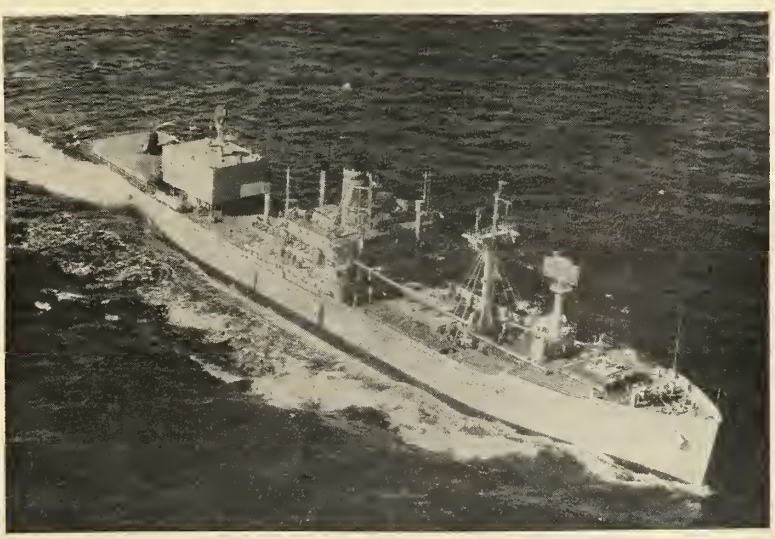
• **Small staff**—The administering government agency on Wake Island is the Federal Aviation Agency, which took over control of the island from the Navy in 1947. Island population is now about 1180 people, mostly employed by Pan American, Overseas National Airlines, and other firms engaged in various phases of trans-Pacific aviation.

Although Wake is essentially the present terminus of the Pacific Missile Range, with support from stations at Midway and Eniwetok, the downrange station at Kaneohe Bay is larger and more elaborate. Located at the Marine Corps Air Station at Kaneohe, the PMR site was activated in September, 1958, and recorded the first IRBM impact in December of that year.

Personnel at Kaneohe number about 120 military, civil service and civilian contractor employees. From the original MILS system at the Oahu station, this Hawaiian complex has grown to include telemetry and tracking units on the islands of Kauai and Hawaii, as well as two telemetry/tracking ships and numerous aircraft.

Kaneohe handles communications to Barking Sands, Kauai, and South Point, Hawaii, as well as to Wake, Midway, Eniwetok and Kwajalein. Bendix Corporation is contractor for the communications net, which is in 24-hour operation.

A teletype circuit carries traffic from Kaneohe to Point Mugu, backed up by a hot telephone line for MILS readiness and range safety traffic. There is also the voice/teletype circuit previously mentioned between Kaneohe



USNS HAITI VICTORY is one of two satellite recovery ships under operational control of PMR. Other is USNS Dalton Victory. Equipment includes two helicopters.

THESE VANS at Barking Sands, Kauai, Hawaii, are operated in support of Pacific Fleet Missile Training. Missiles are recovered on adjoining landing strip.

and Wake. Other teletype circuits connect Kaneohe with Barking Sands and South Point.

• **Recovery headquarters**—The Hawaiian complex is the center of activity during satellite recovery operations, and the three stations provide the same type of triangulation afforded further downrange by Wake, Midway and Eniwetok. Kaneohe is the nerve center of the *Discoverer* recovery operation, acting as coordinator of communications between surface recovery ships, PMR aircraft, and Point Mugu.

The Barking Sands station consists of a mobile van located at the western tip of Kauai, providing telemetry and communications services. Equipment used here was formerly used as mobile units on the mainland. The vans are completely self-contained and independent of outside technical support.

Backup systems insure reliability of all electronic circuitry. If the primary transmitter fails, a secondary transmitter in the command control van automatically takes over. The vans are operated and maintained under contract by Chance Vought.

The South Point Station is more fully equipped than Barking Sands, being furnished with a 60-ft.-high-gain antenna dish with command control, timing, telemetry recording equipment, and associated units. The command control unit can operate satellite transmitters designed for switching on and off during orbital passes over ground stations. In addition, it can send signals to change a vehicle's mission.

• **Plans for Transit**—Now under construction at South Point is a microlock station to be used in conjunction with the *Transit* satellite program. The equipment, designed and fabricated by the Naval Ordnance Test Station at China Lake, Calif., will be operated under contract by the University of New Mexico.

A station for the *Transit* program will also be built at San Miguel, in the Philippines, with operational control being vested in PMR.

The Philippine station, as well as others in this particular project, will have two five-ft. antennas, two Doppler receivers, a WWV receiver for time signals, and data reduction equipment. A teletype link will handle communications.

In addition to the island stations, the PMR instrumentation system includes a number of ships, one of which made the first successful recovery of a satellite capsule re-entering the earth's atmosphere from orbit, *Discoverer XIII*.

Besides their recovery role, the ships are on a "not-to-interfere" basis to support other PMR operations and normal fleet operations.

Various smaller ranges or recovery areas are contemplated as part of the eventual overall PMR setup, with cooperation from various governments in the Pacific area.

These include a tracking range for ballistic missiles and *Dyna-Soar* extending from Point Arguello westward down the range and also passing over Biki atoll, Manus Island, New Guinea, a the northwest coast of Australia, wi tracking facilities also on Christm Island in the Indian Ocean, coveri the area between Christmas and t Australian coast.

On Manus Island, an equatori launch site may be built, taking a vantage of the vast empty expanses the east, so that the earth's rotation c be exploited to help the vehicle atta required velocity.

In addition to the equatorial laun site, an equatorial recovery area is bei considered; it would extend 1000 na tical miles along the equator, eastwa from the 180° meridian, and just abo reaching Christmas/Pacific.

Until the operation of progra such as *Dyna-Soar*, requiring a 15,00 mile range, the most important proje on the range in the near future a *Titan* and the *Nike-Zeus* test progra *Titan I* tests will be well under way the time the extension plans are i plemented, but if the present timetab are maintained, *Titan II*, with its ported half-the-world range, will its first just at the time when PMR equipped to handle such a vehicle.

Nike-Zeus testing, with no speci firing date yet released, apparently w not utilize the extended portion PMR, but will involve Kwajalein Islar *Atlases* fired from the West Coast w be used as targets for *Nike-Zeus* fir from Kwajalein.

The Army is building installatio "in and around" Kwajalein for the tes PMR will provide range support.

PMR has also assigned helicop and aircraft units to Kwajalein to s port the programs. These will oper between Kwajalein and Roi-Nam islands which will work jointly on *Ni Zeus* and the *PRESS* (Pacific Ra Electro-Magnetic Signature Study) pr ect to detect and identify ballistic m sile warheads. It will also try to d criminate warheads from decoys.

For Project *PRESS*, an Advanc Research Projects Agency progra the Army will experiment with ra systems of advanced design and "otl sensing devices" on Roi-Namur. *PRE* is a part of the overall Defender p gram aimed at developing ballistic m sile defense measures. *PRESS* is defi as "a study of the exoatmospheric a terminal physics of ballistic mis flight."

Army Ordnance Missile Comma is acting as ARPA's executive agent *PRESS*, and has awarded Western El tric a contract for $1 million to inst a submarine cable between Kwajal and Roi-Namur for communicati and data transfer. Western Electric w buy the cable from Simplex Wire of Newington, N.H.

Range Programs:

Able III & IV
ADTS
Atlas ICBM
Bullpup (A) & (B)
Caleb Satellite
Centaur
Composite Radiation Satellite
Corvus (I)
Courier
Discoverer
Dyna-Soar
Eagle
Hawk
Hummingbird
Hydra
Hyperjet
Jaguar (Probe)
Mach 2 Expendable Target
Mach 2 Recoverable Target
Mercury
Midas
Minuteman ICBM
MORT (Fleet Training)
NERV
Nike-Zeus (Jet-Head, Weapon System, Target)
NORT (Fleet Training)
Ozarc
Pershing
Phoenix
PRESS
Regulus I
Rella (Probe)
Samos-Atlas
Scout
Sergeant
Sidewinder
Sparrow III
Sunflare
Talos
Tartar
Tepee
Terrier I
Thor IRBM
Tiros
Titan Training Program
Tophat
Transit
Tumbleweed
Typhon
WS/GAR-9

Special Report

A Very 'Can-Do' Outfit Always in 'State of Flux'

Adm. Monroe

(The following is an exclusive Missiles and Rockets interview with Rear Admiral Jack P. Monroe, commander of the Pacific Missile Range, on the future of PMR.)

Q. *Admiral Monroe, there has been some friction in the past between the Vandenberg Air Force base and Point Arguello launch facilities. How does this situation stand now?*

A. The Air Force and Navy are working together extremely well in a very cooperative attitude. The friction you refer to was, I think, the type of friction you could expect to get when any major agencies are required to work together in a new field such as this. The entire safety facilities of PMR, which initially were divided between the Air Force and the Navy, have now been turned over entirely to the Navy. We have Air Force and Navy officers working together at the safety headquarters and working together very amicably, too. All of our areas of disagreement have been ironed out and we are getting along extremely well now.

Flexibility makes it possible to take care of major jobs like Nike-Zeus . . . "this is our life"

Q. *What determines which vehicle will be launched from which base? The Discoverer series is launched from Vandenberg, but the Samos and Midas will be fired from Arguello. Why is this when there are already Atlas pads at Vandenberg, and the Samos and Midas use the Atlas booster?*

A. The *Atlas* Pads at Vandenberg were put there for training shots. They are built to shoot to the west, and they are built to train Air Force crews. This is not compatible with research and development programs such as *Samos*. They are mutually interfering. So the R&D programs, which may someday become operational programs, would therefore interfere with training. The pads built for the *Samos* program can be used for other *Atlas*-boosted programs that go into polar orbits.

Q. *Can you give us some indication what the future of the range is? We have noticed that the original funding figures mentioned in connection with PMR are not consistent with what is currently being spent. Has DOD reduced emphasis on development of PMR or is it going ahead as originally planned? We heard a figure of $4 billion to be spent over a 10-year period, and to date we understand the investment is only $130 million.*

A. When PMR was established in 1958, we were given the job of designing, planning, developing and building it. We then conducted a six-month study to find out what would be needed in the next 10 to 20 years. We talked to all the military services, government agencies and industry segments that would be likely to put a project on the range. This was done so that we could build a facility to provide the basic services needed. If the money was not available to put in all the necessary capabilities, then at least we wanted to build in a capability of future expansion. We didn't build ourselves into pockets, in other words.

We presented this plan to DOD, well knowing that the only money you can get these days is for programs which you can demonstrate are likely to come to the range. So that's the kind of money we got, and we have now essentially completed the Pacific Missile Range as far as the basic tools are concerned. These are radar, timing, telemetry, communications, range ships and aircraft, optical instrumentation, photography, data collection and data reduction. All these are now finished or well along toward completion. So you can say that PMR is essentially complete as far as basic tools.

Now of course, we re-orient all the time as we get new major projects like *Nike-Zeus*. This causes us to do a lot of re-orienting, spend a lot of money for new facilities . . . and this is our life. Every month that goes by, I would say, we get these new projects. This usually requires new facilities, as well as all our old facilities. We look forward to these new projects all the time, and we are always in a flexible situation.

In such a situation, however, it's difficult to look ahead too far. But we have a very enthusiastic, very aggressive and very "can-do" outfit, which can, because of its flexibility, take care of these short-notice major projects. We like to have as much previous notice as possible, of course. The range is a tremendous service agency put here by DOD to assist in the testing of missiles, getting satellites into orbit, getting space projects off the ground, and getting space probes up and recovered.

We're just a big service organization, that's all we are. If it weren't for the major projects that are assigned here, there would be no excuse for having a range like this.

"When we have a 10,000 mile missile, we will go that far . . . At present, we stop at Atlas . . ."

Q. *Would you comment on the extension of the Pacific Missile Range?*

A. Essentially, in working with Atlantic Missile Range and White Sands Missile Range, we cover the world. AMR and PMR meet on parallel 90 west, and the continental United States is handled by White Sands.

The length of any range is determined by the range of the biggest missile it fires. Our largest one to date is the *Atlas*, so we go down as far as the *Atlas* range. When we have a 10,000 mile missile, we will go that far, but at the present time we have no such missile so we stop at the *Atlas* range.

We are also establishing various stations around the world to get the *Transit* satellite program operational. As

(Continued on page 40)

The Missile/Space Week

X-15 Nears 2000 MPH at Half Throttle

North American's *X-15* rocket plane made its first successful flight with the 57,000-lb.-thrust engine last week. Shackled by his contract as to height and speed, pilot Scott Crossfield kept the drag flaps open and the Reaction Motors powerplant at less than half throttle during the 138-second run. Performance reports indicate that the ship hit almost 2000 mph and an altitude of over 65,000 ft. The second flight is expected this week and will probably involve checking out the engine's in-flight stop-start capability. Maximum-performance flights, expected to pass 4000 mph and 100 miles altitude, will take place when NASA assumes control of the ship.

AF Anxious to Press Space Plane

Look for the Air Force to push for at least $20 million in the FY 1962 budget to get its space plane program underway. The unboosted plane would be powered by a hydrogen engine and would scoop up its own oxygen from the atmosphere. Takeoff weight would be between 250,000 and 500,000 lbs. Lockheed, Convair, Douglas, Republic and North American are among companies already conducting design studies.

Moon Probe Hits Veldt

Two pieces of metal that fell on a farm in Transvaal, South Africa, Sept. 25 have been identified as pieces of the second stage of the ill-fated *Atlas-Able III* moon probe.

Telemetry sightings of the pieces indicated they fell from an altitude of 800 miles, the National Aeronautics and Space Administration said. One was a 3-ft.-diameter sphere, apparently a helium bottle used to supply pressure in the *Able*. The other was a piece of metal 28 in. long.

The flight program called for re-entry of the second stage over the Indian Ocean. However, in the actual flight, the *Able* failed to reach full chamber pressure and burned for only about 80 of the programed 110 seconds.

AF Builds Know-How at Vandenberg

The Air Force is building a "blue suit" technical capability for missile and space launches at Vandenberg AFB—a move expected to phase out much of contractors' work at the base. The ARDC field office at Vandenberg, designated the 6565th Test Wing, will be responsible for site activation, military test and evaluation and space launch operations. Site activation will include construction, installation of E780.3,5, checkout and technical assistance. The 6596th Instrumentation Squadron, a unit of the 6594th Test Wing (Satellite), Sunnyvale, Calif., will be attached to the Vandenberg Wing for operational control prior to and during launch for space booster operations.

Off the Pad

Another mid-air catch on Nov. 15 of an Air Force *Discoverer* capsule revived flagging hopes that the U.S. would orbit an animal in space this year . . . Recovery of another *Atlas* data capsule only 12 hours later after a 5000-mile flight will permit further evaluation of new nose cone materials. The AF missile withstood temperatures up to 12,000 deg. during re-entry . . . Later the same day an AF *Mace B* flew 1000 miles after a 24-hour "hot-hold" in its simulated underground hard site . . . The next day the Army's *Pershing* traveled 160 miles in the first fully successful flight test of the rocket's two stages.

Manned Ballistic Launch May be Off Until April

THE LATEST DELAY in the Project *Mercury* flight test program may have pushed the first manned ballistic launch back to April, 1961.

Another attempt may be made this week to launch the first *Mercury Redstone*, scheduled originally for the day before Election Day. The shot was called off because of a leak in the capsule attitude gas system. The capsule was taken down from the launch pad at Cape Canaveral for a complete test of the gas system, which took more than a week.

If all goes well with the *Mercury Redstone* series once it begins, a primate is to be carried on the second and a man on the third. But even with the best of success, a period of less than two months between launchings is considered highly unlikely.

Meanwhile, the *Mercury Atlas* series continues to stretch out. January is now considered the likely date of the second *Mercury Atlas* (MA-2) which will test how the McDonnell production capsule will withstand re-entry at a sharp angle. This experiment was programed last July for MA-1, the first of the series, but the *Atlas* exploded.

Officials of the National Aeronautics and Space Administration report the MA-2 shot is delayed by a decision to use a final production capsule. An R&D capsule was used in the July test.

One official voiced hope that the test rate will accelerate after the next two hurdles. Four McDonnell production capsules are on hand at the Cape now. Two are intended for *Redstone* shots and two are for *Atlas* shots. Two others have been launched.

The number of *Atlas* shots before the manned orbital attempt has never been stated officially, but one semi-official guess is about seven.

Inevitably, the lengthening time required is adding to the total bill. The first guess was $200 million for the overall program. Officially, the National Aeronautics and Space Administration now puts it at $350 million. Some Congressional sources now feel the total may hit $500 million.

Hydrid, Liquid Systems Added to ARPA Program

Project *Principia*, the Advanced Research Projects Agency program for uprating solid propellants, will be broadened to include hybrid and liquid rocket systems. The broadening does not necessarily mean any increase in expenditures. Some avenues for uprating solids 10 to 20% have reached a dead end and will be abandoned.

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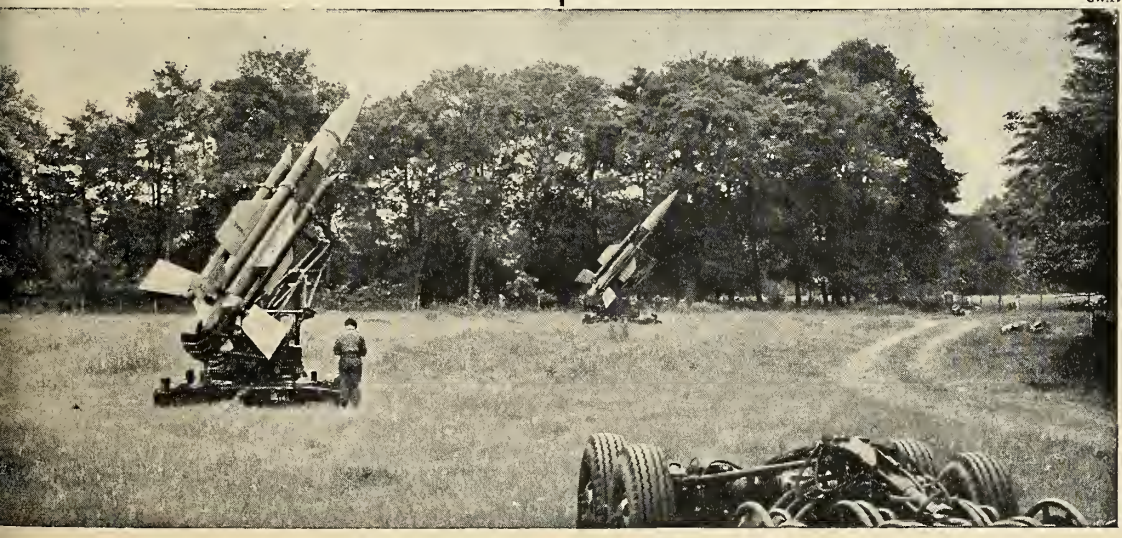

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Technical Countdown

ELECTRONICS

New IR Scanner Developed

A display-type infrared scanner, called Avscan, has just been developed by Avco Electronics and Ordnance Div. Good for detection of aerodynamically heated bodies up to several miles distance, the system is small and lightweight (40 lbs.). It uses four nitrogen-cooled indium antimonide (junction type) detectors and rotating refractive optics. These scan with a resolution of 0.1° by 1°.

Exotic Power Sources to be Studied

General Electric will study precise output control of unconventional power sources under a new Navy contract. Study is aimed particularly at so-called "exotic" power devices: thermionic converters, thermoelectric generators, and fuel cells.

More Fuel Cell Progress

A proof-of-principle liquid-metal fuel cell developed by Allison Div. of General Motors has been operated continuously for up to 1 hour. Current research at Allison is directed toward producing efficient final configuration 1/10 the size of existing prototypes but with same power output.

First Mail Relayed by Satellite

The first "space mail" was relayed last week via the *Echo* satellite between Washington and Newark, N.J. The Post Office's traditional Christmas message—"Shop and Mail Early"—was converted to facsimile, transmitted to the satellite by microwave, reflected back to earth, and reconverted back to its original form. Approximately 5 minutes were required for the complete process.

GROUND SUPPORT EQUIPMENT

Mistram Construction Bids Due Soon

Army Corps of Engineers is expected to open bids early next month totaling $1.5 million for construction of facilities for Cape Canaveral's precision trajectory system (Mistram). Work is scheduled for completion by Sept. 15, 1961.

Atlas Guidance Sites Completed

The last of the scheduled radio-guidance sites for the AF *Atlas* ICBM was finished and turned over to SAC last week at Offutt AFB, near Omaha, Neb. Other installations are at Vandenberg AFB, and Warren AFB, Cheyenne, Wyo.

Thermoelectric Generator for Weather Station

Bureau of Standards has awarded a contract to General Instrument Corp. to build a propane-fueled thermoelectric generator for a Navy automatic weather station in the Gulf of Mexico. The unit is scheduled to run for one year on 25 gallons of propane to power the meteorological instrumentation and telemetry transmitter installed in the unmanned station.

Gas Turbines for Pershing GSE

First gas-turbine support units for the Army *Pershing* have been shipped by AiResearch. Comparable to the dual power units used by commercial jets, the turbine package provides all missile ground power requirements for air-conditioning, ac and dc power, and high- and low-pressure pneumatic power.

Electric Crane Loads Titans

Titan ICBM's can be unloaded and positioned in firing silos within a few minutes with a new electrically-controlled no-clutch crane developed by Unit Crane and Shovel Corp. A remote unit within the silo provides the precise control necessary for positioning the missile within the extremely close tolerances of the silo.

PROPULSION

More Aerobee Shots Planned

NASA plans a series of *Aerobee* sounding rocket shots from Wallops Island to test the properties of liquid and gaseous hydrogen mixtures under zero-g conditions. Information to date has come from Air Force-NASA experiments in KC-135 aircraft out of Wright-Patterson AFB.

Ion Rocket Test Slated

First ion rocket flight-tested will be a tiny device powered by less than 200 lbs. of batteries. The first test will raise the question whether any impulse at all is possible—since ground tests cannot demonstrate the possibility of beam neutralization.

Repeater Satellite Brood Scheduled

Multiple launching of active repeater communications satellites may be tested in a *Centaur*-boosted package in 1963 or '64. Under tentative NASA plans, 8 or 10 satellites would be spewed out of a big carrier each time it hit apogee of an elliptical orbit. Each satellite would have a small propulsion unit to make its orbit nearly circular.

Electrical Propulsion Proposed

Marquardt Corp. is proposing a plasma diode powerplant for spacecraft that would provide 300 kw by direct conversion from a nuclear reactor, bypassing the turbogenerator phase in current systems. Marquardt's design study indicates the system would weigh only 1050 lbs.

ADVANCED MATERIALS

Allison to Develop MM 2nd-Stage Cases

Aerojet-General awarded a development contract for second-stage *Minuteman* steel cases to Allison last week. The GM Division is already deep in first-stage case work.

Temperature Rise Induces Magnetism

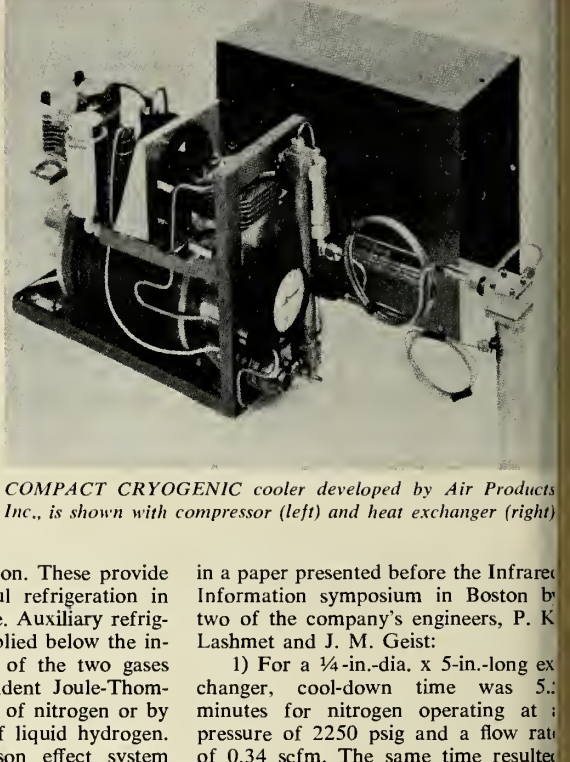
DuPont has come up with metallic compounds that become magnetic as their temperatures rise above a point predetermined by their chemical composition. Chromium manganese antimonide was the first compound discovered. The magnetic switching is controlled by the amount of chromium.

Polymers Improve in Space

Goodyear scientists say that those molecules which do "boil" away in a vacuum frequently leave behind an enhanced polymer. Ultraviolet radiation also may prove beneficial since the break caused by it is made permanent by oxygen fusing to the end of the chain. There being little oxygen in space the chains can re-combine to form strong, or possibly stronger, polymer structures.

Closed-Cycle Coolers for Space

Air Products' cryogenic units are light and small enough for use in satellites and vehicles



COMPACT CRYOGENIC cooler developed by Air Products Inc., is shown with compressor (left) and heat exchanger (right)

by Charles D. LaFond

CLOSED-CYCLE CRYOGENIC cooling systems that are lightweight and compact enough for satellite and space vehicle applications soon will be available for broad use.

Prototypes of an entire family of such units have been under test for many months at Air Products, Inc., in Allentown, Pa.

Rugged and reliable, these closed-cycle coolers have been needed for some time for cooling infrared detectors at liquid nitrogen temperature (77°K) and for cooling down to the narrow range of 15° to 35°K, using liquid hydrogen or neon. For both ground and space vehicle use of parametric amplifiers and MASER's there is a need for cooling down to liquid helium temperature of 3.5°K.

All of these low temperatures can be obtained quite readily under laboratory conditions, but what has not been available in the past is a means for doing this automatically and under "normal" working conditions. Normal could mean an isolated or unattended radio or radar station or space vehicle.

Problems still exist in the development of such systems for space use—primarily that of heat disposal—but research by Air Products so far indicates that these too will be solved shortly.

Engineers at the company's laboratories have been working on the whole problem of cryogenic cooling for the past three years. The current closed compressor-type systems developed have been under test for six months. These have successfully endured 100- and 500-hour test runs without failure.

Principal devices tested which may meet space needs of the future have been Joule-Thomson expansion systems using hydrogen or neon. These provide 0.5 to 2 watts useful refrigeration in the 15 to 60°K range. Auxiliary refrigeration has been supplied below the inversion temperatures of the two gases either by an independent Joule-Thomson expansion circuit of nitrogen or by an external supply of liquid hydrogen.

The Joule-Thomson effect system was selected by Air Products because it offers lower thermodynamic efficiencies than those refrigeration systems employing expansion engines.

Simplicity and compactness were equally important characteristics.

The system is comprised basically of two parts—the Joule-Thomson heat exchanger and the compressor. Helically finned tubes coiled around mandrels are used for the compact exchanger.

High-pressure gas flows inside the tubes; low-pressure gas flows outside the tubes in combined counter- and cross-flow heat exchange.

A variety of exchangers have been built and tested, varying in size from ¼-in. to ¾-in. dia. with flow rates from 0.1 to 1.0 scfm of hydrogen. To reduce radiation heat-leak, the cold end of the exchanger employs a copper radiation shield. This is maintained at roughly liquid nitrogen temperature.

Filters are used within the high-pressure fittings in the head of the exchanger for protection against foreign matter which might otherwise block the small exchanger tubing.

The compressors employed are two-stage, non-lubricated, completely enclosed units.

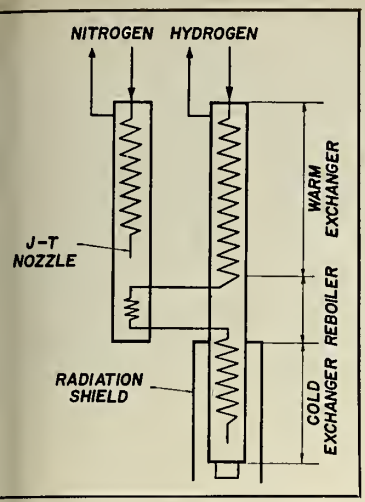
• **Performance**—Cool-down time (the time required to reach liquid stage) in any cryogenic cooling system is extremely important. In the series of exchangers currently undergoing tests the following typical results were described in a paper presented before the Infrared Information symposium in Boston by two of the company's engineers, P. K. Lashmet and J. M. Geist:

1) For a ¼-in.-dia. x 5-in.-long exchanger, cool-down time was 5 minutes for nitrogen operating at a pressure of 2250 psig and a flow rate of 0.34 scfm. The same time resulted with hydrogen at 1800 psig and a flow rate of 0.37 scfm.

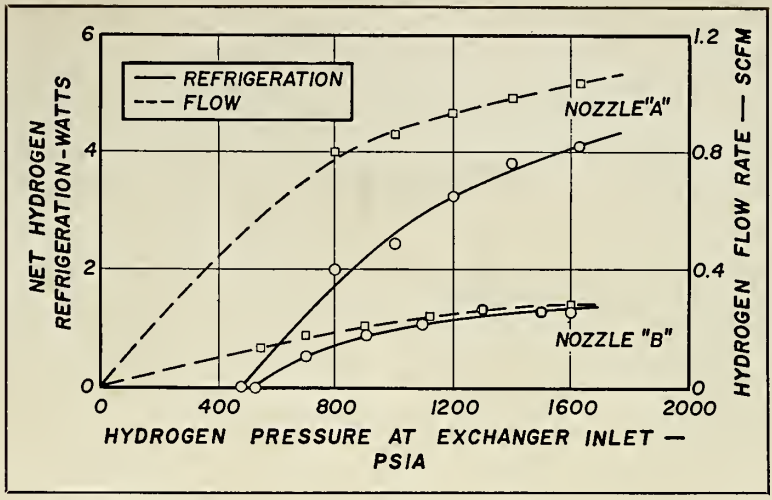
2) For a ¾-in.-dia. x 13-in.-long exchanger, cool-down time was 22 minutes for nitrogen at 2000 psig with a flow rate of 1.28 scfm. The same time resulted with hydrogen at 1500 psig and a flow rate of 0.74 scfm. Since most of the refrigeration during cool down is required to reach liquid nitrogen temperatures, cool-down time depends largely on nitrogen pressure and flow, and is affected only slightly by the hydrogen pressure and flow. Data obtained with the ¼-in.-dia. heat exchanger and presented in the last graph accompanying this article show this effect. In these tests the nitrogen and hydrogen operating pressures were applied to the exchanger simultaneously.

Since the negative Joule-Thomson effect of the hydrogen requires refrigeration, the times presented in the figure are reduced by allowing hydrogen to pass through the exchanger at low pressure during the initial cool-down.

Cool-down times of four minutes said Lashmet and Geist, have been obtained for the ¼-in.-dia. exchanger with initial hydrogen pressure of 200 psia and nitrogen pressure of 2200 psia. If optimum cool-down times are required in a detecting system, the necessary control circuit could be incorporated. Cool-down times calculated from the estimated refrigeration capacities allowing for heat-leak and warm end



SCHEMATIC FLOW diagram of a hydrogen heat exchanger.



NET HYDROGEN refrigeration at various pressures and flow rates (as a function of hydrogen inlet pressure).

temperature difference, ranged from 50% to 90% of the measured cool-down times, the engineers reported.

The differences are believed due to uncertainties in estimating the variation in flow-rate during cool-down, the heat-leak, and the temperature distribution in the heat exchanger.

• **Temperature control**—Close temperature control is maintained, when operating in the boiling liquid region, by supplying the gas at a pressure above the minimum required for the refrigeration load. The inventory of liquid increases in the bottom of the exchanger until the excess refrigeration capacity is balanced by the increase in warm-end temperature difference.

Since the pressure drop on the low-pressure side of the exchanger is small, the slight variation in pressure drop will result in a negligible change in temperature. (In the region of the normal boiling point of hydrogen a temperature change of 0.01°K corresponds to a pressure change of 0.05 psia.)

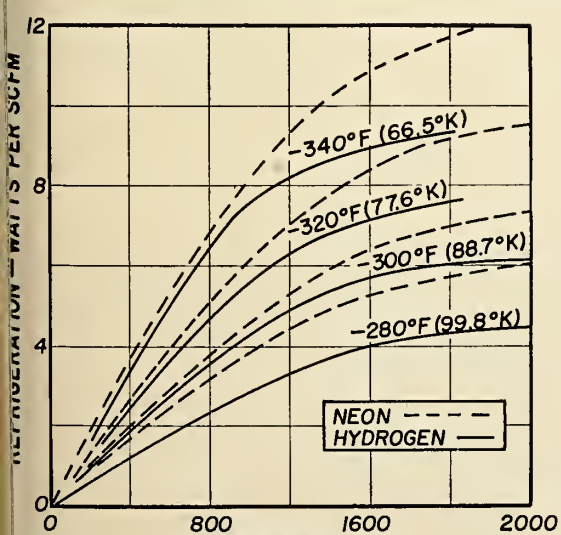
If the heat-load should increase suddenly, a liquid inventory is available for maintaining the cold temperature while the exchanger is adjusting itself to the new condition. This self-compensating behavior insures a stable cooler despite moderate variations in the heat load. This was verified, said the two engineers, during the tests for determining the net refrigeration, since cold temperatures were maintained during large variations in the loads.

When operating the heat exchangers at temperatures above the critical point the refrigeration supplied by the exchanger must be balanced with the heat-load requirements of the system, since there is no self-compensating liquid reservoir.

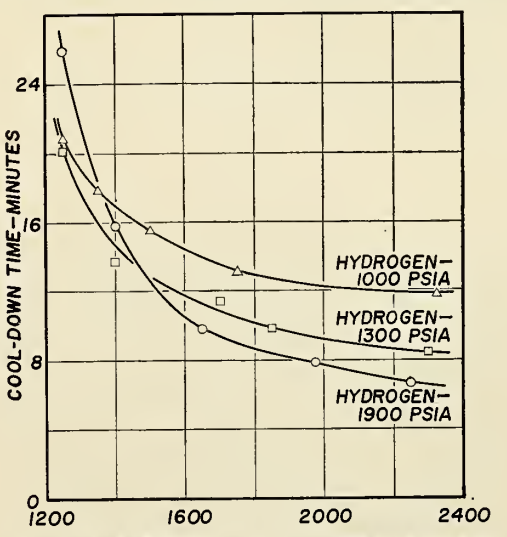
The heat capacity of the dense gas is small compared with the latent heat of the liquid and the system is less stable when subjected to changes in heat-load. The heat capacity may be increased by adding metal to the cold end.

Several methods for controlling the refrigeration to balance the system have been considered by the Air Products engineers and tried in preliminary investigations: (1) control of the inlet hy-

(*Continued on page* 25)



THEORETICAL capacities of Joule-Thomson exchangers as function of temperature and pressure at inlet to unit.



COOL-DOWN TIMES for a ¼-inch-diameter exchanger at various N_2 and H_2 operating pressures.

Hot-gas 'Servos' Are Ready For Design into Missiles, Vehicles

- *An expert report on the direct-energy control system now in use on six R&D missiles.*
- *Why valves determine which servo is best for a specific application*
- *Which parameters are involved in the selection of a type for a given job*
- *How the units offer advantages in weight, low cost and high reliability—if proper propellants are chosen*

by Charles Delson

Applications Engineer
Armament and Control Section
Light Military Electronics Department
General Electric Co.

HOT-GAS SERVOS are ready to be designed into missiles and spacecraft, providing a direct-energy means for controlling weapon systems vehicles.

The term "servo" is a misnomer in this instance. A servo is usually understood to be a means for providing control with some type of closed loop for reduction of error.

A better name is "hot-gas control system," because it includes both open and closed loop types of control and may be expanded to include additional hot-gas-driven components such as turbo-alternators and gyros, as well as gas-generating components and the electrical amplifier, feedback, and compensating networks.

The *Sidewinder* was the first U.S. missile to use hot-gas servos. It is still the only missile in quantity production with hot-gas servo control. But now at least a half-dozen missiles in research and development use such servos—for example, the advanced *Sidewinder, Mauler, Shillelagh, ARM* (Anti-Radiation Missile) and the *Bullpup Trainer.*

• Picking the right servo—The servos can be separated into three broad categories according to valve types. The problem areas of the actuators, the propellant, and the amplifier and feedback networks are important considerations; but it is primarily the valves that have the greatest effect in matching servos to application.

1) The on-off type—sometimes referred to as the Flicker, step-type or bang-bang.

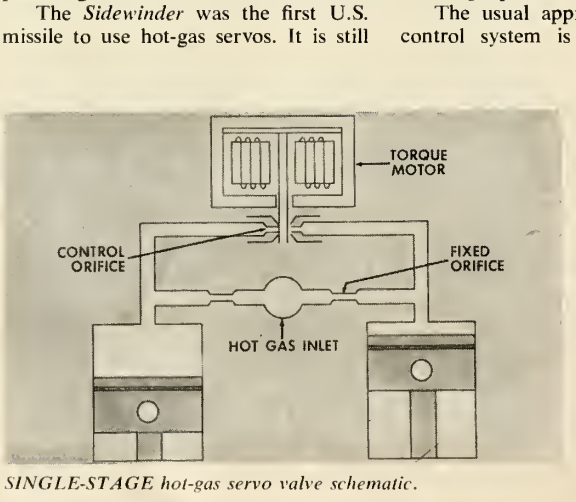
2) The single-stage proportional type—sometimes referred to as the open-center proportional type.

3) The two-stage proportional type—sometimes referred to as the closed-center proportional type.

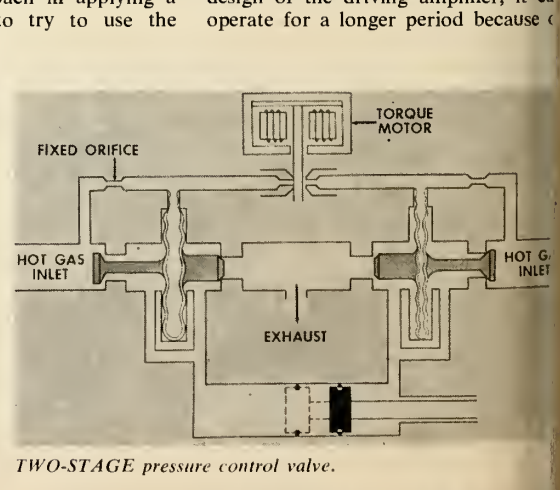
The usual approach in applying a control system is to try to use the simplest type system that will give the desired performance with the highest reliability. The simplest type hot-gas servo system is the on-off type. There are several versions of the on-off control that can be tried with a chosen vehicle. They are the two-position control, three-position control, five-position control, torque-saturated control and time control.

If the on-off control should prove to be unsatisfactory, the next approach is to try the single-stage proportional type control. Generally, on this type the flow rate is always the same no matter what torque output is required and the control is therefore not conservative in the use of the gaseous energy products.

An evaluation should be made with this type of control to determine whether a straight proportional or pulse modulating type is the more satisfactory. Although the pulse modulating type is slightly more complex in the design of the driving amplifier, it can operate for a longer period because



SINGLE-STAGE hot-gas servo valve schematic.



TWO-STAGE pressure control valve.

Bell's All-weather Automatic Landing System—symbolized.

CLEARED TO LAND, WEATHER OR NOT

Today's increasing air traffic demands faster and safer all-weather operation at every airport.

Bell brings this goal one important step closer with its All-Weather Automatic Landing System (ALS) which can fly two airplanes to touchdown every minute, even when visibility is absolutely zero.

The Bell ALS takes over when the pilot brings his plane through the electronic "window in the sky" and guides it to a safe and sure landing.

The system has been flight-proved in more than 4,000 landings with all types of aircraft—small private planes as well as airliners from the DC-3 and DC-7 to the huge Boeing 707 jet. It now is being evaluated at FAA's National Aviation Experimental Center, Atlantic City, N. J.

Unlike other automatic landing systems, the Bell ALS is ground-based so a ground observer monitors every approach and landing. It can operate either fully automatically or under pilot control.

Military versions of the ALS have been ordered by the Air Force. The Navy has selected it for installation aboard the nuclear-powered aircraft carrier USS Enterprise as well as for its other large carriers.

The Bell ALS is but one among many contributions which Bell Aerosystems Company is making to the scientific progress and defensive strength of the free world. We invite qualified engineers and scientists to inquire about sharing our challenging and rewarding future.

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A TEXTRON COMPANY

Advantages of Hot-Gas Servos

FOR SHORTER RANGE MISSILES:

1) Light weight because the energy source is used directly for providing the power output.
2) Long duration storage capacity.
3) Low cost as demonstrated on the SIDEWINDER missiles.
4) High reliability as demonstrated on the SIDEWINDER missiles.

Reference is made to the SIDEWINDER missiles because they are the only missiles that presently use hot-gas servos in large production quantities; and the reliability and low cost of these missiles are some of their primary attributes.

FOR LONGER RANGE MISSILES AND SPACE VEHICLES:
(With Proper Choice of Propellant)

1) Operational capability in the high temperature environment.
2) Operational capability in a radiation environment.
3) Operational capability for long periods of time such as would be required in space travel.

Proper choice of propellant implies the use of not only monopropellants such as hydrogen peroxide, hydrazene, ethylene oxide, and N.P.N., where hot gases from products of decomposition are used for reactive or actuation power, but also some bi-propellants as well as such liquids as Freon, acetone, ethyl acetate, and anhydrous ammonia, whose vaporized gases can be used for minute attitude reaction control on long flights through space.

the dithering effect on the flapper. It also will hold null to a greater accuracy than a straight proportional type because the flapper position does not determine the output torque. It is only the differential dwelling time between one nozzle and the other that will determine torque output.

The final control valve is the two-stage type. In spite of greater complexity, it has worthwhile advantages. The bleed rate across the first stage is very small in relation to the flow rate required for power output. This is an important point in the conservation of gaseous energy. The second-stage bellows design provides a large area high-gain pressure sensitivity. For very small differential position of the first-stage flapper valve, the bellows will provide an immediate control. This increased gain provides greater capability in obtaining higher frequency response.

• **Setting Parameters**—The question now arises as to which of these particular types should be used for a particular application. For this comparison, refer to the Table.

Consider the parameter of response —for an on-off type control, response is the rate of movement of the control surface or nozzle under certain loading conditions. A response rate of 250° per second can be readily attained. However, it is well to note that in the analysis of many on-off control systems, this is much too fast.

The response for proportional controls pertains to frequency response. The response of 10 cps for the single-stage control is the closed-loop frequency response indicated by a Bode plot where the drop-off becomes larger than 3 db.

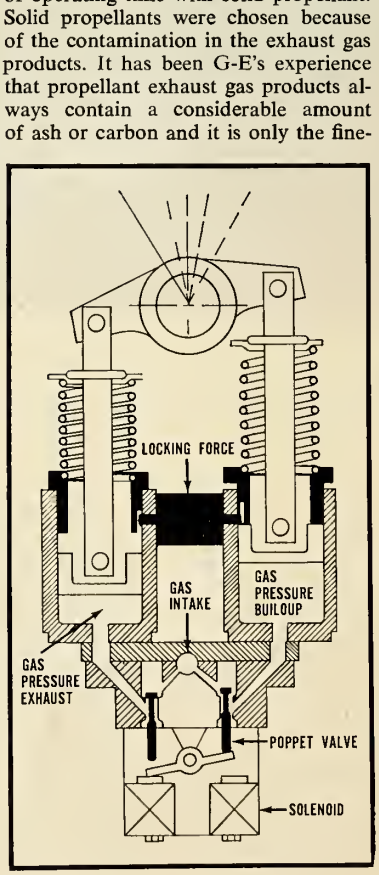
Frequency response flat out to 10 cps on single-stage and 15 cps on two-stage proportional control can be readily obtained. A torque loading of 800 inch-pounds, inertial loading of 0.1 in.-lb-sec² and a hot-gas supply pressure of 1000 psi are used as a common reference across the chart. Increasing the supply pressure increases the response capability of the servos above these rates; however, having a large coulomb friction content in torque output has an adverse effect on response.

The next design parameter is length of operating time with solid propellant. Solid propellants were chosen because of the contamination in the exhaust gas products. It has been G-E's experience that propellant exhaust gas products always contain a considerable amount of ash or carbon and it is only the fineness of these particles and their tendency to adhere to each other and surrounding structure that varies between manufacturers. If certain liquid propellants were used as a design parameter, the length of operating time would be increased considerably and temperature of the gases would then become the main limiting factor.

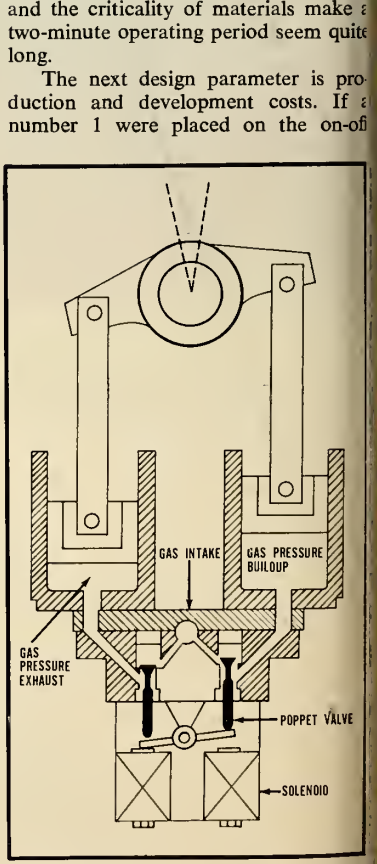
The Table shows that the on-off control will operate for a period of approximately 10 minutes with solid-propellant gases. This period could probably be extended further if it were practical to install longer burning-time grains. Still, a 10-minute grain is about 30 inches long and is quite cumbersome in its packaging requirements.

The length of operating time of a single-stage proportional control with solid propellant is limited to approximately two minutes. This time may be increased somewhat by using a pulse modulating type of circuitry which has a tendency to break the contaminated particles from the flapper valve and blow them through the system. On the two-stage proportional control, the operating time is somewhat under two minutes with exhaust products of solid propellants. The tightness of orifices and the criticality of materials make a two-minute operating period seem quite long.

The next design parameter is production and development costs. If a number 1 were placed on the on-off



FIVE-POSITION discontinuous control valve is one version of on-off unit.



TWO-POSITION discontinuous contro valve. On-off control offers most simplicity

Table of Comparison of Servo Designs

Item	On-off control (Flicker, 2, 3 or 5 position)	Single-stage proportional controls		Two-stage proportional control
		straight proportional	pulse modulating	
Response	up to 250°/sec	10 cps	10 cps	15 cps
Operating time with solid propellants (min.)	10	2	2+	2–
Production and development cost (relative to on-off control)	least (1.0)	slightly higher (1.25)	higher (1.5)	highest (5–6)
Max. torque motor differential current (ma)	80	20	20	15
Fixed orifice dia. (in.)	.....	0.018	0.020	0.008
Control orifice dia. (in.)	0.060	0.036	0.044	0.025
Control orifice stroke (in.)	0.007	±0.0045	±0.0045	±0.002

control, the single-stage proportional control would be approximately 1.25. The single-stage pulse modulating control would be approximately 1.5; and the two-stage proportional control would be somewhere around 5 or 6 because of the complexity of design and manufacture.

The next design parameter is the current required for operation of the coils and torque motors. The on-off control can be readily designed to draw 80 milliamps from a 24-volt source. The current draw is dependent on the voltage available, the valve stroke and seat diameter required to provide proper flow rate, and the weight and size limitations on the coils. On the single-stage proportional control the differential maximum current draw is 20 milliamps. On the two-stage proportional control valve, the differential current draw is 15 milliamps because of the inherent larger gain within the valve.

Other design parameters are fixed orifice diameters, and control orifice diameters and strokes. By looking at the Table, one can readily see why the length of operating time becomes more critical with the proportional valves with respect to the on-off valves and why the cost of these systems is increased. ⁂

Miniaturization Contest Open for Nominations

The 1960 Miniaturization Awards Committee is receiving nominations for its fourth annual competition.

The "think-small" award—sponsored by Miniature Precision Bearings, Inc. honors the individual or organization who has made the year's outstanding contribution to furthering the concept of miniaturization. Winners are chosen by an independent committee of experts from industry, government, and the technical press.

Last year's winner was David A. McLean, Bell Labs, for his sputtered tantalum technique in producing microminiature components and circuitry. Previous winners were The Martin Co. (for development of SNAP 3), and Diamond Ordnance Fuze Labs (for use of photolithographic processes and printing techniques in producing transistors).

Information for entrants, and other data on the awards program is available from W. Hutchinson, Box #604, Keene, N.H. Entries for the competition must be submitted not later than Jan. 10, 1961.

Navy's 'Wobbler' Designed For Accurate Hole Measure

The Navy has developed a device for measuring the diameter of small holes (on the order of 0.2-in.-dia.) to an accuracy of 0.0002 in.

The "Wobbler" was designed at the Naval Ordnance Lab, Silver Spring, Md., to determine within a half percent the amount of explosive contained in small-diameter test fixtures.

Simple in design, the device is basically a cylinder attached to a rod, connected to a dial. The cylinder, with a diameter slightly less than that of the hole to be measured, is inserted in the hole of the test fixture and the rod is rocked or wobbled by hand. As a function of the size of the hole, the movement of the rod is measured by the dial, which indicates the diameter of the hole to within two-tenths of a mil.

The "Wobbler" is being used by the Explosion Dynamics Division of NOL's Explosions Research Department to determine hole sizes in explosive test fixtures.

Closed-Cycle Cooling

(*Continued from page 21*)

drogen gas pressure; (2) control of the refrigeration supplied by the nitrogen circuit; and (3) the addition of an internal heater. Of these methods, the two men believe the third offers the most promise, provided that a sufficiently sensitive temperature sensor and control circuit is used. Additional work is being conducted for control of refrigerant gases, at temperature above critical points.

• **Future uses**—A multitude of uses exist for good closed-cycle coolers. An infrared crystal that must operate at liquid nitrogen temperature could of course simply be immersed in a dewar of liquid nitrogen during the laboratory or testing stage of its application. While this type of system can be used in several actual applications where the dependence on a supply of liquid nitrogen or other fluid is not a problem, more advanced systems are needed for extended operating time.

The chief merits of the Air Products closed cycle system are that it is lightweight, compact and self-sufficient —in that it needs no supply of cryogenic liquid or gas. Therefore, it can be used for space or airborne applications, various types of antenna applications, and other situations requiring these features.

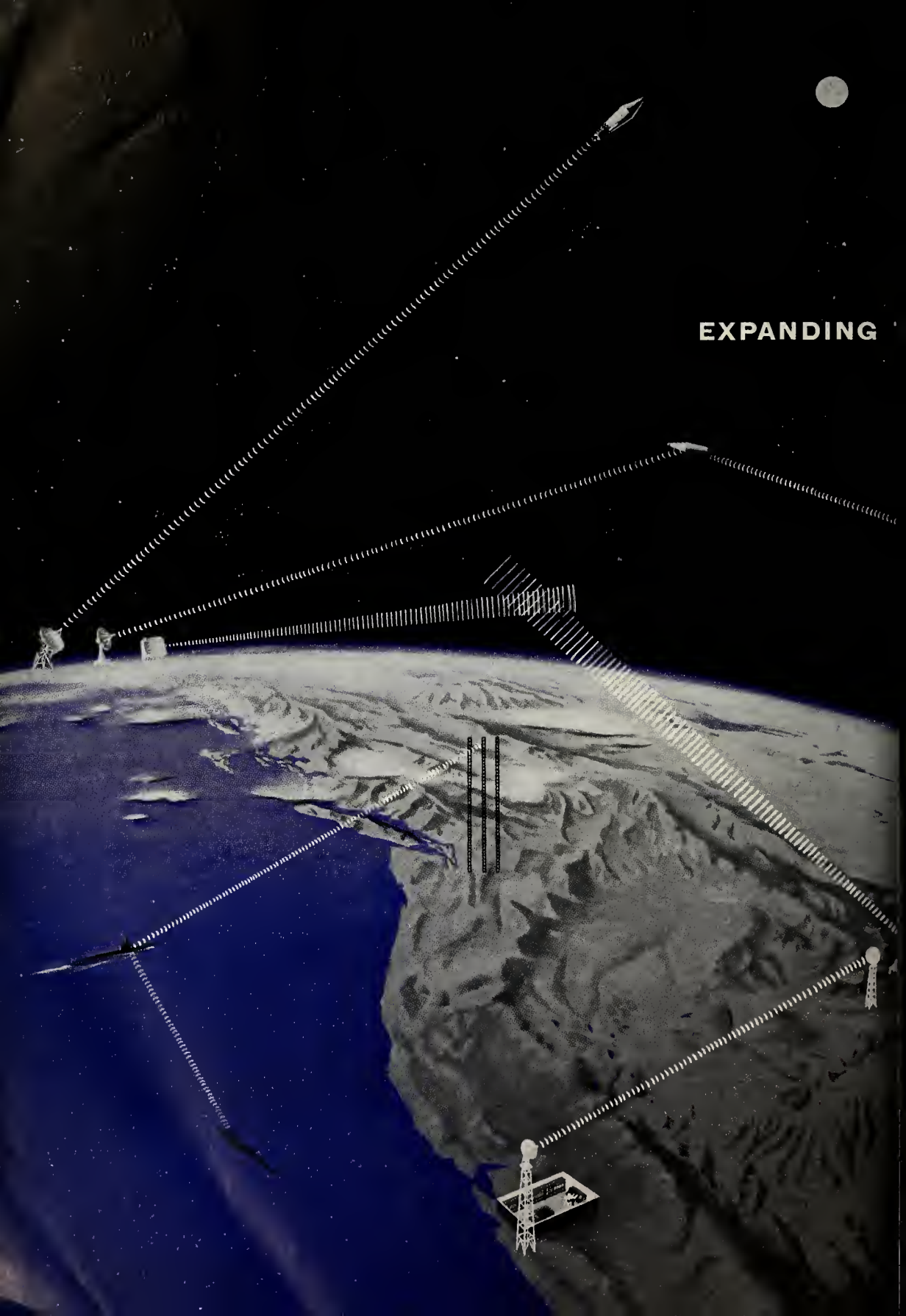
Airborne applications would include infrared detection systems and parametric amplifier radar systems. IR detection devices are used for surveying and detecting, and in the operation of fire control systems. Parametric amplifiers are used to increase the sensitivity of existing radar systems.

Antenna systems, both ground based and airborne, using parametric amplifiers or MASER's, will also use a closed cooling system. By mounting such a compact system on the antenna, the long supply lines or system of joints required with a more conventional system are avoided.

Ultrasensitive MASER's are being used on advanced radio telescope work for detection and communication. During the recent Project *Echo,* signals were received at one installation by a MASER system that was immersed in an open dewar of liquid helium.

This type of system will be replaced eventually by a closed cycle system.

Satellite and space vehicle communication is another important area where the closed cycle system may find wide acceptance. Since high sensitivity can be achieved on the ground with such receiving devices as MASER radio telescopes, the size and power of the sending equipment carried in such a vehicle can be greatly reduced. ⁂


EXPANDING

Herodotus, the historian, records (490 B.C.) the use of burnished shields for military signaling. This was the forerunner of the heliograph, invented by Sir Henry C. Mance, which came into wide use centuries later.

ONTIERS OF SPACE TECHNOLOGY IN

COMMUNICATIONS

Lockheed's interest in developing the science of communications extends from the depths of the oceans to deep space. Its Missiles and Space Division research programs deal with the development and application of statistical communication and decision theory in such areas as countermeasures; telemetry multiplexing and modulation; scatter communications; multiple vehicle tracking; millimeter wave generation and utilization; sonic signal detection and processing; avoidance of multipath degradation; and interference avoidance.

Associated research and development efforts are directed toward propagation studies and advanced antenna design; low noise amplifiers; vehicle borne signal transmission and reception, data storage and processing; solid state materials and devices.

The scope of such activities extends from advanced studies of naval communication problems on and under the oceans; the many applications to satellite vehicles; on to the specialized communication problems of deep space explorations. Latter needs are exemplified by high frequencies, low weight and power, high stability, low effective bandwidth, extreme reliability and basic simplicity requirements.

Engineers and Scientists: Investigating the entire spectrum of communications is typical of Lockheed Missiles and Space Division's broad diversification. The Division possesses complete capability in more than 40 areas of science and technology — from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; communications; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetohydrodynamics; man in space; materials and processes; applied mathematics; oceanography; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sonics; space medicine; space navigation; and space physics.

If you are experienced in work related to any of the above areas, you are invited to inquire into the interesting programs being conducted and planned at Lockheed. Write: Research and Development Staff, Dept. K-29B, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / **MISSILES AND SPACE DIVISION**

Systems Manager for the Navy POLARIS FBM; the Air Force AGENA Satellite in the DISCOVERER, MIDAS and SAMOS Programs

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
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A Stride Forward in Ion Motors

NASA reports sharp improvement in performance of units powered by electron-bombardment sources for total of 50 hours

MONTEREY, CALIF.—Bright prospects for ion motors using electron-bombardment ion sources are reported by scientists who operated two such motors with more promising results than had been previously attained.

The work was reported by Harold R. Kaufman and Paul D. Reader, of the Lewis Research Center of the National Aeronautics and Space Administration. They told the Electrostatic Propulsion Conference of the American Rocket Society here that NASA has operated two ion motors using mercury fuel for a total time of about 50 hours.

The motors used 10-centimeter-diameter ion sources and obtained a power efficiency of about 70%, a propellant efficiency of over 80%, specific impulse of 5500 seconds, with an ion beam current of 0.125 ampere.

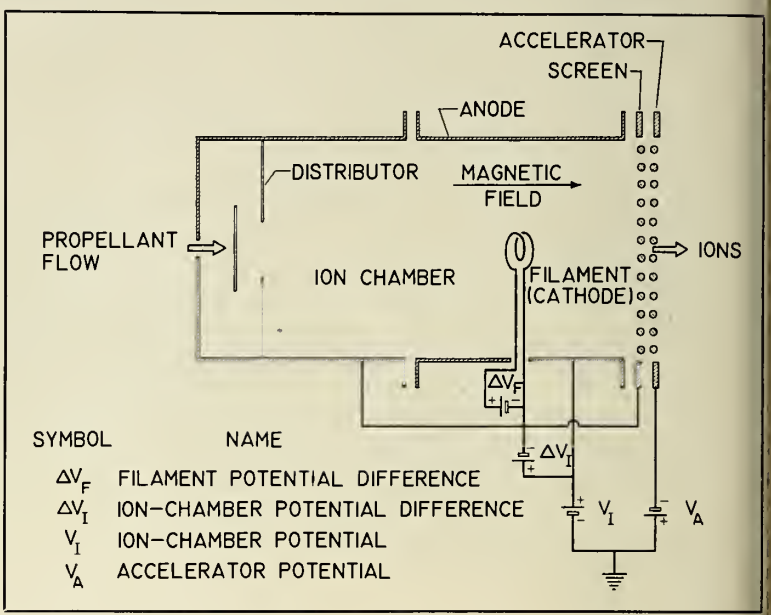
Although some at the conference felt that the electron-bombardment method is not yet as practical as porous tungsten ionizers, they were pleased that the NASA work had produced such favorable results.

The conference was described by many members as one of the most useful of its kind, because of the very high content of scientific information—"instead of the usual batch of sales pitches in the form of technical proposals," as one member put it.

• **NASA's system**—In theory, the NASA engines have a gaseous propellant entering through a distributor, and subsequently ionized by high-velocity electrons in the 20 to 100-volt range, emitted by a hot filament. Screen, distributor, and negative end of the filament are operated at the same potential, so that an electron emitted from the filament should not go to either end of the ion chamber.

A magnetic field parallel to the axis prevents the high-velocity electrons from reaching the wall without first colliding with particles in the ion chamber. Some of the ions that are formed pass through the screen at the downstream end of the ion chamber and are accelerated to become the beam.

With the ion chamber filled with a plasma, high velocity electrons are injected into the plasma to ionize neutrals, but the bulk of electron density would be composed of electrons with a velocity too low to ionize many atoms.



SCHEMATIC DIAGRAM of the ion engine with electron bombardment ion sources operated by scientists of the National Aeronautics and Space Administration.

Performance of the second of the two engines was markedly better than the first, which was mainly an effort to evaluate the ion source. The first was operated for 10 hours and the second for 40 hours.

The first engine, running at ion beam currents from 0.01 to 0.06 ampere and specific impulses from 3200 to 5500 seconds, operated as follows, with beam current at 0.060 ampere:

Specific Impulse: 4500 seconds

	Volts	Amperes	Watts
Magnetic Field	12	15	180
Filament	8	6	48
Ion chamber discharge	50	1.5	75
Accelerator Impingement	3000	.010	.30
Ion Beam	2000	.060	120
Total			453

Specific Impulse: 5500 seconds

	Volts	Amperes	Watts
Magnetic Field	12	15	180
Filament	8	6	48
Ion chamber discharge	50	1.5	75
Accelerator Impingement	4000	.017	68
Ion Beam	3000	.06	180
Total			551

The overall power efficiencies of the two points on the performance scale (beam power divided by total power) were 27 and 33%. Propellant flow rate for both points was equivalent to 0.075 ampere, indicating a propellant utilization of 80%.

The second engine differed from the first in the wire grid material, which was tungsten instead of stainless steel; the wires were left free at the ends to allow for thermal expansion without warp; insulators were shielded from a direct view of the ion chamber to prevent short circuits resulting from deposits; and the magnetic field coil was changed to give a more axial field with more turns used to reduce associated power loss.

Accordingly, the second engine operated as follows:

Specific Impulse: 4500 seconds

	Volts	Amperes	Watts
Magnetic Field	7	5.7	40
Filament	7.5	6.0	45
Ion chamber discharge	50	1.85	92
Accelerator Impingement	3500	.0015	5
Ion Beam	2000	.100	200
Total			382

Specific Impulse: 5500 seconds

	Volts	Amperes	Watts
Magnetic Field	7	6.7	47
Filament	5.2	6.2	32
Ion chamber discharge	50	1.7	85
Accelerator Impingement	4000	.0032	13
Ion Beam	3000	.130	390
Total			567

NASA says the biggest single factor in the performance increase was a reduction in the magnetic field coil loss, although reduced impingement current and improved ion chamber performance aided in the improvement.

Overall power efficiencies for the two performance points shown were 52 and 69%. Propellant flow rate was equivalent to 0.158 ampere, so that propellant utilizations were 63 and 82%.

Although only mercury was used as a propellant in the tests covered, NASA emphasized that the engine can use many types of fuel.

• **Multiple beam motors**—As many as 19 ion beams from a single motor have been achieved by Electro-Optical Systems, Inc., according to a paper presented by four members of the company, M. P. Ernestene, A. T. Forrester, R. C. Speiser and R. M. Worlock.

The multiple beam systems are seen useful where "practical thrust levels" must be produced. Configurations operated include circular porous tungsten ionizers mounted in close packed hexagonal arrays. Accelerating and decelerating electrodes had corresponding multiple circular apertures. The porous tungsten ionizers were back-fed from a cesium vapor supply system controlled by a needle valve.

Thrust from an aperture emitting 3000-volt cesium ions corresponding to a specific impulse of 6600 seconds, is 34 micropounds at most, according to the EOS group. Higher voltages can produce more thrust, but it is not considered possible to get useful thrust levels from a single aperture for the voltages which can be reasonably expected for ion motor application.

• **Improved materials**—Progress in fabrication of large-size porous tungsten components for ion engines has been achieved, with resulting components measuring 5 inches in diameter by ¼-in. thick, according to Semicon Inc.

L. J. Cronin, the firm's president, said it has also produced small beam-forming discs of porous tungsten which can be joined to refractory metals by a brazing technique developed at Semicon. He said other developments include an "S" cathode with a lower work function than conventional electron emitters of the tungsten dispenser type, intended to aid the neutralization problem in ion motors. ⌗

space medicine

Astronaut to Get Tasty Food

DINNER IN SPACE may not be the *specialité de la maison* at Antoine's, but it still may beat the blue plate special at Joe's.

Air Force diet specialists agree that the astronaut's food may be just as important psychologically as it is nutritionally. Good hot meals will have to compensate for the cigarettes, wine and women he left behind.

ARDC's Lt. Col. Albert A. Taylor, assisted by Beatrice Finkelstein and Robert E. Hayes, has come up with a menu with such delicacies as:

–Oatmeal topped with sugar and cinnamon, coffee and bread for breakfast.

–Sliced turkey, roast beef sandwiches or spaghetti for lunch.

–Veal, turkey or beef in chunk form, with mashed potatoes or rice, buttered green vegetables for dinner.

–Cookies and fruit at every meal.

A much more economical diet in terms of weight, space and power supply can be achieved by the use of "food bars," Col. Taylor points out. But a "high level of acceptability" feeding plan will produce a more effective astronaut.

A well-varied diet for an intermediate duration flight—3 days up to several months—can be planned with canned, dehydrated and instant foods.

Additional water for food preparation will bring the water requirement to about 2500 to 3000 milliliters (almost 3¼ quarts) a day for a two- or three-day trip.

A water tank for 9000 milliliters would weigh about 23 lbs. and occupy 0.4 to 0.5 cubic feet. Studies are under way on a water heater weighing about 5½ lbs.

The now familiar squeeze tube studied in weightless maneuvers would be used for packaging and serving food. Rectangular aluminum cans to which water can be added will probably be used for dehydrated foods. Meat solids will be wrapped in bite-size chunks and stored in cans.

• **Longer flights**—Journeys lasting several months will require a partly closed ecological system recovering waste water. Col. Taylor ups the water requirement to 5000 milliliters (about 5¼ quarts) on longer voyages, since an additional 2000 ml. will be necessary for hygiene purposes.

A small, suitcase-type electric oven and a thermoelectric refrigerator are being studied by the Air Force for use in the "most desirable food plan." Again, weight requirements will dictate the calibre of the food.

Several of the big food packagers have pushed the space food drive with the idea that a new packaging method could bring commercial dollars. The TV dinner can be partly attributed to—or blamed on—the extensive Air Force studies for hot meals for long-range bomber flights.

• **Closed system studies needed**—"The next step, is to develop the closed ecological system," says Col. Taylor.

"Closed ecological systems must be brought out of the basic research stage by beginning applied research. We will need at least a concentrated 10-year effort to develop a workable system.

"Twenty-five percent of the work can be accomplished by in-house effort within government institutions and 75% under contracts with universities, nonprofit organizations and industrial firms," the ARDC Biomedical Chief estimated. ⌗

First 'Space Kitchen' To Be Delivered in April

The Whirlpool Corp., home appliance manufacturer, has received a contract from ARDC's Wright Air Development Division for development of a "space kitchen."

The experimental model, to be completed in April, 1961, will be designed for an area about 10 feet long by 7½ feet in diameter. It must accommodate a three-man crew on a 14-day mission in a multistage rocket.

Appliances in the kitchen will include a miniaturized, thermoelectric refrigerator and a freezer, a three-cavity oven and a 2½-gallon water system with its own heater. They will be used to heat or dispense food prepared before flight.

Air-free water will be provided by a manually operated positive-displacement pressure pump. The kichen will be equipped with support handles to aid the astronaut in maneuvering in the weightless condition.

The pilots will eat one at a time, and will have to strap themselves down in their chairs. Food will be squeezed from containers into the pilot's mouth.

When he is through, he will "wash the dishes" with specially prepared cloths. Waste will be deposited in self-sealing disposal sections and sprayed with an antiseptic solution.

Space Dominates Hydraulics Meeting

DETROIT—The solution of hydraulic problems in space follows the approach taken in a murder mystery, but with two major differences—seldom is there a "corpse" or a "scene of the crime."

If you're lucky, says M. Ogman, Senior Design Engineer of Convair Astronautics, you may have a mutilated corpse to examine; missiles occasionally explode on or near the launching site.

But the Convair scientist told the 10th Annual Aircraft Hydraulic Conference recently that all you usually have left is a farewell message recorded back on earth as pen scratchings on a piece of paper.

Ogman pointed out that no *Atlas* failure had ever been attributed to malfunction of the hydraulic system—yet this does not imply a perfect system.

This is because less and less telemetry is assigned to a system as more and more confidence is placed in its performance.

The most common error on the part of the designer-turned-investigator arises from inability to rationalize a sequence of events to fit the conditions that have occurred.

The meeting, sponsored by Vickers Inc., Division of Sperry Rand Corp. heard Ogman outline a plan to create failure tests on a system level using missile simulators already in existence. Such data would greatly assist any future flight failure investigation.

Some possible areas of interest included: Complete or partial loss of accumulator precharge, complete or partial loss of reservoir pressurization, system performance with air in the oil, system performance with controlled external oil leakage, and loss of variable-volume pump pressure compensation.

Ogman pointed out that he had compared frequency responses of servo actuators on the *Atlas* simulator with a properly bled system and then with the system infiltrated with measured amounts of air. At the conclusion, one could not determine which system had the air.

• **Heat barrier**—High-temperature hydraulics was discussed by W. Bobier of Vickers. The hydraulic-fluid feasibility tests have reached 1000°F with the development of the polyphenyl ethers by Shell Development Laboratories. The main problem in high-temperature hydraulics revolves around the sealing aspects.

Studies in this field were reported by S. Cannizzaro of Republic Aviation, who said that although the solution is still being sought Republic's efforts have developed at least part of the answer.

A two-part paper compared battery, hot gas and inertia wheel power supply systems for short-duration vehicles. The first part was presented by H. Howard and H. Markarian of Vickers.

The two scientists compared the systems for a booster assuming a three-stage missile, each stage with a 60-second operating time and the computer gyro's and instrumentation power equal to 1 KVA of precision AC power for 180 seconds. Servo actuator amplifier power requirements was set at 50 watts of either AC or DC during the operating time of the individual stage.

A bleed gas AC system emerged as the most promising because it has the lowest effective weight, 100% checkout reliability, excellent achievable reliability and maximum operational temperature range—and its weight does not increase if the missile booster rocket engine firing duration is increased.

Having selected the bleed gas AC system, the experts went on to describe, in greater detail, a system using an integrated hot-gas motor AC generator. The presentation was made in two phases—one consisting of the operating mode when the system is airborne, the other the operating mode when the system is being periodically checked out with ground power.

The second part of the paper dealt with an inertia wheel power supply for a hypothetical manned space vehicle. N. M. Fruktow and J. J. Ventura of Space Technology Laboratories, Inc., briefly treated the history of flywheels and the general types available.

Advantages and possible disadvantages were listed. The STL experts proposed an inertia wheel auxiliary power supply for all boost stages, and these could be hydraulically, electrically or ram air pneumatically energized.

In the vehicle coast phase, the wheel system would stop delivering hydraulic power after third stage burnout and provide only electrical power. This continues for two hours, after which the re-entry phase begins.

The authors concluded that the ram air type inertia wheel is the most suitable system for the re-entry phase and summarized ram air turbine and scoop duct designs.

Two vernier solo flywheel second stage AP systems were considered. In one configuration a single unit, used as motor and pump, changes from one function to the other at sustainer cut off. In the second configuration the motor and pumps are separate units both connected to the flywheel. The flywheel is accelerated by the sustainer hydraulic system.

According to Fruktow and Ventura there is no essential difference in the operation of the two configurations but the separate motor and pump system has a definite edge with respect to reliability.

• **Desert tragedy**—The effects of long-time storage on hydraulic components is of interest in connection with the deployment of ICBM's in underground silos. A. B. Billet, senior staff engineer at Vickers' Aero Hydraulics Division, concluded that long term silo storage would present no foreseeable problems if humidity and temperature are controlled ". . . in the presently planned manner."

Billet's conclusion was drawn from a study of hydraulic components after 17 years' exposure in the Libyan Desert. These parts were removed from the ill-fated B-24 "Lady Be Good," discovered in 1959 by an oil exploration crew.

Many types of equipment were recovered in duplicate and this made it possible to test one piece as-is while disassembling and inspecting a similar part as-is. The method reduced the possibility of introducing error which would occur if the same piece were tested and then inspected after such a long period in an adverse environment.

All hydraulic units had an excellent coating of oil and met the efficiency requirements of new units. A check on a quart sample of recovered standard red hydraulic fluid led to a belief that only minor deterioration had occurred.

Other papers covering the missile field included hydraulic designs aboard the *Polaris* and *Minuteman* missiles. Kurt Stehling of NASA spoke on space vehicle operations and design considerations. Attitude controls development at Vickers were described by Dr. W. W. Chao.

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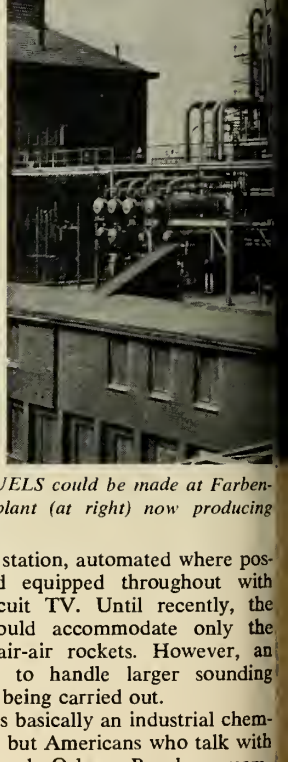
European Propellants Work Dra

Mutual advantages of sharing research developments and markets create affiliations in Italy, Germany and elsewhere

ROCKET propellant press (at left) of BPD's Explosives and Ammunition Division at Colleferro. The Italian firm is a major maker of double-base solid propellant.



SOLID FUELS could be made at Farbenfabriken plant (at right) now producing

"ALL ROADS LEAD to Rome," but missile industry officials who have been there recently are familiar with one road that passes on through Rome and wends its way 30 miles south to the modern, spotless, and wealthy suburb of Colleferro.

This planned, garden-type community of 15,000 people is one of the European missile industry's most important centers, organized, financed, built, and occupied by Societa' Bombrini Parodi-Delfino—Italy's huge chemicals-muntions-solid propellants complex.

Almost every day, one or several American missile and propellants industry officials make the side trip to still-expanding Colleferro. There they can make contacts, pick-up information and—as several U.S. firms, including Aerojet, already have learned—form affiliations. Bombrini Parodi-Delfino (BPD) is headquartered in Rome (Via Lombardia No. 31) and has a branch office in Milan; but it is to Colleferro that Americans make their way.

Colleferro, the complete "company city," is an example of BPD's self-reliance. So is the company's attitude toward rocket production. Parodi-Delfino produces all components—fuselage, fuses, propellant—and assembles a 50 mm air-air rocket in Colleferro. It has just finished testing a second small rocket that will be produced entirely at Colleferro and marketed, it hopes, in the U.S. as well as throughout Europe. It is a unique design by BPD. Nozzle offsets produce a rifled rotation of the fuselage, while the fins remain stationary. The fins are attached to an outer band separated from the fuselage by ball bearings. Of course, it uses a BPD solid propellant.

The company is interested only in solids, no liquids, and is particularly well-known in double-base technology. In the last year, it has devoted much effort to the composite powder field. BPD is an industrial leader in gunpowder and munitions, cement, insecticides, and synthetic textiles. In every case, everything is produced at Colleferro—from raw materials to finished product. Besides production facilities, BPD maintains at Colleferro a complete static test station, automated where possible, and equipped throughout with closed-circuit TV. Until recently, the station could accommodate only the 50 mm air-air rockets. However, an expansion to handle larger sounding rockets is being carried out.

BPD is basically an industrial chemicals firm, but Americans who talk with Dr. Alvaro de Orleans Bourbon, member of the board of directors, or with Dr. A. Cereseto, Director of Development, come away convinced that propellants will play an increasingly important role in Bombrini Parodi-Delfino's plans.

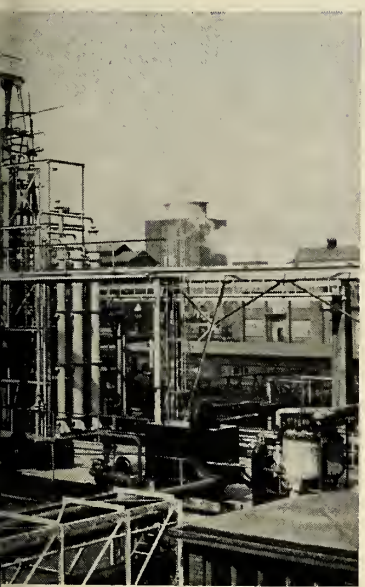
• **How U.S. firms benefit**—Colleferro is but one stop on a route that is travelled more and more by U.S. missile people. Some American chemical officials say they feel that they are on a commuter circuit with Paris, Rome, Geneva, Frankfurt, Essen, London, and their home offices.

Why this new interest in European propellants?

American firms are finding advantages—one of them is rapidly be-

S. Firms

by S. David Pursglove



lastics intermediates. Company has five najor locations, 50,000 chemical workers.

oming a necessity—in affiliating with European firms (M/R, Oct. 24). It gives them an opportunity to supply ropellants needed in Europe's own nushrooming defense and sounding ockets programs, supply U.S. missiles n Europe, and cash in on an expected ncrease in European propellants re- earch. It helps to be on the scene, hrough European affiliates, in order o better adjust to the increasingly im- ortant Common Market and Free Trade bloc concepts of business.

• **Dividends for Europeans**—The European firms are looking forward to he arrival of U.S. firms. Europe espe- ially welcomes American know-how nd facilities in high-energy fuels—an rea virtually unexplored in Western Europe until now. European companies eek affiliations with U.S. firms for everal reasons, including these:

–The growing number of NATO nissiles and the Defense Department's ncreasing insistence that propellants for J.S. forces be produced in Europe is training European capacity: more U.S. noney, know-how, and hardware is needed if this demand is to be met.

–European governments are just now getting interested in high-energy propellants—both for their own rockets and for new U.S. missiles expected in Europe within a few years; affiliations with U.S. companies in this area can save European firms time and money.

• **Another Italian entry**—Italy is not the only country moving ahead in propellants, and BPD is not the only Italian firm interested in the Space Age. Another company interested in Europe's rocketry expansion, especially in high-energy fuels, is Larderello, of Pisa. This company is Italy's major supplier of boron. It has rights to Europe's only significant native source of boron, the mineral geysers near Pisa.

Larderello at present furnishes only boron compounds for industrial use. However, it is developing important contacts with possible users of boron derivatives in H-E fuels.

• **Germans active**—Europe's other major boron supplier is Suddeutsche Chemische Werke, a German company wholly owned by Stauffer Chemical Co. (M/R, Oct. 24). SCW has no local source, but imports crude borates from Stauffer's U.S. plants, and refines them as borax, metallic borates, and boron fluorides.

Stauffer is also affiliated with the German firm Degussa, one of the companies that developed Europe's centrifuge process for uranium isotope separation. Degussa licenses Stauffer's electron beam furnace process for producing nozzles as well as other rocket components.

At least two other German firms are strongly interested in rockets: Wasag Chemie, Essen, which is working in H-E fuels; and Telefunken, Berlin, which has a piece of the hardware program for *Hawk* (BPD leads in the propellant end of *Hawk*).

The huge German chemical industry represents one of Europe's major sources of propellants. However, the big chemical companies are quiet about their interest in propellants; some vigorously deny any interest at all (but send representatives to meet with U.S. missile principals at the embassy in Washington).

It's hard to blame the companies, however. There is strong pressure in Germany to avoid munitions publicity and ward off the "merchants of death" tag that has attached to the German chemical industry in the past.

The enormously effective I.G. Farben cartel, forced to split following World War II, would be Germany's best provider of propellants if it were reassembled. Such a hope is not vain. Gears are kept oiled in Bonn and Frankfurt to bring I.G. Farben once again under central direction if it is ever required. The four major successor companies are autonomous firms, but they keep in close touch. They are: Fabrike Hoechst, Badische Analin und Soda Fabrik (BASF), Farbenfabriken Bayer, Chemische Werke Hüls.

• **Wide inventory**—Among the propellants that they and other German firms can supply, or already deal in heavily as industrial chemicals are:

–Alcohol—BASF, Hoechst, Degussa (which is strongly interested in propellant grade alcohols, and is considered a propellants firm).

–Analine—Bayer (BASF would not be a major supplier despite the company's name).

–Hydrogen Peroxide—Degussa, Kali-Chemie Hanover, Merck, Riedel de Haen, A.G. (Hanover), Dr. Theodor Schuchardt GmbH & Company (Munich).

–Hydrazines—Bayer, Schuchardt.

–Oxygen—Hoechst, Chemische Werke Hüls, Bayer.

–Perchlorates—Riedel de Haen, Schuchardt, Merck.

–Boron Compounds—SCW, Riedel de Haen.

These companies can supply propellants intermediates. Whether they are willing is another matter. However, Germany is not without its rocket interests, even though production and most R&D is conducted in other countries. One American chemical company official says: "The Germans are 'bootlegging' their scientific level rocket work." This is mostly physics and some applied research on hardware, with little effort going into propellants.

At least one extra-national German research effort is centered in Laboraboire de Récherches Techniques, St. Luis, Heiut-Rhim, France. This is a joint German, French and Italian group seeking new techniques in missiles and propulsion.

• **Elsewhere in Europe**—Switzerland, too, is "bootlegging" some rocket and missile research. The country is neutral almost to the point of aggressiveness: Although it conducts aircraft research within its borders, it feels that neutralism calls for most of its missile interests to be pursued in other countries. This is done through foreign subsidiaries, such as the Italian affiliate, Contraves-Italiano (part of the Orlikon group).

France and England, partly because of their closer ties with the U.S. and certain missile-oriented internal politics, are special cases. They are making new moves in the field of rocket propellants, and there are some advantages for affiliation with French and British firms. These countries and North Europe will be treated later in M/R. ⁂

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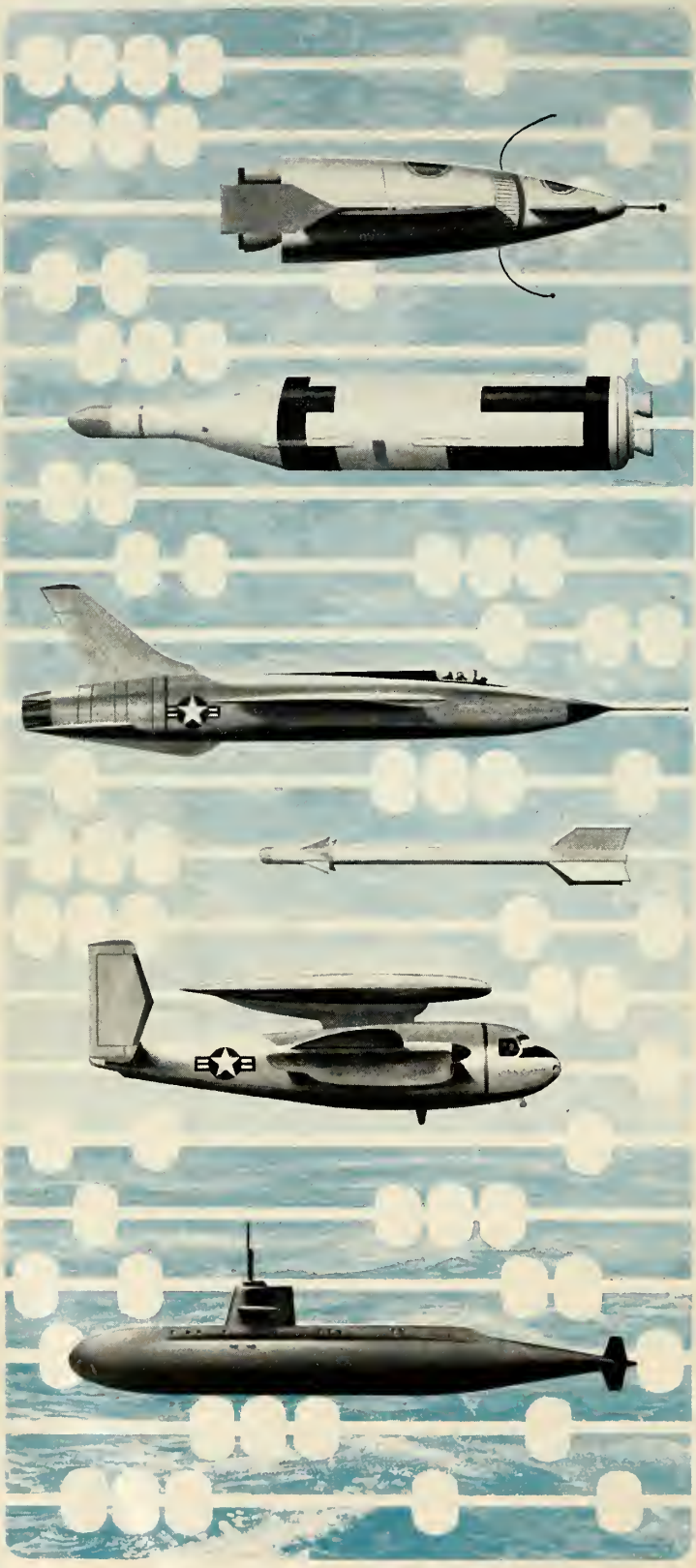

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F.A.I. Rules Put Russians on Spot

Soviets may have to release secret rocket data or forfeit chance to qualify for world records in space contest

by Bernard Poirier

NEW REGULATIONS for establishing world records in outer space have been made by the International Aeronautical Federation and if the USSR sticks to the rules, it appears likely the secrecy barrier on Soviet rocket data may be broken.

In establishing the new records, the F.A.I. (Fédération Aéronautic Internationale) stipulated that:

–"The flight plan must be submitted to and be approved by the F.A.I. prior to the record attempt."

–"The contest event, in its entirety, must be verified as to the accuracy by instrumentation, on the ground or in the vehicle, sanctioned and approved by the F.A.I."

–"The vehicle component reaching the maximum performance and in which a pilot has been present from the initial thrust at the earth surface position must return to the surface at the earth with the pilot (astronaut) alive."

Since Russian space rockets have been closely associated with their ICBM development, it seems that Russia will balk before complying. However, because of her propaganda gains based on rocket achievements, she may still capitulate in order to get official recognition—lest she be suspected of cheating or exaggerating.

A record recognized by the F.A.I. will enhance the prestige of any achievement in space. If, for example, the U.S. establishes a record, she at once gets recognition from 48 member countries, including Russia, plus four associated groups in Guatemala, India, Southern Rhodesia, and Cuba.

All NATO countries and all Communist bloc nations, except East Germany and Red China, are members. The remainder are from Latin America, Africa and Asia.

Russia has often claimed F.A.I. world aviation records through its member organization. All members, including Russia, "must accept and apply these new rules" on World Space Records said F.A.I. Director General H. L. Gillman.

With this background in mind and remembering the fact that the F.A.I. has had a reputation for honesty among member nations since its inception in 1905, it would seem almost dishonest for a member to start recognizing only politically acceptable F.A.I. regulations. This could be the case regarding space records.

• **Bill of specifics**—Russian policy could be seriously shaken by the clearly expressed rules requiring that supporting documentation be submitted and certified on such "details" as:

–Advance notice that an attempt for record will be made

–Type of rocket engine(s) used

–Power (Thrust) of the engine(s)

–Number of engines

–Date of Launching

–Time launching will take place

–The location and name of the launching site

–Report on boosters to assist lift-off or other special apparatus installed to assist control and landing.

–Evidence and report of any accidents

–The weight of the vehicles and appropriate parts

The F.A.I. membership has supported and accepted the organization's regulations. Having concentrated its rocket propaganda towards neutral or noncommitted nations, Russia finds herself in an international organization whose membership is composed by a majority of so-called neutral and noncommitted nations and whose regulations are diametrically opposed to its policy of secrecy. At this time it is obvious that Russia cannot conform to the rules and maintain its policy.

World Records now available can be claimed on the basis of Duration of Flight, Altitude without Earth Orbit, Altitude with Earth Orbit and Greatest Weight lifted 62 miles (100 km.) or more.

New records will be established. Mr. Gillman said, "at any meeting of the Committee called especially to consider new types of record, specialists on the subject will be invited to attend."

Smaller countries can compete and even succeed for some of the records. Every country on record for having performed rocket achievements within some of the necessary parameters have official membership in the F.A.I. All have access to the new Space Rules listed in Section 2.A of the famous F.A.I. Sporting Code. The rules pertain to vehicles propelled by rockets.

Today's principal competitors are represented by the Aero-Club Federation of Australia, the Royal Canadian Flying Clubs Association, the National Aeronautic Association of U.S.A., Aéro-Club de France, the Royal Aero-Club of the United Kingdom, Nippon Koku Kyokai, and Aéro-Club Central de l 'U.R.S.S.

Headquarters for the Fédération Aéronautique Internationale is in Paris. The President is M. J. Allez, First Vice President is Dr. W. Muri, the Director General is H. R. Gillman and the Treasurer is M. J. Blériot.

A Frenchman, a German and a Belgian are credited with suggesting the creation of the Federation during their attendance at the Olympic Congress in Brussels on June 10, 1905. ⌗

West Germans Appoint Space Research Advisers

BONN—The Aeronautical Advisory Board of the Federal Ministry of Transport has constituted a committee to advise the ministry on all problems arising in connection with space research and exploration.

Members of the Committee for Space Research are: Prof. Bartels, Director of the Institute for Physics of the Stratosphere, Göttingen; Prof. Ehmert, department head of Max-Planck Institute for Aeronomics, Lindau/Harz; Prof. Goercke, Technical University, Stuttgart; Prof. Graul, University of Marburg; Prof. Pascual Jordan, University of Hamburg; Prof. Dr. Kienle, University Observatory, Heidelberg; Prof. Dr. Moeller, University of Munich; Prof. Dr. Quick, Technical University, Aachen; Prof. D. Roessger, Technical University, Berlin; Prof. Dr. Saenger, Research Institute for Physics of Jet Engines, Stuttgart; Prof. Dr. Strughold, U.S. Air Force School of Aviation Medicine; Dr. Gerlach, Deputy Chairman of DGRR (German Society for Rockets and Space Research).

soviet affairs

By Dr. ALBERT PARRY

Rocket Boss Nedelin's death

was announced by the Soviet government on Oct. 25 in the close-mouthed way the Red information service usually reveals such top-level accidents. The world was told that Marshal Mitrofan I. Nedelin was killed in a plane crash—and this terse word followed by only four days the Moscow news that Colonel General Nikolai Pavlovsky, a Soviet armed forces staff officer, had died in the line of service. There was much eulogizing of both men, but no further details of either accident.

Was some rocket-launching failure

of considerable dimensions connected with the two (or perhaps more) deaths? We know that in September and October Nikita S. Khrushchev stayed in New York longer than he had originally planned. We can surmise that the premier's American stay was not lengthened because he was deeply engrossed in United Nations affairs. It is plain that Khrushchev postponed his departure from our shores because he was waiting to get spectacular tidings of his rocket men's achievements while he was on United States soil—so as to make his visit here truly triumphant.

But no news of a successful man-into-space experiment

flashed to Nikita during his New York sojourn, and finally he left for home—in a hurry, taking a plane instead of his slow ship *Baltika.* On landing in Moscow he may have been quite stern to Nedelin and other Soviet high-bracket missile-and-rocket men. Responding to such talking-to, Nedelin and his immediate entourage may have tried to expedite matters by an overly pressing and personal supervision of rocket launchings. Something or other, in addition to Kremlin tempers, may have blown up in their faces. Perhaps this is how those two top-ranking lives were lost, and possibly a few more than just those two—of Nedelin and Pavlovsky.

Nedelin had prepared for rocketry

by his long and successful service in Soviet artillery. I will not repeat his colorful career story here—the reader will find it in my column on page 45 in MISSILES AND ROCKETS of June 13 last; also, in more detail, on pages 136-137 and 149 of my book *Russia's Rockets and Missiles,* just published by Doubleday & Company of New York. Both these sources shed light also on the organization of Russian rocketry.

What interests us in addition to Nedelin's completed career is the personality of his successor as chief of Soviet rocketry, Marshal Kirill Semyonovich Moskalenko. Commander of the Moscow garrison for the last several years, the new rocket-marshal does not appear to have any special rocketry or even artillery preparation for his fresh appointment. Now 60 years of age, Moskalenko is an oldtime infantry man. In World War II he commanded first a rifle corps and then an army, chiefly in his native Ukraine, whence he drove the Nazi invaders across the Carpathian Mountains into Czechoslovakia. A Communist Party member since 1926, Moskalenko advanced in the Party's hierarchy simultaneously with his military promotions. In 1956, when he was made marshal, he was also elevated to the important Moscow Regional Party Committee and a month later to his membership in the Central Committee of the Communist Party.

A rocket expert

that would be less of a Party man and more of a new-generation scientist-warrior could have been appointed to the latest vacancy in Soviet rocketry by Khrushchev, but was not. The fact is that Khrushchev and his Party oligarchs, while using young military technicians intensively and skillfully, do not trust them for those top rocketry posts where they could make (or help make) policy. Hence the appointment of Old Man Moskalenko who, like Old Man Nedelin before him, is a zealous Party-line marshal, and has far less specific rocketry knowledge than the late Nedelin possessed. ⁂

industry

BENDIX-PACIFIC DIV. of The Bendix Corp. has broken ground for a multimillion-dollar electronics center on an 80-acre site in the Northern San Fernando valley. The first building to be constructed will be used primarily for electronic production, according to Bendix. An adjacent building will house the division's sonar testing facilities, including a 500,000-gallon-capacity tank.

VARIAN ASSOCIATES has created a new department to concentrate on military applications of magnetometry, the Military Magnetics Department. The company has also announced that Varian has reached preliminary agreements for the merger of Eastern Industries into Varian.

CONTROL DATA CORP. has established a Research Laboratory at St. Louis Park, Minneapolis, to conduct advanced investigations in the digital electronics equipment field.

ELECTRO-TEC CORP. will build a 50,000-sq.-ft. plant on a 10-acre site in West Caldwell, N.J. The plant will contain a research area and a greatly expanded prototype engineering and production department for Electro-Tec's line of precision electromechanical devices.

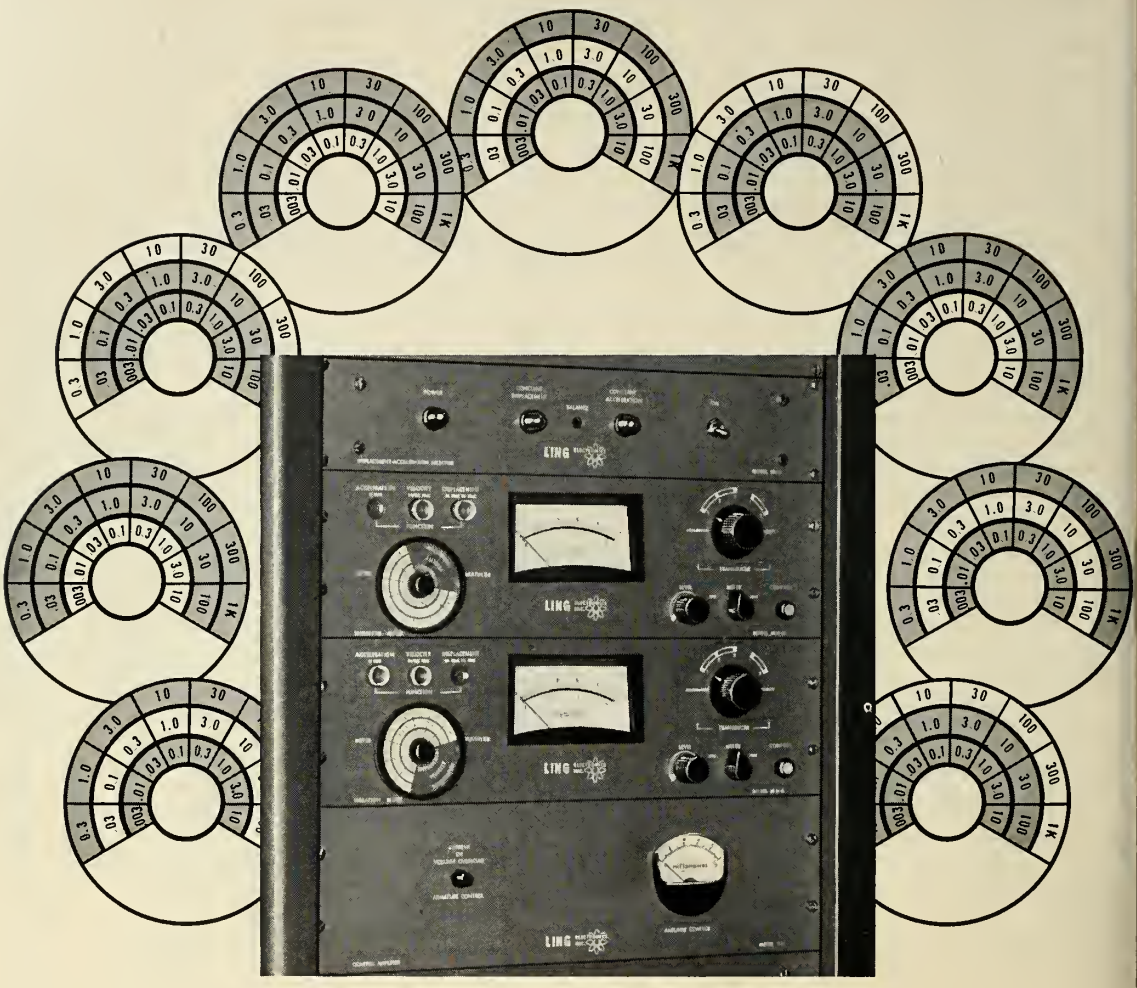
PHILCO CORP. has formally dedicated its expanded facilities of the Sierra Electronic Corp. Division of the Company's Government and Industrial Group. Philco added 50,000 sq. ft. to its existing 35,000-sq.-ft. facility. In Menlo Park, Calif., the company announced it will expand its employment from about 200 to nearly 500 employees.

COLLINS RADIO CO. has formed a Communication and Data Processing Division to provide electronic data processing services to industry. A $1-million building to house the center is nearing completion.

financial

Marquardt Corp.—Sales of $51.1 million for the 40-week period ended Oct. 9 were reported, as compared to sales of $50.5 million the like 1959 period. Net earnings fell under the previous year's period, $1.1 million compared to $1.3 million.

General Dynamics Corp.—A net loss of $25.1 million for the first nine months of 1960 was reported, compared to a profit of $24.5 million the like period last year. The company charged off all current and anticipated costs for the Convair 880/600 commercial jet program, totaling $61 million.



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Kennedy Expected to Work Closely with NASA Chief

PRESIDENT-ELECT KENNEDY is expected to identify himself closely with America's space activities.

Although there still is no hint as to who will be the new chief of the National Aeronautics and Space Administration, sources close to Kennedy and Vice President-elect Lyndon B. Johnson say the man chosen will be a close adviser to the President on space policy.

The situation will contrast with that in the present administration where NASA Administrator T. Keith Glennan has not been particularly close to President Eisenhower. Instead, Eisenhower has been guided by recommendations of his scientific advisers—first, James R. Killian, and later, George B. Kistiakowski.

• **New stress on prestige**—The effect of listening to scientists who were basic research-oriented, the new administration's advisers feel, has been a go-slow policy on space because of the high cost. It has been easy to persuade scientists that, from the purely scientific point of view, money is invested much more fruitfully in other, less expensive research areas.

The new administration will give much greater emphasis to prestige and possible military values of space exploration. As a result, possible conflicts between civilian and military aspects are expected to be the knottiest policy questions to be settled at the White House level.

One highly knowledgeable official predicted that a certain amount of duplication between military and civilian programs will be permitted as a lesser evil than taking a chance that either side might miss a good bet. But the same official declared that so expensive a duplication as *Thor* and *Jupiter* will never be tolerated by the new administration.

• **Modified council?**—It is the need for extensive policy guidance at the White House level that is reviving to some extent the Space Council, which was conceived originally as a permanent staff of up to 100 specialists who would advise the President and a council composed of Cabinet members, heads of government science agencies and a few non-government scientists.

Objections to the Space Council have centered on the fact that it takes up the time of the Secretary of State and others with a chore outside their field of interest. Thus, if something like the council should be retained, its structure might be modified, at least to the extent of authorizing members to be represented by deputies.

Whatever structure is adopted, advisers to the new administration feel that something should be established to help the President carry out the responsibilities given him by the Space Act of 1958. The act directs the President to:

–Survey all significant aeronautical and space activities, including the policies, plans and accomplishments of all government agencies.

–Develop a comprehensive space program.

–Fix responsibility for direction of major activities.

–Provide for cooperation between NASA and the military and specify which activities may be carried on concurrently by the two.

–Resolve differences among departments and agencies on space activities.

The act authorizes the President to appoint an executive secretary to be paid $20,000 a year and two top assistants at $19,000 a year exempt from the Civil Service laws. ⌗

ARS Seeks to Raise Dues To Meet Increased Costs

The American Rocket Society is asking members to vote on a proposed dues increase from $15 to $20 a year.

The ARS said the cost of servicing members has risen to a level of $66 a year. The difference is made up by revenue from advertising in the two society publications, Astronautics and the ARS Journal, and from exhibits.

Prior to the society's annual meeting in Washington beginning Dec. 5, members are also balloting on officers for 1961. Harold W. Ritchey, vice president and technical director of rocket operations for Thiokol Chemical Corp., is the choice of the nominating committee for president. William H. Pickering, director of Jet Propulsion Laboratory, Cal Tech, is the nominee for vice president.

Five directors will be elected from a slate of 10 put forth by the committee. They are: William J. Cecka Jr. of Rocketdyne, Robert A. Cooley of Chromalloy Corp., Prof. George Gerard of New York University, Prof. Samuel Herrick of UCLA, Robert H. Jewett of Boeing, Arthur Kantrowitz of Avco-Everett Research Laboratory, Bryon G. MacNabb of Convair-Astronautics, Simon Ramo of Thompson Ramo Wooldridge, Charles W. Williams of Chrysler Corp. and A. M. Zarem of Electro-Optical Systems Inc.

Highly instrumented aircraft . . .

(Continued from page 15)

you know, this is going to be the first operational satellite program, and will be the first satellite which will be usable by all the world, and PMR has the responsibility of establishing tracking stations for it.

Q. *Regarding your remark about the range of Atlas constituting the present limit of PMR, we understand that Titan II will have a range considerably in excess of present ballistic missiles . . . well beyond 10,000 miles. Presuming we would foresee range requirements, are we planning ahead to be able to track vehicles such as Titan II and Dyna-Soar over PMR?*

A. *Dyna-Soar* is being treated as a satellite. It goes around the world exactly as a satellite does, so you can't say *Dyna-Soar* has any particular range. So long as it stays in space, its range is a function of its speed.

"AMR gets far more data per firing than we do" . . . PMR's unconcerned between burnout and splash

Q. *Titan II, however, will reportedly have a range considerably in excess of what AMR can handle. Can its impact be accurately predicted and actually determined?*

A. I think you may be wrong about the range that AMR can handle. By shooting down between South America and Africa, they can handle any range that we are likely to put into a missile. As you know, they've demonstrated the *Atlas* at 9000 miles, and the range has another 1000 easily, because once they pass the tip of Africa, they have nothing but water ahead of them. So there's no limit to their range for R&D phases of a missile. Our firings out here are fo training and operational purposes.

Q. *However, we understood that the impact predictio on that Atlas was made from trajectory calculations and no from any actual impact information gathered at its terminus Now, if it's desired to check accuracy over such extrem ranges, isn't it necessary that some sort of definite splas net be set up?*

A. Well, they have a splash net in the Atlantic and the know exactly what the range is of each *Atlas* that has beer fired. They get far more volume of data from every firin than we do. They are interested in an R&D missile from th time it takes off, all through its trajectory, until the instan it hits. We at PMR essentially watch a missile only unti burnout and then we pick up the splash when it lands. I between these points, we don't pay any attention to it.

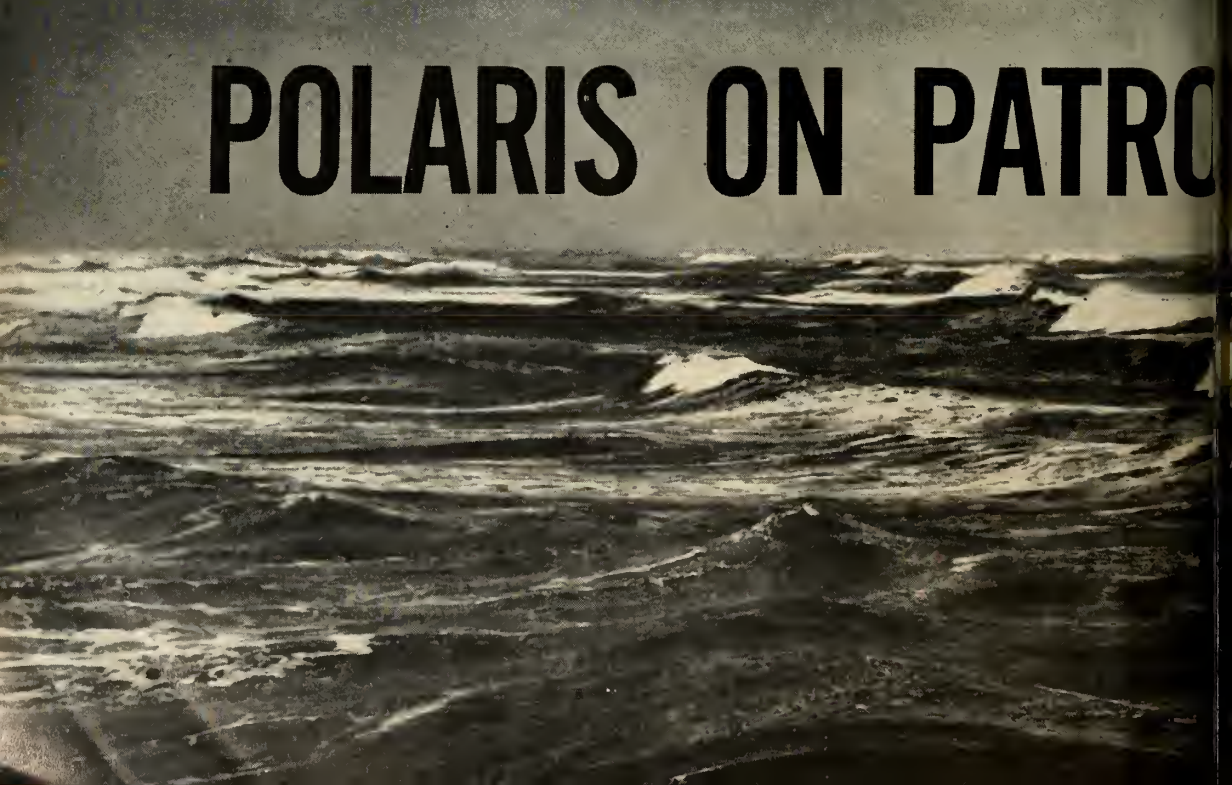
Q. *Does all your information come from hydrophon setups downrange?*

A. No, we have four very highly instrumented aircraf for airborne telemetry, airborne radar, communications beacon pickup and other things.

Q. *On the Nike-Zeus program, what facilities beside those at Kwajalein and Roi-Namur have been established?*

A. You really should ask the Army about this, but a general answer is that, like any R&D program, the first few months are spent testing components. The radar componen is being tested on the Atlantic Missile Range, where they can see the R&D shots coming downrange and get signature from them.

Q. *How do Nike-Zeus and Project PRESS (Pacific Range Electromagnetic Signature Study) tie together, insofar a*



hey are both users of PMR and have adjacent interests?

A. That's the reason Project *PRESS* was put on Roi-Namur. It is a program to get electronic signatures from missiles. The place to put them is where you get free targets to look at. So naturally, we located close to Kwajalein so that we could look at all the targets that are fired at the *Nike-Zeus* installation. This is so the radar operator can look at the thing coming downrange and tell if he's looking at an ICBM, IRBM, a decoy, a satellite, or whatever it is. It is expected that this will be quite possible, but we need a lot of data.

Q. *When the Soviets fire rockets into the Pacific, we understand that your PMR facilities have provided impact data on those shots. Can you comment?*

A. No, I can't comment on that. It would be very short-sighted of us not to use all the equipment we have, of course, to observe any firings in the Pacific. You could expect that we would use all the equipment available.

No commitments now for launching large boosters . . . but deep canyons could handle biggest thrust

Q. *In the same light, can you give any idea what the range of the MILS (missile impact locator system) at PMR stations is?*

A. We build the MILS to handle whatever projects are in the range, and the range is sufficient to take care of everything from IRBM's to ICBM's. If we ever get a longer range missile, we'll just extend the net. It's a very simple procedure. The sound waves go all over the Pacific, so it's no problem.

Q. *When the 1½-million-lb.-thrust rockets come along, will Arguello have the launch facilities to handle them . . . are these launch facilities being built now?*

A. No, we're not building any right now, but we have set aside areas in which we could put not only 1½-million-lb.-thrust rockets, but six or ten million lbs. thrust or even greater. We have deep canyons there which have 2000-foot mountains surrounding them, making natural revetments against sound and explosions. These are ideal for large boosters. We are also keeping Arguello sanitized (devoid of permanent administrative facilities) so that when the time comes to put large boosters up there, as it undoubtedly will, we will be ready for them. As of today, however, we have no firm commitments and we are not doing anything but master planning.

"When people ask me when the range will be finished, I reply that it will never be finished."

Q. *Does this include nuclear rockets? Could Arguello ground-launch a nuclear rocket?*

A. We could fire a nuclear rocket provided it is the second stage or higher. We wouldn't want to fire from Arguello with a first stage nuclear rocket. It's just too dangerous for the people in the area.

Q. *Do you have any further comments on the future of PMR?*

A. The thing I would like to leave you with is this: These ranges are never built and completed. We are always in the process of phasing in new projects and phasing out old projects. The new projects almost always require some new facilities or some increase in the instrumentation or better instrumentation. So we are always in a state of flux at these ranges, and when people ask me when the range will be finished, I reply that it will never be finished. We have all the basic tools now, but each project will need additional facilities, so that's our life. ⌘

SPACE SIMULATORS rise on East and West Coasts. At left is Tenney Engineering's high-altitude simulator for Project *Mercury* Astronauts at Cape Canaveral. At right is a cutaway drawing of Lockheed's vacuum chamber to test big satellites like Agena.

Discoverer XVII 'Most Successful'

LOS ANGELES—Extended orbiting of the *Discoverer XVII* capsule before its mid-air recovery may yield new data on sunspot activity and the Aurora Borealis.

Intense sunspot activity occurred during the period in which the capsule was in space with instrumentation designed to record solar effects. Apogee was 615 miles.

"We let *Discoverer XVII* fly until the 31st pass—rather than bring its capsule down on the 17th pass as planned. *Discoverer* was functioning so well," Maj. Gen. O. J. Ritland, Commander of the Air Force Ballistic Missile Division, said.

Success of *Discoverer XVII* may mean the next *Discoverer* shot will carry a monkey into space.

Discoverer XVII, employing Lockheed *Agena-B* successfully for first time, was boosted into orbit by a Douglas *Thor* on Nov. 12. *Agena-B* first was used in the program on *Discoverer XVI* but failed to separate.

• **Second pass succeeds**—Aerial recovery of the gold-plated instrument capsule was accomplished Nov. 14 some 500 miles northeast of Hawaii by an Air Force C-119 piloted by Capt. Gene W. Jones.

The capsule floating down under a silver and orange parachute was first sighted at 30,000 ft. After an unsuccessful pass at 11,000 ft., the C-119 succeeded in hooking it at 9500 ft. The capsule, slightly scorched by re-entry, was flown to Lockheed's Sunnyvale, Calif., plant.

An Air Force announcement said: "From first orbit acquisition through re-entry and recovery, this has been our most successful operation in the *Discoverer* series. The capsule dropped right into the ballpark, in plain view of four C-119 aircraft."

Radio signals from the satellite vehicle were poor on its first polar orbit but later improved. Signal for capsule ejection was given for the first time by ground command. On previous *Discoverer* shots, this has been accomplished by a timing device.

• **Restart under wraps**—Gen. Ritland reported that *Agena-B's* space restart capability was not used on *Discoverer XVII.*

"But in future firings with more sophisticated systems," he said, "it will permit us to control a satellite's course to a much greater degree—and even change its orbit."

Gen. Ritland discouraged speculation that successful release of the capsule on ground command would lead to satellite bombing systems. He noted that the national policy does not consider the use of space for offensive weapons and added: "The problem of keeping satellite bombers aloft—and keeping them absolutely reliable for long periods—would be tremendous."

He acknowledged, however, that a similar recovery system will be used to recover reconnaissance data from *Samos* satellites.

New Departure Using 'Cleanest Room'

SANDUSKY, OHIO—General Motors' New Departure Division last week began operation of its newest "clean room" for the assembly of precision miniature ball bearings.

Unabashedly calling the new facility "the cleanest place on earth," N/D says it combines the best features of all the newest such facilities in this country—and includes some unique ideas of the division's own.

All vertical walls are stainless steel or plate glass and lean into the clean area. There are no corners or flat surfaces to collect dirt or dust. All steel is grounded to preclude static charges. Even screwheads are covered with stainless buttons to streamline them into flat surfaces. Doors are frameless plate glass with no dust-gathering ledges or moldings. All assembly, testing, and packaging operations are performed under individual stainless-steel "Sterilshields."

The area is, of course, under positive air pressure. The air is changed 20 times each hour and two-stage-filtered for a maximum particle size of 5 micron. Temperature is held at 72 (±1)°F and humidity at 30-40%.

Lenses for the lighting fixtures are integral with the ceiling and the fixtures themselves are accessible from outside the controlled area.

Traffic, one of the greatest enemies of a clean environment, has been virtually eliminated here. No one except workers regularly assigned to the area may enter. Workers are cleaned in special "air-showers" and must don complete nylon uniform covering everything but their faces before entering the area. They cannot use cosmetics, chew gum, eat food, smoke, or even have lead pencils in the room. Only special line-free data paper is allowed.

New Departure engineers maintain that such ultra-clean facilities are one of the most promising approaches to solving the reliability problems of precise missile/space gyroscopes and guidance systems.

Switch to liquid hydrogen . . .

Centaur: New Power, New Problems

by Jay Holmes

SIX OR SEVEN MONTHS from ow, the United States will begin flight sts of the *Centaur,* which will embody ie most radical advance in rocket pro- ulsion since the Germans at Peene- iunde developed the *V-2.*

Centaur, a 2½-stage vehicle based n an *Atlas* ICBM, has an upper stage iat burns liquid hydrogen, a fluid that iust be kept at the fantastically low emperature of –423°F, a scarce 36° 'ahrenheit above absolute zero. Liquid ydrogen is 126° colder than LOX, the xidizer in *Centaur's* bipropellant ystem.

Switching from RP-1 to liquid hydrogen increases a liquid rocket's specific impulse from 30% to 40%. Although additional tankage is required ecause of hydrogen's extremely low ensity, there still is a large gain in erformance.

One comparison between conventional and high-energy upper stages is rovided in the lift capacity of *Centaur* id *Atlas-Agena B,* which has a large pper stage with storable liquid propel- nts. For a nominal 300-mile orbit, *entaur* will lift 8500 lbs., more than alf again the 5300-lb. capacity of *tlas-Agena B.* For escape, *Centaur* in lift 1450 lbs., compared with 800 s. for *Atlas-Agena B.*

But switching to liquid hydrogen as brought a series of new technical roblems, as well as intensification of me old ones. Its greater performance pacity creates opportunities that, in rn, create other technical problems.

• **New headaches**—*Centaur* will be e first rocket vehicle designed specifally for achieving a 24-hour orbit—hich opens a whole series of headhes in achieving that very precise tratory, 22,900 miles above the equator.

The first 10 *Centaur* flights will be imarily concerned with vehicle delopment. They will cover a period om 1961 to late 1963 or early 1964. othing but vehicle performance gear ll be aboard the first three flights. On e remaining seven, other scientific d spacecraft experiments will be card on a space-available basis.

Some of the payloads will be exriments in Defense programs, such the *Advent* 24-hour communications ellite. NASA experiments include the oject *Surveyor* soft-landing spacecraft d a few planetary shots.

NASA MODEL of the Centaur vehicle.

One of the most interesting experiments under consideration is a NASA attempt to launch multiple active communications satellites. Under the scheme, possibly 8 or 10 satellites would be packed into a container launched into an elliptical orbit with apogee upwards of 2000 miles.

Each time the container reached apogee, one satellite would be ejected, with a small propulsion unit set so that it would go into a high circular orbit. Each would be pointed in a slightly different direction, so that the orbits would be different.

No date is set for the first multiple launching, but it probably would be late in the *Centaur* development program, probably no earlier than 1963. Multiple launching of communications satellites is considered the best approach to reducing the cost enough to make intercontinental satellite communications commercially feasible.

The toughest technical problems in developing *Centaur* are related to the extremely low temperature of liquid hydrogen. Heat transfer is causing numerous headaches. During the coast periods between the three powered phases of flight to a 24-hour orbit, the tanks will be partly filled with liquid hydrogen slowly bubbling into gas.

While in direct sunlight, the *Centaur* tanks will be heating up fairly rapidly. Considerable study is in progress at NASA laboratories and by Convair, the prime contractor, to learn how much heat can be withstood and how much insulation must be used to avoid bursting the pressurized stainless steel tank. One solution under consideration is turning the engine end toward the sun as a shield.

• **Venting problem**—When the pressure builds too high, the tanks will be vented. But venting creates another problem. Under zero-g conditions, a mixture of gaseous and liquid hydrogen becomes a relatively uniform foaming suspension. Thus venting would release liquid along with the gas, considerably reducing total impulse.

The Air Force's Wright Air Development Division is cooperating with NASA on experiments in its KC-135 aircraft specially equipped to provide up to 35 seconds of weightless flight in a ballistic trajectory to investigate hydrogen properties. *Aerobee* sounding rocket shots from Wallops Island are planned soon to provide more data.

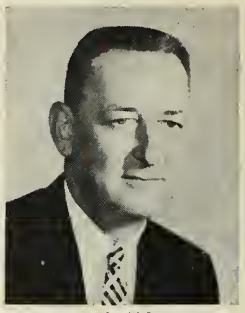
NASA and contractors are experimenting with several techniques of equipping vents to distinguish between liquid and gaseous hydrogen. All are classified.

A third problem is making certain that the liquid finds its way into the engine without too much gas mixed in at restart. Ullage rockets with thrust somewhat under 1 g create "gravity" that pushes the mixture back into the engine, but too much gas would make the engine run away and possibly destroy itself.

There is no plan for any fourth start for the *Centaur* engines, developed by Pratt & Whitney. The engines are capable of starting an indefinite number of times, but fuel will be provided only for three: the initial powered phase into a low orbit, the lift into an ellipse leading to a 24-hour orbit, and the final burst that converts the ellipse to a circle about the equator.

If further correction is needed, it will be provided by small, precise propulsion devices attached to the spacecraft itself. ⌘

names in the news


LANG


BUTTERFIELD


DUDENEY

John P. Butterfield: Named executive engineer on the corporate staff of The Martin Co. Was formerly director of advanced projects for the Chrysler Corp. From 1952 to 1958, as executive engineer for Chrysler he worked directly for **Dr. Wernher von Braun** on the *Redstone* and *Jupiter* missile programs.

Herman I. Rudman: Former manager of sales promotion with Photocircuits Corp., named marketing manager of Melpar, Inc.'s Special Products Dept.

Gordon D. Wedell, E. F. Forsythe and **Edwin A. Boyan:** Join the technical staff of the Data Systems Project office of Ramo-Wooldridge, a division of Thompson Ramo Wooldridge Inc.

Charles F. Thomas: Former leading engineering and contracting executive of the Lockheed Aircraft Corp., joins RCA's Major Defense Systems in the newly-created post of manager of marketing and planning.

Peter N. Dudeney: Appointed director of engineering for Vitro Electronics, a division of Vitro Corporation of America. Prior to joining the firm in 1958 as senior electronic design engineer, he served as senior design engineer for Bendix Friez and senior electronic engineer for A. V. Roe, Ltd.

Dr. E. R. Roberts and **J. B. Cowen:** Appointed to newly created positions of assistant manager with Aerojet-General Corp.'s Solid Rocket Plant. **Dr. Karl Klager** is now senior division manager, Solid Rocket Development, and **Dr. A. O. Dekker**, senior division manager, Solid Rocket Research.

Dr. Alan J. Rowe: Named manager of research in Hughes Aircraft Co.'s industrial dynamics department. Was formerly director of management control systems research at the System Development Corp.

Jack Lang: Former sales manager for Kimball Manufacturing Corp., named director of marketing for McCormick Selph Associates, responsible for all marketing and sales activities as well as advertising and public relations.

H. Malcolm Wilkinson: Appoint manager of the Data Acquisition a Logging Section of Stromberg-Carlso Electronics Div. Was formerly with t Research and Advanced Developme Div. of Avco Corp. and most recently charge of Instrumentation Systems Epsco, Inc.

Abel M. Schwartz: Named director advertising for Astrosystems, Inc. W associated with Thiokol Chemical Corp Reaction Motors Div.

Alan M. Brown and **Bernard Kliban** Join Electro-Mechanical Corp. as pre dent and vice president-engineering, spectively. Both were formerly associat with Adler Electronics.

Dr. Edward A. Parker and **James Powers:** Promoted to technical direct and research director, respectively, Technic, Inc.

Melvin Kohner: Appointed chief gineer of John Oster Manufacturing C Avionics Division.

Dr. Robert W. Mason: Former te nical supervisor of laboratory resear named assistant director of laboratory search at Allied Chemical's Gene Chemical Division.

John D. Blitch: Appointed assist to the executive vice president of C vair Division of General Dynamics Co Was formerly on the staff of the p gram planning manager for the *Pola* missile system at Lockheed Missiles a Space Div.

Strain "Tim" Sutton: Named natio sales manager of Tensor Electric Devel ment Co., Inc.'s newly created commerc division. Was formerly sales manager Acoustica Associates and Narda Ult sonics.

Dr. C. M. Wolfe: Joins Borg-War Controls as head of Transducer Engine ing. Previous posts: research specialist United Electrodynamics; group des engineer at Convair; supervisor in plied physics at North American Av tion, and supervisor, Physical Measu ments Dept., at Aerojet-General.

contracts

NASA

Avco Corp.'s Research & Advanced Development Div., Wilmington, Mass., for study of the re-entry portion of *Project Apollo*. Subcontract from Convair.

Giannini Controls Corp., Duarte, Calif., for continued research on an accelerator which eventually may be capable of reproducing orbital re-entry conditions in the laboratory. Amount not disclosed.

$49,252—Electro-Optical Systems, Inc., Pasadena, for test and evaluation of a company-developed hydrogen-oxygen fuel cell.

NAVY

Cubic Corp., San Diego, for building 1100 seven-bit binary counters for the U.S. Navy Electronics Laboratory. Amount not disclosed.

$26,000,000—The Bendix Corp., for continued development and evaluation of the *Eagle* missile system.

$43,386—Walker Electrical Co., Inc., Atlanta, for missile fire control switchboard for *Tartar*.

AIR FORCE

Olin Mathieson Chemical Corp., New York City, for development of gas generators for both stages of the *Skybolt* missile. Amount not disclosed.

General Motors' Allison Div., for building second-stage rocket motor cases for the *Minuteman*. Subcontract from Aerojet-General Corp. Amount not disclosed.

$8,232,000—Avco Corp.'s Electronics & Ordnance Div., Cincinnati, for continued production of the FPS-26 height finder radar.

$2,485,000—General Electric Co., for procurement and production of on-site and off-site depot level maintenance supply and support services for AF-owned ground communications electronics equipment.

$1,000,000—Aerojet-General's Spacecraft Div., Azusa, Calif., for conducting study and research on a swept-wing aerospace craft.

$950,000—Technical Operations, Inc., Burlington, Mass., for continued development of a two-sided global air war game.

$740,855—Beckman Instruments Inc.'s Systems Div., Anaheim, Calif., for building 17 electronic units for the *Minuteman*.

$199,769—General Electric Co.'s Technical Military Planning Operation, Santa Barbara, for study and research on a class of advanced systems to help keep U.S. defense in step with technological progress.

$139,248—Douglas Aircraft Co., Santa Monica, for studying the delivery of food and other essentials to men in earth satellites. Project *SLOMAR*.

ARMY

$77,800—Ransdell Construction Co., Dallas, for shops, missile assembly and maintenance and technical supply building.

$76,000—Colorado Research Corp., Broomfield, Colo., for a new type of television transmission system applicable to military communications, reconnaissance and surveillance in space technology.

$15,715—Western Electric Co., New York City, for *Nike* repair parts. (Four contracts.)

$39,000—Joseph Della Penna Construction Co., Haskell, N.J., for improved *Nike-Hercules* system.

$80,000—Hallock Construction, Inc., Easton, Md., for improved *Nike-Hercules* systems.

$94,693—B. B. McCormick & Sons, Inc., Jacksonville Beach, Fla., for construction of a mobile launch facility for the *Minuteman*.

$8,545—Radiation, Inc., Melbourne, Fla., for digital tabulation and plotting system.

$9,778—Hawkins & Westbrook, Abilene, Tex., for re-entry vehicle facilities at Dyess AFB.

$7,049—The Martin Co., Orlando, for emergency replenishment spare parts for *Lacrosse* missile system.

Navigation Satellite Receiver

Type 2501-A Receiver, available from Nems-Clarke Co., (Vitro Electronics) has been designed specifically for measuring the Doppler shifts of incoming signals over a wide tuning range.

The unit is continuously tunable from 55 to 260mc and features a low noise figure throughout the band. Two inputs are provided: one for the frequency to be measured, and a second input for a standard reference signal. In normal operation the reference input amplitude is adjusted to operate the detector in a linear fashion, and its frequency is offset by an amount slightly greater than the maximum Doppler shift expected. This produces detector action similar to a frequency mixer, the output being the difference frequency between the incoming signals. Operation in this manner produces an output signal in which the s/n has not been deteriorated due to detector action.

Circle No. 225 on Subscriber Service Card.

Linear-Flow Transducer

H. E. Sostman & Co. has available a line of linear-with-flow transducers suitable for use with orifice plates, flow tubes, or weirs. Series #IP-1170 Flow Transducers utilize an opposed-bellows meter body in conjunction with a precision potentiometer winding to provide an output signal directly proportional to flow. The extraction or characterization is accomplished by tapping and shunting the winding to the specific curve desired. Total resistance values from 500 ohms up to 5000 ohms are available depending on specific application requirements.

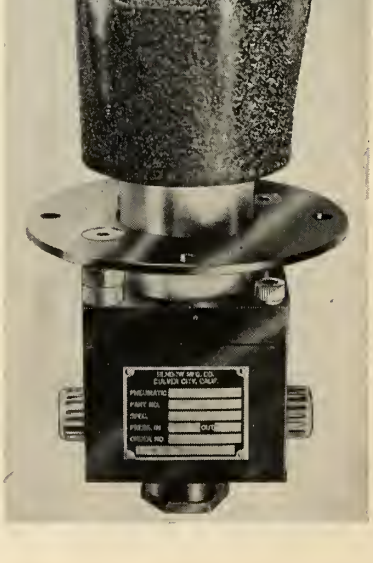
Circle No. 226 on Subscriber Service Card.

Pneumatic Regulator

A lightweight pneumatic regulator, Series 8225, that operated from 0 to 5000 PSI with constant outlet pressure, has been developed by Benhow Manufacturing Corp.

Pressure outlet is adjustable from 0 to maximum with one LO-Torque hand control, or an electric remote control unit, as required. An automatic relief provides system protection and a special ball-bearing guide insures accurate sensing. Temperature range is from −65° to +275°F; inlet pressure to 6500 psi; proof pressure 8000 psi.

Circle No. 227 on Subscriber Service Card.



Magnetic Tape Head

The Nortronics Co., Inc., has ava able a "J" Series of miniature recor erase/playback magnetic tape hea These heads measure ¼ in. diame by ¼ in. long, and are designed f use in transistor circuitry. The hea have a low impedance and excelle frequency response. Track width 0.070 in.

Circle No. 228 on Subscriber Service Card.

Synchro Dial and Weight

Angler Industries has available line of synchro dials and weights f friction torque tests, synchronizing te and spinning tests per MIL-S-20708.

The Dial in this testing device supplied with a Collet type clamp f quick disconnect for high productio testing and the complete unit may al be used for environmental testing Synchros. A basically essential testi device, the F-100 series as it is call is suitable for testing Synchros from si 11 to size 37.

Circle No. 229 on Subscriber Service Card.

High Accuracy Flowmeter

A flow measurement system f liquids having an accuracy of ¼ 1% of instantaneous reading is bei produced by Auto-Control Labor tories, Inc. The "High Accuracy Flo meter" is a positive-displacement mu tiple-piston unit converting precise measured volumes of liquid into a hig frequency pulse rate proportional to t volume measured. This signal can fed into a digital counter reading d rectly in GPM or to an analog met or X-Y plotter.

Circle No. 230 on Subscriber Service Card.

Surface Thermometer

Arthur C. Ruge Associates, Inc has added a series of transducers pe mitting surface temperature measur ments over a usable range from a solute zero to 2000°F.

The units consist of a grid of C platinum wire encapsulated in pu aluminum oxide. The first two tran ducers in this series are the APM-5 a 50-ohm nominal resistance unit, ar the APM-100, with 100 ohms nomin resistance.

Circle No. 231 on Subscriber Service Card.

Woven Wire Filter Types

Over 225 items, of 20 basic type of standard woven wire mesh, elemen in-line filters are now available fro

ircraft Porous Media, Inc. These fil-
r assemblies have inlet and outlet con-
ections on the axis of the sinter-
onded woven wire elements. Standard
nits range in tube or pipe sizes from
to 12 in.

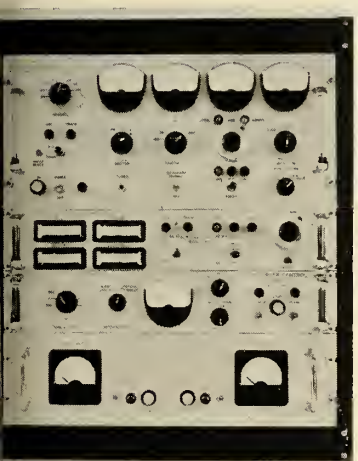
Removal ratings vary from 1½
icrons to 149 microns or coarser. A
ariety of fluids, ranging from cold
ases to hot viscous polymers, may be
andled over the temperature range
320°F to 1000°F. Fuels, lubricating
nd hydraulic fluids are among the hun-
reds of fluids which can be accom-
odated.

Circle No. 232 on Subscriber Service Card.

hase Lock Receiver

A series of Phase Lock Receivers is
vailable from Hallamore Electronics
ivision, Siegler Corp.

The receiver, designed to integrate
allamore phase-lock detection with an
ntire series of complementary modules,



perates with a wide dynamic range of
00 db at a sensitivity of −185 dbw.
he five modules that constitute the
ceiver are the detector, converter,
nverter control, remote acquisition
ntrol, and power supply.

Circle No. 233 on Subscriber Service Card.

uality Control Cabinet

A Space Saver testing unit is being
anufactured by Alpha Electric Re-
geration.

The unit is Composed of a roll-
out-type chassis cart and three sepa-
te, self-contained cabinets: high-low
mperature, humidity, and high heat
mperature. Cabinets are available with
her mechanical refrigeration or liquid
O_2. Removable for use on or off
e cart, the cabinets allow three in-
vidual testing procedures to be con-
cted at the same time.

Circle No. 234 on Subscriber Service Card.

new literature

SUPERBOLT REVIEW—A family of superbolts and companion locknuts for applications up to 900°F is covered in two new bulletins published by Standard Pressed Steel Co. Separate four-page bulletins review the new 900-degree aircraft bolt, the EWB 926, and mating featherweight self-locking nut—the FN 926. Between them, the two fasteners comprise the first threaded joint of 200,000 psi ultimate tensile strength at 900°. Room temperature tensile rating is 260,000 psi minimum.

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VACUUM COATINGS—Custom vacuum coating services for functional and unusual decorative purposes are the subject of a 4-page brochure just issued by Poly-Kote, Inc. Described are coatings for abrasion, corrosion, and high temperature resistance, as well as unusual electronic effects.

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RESISTANCE WELDING CALCULATIONS—An 8-page brochure (SP-8A), containing tables which simplify calculation of the electrical power supply required by resistance welders, is available from the Taylor Winfield Corp. Factors of electrical demand and duty cycle are tabulated to establish minimum welder transformer KVA ratings. Maximum safe rate of operation of a welder can be readily determined by use of these tables, which establish the maximum electrical duty cycle of a transformer under various demand loads.

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GAGING INSTRUMENTATION—A product brochure on gaging instrumentation, is available from Measurement Control Devices. Designated Catalog No. G-100, the illustrated brochure describes in detail the systems and components available for the continuous indicating the monitoring of minute changes in dimensions for control usages. Describing bearing, comparator and height type gaging heads, the brochure also explains in detail mounting stands as well as amplifier and display units for use in closed loop servo indicating systems or such as extended scales indicator and strip chart recorders are also described.

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MISSILE HYDRAULICS COMPONENTS—An eight-page brochure on missile hydraulic components and their application has been published by Denison Engineering Division, American Brake Shoe Co. The publication outlines the use of hydraulic pumps, motors, and controls in missile transporters, erectors, launchers and in testing and checkout systems. Illustrated sections on completely integral hydraulic power plants and valves are included with performance data.

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letters

NASA's Ion Engines

To the Editor:

It was encouraging to see an article on electric propulsion in your magazine (M/R, Nov. 7, pp. 24-25). We, at the National Aeronautics and Space Administration, appreciate your interest in this rapidly developing propulsion field.

While the NASA program for flight testing ion engines is still under discussion, the present program calls for initial flight tests of smaller ion engines than the 0.1 lb. thrust, 30 KW engine mentioned in your article. The smaller engines can be tested for approximately an hour above 250 n.m. using battery power in payloads weighing around 150-200 lbs. rather than the 100 lb. payload M/R indicated. The NASA-developed *Scout* vehicle is being considered for these initial ballistic flight tests of ion engines.

Also, I want to clarify some of the statements which were attributed to me in the article. On the question of flight tests, I was quoted as saying that it was impossible to prove a higher (specific) impulse figure (20,000 sec. or more) without experiments in space. The problem is more basic than you indicated. We cannot prove any impulse figure or cannot be certain that an ion engine will operate at all in space without flight testing. The question of whether the positive ion beam can be effectively neutralized by injection of electrons can only be answered with certainty by experiments in space. As you pointed out, earth-bound test tanks do not adequately simulate the condition of outer space due to the imperfect vacuum and finite walls. Thus, we are studying various methods to test ion beam neutralization schemes and to check the operation of various ion engines in space.

If the initial tests for neutralization prove satisfactory, we will test larger engines and hope to have an operating engine by 1965 which will mate with the 30 KW SNAP-8 power supply. It is hoped that this engine will produce 0.1 lb. thrust at a specific impulse of 4000-6000 seconds. This particular program is to develop a first generation ion engine and higher impulse engines can be expected later.

The M/R article mentioned that the electric engines will reduce the cost, weight and complexity of launch vehicles required for missions to Mars, Venus and beyond. The electric engines are being designed to operate in space after they have been placed there by a launch vehicle of the *Centaur* and *Saturn* class. Thus, the development of these engines will only affect the design of the upper stages of the vehicle and not the basic launch vehicle.

My final comment concerns the subject of NASA-sponsored supporting r search on electric propulsion engine which included ion, arc jet, MHD, ar colloid. You are correct in saying th NASA Headquarters will be receptive unsolicited proposals. However, these pr posals also can be submitted directly Marshall Space Flight Center, Huntsvill Ala., where Dr. Ernst Stuhlinger and h staff sponsor and direct research and d velopment programs in electric propulsio

Again, thank you for publishing article on the new and challenging fie of electric propulsion. We appreciate yo interest in the NASA programs.

Richard J. Hayes
Capt., USAF
Technical Specialist
Electric Propulsion
National Aeronautics
Space Administration
Washington, D.C.

No Trouble on Samos Pad

To the Editor:

The Oct. 17 M/R tells (on p. 16) the first *Samos* shot by the Air For from the Naval Missile Base at Poi Arguello, Calif., which I was lucky observe.

It was a perfect launching even *Agena B* did not perform as intended.

This launch site was turned over to t Air Force on March 18, 1960, just s months and 23 days before firing.

Wells Benz Inc., were the Gener Contractors on the only two *Samos* pa constructed at Point Arguello to date.

Incidentally, the gantry shown in t picture is not from Point Arguello; t gantry at Arguello has an all-electr bridge crane and there is no metal sidi on the outside. Somebody goofed.

Here is hoping that the next *Age* works and gives Nikki a lot of worry sending us pictures of his front door.

R. M. (Red) Cameron
General Superintendent
Wells Benz Inc., Contracto
Phoenix, Ariz.

High Praise for Kane

To the Editor:

The article by Lt. Col. Francis Kane in M/R of Oct. 24 ("A Call for I tellectual Innovations") represents son of the finest thinking that has ever be displayed in any magazine in the astr nautics industry. Though his article m not represent the official thinking of t Air Force, it would be well for all A Force officials to read and understa Colonel Kane's article without delay, a to indeed make this the official line thought. Colonel Kane has in the sh space of a little over two pages point out the crucial ailment in the defense e tablishment in the United States. The ne for basic research is literally the mo crucial need in our time.

Saunders B. Kramer
Senior Member, American Astr nautical Society
Fellow, British Interplanetary Society
Sunnyvale, Calif.

—when and where—

NOVEMBER

onference on Electro-Optical and Radiation Devices sponsored by IRE Professional Group on Electron Devices and AIEE, Stanford Research Institute, Menlo Park, Calif., Nov. 20-21.

merican Physical Society, University of Chicago, Chicago, Nov. 25-26.

SME Winter Annual Meeting, Statler-Hilton Hotel, New York City, Nov. 27-Dec. 2.

overnment Contracting Course, National Defense Education Institute, sponsored by National Security Industrial Association and Harbridge House, Inc., Los Angeles, Nov. 28-Dec. 9.

r Research and Development Command's Seventh Annual Science and Engineering Symposium, Statler Hilton Hotel, Boston, Mass., Nov. 29-30.

DECEMBER

E Professional Group on Vehicular Communications, Sheraton Hotel, Philadelphia, Dec. 1-2.

nerican Institute of Chemical Engineers, Statler Hotel, Washington, D.C., Dec. 4-7.

ectronics Industries Association, Third Conference on Maintainability of Electronic Equipment, Hilton Hotel, San Antonio, Tex., Dec. 5-7.

RS Annual Meeting and Astronautical Exposition, Shoreham Hotel, Washington, D.C., Dec. 5-8.

tional Conference on the Application of Electrical Insulation, Conrad Hilton Hotel, Chicago, Dec. 5-8.

nerican Nuclear Society, Mark Hopkins Hotel, San Francisco, Dec. 11-14.

ternational Scientific Radio Union (URSI), IRE Fall Meeting, NBS Boulder Labs, Boulder, Colo., Dec. 12-14.

dustrial Building Exposition and Congress, Coliseum, New York City, Dec. 12-15.

nual Eastern Joint Computer Conference, Hotel New Yorker and Manhattan Center, New York City, Dec. 13-15.

omic Industrial Forum, Annual Conference, Fairmont Hotel, San Francisco, Dec. 14-16.

titute of the Aeronautical Sciences, Wright Brothers Lecture, Smithsonian Institution, Washington, D.C., Dec. 17.

nerican Association for the Advancement of Science, Annual Meeting, Philadelphia, Dec. 26-31.

JANUARY

nposium on Thermoelectric Energy Conversion, Joint Technical Society, Department of Defense, Statler Hilton Hotel, Dallas, Tex., Jan. 8-12.

enth National Symposium on Reliability and Quality Control, Bellevue-Stratford Hotel, Philadelphia, Jan. 9-11.

ernational Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Jan. 9-13.

American Astronautical Society, Annual Meeting, Sheraton-Dallas Hotel, Dallas, Tex., Jan. 16-18.

Winter Instrument-Automation Conference and Exhibit, Instrument Society of America, Jefferson Hotel and Kiel Auditorium, St. Louis, Jan. 17-19.

29th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York City, **(Honors Night Dinner,** Jan. 24), Jan. 23-25.

American Mathematical Society, National Meeting, Willard Hotel, Washington, D.C., Jan. 24-27.

Society of Plastics Engineers, Annual Technical Meeting, Shoreham and Sheraton Park Hotels, Washington, D.C., Jan. 24-27.

American Institute of Electrical Engineers, Winter General Meeting, New York City, Jan. 29-Feb. 3.

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editorial . . .

Foreign Policy and Your Own Life

THE DANGER AREAS of American foreign policy—those areas which contain a threat to the security of the country—are being studied and charted by a special committee named by President-elect John F. Kennedy shortly after his nomination.

Chairman of the committee is Paul H. Nitze, president of the Foreign Service Educational Foundation, a member of the U.S. Strategic Bombing Survey and former Department of State economist. Members are: David K. E. Bruce, former ambassador to France and Undersecretary of State; Roswell L. Gilpatric, former Undersecretary of Air Force; James A. Perkins, consultant to the RAND Corp. and the Dept. of Defense and a member of the Counsel of Foreign Relations.

The Nitze group, known generally as the Kennedy Committee on Defense and Foreign Policy, is one of two named by the President-elect. The other, under the chairmanship of Sen. Stuart Symington, is mapping out a proposed reorganization of the Department of Defense (M/R, Nov. 14, p. 8). Both groups have been asked to report by Dec. 31.

Mr. Nitze's assignment is formidable. Consider the scope of it: the international problems of today which have a direct bearing on the security of the United States.

Do we aid and abet De Gaulle's plan to make France a fourth nuclear power, or do we stand aloof? How long can we hold on to the strategic air bases in North Africa? What would be the effect of turning nuclear weapons over to NATO? How do we deal with the old problems of Quemoy and Matsu, which unexpectedly became a campaign issue?

The state of our foreign trade balance directly affects our security, as does our overall prestige abroad. There are Cuba and Castro, the possibly inspired revolts of Central America, the recognition of Red China and the defense of Berlin. The proposed reorganization of the Pentagon has a bearing, to the extent that it affects our military posture.

The Nitze committee in some form will, we understand, be a continuing operation. Its reports and studies will be available to the White House and the Departments of State and Defense.

IF THE ASSIGNMENT given the committee is formidable, it is also greatly necessary. It will mean that the major foreign policy problems facing the new President will be studied and analyzed in fine detail.

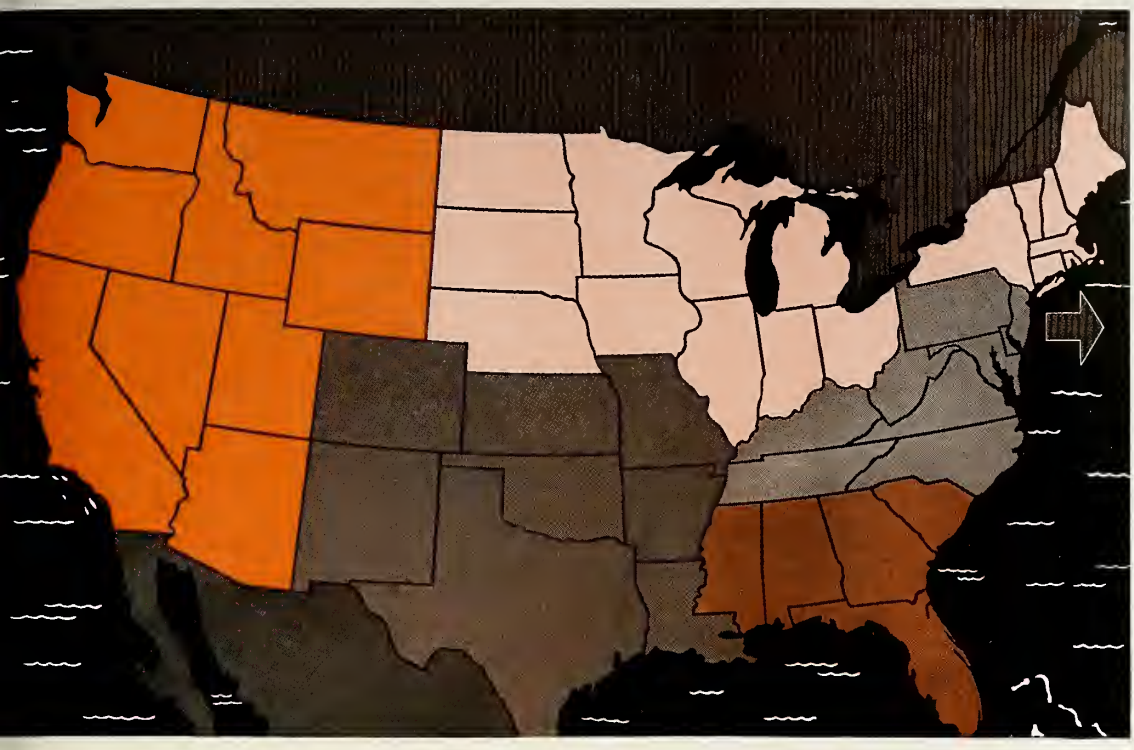
And from the analyses will, we trust and hope, come plans for as many eventualities as can be logically foreseen. They will be the basis of plans, long-range and short, which will give our foreign policy a consistency it has not had in years.

Such plans are not mysterious and remote. They affect the everyday lives of the American people; particularly they affect the defense industry. Upon some of these plans should be based our capability to fight small wars. Upon others may rest a decision as to how many missiles are needed and what kind; whether or not we resume atomic testing—or spend twice as much in our space exploration program.

Government agencies always plan to one degree or another. Presumably there was a plan for handling the situation should a U-2 be shot down over Russia. If so, it was obviously inadequate.

Good national planning is necessary now as it never has been before. And the more experience, thought and consideration which can be brought into that field the better the planning will be.

Clarke Newlon



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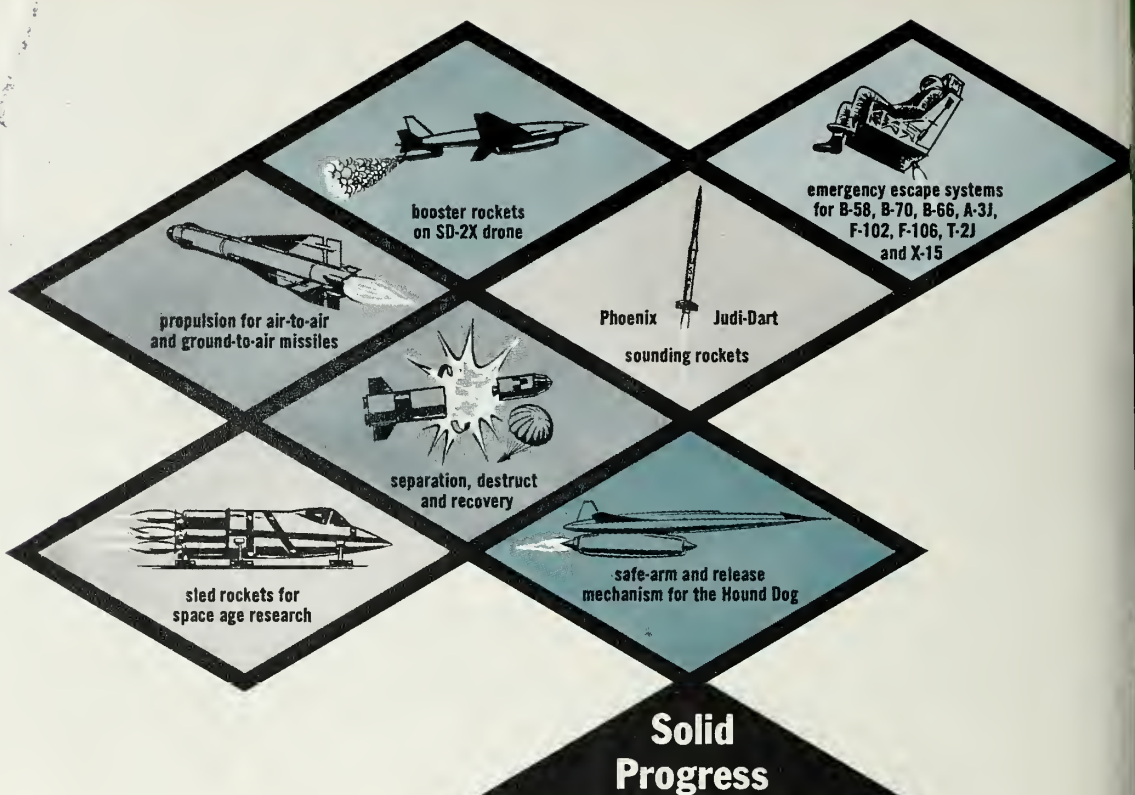

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