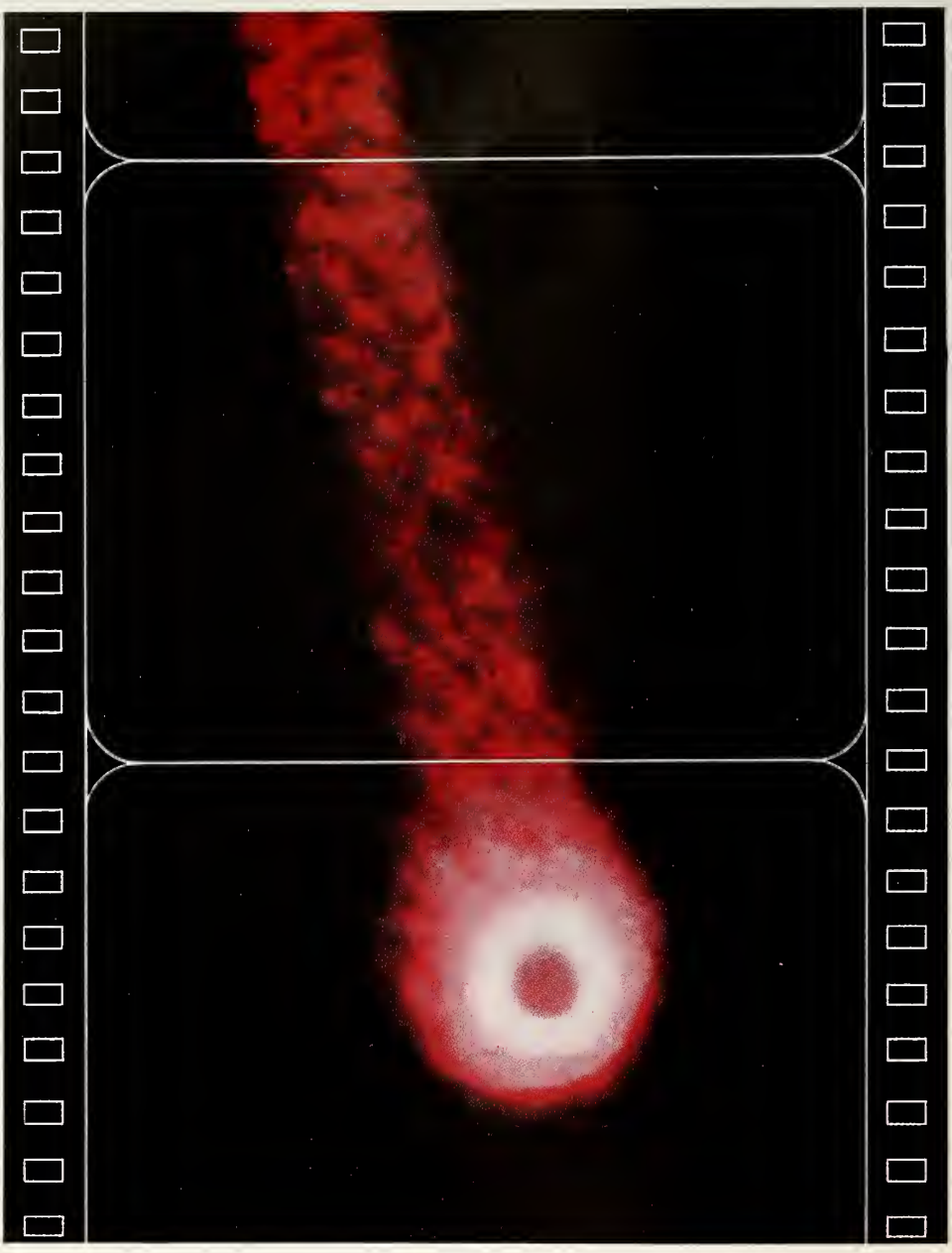
July 25, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

Lockheed's Root and Navy's Raborn

AN AMERICAN AVIATION PUBLICATION



Re-entry portrait at 12,000 MPH. Critical performance data of re-entry vehicles at temperatures exceeding 12,000 degrees are obtained by a re-entry monitoring team from the Avco-Everett Research Laboratory. Portraits under these difficult conditions are obtained regularly as part of a general research program to study re-entry phenomena and related problems. Airborne equipment is used to acquire radiation data, trajectory information, and photographic documentation.

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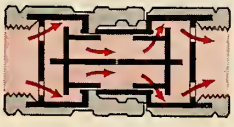

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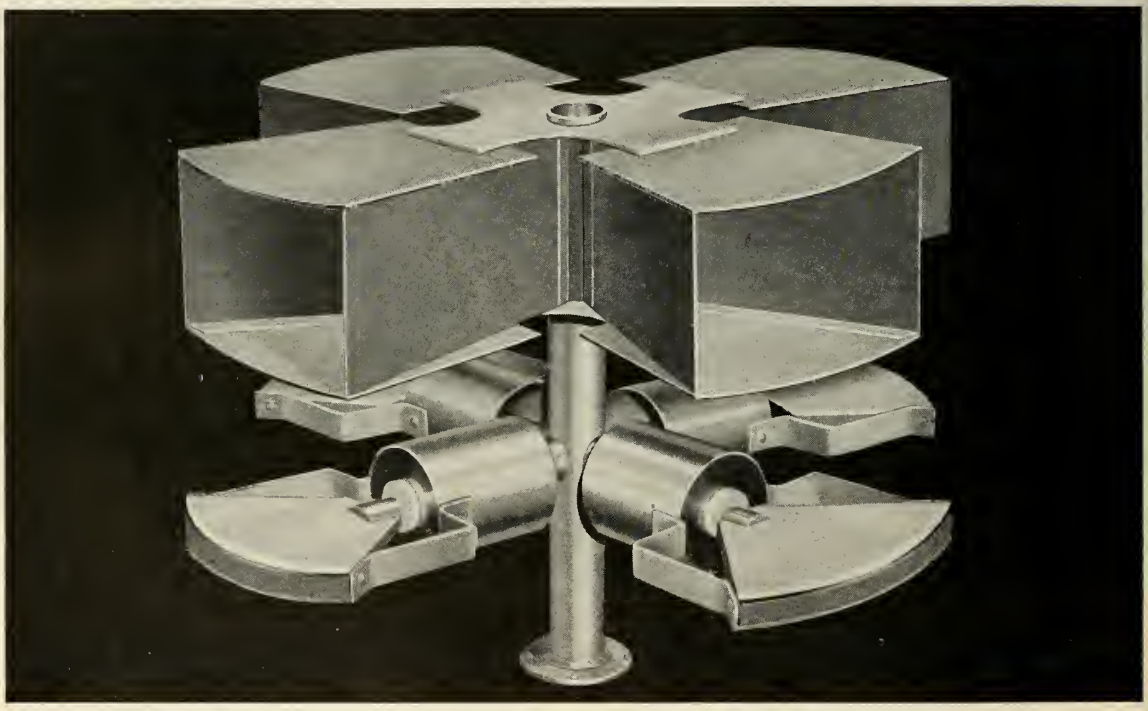

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THE MISSILE / SPACE WEEKLY

missiles and rockets

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THE COVER

L. E. Root, Lockheed group vice president for missiles and electronics, and Rear Adm. W. F. Raborn, Navy's Polaris Chief. For special Polaris report, see p. 11.

JULY 25 HEADLINES

SPECIAL REPORT ON POLARIS

ELECTRONICS

ADVANCED MATERIALS

DEPARTMENTS

30,724 copies this issue

The Countdown

WASHINGTON

More Money for Polaris Subs

Expect the Navy to parlay its spectacular "proof of pudding" underwater *Polaris* shots into a Congressional request for four more missile-packing submarines. The request may come in August or in the supplemental budget. The entire FBM program may get an extra shot of steam this week at the Republican convention. Odds are good Vice President Nixon will answer Democratic "missile gap" charges by pointing to the success of *Polaris* and the fact that 32 *Polaris* missiles will be on station by Christmas.

Answer to Atlas Slippage?

Shift of responsibility for *Atlas* base construction to the Air Materiel Command's Ballistic Missile center is being interpreted in Washington as an Air Force move to prevent further slippage in the program. Maj. Gen. Thomas P. Gerrity, chief of BMC, assumes top management of base building on an equal status with ARDC's Ballistic Missile Division chief, Maj. Gen. O. J. Ritland. Gerrity's new job, however, will not extend to the *Atlas* pads at Vandenberg AFB, Warren AFB and Offutt AFB—where the slippages of three to six months have occurred.

Standby Space Rocket

"Kicking around" Cape Canaveral is a *Titan* missile that could be used for a space shot by the Air Force. The big bird—left over from a development test series—is capable of lofting about 4000 lbs. into orbit. However, there is no indication when—or if—the AF will fire it.

"Wild Life" Atlas?

Next *Atlas* to be launched from the Cape will carry a recoverable re-entry body. One rumor says the vehicle will contain some form of life—possibly a primate—for Air Force space flight research.

Pershing Moving Fast

Race is on to move up the operational date of the Army's solid fueled *Pershing*, now set for 1962. Optimistic observers feel the weapon will be ready in 1961. Tactical version will be about 30 ft. long (4 ft. shorter than R&D version); 48 in. in diameter and weigh about 10,000 lbs.

Hard Mace Sites

Acoustic and insulating problems appear to be licked in the design of a hard site for *Mace* tactical missiles. Go-ahead for construction of bases (four missiles to a site) in West Germany is expected soon.

INDUSTRY

NASA Unveils Industry Plans

Contractors are being given a look at NASA's plans —both immediate and over the next 10 years—at a classified briefing July 27-28.

Insiders?

Latest speculation has the Grumman-Westinghouse and Bendix-Republic teams on the inside track for NASA's orbiting astronomical observatory. Contract could mean up to $100 million to the winner over the next 10 years.

Fallout from Polaris

Several industry proposals to put ICBM's—*Minuteman* and *Titan*—on ships of the moth-ball fleet are still being pushed hard. But, despite the Air Force's desire for more mobility, these proposals are now given little chance in the light of the prove-out of the *Polaris* system. On the positive side: *Polaris* is now credited with knocking a full year off the development of *Minuteman* and of greatly advancing *Pershing*.

On Mahogany Row

Succeeding Richard Horner as the No. 3 man at NASA is Robert G. Seamans, 41, chief engineer of RCA's missile electronics and controls division. He will take over Sept. 1 . . . Douglas Aircraft has lost—through resignation—vice president Ed Heinemann.

INTERNATIONAL

U.S. Buying anti-jammer

C.G.S.F. (France) has U.S. orders in hand for the super-secret "Concinotron"—said to be an anti-jam device for anti-ICBM guidance.

Germany Staying With Cobra

Contrary to reports that Germany will by-pass *Cobra* (COUNTDOWN-May 30) Bolkow-Entwicklungen says the German Army is still interested in the anti-tank missile for infantry. The *SS-11* is heavier and will be deployed exclusively on vehicles.

Secret SS-11 Test

COUNTDOWN hears that a secret test of the *SS-11* was conducted recently in the Dauphine Alps near Huez by Nord-Aviation and the French Army. Alpine troops used a new waist belt fire control to launch five of the missiles at an 8,700 ft.-high site.

Over the Iron Curtain

Japan will launch its first three-stage *Kappa-9* sounding rocket this fall. It will peek over the Iron Curtain, carrying a 33-lb. payload to an estimated 248.4 miles in another step to perfect a high altitude weather reconnaissance system.

—reviews—

A STUDY OF THE CORROSIVE EFFECTS OF THE COMBUSTION PRODUCTS OF BORON CONTAINING FUELS ON SELECTED HIGH TEMPERATURE MATERIALS, F. J. Loprest and S. J. Tunkel, Thiokol Chemical Corp. for WADC. Order PB 161421 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C., 331 pp., $5.

The corrosion behavior of a wide cross section of high temperature alloys, under unstressed conditions in the combustion products of boron-containing fuel was examined. Much of the study was devoted to dynamic testing. Test conditions simulated combustion products from a potential boron containing high energy fuel.

CLASSIFICATION OF ELECTRON TUBES, J. Haantjes and H. Carter. Macmillan, New York. 100 pp., $3.50.

A beautifully illustrated and well written book of especial interest to the student and "layman" who needs a general understanding of the types and functions of electron tubes.

Cutaway color views and brief descriptions explain the operation and applications of all major types. Basics of electron theory are also simply presented.

A glossary of "odes" and "trons" defines common terms used in the designation of tubes and their components.

INVESTIGATION OF THE STRENGTH AND DUCTILITY RELATIONSHIPS IN TITANIUM-ALUMINUM ALLOYS BETWEEN 6 and 15% ALUMINUM FOR APPLICATION AT ELEVATED TEMPERATURES. B. S. Lement and others, Manufacturing Labs, Inc., for WADC. Order PB 161424 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 74 pp., $1.75.

The results of a one year study of the strength and ductility relationships in a series of titanium-aluminum alloys varying from 6 to 15% aluminum are reported. The main objective of this investigation was to learn more about the embrittlement phenomenon in order to extend the useful range of aluminum content.

INVESTIGATION OF LIQUID NITRIC OXIDE AS A ROCKET OXIDIZER. L. E. Bollinger and R. Edse, Ohio State University for WADC. Order PB 161300 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 29 pp., $.75.

This is the final report of a series of studies on the use of liquid nitric oxide as an oxidizer for rocket engines. From the limited experiments conducted, researchers did not find liquid nitric oxide favorable as a rocket oxidizer because of the long residence time required for nitric oxide to react fully with the fuels used. The studies also show that nitric oxide may affect the smooth combustion of nitric acid with a fuel because of the long chemical reaction time of nitric oxide.

—when and where—

JULY

Thermochemistry of Rocket Propulsion, a short course, University of California, Los Angeles, July 25-Aug. 5.

Denver Research Institute, Seventh Annual Symposium on Computers and Data-Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

AUGUST

Fourth Global Communications Symposium, co-sponsored by IRE, Professional Group on Communications Systems, and U.S. Army Signal Corps, Statler Hilton, Washington, D.C., Aug. 1-3.

Massachusetts Institute of Technology, Special Program on Modulation Theory and Systems, Cambridge, Aug. 1-12.

International Symposium on Rarefied Gas Dynamics, University of California, Berkeley, Aug. 3-6.

University of Connecticut, Institute for Practical Research on Operations, Storrs, Aug. 7-13.

University of Connecticut, Third Annual Institute on Missile Technology, Storrs, Aug. 7-19.

Annual Meeting of the Association of the U.S. Army, Sheraton-Park Hotel, Washington, D.C., Aug. 8-10.

American Astronautical Society, Western National Meeting, Olympic Hotel, Seattle, Aug. 8-11.

American Institute of Electrical Engineers, 1960 Pacific General Meeting, El Cortez Hotel, San Diego, Aug. 8-12.

ASME-AIChE Heat Transfer Conference and Exhibit, Statler-Hilton Hotel, Buffalo, N.Y., Aug. 15-17.

XIth International Astronautical Congress, IAF, Stockholm, Aug. 15-20.

Cryogenic Engineering Conference, University of Colorado and National Bureau of Standards, Boulder, Aug. 23-25.

Western Electronics Show and Convention, Los Angeles Memorial Sports Arena, Aug. 23-26.

International Union of Pure and Applied Physics, International Conference on High Energy Nuclear Physics, University of Rochester, Rochester, N.Y., Aug. 25-Sept. 3.

The German Rocket Society, Annual Meeting, Hanover, Aug. 26-28.

University of Connecticut, Eleventh Annual Basic Statistical Quality Control, Institute, Storrs, Aug. 28-Sept. 9.

The Combustion Institute, 8th International Symposium on Combustion, California Institute of Technology, Pasadena, Aug. 29-Sept. 2.

10th International Congress of Applied Mechanics, Congress Bldg., Stresa, Italy, Aug. 31-Sept. 7.

SEPTEMBER

Society of Instrument Technology and British Interplanetary Society, One-day joint symposium on Rocket and Satellite Instrumentation, Manson House, London, Sept. 1.

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

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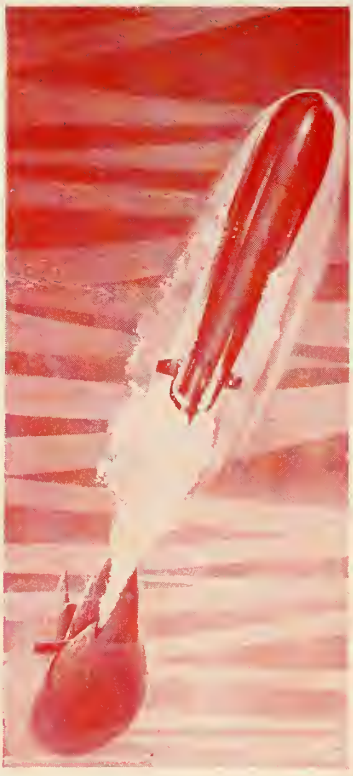
OUTERSPACE VEHICLES—Sundstrand has been the prominent factor in the development of a solar mechanical engine which, using an advanced working fluid, is capable of providing a continuous source of power generation for satellites, platforms and other space vehicles. A closed cycle power conversion system, this exotic, advanced power system is typical of the research and development work *currently* being conducted by Sundstrand for outerspace vehicles.



UNDERWATER VEHICLES—With an increasing interest in utilizing the deep oceans for both peaceful and defensive purposes, Sundstrand is *currently* engaged in a program investigating the use of a common working fluid in closed cycle systems for underwater propulsion. This work also includes the study of advanced research torpedo configurations.

RE-ENTRY VEHICLES—Since Sundstrand developed the first successful monopropellant missile APU in 1952, Sundstrand has produced a continuous flow of advancements in this area. Sundstrand is *currently* developing a chemically fueled open cycle power generation system which, using hydrazine or hydrogen and oxygen as the propellant, drives a generator for electrical power. It is proposed for re-entry vehicles and similar applications.

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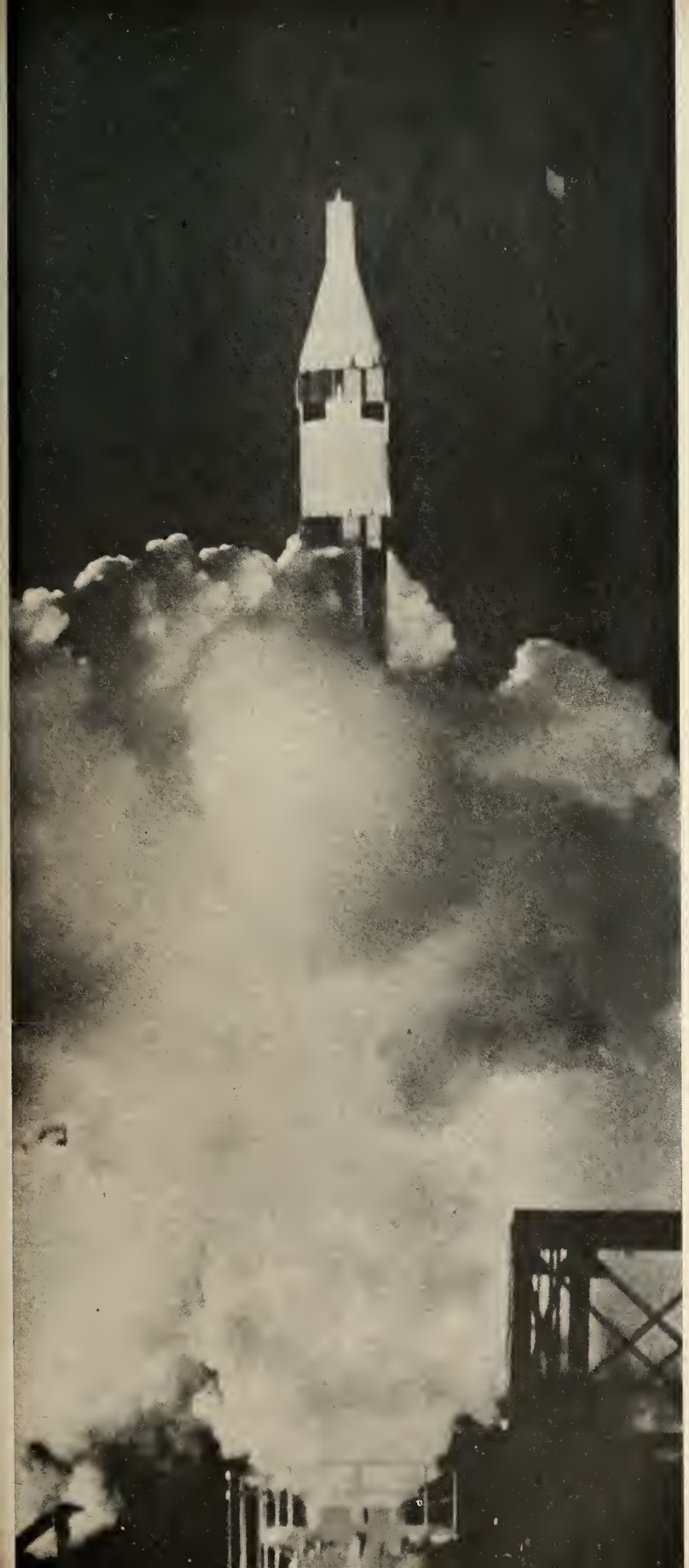


POLARIS

FBM Program Starts Rolling: A Special Report

system is proven . . .

The Issue Now: How Many Polaris Subs

by James Baar and William E. Howard

CAPE CANAVERAL—The mighty *Polaris* missile system last week raced toward its October operational date with the issue of how large a *Polaris* fleet is to be built still in doubt.

The nuclear-powered submarine George Washington successfully launched not one but two operational *Polarises* for the first time while submerged off the coast of northern Florida.

The stubby 28-ft. missiles roared more than 1000 nautical miles down the Atlantic Missile Range within less than three hours and were reported to impact well within the target area.

The tests were considered to be the "proof of the pudding" by the men who have worked at almost killing speed since 1957 to develop the *Polaris* system.

The sending of the George Washington on station by October with 16 nuclear-tipped *Polaris* missiles in her magazine appeared assured. The Patrick Henry—second submarine of the *Polaris* fleet—is expected to follow by December.

But how many more *Polaris* launching subs will follow the first two into the oceans around the Soviet empire remains to be determined.

The Navy is continuing to press for a *Polaris* fleet of 45 submarines. The total cost is estimated at $8.6 billion.

The Eisenhower Administration to date has agreed to construction of only 14 *Polaris* subs along with procurement of long-lead items for seven more. Administration authorization for two—originally added by Congress over Administration objections last month—was disclosed within a hour after the second successful launching.

Pressure to increase the number of submarines is expected to result in one of the hottest issues of the presidential election campaign. Congress could authorize more when it meets again next month.

Meantime:

• The George Washington will continue missile launching tests off Cape Canaveral for the next several months. The Patrick Henry will join her sister ship at the Cape probably by late summer.

• The Navy's Special Projects Office, directing development of the *Polaris* system, is pushing work on the 1500-mile-range version of the missile and looking toward development of a 2500-mile model. The 1500-mile *Polaris* is expected to be operational before 1963.

Polaris Major Factor in Proposed 1000-Miss

by Clarke Newlon

PARIS—Spurred on by the increasing truculence of Nikita Khrushchev, Supreme Headquarters Allied Powers Europe is pushing forward with plans for a thousand-weapon NATO missile force to help contain the threat from the Communist armies of Eastern Europe. The force would be land-based and mobile.

When and if approved by the NATO ministers, the strategic force will be strung through the 12 NATO countries of Western Europe.

Projection of the missile arm follows recent statements by General Lauris Norstad, Supreme Allied Commander, that the forces needed now to defend Western Europe are double those deemed necessary in 1949, when NATO was founded.

The missile group will constitute a force in being actually under the command—in peacetime as well as in event of war—of Gen. Norstad.

There is every possibility that formation and actual training of the force will begin within the next six to nine months.

It would be armed probably with either the American *Polaris* or *Pershing*—or a mixture of the two—and probably would not be operational for two years or more.

• **Planned long ago**—The first step toward a missile force was taken more than a year ago when *Jupiter* IRBM missiles presently being installed in southeastern Italy were placed under direct SHAPE command. The Italian bases have been kept under wraps due to strong Communist opposition.

It has just been revealed that base construction has been completed and the pads are ready for the missiles. They will be manned by Italian crews under SHAPE command, with the *Jupiter* atomic warhead under U.S. control.

All other forces committed to NATO are under national command (as are the *Thor* ICBM's in Britain) and are simply committed to SHAPE in event of war.

SHAPE has long had plans for such a force but only recently has pressed strongly for action. General Norstad, it is understood, has asked for an organization to be armed with about 300 missiles, which would be increased gradually up to 1000.

The entire matter now rests with the NATO Council of Ministers, which must approve the plan for the NATO missile force before it can be implemented by SHAPE. Because of political implications, the SHAPE military is very reluctant to discuss concrete plans.

• **U.S. offer**—There is little doubt that any such force would be armed with U.S. missiles—if for no other reason than that they will be available. Following the last Defense Ministers' meeting in April, U.S. Defense Secretary Thomas Gates said:

"I am a little bit bound by a commitment that I made along with other Defense Ministers not to discuss this. However, parts of this have come out. We made a preliminary offer to the NATO meeting for consideration by the NATO Council to sell them certain land-based mobile missiles and this had certain restrictions and caveats in connection with it, and the missile under discussion is the *Polaris* missile, but I don't think that I would like to breach my commitment to the NATO Council to say where they would go from there.

"It is a complicated business and it will take some time and thought on the part of the nations involved to see whether they want to proceed with it or not."

When word of Gates' offer of the *Polaris* became known at the Pentagon the Army immediately moved forward with a counter offer of the *Pershing*. Originally developed as a 200-mile surface-to-surface missile, the *Pershing* has now been projected to much greater distances—staying within its five-ton propellant weight—and

• The NATO Council is considering purchase of bundreds of the current 1200-mile-range *Polarises* for deployment in land-based fixed and mobile launchers in Western Europe. If tbe European NATO nations buy *Polaris*, they are expected to order missiles coming off the current production line.

• **Watchful waiting**—The historic first launching of a *Polaris* from the George Washington took place at 1:39 p.m. EDT on July 20. The 380-ft. submarine was cruising beneatb tbe surface in about 250 feet of water, some 30 miles due east of Cape Canaveral.

The Observation Island Test Ship lay at anchor about 2000 yards away. A destroyer circled tbe operating area in search of Soviet submarines and "spy ship" trawlers.

Rear Adm. William F. Raborn, director of the *Polaris* program, was aboard the George Washington. So were representatives of the leading members of tbe *Polaris* industry team: Lockheed, General Electric, Aerojet-General, Westinghouse and Sperry. Members of the George Washington's Blue Crew launched both missiles.

Unlike two days earlier, wben range instrumentation problems forced a launching to be postponed, the countdown for the first *Polaris* was stopped briefly only two times—once because a merchant ship had sailed into the impact area.

Nothing could be seen of tbe George Washington except the tip of a tall telemetry mast that poked through the deep blue Atlantic. The mast, which towered high above the top of the submarine's sail is needed for range communications and is not part of the operational system.

Seconds before the countdown reached zero, a puff of green smoke appeared near tbe mast's tip as a signal to cameramen on the Observation Island. Then the champagne bottle-shaped missile ripped from the sea, pulling a spout of water behind it. The first stage ignited in the air and the missile shot into the clear Florida sky.

The second stage separated from the first about 54 seconds after the launching and the missile continued downrange, leaving a long tbin trail of white smoke behind it.

The George Washington successfully launched the second *Polaris* at 4:32 p.m. EDT. Again there were only a few minor holds. Most of the time was needed for the normal adjustment of the test range between shots.

• **Reward for four years**—Tbe "proof of the pudding" launchings culminated a development effort that began in December, 1955, when the Special Projects Office was established with Raborn as its head. SP's assignment was the development of a sea-going fleet ballistic missile.

The Navy first attempted to adapt the liquid-propelled *Jupiter* for ship-board use. A year later it switched to development of the solid-propelled *Polaris*.

The original program called for producing a 1500-mile-range *Polaris* by 1963. However, three years were sbaved from the program, primarily by reducing the range of the initially operational missile to 1200 miles.

Before this month, all components of the missile had been proven. A *Polaris* had been successfully launched from tbe Observation Island. A cut-grain test vehicle had been launcbed from an underwater tube off San Clemente Island, Calif. But *Polaris* had still to be "married" to a submarine.

The wedding took place at 1:39 a.m. EDT July 20.

rce for NATO

the Army claims that witbin two years it will have a 1200-mile capability. Certainly it should develop into a 600 to 700-mile capability.

Botb *Polaris*, with its 1200-2500-mile potential, and *Pershing* are solid-fuel missiles. Both are mobile, in the sense that tbey could be fired from rail cars, barges or even trucks.

• **Broad advantages**—The prospect of a NATO missile force has fascinated military planners for several years. It could solve several of the major problems which have beset SHAPE since its inception some eleven years ago, including:

• Control of the nuclear warhead.

• Reassignment of national forces.

• Centralized and unified training with a common weapon.

• Logistics and supply.

There are literally a dozen different forms which such a NATO missile force could take. One might be a completely integrated force complete with officers and enlisted personnel. Another might be local troops with NATO officers. Still another might be completely national units with NATO officers for liaison with SHAPE and to control nuclear weapons.

• **Amendment called for**—Under any arrangement, it would be necessary to amend tbe Atomic Energy Act to permit the United States to hand over control of nuclear warheads to SHAPE or to delegate SHAPE as the agent for the U.S. It is generally believed Congress would go along with some such proposal.

In a speech made in December, 1959, General Norstad said:

"It should not be assumed that even the creation of a multinational atomic authority—making an alliance, NATO for instance, the fourth atomic power—would necessarily influence the desire of some nations to pursue their own independent quest for an atomic weapons capability—although sucb action might very well remove a good part of tbe motivation of others to do so.

"Our present strategy influenced as it must be by the hopes and the needs of 15 nations, is inevitably one of compromise. This has certainly given us a useful start. But for the Alliance to have continuing life and meaning, it needs an increasing authority.

"Action to pass to tbe Alliance greater control over atomic weapons and subjecting tbeir use more directly to the collective will, if politically feasible, could be a great new step."

The problem of national forces which had been earmarked for NATO being moved out of SHAPE's domain has be-deviled every SHAPE commander. France, with her North Africa preoccupation, has been a particular offender. Tbe establishment of a NATO missile force should cure this ailment.

Witb one—or even two—missiles, a central training base could be established in Europe to train crews of any country participating, whether they were to be used as national units or mixed forces.

The supply and logistic difficulties, normally tremendous in maintaining such a force equipped with multiple and varied weapons, would be greatly reduced by using a common weapon and common support equipment.

Twelve European NATO countries could be involved in basing such a NATO missile force. Of these, two—Britain and Italy—either have or soon will have missiles. Turkey bas requested them and will probably receive the *Jupiter*. France migbt agree or might demand special autonomous consideration. Neither Norway, with its common border with Russia, nor Denmark is likely to base atomic missiles on its soil for internal political reasons. Portugal would be uncertain. Most of the other NATO nations are believed likely to accept them.

Navy to Use Corvus Money For New Air-to-ground System

Money recovered from the cancelled *Corvus* program will be spent on a newer air-to-ground missile system, the design of which is already under study, a Navy spokesman said after the $80-million cancellation was announced.

The Navy is believed seeking an air-launched missile with a potential range up to 500 miles, thus increasing its capabilities in the strategic area. *Corvus* range was only 100 miles and apparently the Navy saw no feasible way to extend this greatly.

The Navy knocked down reports that the *Corvus* money would be spent on either the *Polaris* or the super carrier programs, both of which carry national priorities and for both of which the Navy would like more funds. Nor, said the Navy, would the money go for *Eagle,* an air-to-air missile under development which could conceivably be adapted for air-to-ground deployment.

Prime contractor for *Corvus* was Temco Electronics and Missile Co. at Dallas. About $80 million had been spent on the missile, which was nearing production. The overall program envisaged spending $450 million. The Navy declined to say how much of which had been committed and how much was recoverable.

In rationalizing the $80 million spent, the Navy said that much had been learned from the program, particularly in the guidance field. Cancellation came because newer designs carried greater potential.

The Air Force *Hound Dog,* a currently operational air-breather with a 500-mile range, is too heavy for practical Navy use—as will be the USAF's ballistic, 1000-mile range *Sky Bolt. Corvus,* designed to be fired from carrier-based aircraft, carried the following specifications: range, 100 miles; speed, supersonic; payload, H.E. or nuclear.

Temco Spokesmen 'Flabbergasted'

DALLAS—"We were flabbergasted," Temco Electronics and Missile Co. officials told M/R when asked for their reaction to the Navy's sudden cancellation of the *Corvus* air-to-surface missile.

First word of the contract cancellation reached Temco, a subsidiary of Ling-Temco Electronics, Inc., in a report in the Dallas *Times-Herald.* One of its reporters had been informed of the Navy's action through a release from the Washington office of Rep. Bruce Alger (R-Tex.)

A highly successful flight of the *Corvus* missile had been made only a week ago at Pt. Mugu, Calif. A company representative was in the Pentagon at the time of the contract cancellation trying to clear a news release describing the near-perfect mission.

Work on the *Corvus* project accounted for nearly 20% of the company's backlog. "As far as the public is concerned," said an official, "this comes at a particularly bad time since we have just completed the Temco merger with Ling-Altec Corp."

All subcontracts were immediately cancelled by Temco. Principal subcontractors include: Reaction Motors division of Thiokol Chemical Corp., propulsion; W. L. Maxson and Texas Instruments, guidance; Emerson Research Laboratories, target detection; Horkey-Moore Associates, launcher; Talco, Inc., recovery system; and Bulova Watch Co., safety and arming.

Layoffs of 200 hourly-paid workers started Tuesday afternoon and up to 500 others will be dropped within the next two weeks.

Since Temco had a recruiting campaign on for professional and skilled technicians, most of these employes on the *Corvus* program will be transferred to other jobs.

Temco has no other missile systems contracts but is doing subcontract work on *Minuteman* (engine components), *Sergeant* (motor cases), *Hawk,* GAR-9 *Falcon,* and *Davy Crockett.* The company said it also has proposals out for a boost-glide type space vehicle.

Court Ends Camras' Patent On Magnetic Tape

The broad magnetic recording tape patent held by Marvin Camras and assigned to Armour Research Foundation is "clearly invalid," says the U.S. Court of Appeals, Seventh District—Chicago.

This ends the 5-year litigation freeing the entire industry of the restraint under which it has operated since Camras was issued the patent in November, 1954.

Plaintiffs, Armour and Minnesota Mining and Manufacturing Co. (who controlled the patent), charged C. K. Williams & Co. and Technical Tape Corp. with infringement in 1955. The U.S. District Court, East St. Louis, Ill., upheld the defense in February, 1959. The appeal followed.

Williams is a basic producer of iron oxide pigments and magnetic iron oxides. TTC used the Williams iron oxides to manufacture and sell magnetic recording tape.

Camras' patent No. 2,694,656 was unusually broad, covering his invention of certain types of magnetic iron oxides, methods of producing them, and their use for magnetic recording and reproduction.

Other tape manufacturers favorably affected by the decision include Audio Devices, Inc.; Ferrodynamics Corp.; ORR Industries Div., Ampex Corp.; Reeves Soundcraft Corp.; and American Recording Tape Co.

Lockheed Strike Ends As Workers Accept Contract

BURBANK, CALIF.—Lockheed Aircraft Co. machinists returned to work last Monday after ending their month-old walkout by a 3-2 vote.

A company official said the new contract accepted by workers in the Missiles and Space Division is essentially the same as that tendered by Lockheed and rejected by the International Association of Machinists last month.

Affecting 10,500 hourly workers in six plants, the new pact includes these principal provisions:

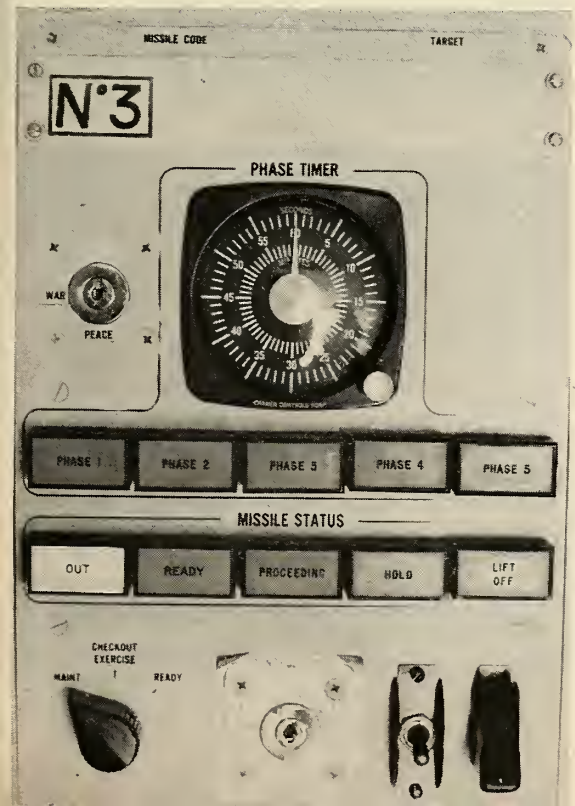
- A wage increase, retroactive to June 13, of 4 cents/hr. plus a 3-cent/hr. increase next year.
- Preservation of an additional 2 cents/hr. cost-of-living raise from the previous contract, and freezing at 6 cents/hr. of previously granted c-of-1 pay. New provisions are made for any increase in cost of living after July, 1961.
- Layoff benefits of $50 for each year of employment up to $500 maximum.

The union's demand for an agency shop (whereby all workers eligible for union membership would pay dues even if they did not join the union) was the main strike issue, according to the company. It was not granted.

An IAM spokesman said the walkout resulted from Lockheed's attempt to reclassify jobs. He said this would have cost workers an average of $20/wk.

The division is prime contractor for the Navy's *Polaris* IRBM and for the *Discoverer, Samos* and *Midas* satellite systems. Despite the strike, all critical defense contract dates have been met, Lockheed said.

This is How Thor 'Double Veto' Works



FELTWELL, ENGLAND—In the event of war, one of the keys hanging around the neck of USAF Major Curtis Hintze, left above, could loose the first atomic missile to strike at the Soviet heartland.

Under the famous double-key, double-veto system employed at the *Thor* IRBM base here, one British and one American officer, under instructions from their governments, must turn the keys in the locks which will permit the firing of the 1500-mile missile. As the system works, the British officer turns the key which starts the countdown and carries it (see below) through Phases 1, 2, 3, 4 and most of 5. With about two seconds of Phase 5 remaining, Major Hintze or his counterpart must take one of the keys from the chain around his neck, insert it in the lock pictured below and turn as marked—from peace to war.

His key activates the nuclear warhead and clears the way for the final seconds of countdown before the weapon lifts from the pad. When on duty, Major Hintze and his counterpart officers sit beside a direct-line phone to SAC headquarters in Omaha, Neb.

Above, the dogs which help guard this *Thor* base. Turn the page for further pictures.

(NATO official photos)

Last step is turning the second key for

SHOULD THE WARNING of war come, Flight Lieutenant Couttes, shown below, left, talking with Major Hintze, would turn his key and the action pictured on these pages would take place.

Phase 1: About 2 minutes; the hangars covering the *Thor* would slide back (right).

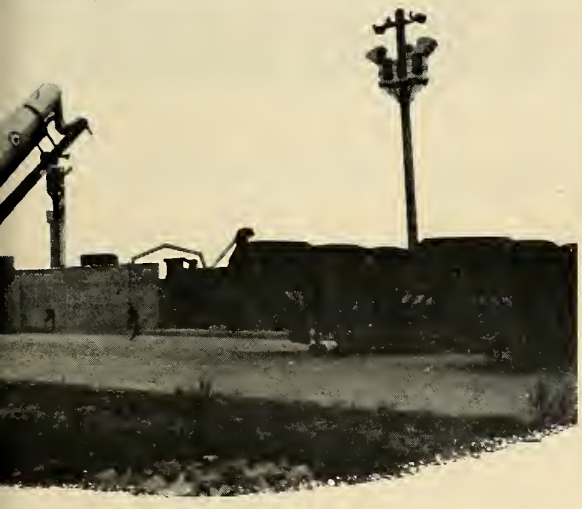
Phase 2: about 2½ minutes; the missile would be raised to vertical position (center).

Phase 3: about 8 minutes; the missile is now being fueled with kerosene and liquid oxygen. Through Phase 3 the countdown can be held for hours if desired.

Phase 4: about 2 minutes; waiting for stabilization and topping of the fueling operation.

Phase 5: about 2 minutes; final visual checking for guidance alignment and automatic sequencing. And—if the second key is turned—activation of the warhead and blastoff.

y in case of war . . .



THE THOR firing shown at right occurred at the USAF testing and training base, Vandenberg AFB, Calif. No *Thors* have been fired from Feltwell—nor will they ever be except in event of war. It is one of four such IRBM bases strung along the northern coast of England. The others are Helmswell, Driffield and North Luffenham.

Each base is of squadron strength—15 missiles. Each base consists of a main site and four satellite sites, each with three missiles. Maintenance and housekeeping facilities are at the main site. Each base has about 1000 RAF personnel and 100 USAF personnel. The Americans are responsible for nuclear warhead storage and maintenance, for technical supply and training. Main site and satellites are separated by about 20 miles.

At each base five crews of 16 men and several trained dogs operate on an around-the-clock basis. The crews consist of one officer and six non-coms for launching; one U.S. officer with the second key; five police guards, one fireman-driver, one cook and one motor transport man.

POLARIS

SPECIAL REPORT

Integration Expedites Production

Successful program also boasts easy interchangeability of units, rigid tolerances and highly detailed manufacturing procedures

by Frank G. McGuire

SUNNYVALE, CALIF.—Much of the success of *Polaris* is a result of applying hydrodynamic design to an aerodynamic mission.

The missile spends only a few seconds passing through a few feet of water, but this short journey has had more influence on its configuration than the ensuing 1200 miles of travel through the atmosphere and space.

Lockheed Missile and Space Division points out that the strength, clean lines, compactness and safety features required by the missile's operational launching method and environment have helped, rather than handicapped, the FBM's mission.

LMSD is missile system manager and prime contractor for *Polaris*, operating under the Navy's Special Projects Office headed by Rear Admiral William F. Raborn, Jr.

Integration of the dual roles—a hydrodynamic body and an aerodynamic body—is characteristic of the integration required throughout the vehicle and the supporting systems, including the submarine.

Interchangeability for ease of servicing aboard submarines is another *Polaris* keynote. The guidance system, hydraulic jetavator actuator units, and other subsystems are plug-in units which may be replaced or serviced by submarine crew members while the missile remains in its launch tube.

The one major subsystem not serviced aboard the submarine is the reentry body and its contents. The solid-rocket motors, produced by Aerojet-General Corp., presumably require no servicing at all.

For those maintenance problems or routine cycles not within the submarine's capability, the Navy is outfitting special submarine tenders for the *Polaris*-launching fleet of nuclear submarines. This of course does not prevent them from servicing any other type of submarine in the fleet, as well.

These tenders, the first of which is the USS Proteus, will have an extensive supply of spare parts, technicians, checkout and test equipment, and other highly specialized items. Nevertheless, dependence on the tender has been reduced by the placement of plug-in spares aboard the submarine.

• **Production underway**—Production of "war inventory" *Polaris* missiles has begun at LMSD's facility here, but not at maximum capacity. Missiles are shipped to the naval base at Charleston, S.C., in dismantled condition. The two propulsion units are shipped separately by Aerojet from Sacramento, while LMSD ships interstage structures, equipment bays, re-entry bodies and other accessory items and systems. These packages are assembled at Charleston before loading aboard submarines.

A similar system is used for flight test vehicles, except that the assembly is done at Cape Canaveral. Despite this method of piecemeal shipping to an assembly point across the country, LMSD can completely assemble and test missiles at its Sunnyvale facility in order to insure reliability. Test equipment used in this program is itself tested periodically.

Manufacturing procedures in the program are far more detailed than standard manufacturing routines. Fabrication steps are spelled out in minute detail, tolerances are tighter than those used in modern jet aircraft, and inspection is extremely rigid.

Second, and sometimes third, sources are established for most com-

ponents. When requests for specialized items are sent out to industry, LMSD evaluates replies, eliminates unsuitable designs, picks the best as early as possible to avoid supporting parallel designs too long—and then establishes, if possible, several sources for this preferred design.

Some components are made in-house; for example, the molding of electrical conduits, which has advanced to the point where it is now an almost completely automated operation. The company tries to avoid procuring proprietary items because of the complications involved in establishing several sources.

• **Cut-rate skirts**—A prime example of items made in-house is the conical skirt which connects the second stage and the re-entry body. Constituting "one of the most frustrating and time-consuming steps in the manufacturing process," this skirt was procured—on a trial basis at first—from the area's biggest and most experienced fabricators. Not one acceptable skirt was ever delivered.

A company engineer, Robert O'Neill, came up with a device to hold the work piece at its apex while a large roller proceeded to bend the piece into a perfect skirt on one pass. This operation, requiring only a few minutes, replaced the previous one in which two men worked for eight hours to get similar results.

The newly-devised method saved $50,000 annually, increased production rate, and reduced the number of rejected parts. It turns out a mechanically perfect cone in every operation, Lockheed says, and does away with the necessity of replacing each rejected piece of raw material at $500 per cone.

A precision-tolerance item, this truncated cone surrounds the equipment bay forward of the second-stage rocket motor. Pressurization is intended to simplify design of the electronic equipment. Operating in a consistent environment such as this, the electronics systems operate easily when passing through water, atmosphere, space, then re-entry.

Sealing of the pressurized bay is essential to avoid the escape of air underwater. Because the *Polaris* is not guided in its underwater phase, the configuration must be hydrodynamically clean. An air leak might induce cavitation that would affect its stable ascent to the surface.

In designing the destruct system for *Polaris,* which is included on every vehicle except war birds to be fired in anger, LMSD had a knotty three-way problem. First, neither the destruct system nor the rocket ignition system can be armed while the missile is in the launch tube. Secondly, the destruct system must be armed before the igniters can operate. Thirdly, in case the igniters fail to function properly, the destruct system must be disarmed immediately, so that an explosion does not occur when the bird falls again.

The destruct system consists of a shaped charge located at the head end of the rocket motors for each stage. In event of actuation, the charge ruptures the head closure to such an extent that the propellant burns, but has no propulsive effect, since gases escape from each end simultaneously.

• **Fabrication problem licked**—Early in the program, LMSD's Manufacturing Development Engineers were asked to come up with an acceptable method of welding magnesium-thorium, an alloy with good physical properties at high temperatures, but with poor welding qualities. Technique was apparently the key to the problem, rather than any inherent quality in the material itself.

Distortion and cracks developed under normal circumstances, leading to a great deal of unacceptable work after processing. LMSD has since adapted machinery, laid out X-ray methods, working speeds, and other details for successfully welding the alloy. Previously, no standards existed for the inspection of such Class A welds.

Present operations with magnesium-thorium utilize automatic machinery, adequate ventilation to carry away gases produced, and TIG (tungsten inert gas) and MIG (metal inert gas) welding methods.

The gas used is a mixture of 75% helium and 25% argon. A backup bar of either copper or steel is used for its chilling effect on the metal to avoid overheating getting beyond the weld area. Steel is preferred because it is similar to copper in effectiveness, but costs less.

A channel in the backup bar permits gas, as well as the 75 helium/25 argon mixture, to flow through it, then pass into the immediate weld area through small holes drilled the length of the backup bar. This gas has a cooling effect on the weld.

The detailed procedure to prevent overheating of parent metal beyond the immediate weld area is designed to insure consistent quality at high temperatures throughout the parent metal, heat-affected zone, and the weld. LMSD manufacturing development engineers found that magnesium-thorium alloy is best welded in the hardened condition, to avoid the necessity of heat treating later. Although the resulting weld is not as efficient as possible at room temperature, the most effective strength distribution occurs at anticipated operating temperatures.

CONICAL SKIRT for *Polaris* is guided through the giant roll. Lockheed says the technique saves about $50,000 a year.

LOCKHEED Missiles and Space Division electronic technicians ready microminiaturized telemetry units for test vehicles.

Special Report

Longer Range Promised Through Improved Motors

Aerojet program has already hiked I_{sp} by 15% and more gains are expected; plans call for hotter propellants, fiberglass casings

SACRAMENTO, CALIF. — Substantial changes in the propulsion system for the *Polaris* fleet ballistic missile will boost range of the weapon toward the 2500-mile figure.

Aerojet-General Corp., producer of the propulsion system for *Polaris*, revealed a number of improvements in the offing, including:

- New, hotter propellants to raise specific impulse.
- Use of fiberglass for second-stage motor casing.
- Switch from jetavator thrust vector control to movable nozzles.
- Adoption of lighter inert parts through all parts of the system.

Aerojet disclosed that the continuous program for product improvement has resulted in a 15% increase in specific impulse over the past three years. This increase is expected to continue.

W. R. Kirchner, Director, *Polaris* Program at Aerojet, cited other carefully planned changes in *Polaris* production, intended to take advantage of everything which will result in higher performance and reliability.

Present roll and weld motor casings of 6434 steel (an offshoot of 4340) may be replaced by hydrospun casings. Cases formed by hydrospinning have already been flown on *Polaris* test vehicles. Additionally, explosive forming will be exploited for use on heads of cases.

"When our development program permits it, we will use fiberglass cases on second-stage motor casings to lighten their weight," Kirchner said, pointing out that mass fraction is more vital on the second stage than on first stages.

In the second stage now being used with the FBM system, combination plastic and metal nozzles are being employed, with a refractory throat insert. This method has reduced the weight of the nozzles by 30%. However, a switch to the higher-performance, hotter propellants previously mentioned may force a return to all-metal nozzles, due to the inability of presently-known plastics to withstand the temperatures.

The temperature of the new propellants will be well over 6000°F, or hotter than the propellants now used in *Minuteman*. Most credit for the boost in performance in the new propellants goes to the additives used, mostly aluminum, but also to some other materials intended to increase compatibility.

- **Synthesis**—Aerojet also is pressing for a method to synthesize fuel systems. Materials likely to be used in event all the propellant improvement projects bear fruit, include tungsten (melting point 6300°F) or graphite (sublimation point of 6500°F).

Combustion pressures in the first stage of present *Polaris* configurations is about 1000 psi, while the second stage is 500 psi.

The use of jetavators may also be ruled out with the newer propellants now in sight. In addition to presenting an obstacle to the exhaust stream, the materials may be affected by the heat to such an extent that efficiency and reliability become marginal.

- **Nozzle thoughts**—A major change, proven possible by *Minuteman*, would be in the thrust vector control system. Movable nozzles, swivelling on one axis during powered flight, will be incorporated into the missile design.

Nozzles now under consideration at the Sacramento facility of Aerojet are being tested on a liquid propellant rocket engine, capable of being shut down at various burning periods, to study effects on new designs.

One of Aerojet's proudest accomplishments is the success of the continuous mixing process used in the propellant processing phase. The plant, designed and constructed by the com-

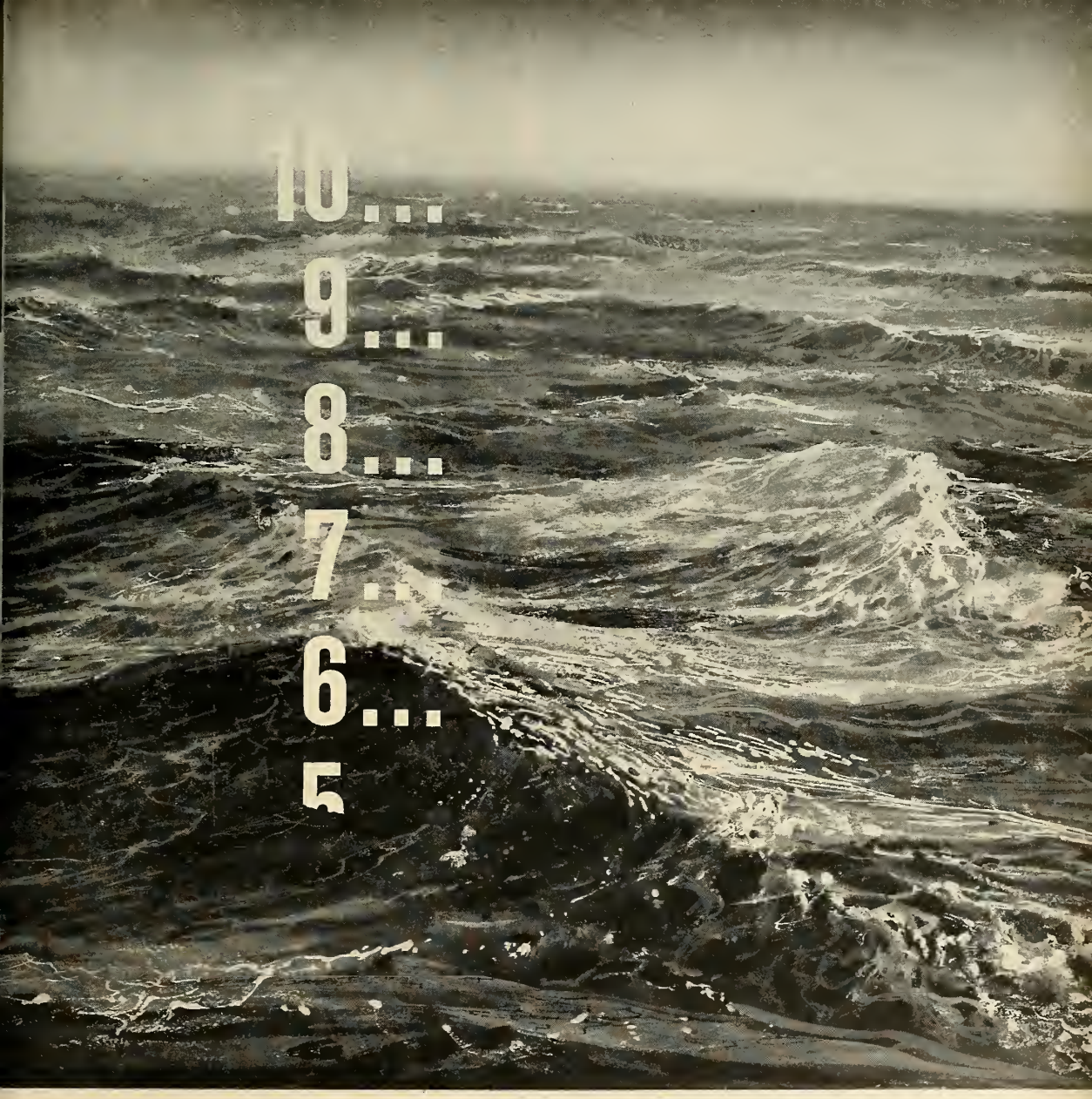
Kirchner New Director of Aerojet Polaris Setup

Sacramento, Calif.—A reorganization designed to streamline Polaris production operations at Aerojet-General Corp. has been set up. The new arrangement will place all fleet ballistic missile operations under one director.

Affected activities include contracts, procurement, quality control, fabrication and testing, which were previously handled by corporate groups. The new organization brings all FBM work into one group under W. R. Kirchner, formerly Associate Manager for Solid Rocket Research and Development.

Divisions within the new Polaris group are Manufacturing and Material, Engineering, Testing, Advanced Design, Engineering Services, Reliability and Quality Control, and Contract and Program Administration. Organization is therefore a self-contained unit.

Factors bringing about the reorganization, in addition to accelerated production schedules, include probability that the FBM will eventually become a land based IRBM as well as a weapon for use from surface ships. These applications would increase both quantity and time span of Polaris production.



Day by day the Polaris missile gets nearer to its first submarine test firing... nearer the day when, operational, it will become one of our nation's most formidable deterrents to aggression. For with submarines serving as mobile missile launching pads, any target on earth is within deadly striking range if retaliation becomes necessary.

The Polaris-launching submarines are splendidly fitted out not only to aim and fire and accurately guide the missile, but also to defend themselves. Advanced Sperry submarine equipment contributes to both these functions. For precise navigation there is SINS (Ship's Inertial Navigation System), automatic steering and stabilization, depth detectors, gyrocompasses, diving and maneuvering controls, instrumentation, and computers... and the NAVDAC computer which correlates all navigation data. For anti-submarine warfare the subs have Sperry torpedo fire control systems, sonar sub detection equipment, the attack periscope itself. At two special laboratories both aspects of the Polaris program are being refined and integrated: one of which simulates submarine navigation, the other the environments of the sea.

Sperry's role in the Polaris program is typical of the Company today, achieving through specialized divisions an integrated capability that is contributing to every major arena of our environment. General offices: Great Neck, N. Y.

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STEPS IN motor production. Left to right: Inside welding of girth seam, *Polaris* first stage; casting bell installed over motor; grain-forming core removed from motor; positioning first stage for welding; second stage motor loaded for shipping.

pany, is billed as the first solid fuel continuous mix plant to go into production in this country. The plant has established records for propellant production already, Aerojet says.

The ratio of operating personnel required by the batch vs. continuous mix processes is about 6:1, the company adds, with great savings in money and time. Much closer quality control and tolerances are also realized.

The final product of a continuous mix line is reported to be safer than by other methods, despite a sensitive period during the process. Maximum amount of propellant involved at any one time in the continuous mix facility is about 20 lbs., said Kirchner, whereas batch mixing can bring large amounts of propellant together.

"If we should ever have an accident with this continuous mix plant," Kirchner said, "all we would lose is 20 pounds of propellant." He emphasized, however, that the new processing method is considerably safer than any method of batch mixing.

Polaris missiles using continuously mixed propellant have already been fired successfully at Cape Canaveral, indicating a favorable result of the change of processing methods.

Ignition of the solid-propellant motors is accomplished by a unique electromechanical device which has the elementary functions of a computer, but is not considered as such in the usual sense of the word. Built by Donner Scientific Company, the unit bases ignition on a sequence of events occurring within permissive time intervals. The missile must acquire a certain velocity within a specified time as preprogramed, or the system aborts. The parameters of ignition do not include broach sensing.

Seals developed for the nozzles while underwater consist of two pieces of material. One, a graphite seal, is located at the throat of the motor. Several inches downstream from this, in the conical exhaust nozzle, is a styrofoam plug weighing about 244 grams and containing a one-way valve.

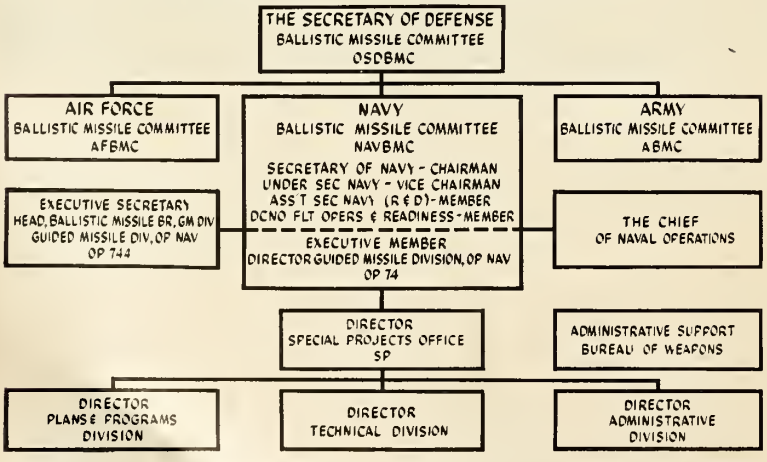
This valve permits excess pressurizing gas from the motor to exhaust, but prevents sea water from entering. A narrow tube of plastic passes through the plug via this valve. The plug is cemented to the straight nozzle walls, and is blasted free upon ignition of the motor.

Theoretically, says Aerojet, passage of the missile through the water is at a rapid enough rate to insure that sea water would not enter the nozzle, but the seals were developed as added insurance.

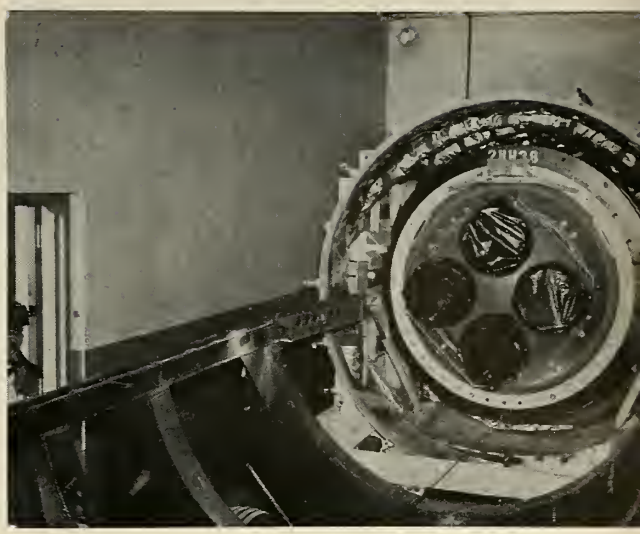
Major Aerojet contributions to the *Polaris* program, as seen by the company, include:

- Developed and static fired in 1956 the largest solid propellant rocket motor in the U.S., and probably the world, to prove capability of solid fuels. Present version of this motor is used on the first stage of *Scout* vehicle, producing 100,000 pounds thrust, for a total energy release of over four million pound/seconds.
- Developed means of terminating

Organization of the FBM Program



POLARIS DEVELOPMENT is directed by the Special Projects Office of the Bureau of Weapons, headed by Rear Adm. William F. Raborn, Jr.



thrust within milliseconds, in order to insure accuracy.

- Developed jetavators needed to provide thrust vector control.
- Designed and constructed first continuous mix plant for solid fuels to go into production.
- Developed method of using nuclear energy to inspect *Polaris* rocket engines and to insure quality control during manufacture.
- Developed partial burning charges propellant for use in test missiles to check out launch systems.

Post-Storage Test Success

An operational-type first-stage *Polaris* motor has been successfully static-fired after being stored for more than 1½ years, Aerojet-General reports.

Storage conditions duplicated temperature of storage in a submarine launch tube. Aerojet said the test proved that *Polaris* motors can be stored aboard subs for very long periods and then perform as required on command.

Dr. Kirchner, Director of Aerojet's *Polaris* program, declared that development of the missile represented a huge advance over a four-year period. When the program began, he said, the largest operational solid rocket was the Navy *Terrier*. He said the *Polaris* first stage is about 10 times as powerful as *Terrier*, and the second stage at least four times.

"The difference between the *Polaris* and the largest solid rocket in production for field use at the time the attempt to develop *Polaris* was begun is phenomenal," Kirchner said. "The aircraft industry would have accomplished the same feat if they had jumped from production of the P-33 to the jet-powered F-100 within the same time span of four years."

Polaris Box Score

First launch in the Polaris test program was in the summer of 1957, when an FTV (flight test vehicle) failed. The remaining 21 vehicles in the FTV series were successful.

VEHICLE	DATE	RESULTS	REMARKS
AX-1	9/24/58	Partial success	Programer failed to pitch over.
AX-2	10/15	Failure	First stage exploded destruct.
AX-3	12/30	Partial	Second stage destructed.
AX-4	1/19/59	Partial	Fell short due to control problem.
AX-5	2/27	Partial	Control problem in first stage.
AX-6	4/20	Success	
AX-7	5/18	Partial	Control problem caused outside loop.
AX-8	5/8	Success	700 miles.
AX-9	6/29	Success	730 miles.
AX-10	6/12	Partial	Second stage destructed.
AX-11	7/15	Partial	Performed loop. Flew 73 seconds.
AX-13	8/14	Success	First from ship motion simulator.
AX-14	9/28	Partial	Destructed.
AX-15	8/6	Partial	Second stage failure.
AX-18	8/25	Partial	Second stage failure.
AX-20	10/2	Partial	First stage destruct.
AX-22	8/27	Success	First from EAG ship.
A1X-1	9/21/59	Success	900 miles.
A1X-2	10/12	Partial	Second stage failure.
A1X-3	11/20	Success	
A1X-4	12/7	Success	
A1X-6	12/15	Partial	Second stage failure.
A1X-5	12/21	Partial	First stage failure. SMS launch.
A1X-7	1/7/60	Success	First fully-guided shot.
A1X-8	1/13	Success	
A1X-9	1/20	Success	
A1X-10	1/27	Success	
A1X-11	2/10	Success	
A1X-12	2/4	Success	
A1X-13	2/26	Partial	Second stage destruct.
A1X-14	3/9	Success	
A1X-15	3/18	Success	Ship motion simulator.
A1X-16	3/25	Partial	Second stage failure. SMS launch.
A1X-17	5/23	Partial	EAG launch.
A1X-18	3/29	Partial	Second stage terminated. EAG launch.
A1X-19	4/18	Partial	EAG launch.
A1X-22	4/25	Success	
A1X-23	4/29	Success	First "double-header" on same day.
A1X-25	4/29	Success	Ditto.
A1X-27	6/7	Partial	
A1X-30	5/18	Success	Ship motion simulator launch.
A1X-32	6/22	Success	EAG launch.
A1X-34	6/22	Success	SMS launch.

As of 29 June 1960, list is complete to A1X-34.

FBM Accuracy Starts with SINS

Ship's Inertial Navigation System is proud keystone in the Polaris program, uses triple redundancy to guarantee pinpoint accuracy, is immune to countermeasures

by Charles D. LaFond

The ultimate in guidance and fire control systems for the *Polaris* fleet ballistic missile would go for nought without the checkreins of ultra-precise and reliable navigation of its submarine launching platform.

Development of such a system and the support facilities to test and maintain it represents a glowing chapter in the book of *Polaris* technological achievements.

Offering a precision of the same order of magnitude as missile-borne inertial guidance, SINS (Ship's Inertial Navigation System) provides pinpoint location and "inner-space" guidance accuracy over many months, rather than minutes.

• **Early history**—A Navy feasibility contract for a similar inertial system was awarded to Sperry Gyroscope in 1951. Sperry's scientists recommended a heavier but advanced version of its more conventional Mk-19 gyrocompass, in development since 1948.

In 1952, Dr. Charles S. Draper, of Massachusetts Institute of Technology, was given a design contract for a prototype inertial system. When it had been built and tested, this unsophisticated system was big and its performance was relatively poor. But it proved the feasibility of such a design.

Bids then were requested for a redesign of the MIT system with tightened requirements. Two contracts were awarded: Autonetics Div. of North American Aviation and the Marine Div. of Sperry.

NAA had a system, the N-6 developed for the old *Navaho* (XSM-64, surface-to-surface ICBM). With beefing up, the system could be made available before the Sperry version.

Although similar, the two systems were never intended to be interchangeable. NAA's version is called the Mk-2 Autonavigator, N-7A. Sperry's is the Mk-3 Gyronavigator. Both systems are referred to as SINS.

MIT has continued to collaborate with both manufacturers on the navigational systems. Sperry integrates all of the equipments used in the navigation system, conducts performance testing, and develops maintenance and repair routines and instructions. In effect, Sperry has been the navigation systems manager.

• **Tri-redundancy for reliability**—SINS' function is to determine true north, true vertical ship position and speed necessary for accurate missile firing.

Immune to countermeasures, SINS can if necessary steer a submarine to any predetermined position at sea without using external reference points.

It employs a 3-gyro stable platform for directional control and accelerometers for distance indication.

To assure accurate and reliable in-

SPERRY MK-3 SINS is ready for the Navy's third and fourth *Polaris* subs. Foreground, one of three inertial platforms; rear, NAVDAC computer and control cabinets.

formation, a system of "checks and balances" is used.

The navigation center consists essentially of four systems: three separate SINS, a Type 11 Stabilized Periscope System (for celestial navigation while submerged), radio navigation systems (other details classified), and two NAVDAC—Navigation Data Assimilation Computers. These are general purpose analog/digital computers, employing sequential programing and a 13,000-word memory drum.

The optical star tracker has its own analog/digital computer called STARDAC, a data stabilization computer which receives ship's motion information directly from SINS. It helps keep the periscope locked onto the "fix" star, computes ship's position and feeds the data to NAVDAC.

Over long periods of time, the gyro stable platforms tend to drift slightly. The three SINS are used for comparison and to permit reset continuity. Data from the radio navigation system and the Type 11 star-tracking periscope also are fed into the computer.

Data from the five inputs are compared continually. When one of the SINS is determined to have drifted beyond tolerance, NAVDAC, on operator's command, resets the wayward instrument.

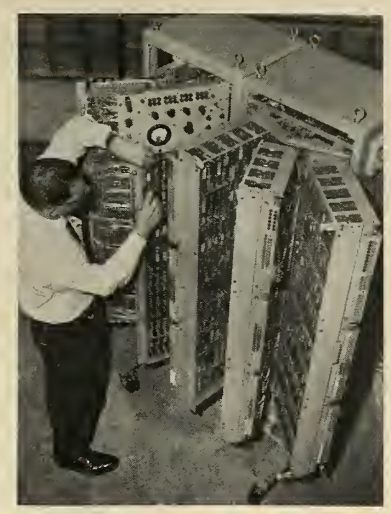
Ships' position (lat. and long.), true heading or course, ground speed, pitch and roll conditions all are computed with remarkable accuracy. In missile launching operations these data are fed to the fire control system.

(The fire control system was designed, developed, and produced by General Electric's Ordnance Dept. Besides the data from SINS, target location from the fire control officer is provided so that the FCS can solve the ballistic problem prior to launch.)

• **Tests ashore and afloat**—The first experimental Sperry SINS was delivered to the Navy's USS Compass Island for surface tests in September, 1956. NAVDAC was delivered to the floating laboratory in January, 1958.

Finally—in October, 1958—Sperry completed its "Ashore *Polaris* Navigation Center." This is a complete replica of the submarine navigation control center used to conduct intensive tests and system evaluation. Equipment integration and optimum performance of the entire complex are assured from the research performed at the Syosset, N.Y. center.

Now installed on the Navy's other floating test lab, USS Observation Island, the Navigation Center has undergone practical use in firings at sea with fully guided *Polaris* missiles.



CELESTIAL navigation data is obtained rapidly with the Type 11 Stabilized Periscope and this STARDAC control computer. Developed by Epsco, Inc., the system determines absolute coordinates between the "fix" star and earth and feeds the data to Sperry's NAVDAC for SINS gyrodrift connection.

• **$5 million repair shop**—By 1961, the *Polaris* submarine tender Proteus (AS-19), commissioned July 8, 1960, should be fully outfitted. Capable of performing almost any repair at sea, the vessel includes a $5-million navigation repair center.

Housed in a 34 x 20 ft. room is everything needed to check out and repair any of the navigation equipment. NAVDAC's will be used for performing test sequences in conjunction with a variety simulation gear.

A dual binnacle is provided to mount both types of SINS. These will be used as "standards" against which operational systems may be compared. This will be accomplished by module replacement.

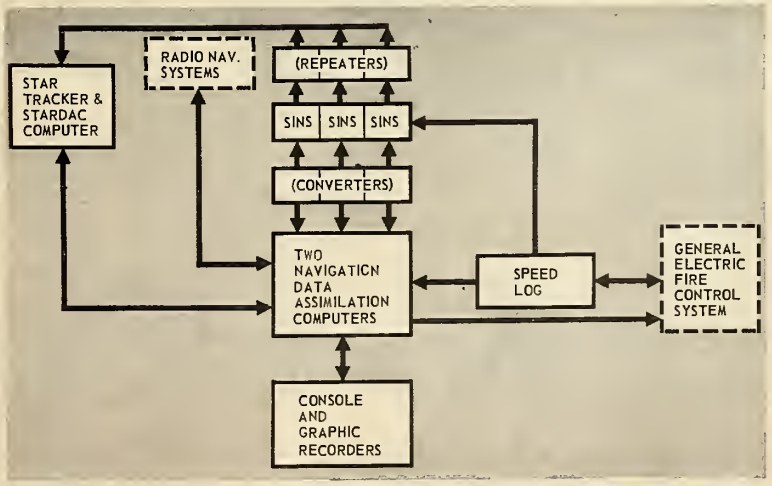
The repair center designed and installed by Sperry carries a considerable amount of equipment for fault location. It includes a SINS patchboard switching rack capable of handling either type, together with three gyroscope and accelerometer storage ovens, multispeed SINS repeaters (translators), a time-frequency standard, individual equipment test racks and module testers.

Very little actual repair of navigation equipment will be performed by the facility. Its 16 enlisted personnel, according to Warrant Officer P. X. Barger, Chief of the center, will work mainly on fault isolation, module replacement, adjustment and alignment of systems. Faulty parts will be tagged and sent to appropriate repair depots ashore.

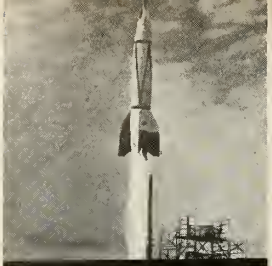
• **SINS improvement continues**—With 12 of its Mk-3 SINS delivered so far to the Navy, Sperry says it will deliver 19 more starting in July. These will have a different computer system.

Sperry also said that the newer systems include two important advances: interchangeable gyroscopes and "an improved and integrated" polar mode of operation permitting improved operation under ice.

The Mk-3 SINS will be installed on the third and fourth *Polaris* subs—the USS Sam Houston and USS John Marshall. These are both of the newer and larger 608-class. (The USS George Washington, first *Polaris* nuclear sub, is 598-class. North American's Mk-2 SINS will be installed in these boats.)



SIMPLIFIED BLOCK DIAGRAM of *Polaris* submarine navigation center using SINS. Control equipment is in Attack Center below the sail of newer nuclear subs.



BUMPER 8, JULY 24, 1950

ATLAS "LONGFELLOW," 1960

FROM THE EXPERIMENTAL BUMPER IN 1950 TO THE ATLAS IN 1960 . .

CAPE CANAVERAL'S FIRST

Just ten years ago yesterday, the first experimental missile was fired from Cape Canaveral. Here, General Electric reports on this key U.S. missile and space research center's first ten years of progress.

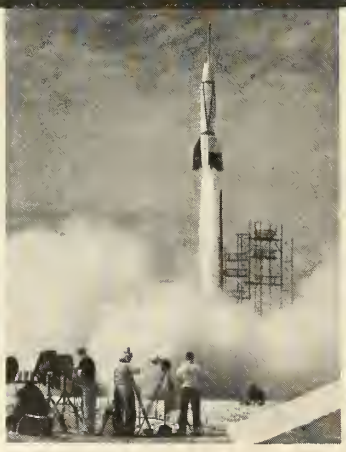
A few men, a quickly constructed wooden "command post" and the firing of a hybrid Army Wac Corporal/V-2 missile called BUMPER 8 . . . this was the beginning ten years ago yesterday of what today is the largest missile test center in the world: Cape Canaveral.

AS BUMPER 8, developed under General Electric systems management, climbed away from the then Long Range Proving Ground Division, the only horizon-breaking landmark was a lighthouse tower near a cluster of homes. Today, this scene has been dramatically changed with miles of hard top roads leading to hundreds of launch sites, test centers, hangars, fuel supply areas and block houses.

Behind this changed scene lies a record of more than 800 successful launchings that have been conducted by the three U.S. military services and other government agencies working with Air Force Missile Test Center personnel who maintain and operate "the Cape," or Station One of the Atlantic Missile Range and the islands "downrange."

AMERICA IS ACHIEVING IMPORTANT MILITARY AND SCIENTIFIC PROGRESS FROM CAPE CANAVERAL MILESTONES LIKE THESE . . .

FIRST CAPE LAUNCH



Wac Corporal/V-2 missile called BUMPER 8 was fired by handful of Army and G.E. personnel on July 24, 1950. It provided vital data as basis for early missile progress.

X-17 THREE STAGE MISSILE

First fired in July, 1956, Air Force X-17 re-entry test vehicle was designed to achieve high re-entry velocity and yielded important information relative to ballistic flight problems.

EXPLORER I SATELLITE

This nation's first satellite was launched on January 31, 1958 from the Cape and is still in orbit. Army Jupiter-C booster placed this historic satellite into orbit around the earth.

YEARS OF MISSILE AND SPACE PROGRESS

These launchings have paid immeasurable dividends. In the area of U.S. missile progress, Cape Canaveral test launchings have led to the present operational status of Thor, Atlas, Jupiter, Snark and Matador, and are now speeding the development of Polaris and Titan.

In the area of space technology, missile test flights from the Cape have proved the reliability of U.S. ICBM re-entry vehicles and the accuracy of U.S. ICBM radio command guidance, provided information on the belt of radiation around the Earth and other valuable data about space environment and flight that will serve scientists in their efforts to conquer space.

In satellite progress, the successful launchings of Pioneer, Explorer, Transit, Tiros and other satellites from the Cape have paved the way for a whole new generation of orbiting bodies that will aid in communications, navigation, weather forecasting and in the protection of the Free World.

This progress has truly been the result of team effort. The military services and government space agencies together with companies like General Electric . . . a member of the Cape team since its Bumper 8 missile beginning . . . have made vitally important contributions. General Electric, its Defense Electronics Division and the Defense Systems, Heavy Military Electronics, Light Military Electronics, Missile and Space Vehicle, and Ordnance Departments that are a part of this Division are proud to be members of this team and contributors to this progress.

A unique 15 x 19-inch four color illustration, suitable for framing, of the historic first missile launching from Cape Canaveral is available upon request from General Electric Company, Section 160-88, Schenectady, N. Y.

DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

ST PAYLOAD RECOVERY

First payload, a re-entry vehicle data capsule, to be recovered from space was launched by USAF Thor missile in 1958. G.E. built both re-entry vehicle and capsule.

FIRST ABLATION ICBM CONE

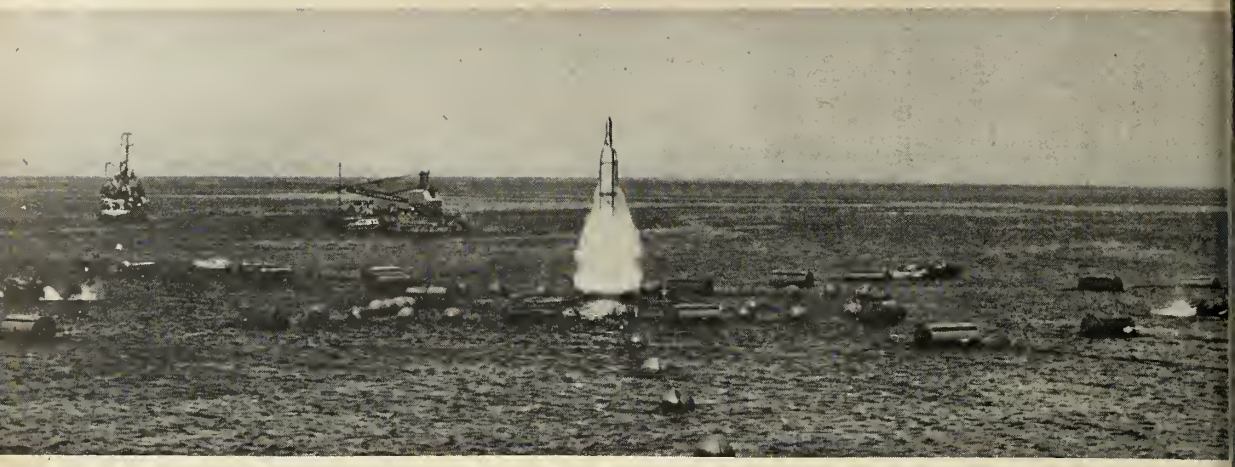
First ablation re-entry vehicle to fly full ICBM range was developed by G.E. and launched on July 9, 1958 . . . proved feasibility of ablation for ICBM re-entry.

FIRST POLARIS SHIP LAUNCH

First Polaris shipboard launch was made from Navy's USS Observation Island on August 27, 1959. G.E. is producing Polaris fire control and inertial guidance systems.

LONGEST MISSILE FLIGH

USAF Atlas with G.E. radio command guidance and re-entry vehicle launched this May flew more than 9000 miles . . . longest Free World missile flight recorded to date.



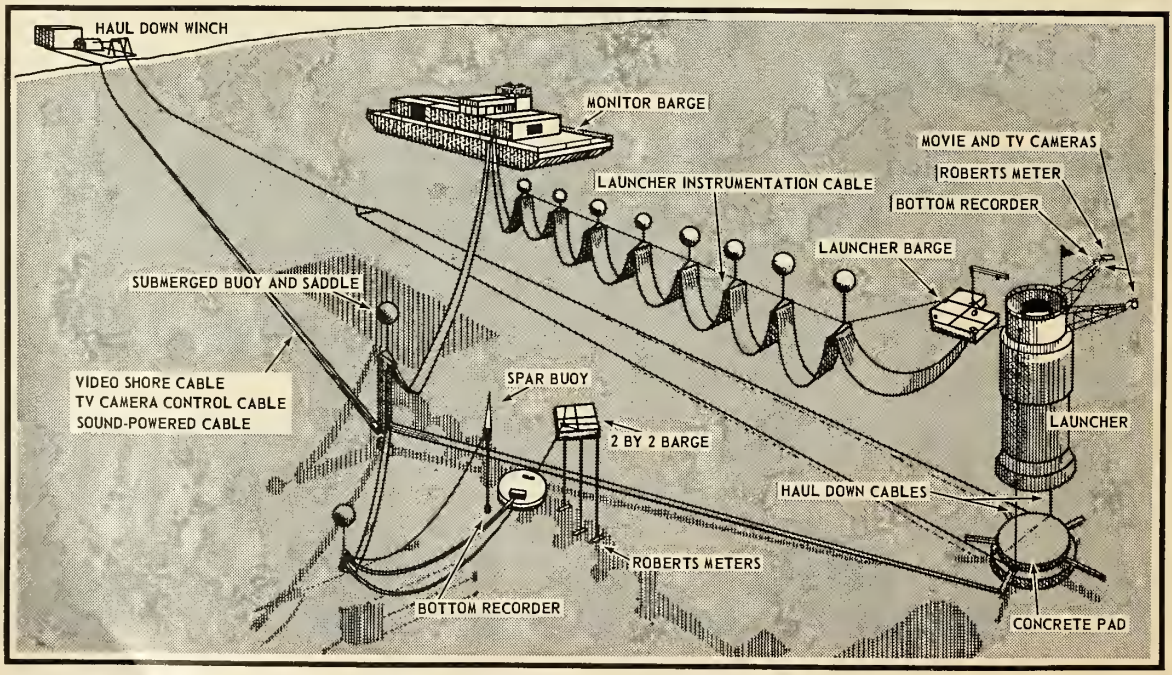
Special Report

'Pop-Up' Site Saves Millions in Polaris R&D

THE NAVY ESTIMATES it has saved millions of dollars in *Polaris* research and development with its unique underwater missile test range off the coast of California.

A part of the Naval Ordnance Test Station, the San Clemente Island facility has provided the program with invaluable test data on underwater launching since its inception a little over two years ago. The "Pop-Up" site has fired a number of test vehicles ranging from totally inert "slugs" to powered missiles.

Early tests helped perfect tech-



MONITOR BARGE is "central control" of Navy's underwater missile test range. Control and monitoring equipment on the barge is connected by underwater cable to launcher and instrumentation. Test data on each firing is collected by recorders, meters, TV and movie cameras, and 150-channel cable-telemetry systems. Telemetry ground station and radar plotting station are located on a hill above the launching site. (Drawing is reproduced by courtesy of Naval Institute Proceedings.)

←

FIRST TESTS at San Clemente Pop-Up station helped determine and refine techniques for compressed-air firing of missiles from submarine tube. Nets suspended from buoys surrounding the launcher catch the test vehicle when it falls back to the surface.

→

DOLPHIN test vehicles were used in the Polaris R&D program to check submarine launching systems, train submarine crews in missile launching and determine underwater trajectories of missiles in sea conditions ranging in severity up to hurricane force.

niques for "firing" the missiles by compressed air from under the sea's surface. Later in the program, inert *Dolphin* test vehicles were used to check out submarine launching systems, train missile sub crews, and determine underwater trajectories of missiles in different sea conditions.

Last April, the first powered *Polaris* was fired from the submerged pad. It was identical to an operational model with the exception of a dummy second stage and a short-run first stage. This and a later test, checked out the launching and actual ignition of first-stage motors.

The big money-saving feature of the test program is, of course, the capability of recovering the test vehicles for re-use. In addition, equipment checkout and crew training was conducted without loss of missiles or the use of submarines. The net result was to have an operational missile, launching equipment, and trained crews ready at the same time as the fleet ballistic missile submarine.

Now that the 1200-mile *Polaris* research and development program is completed, modifications to the launching equipment will be made to accommodate first models of a new 1500-mile (or longer-range) version. The primary change will be in lengthening the launcher tube. New missiles will be longer than the present operational model, but their diameter will be the same.

San Clemente Island provides an almost ideal spot for the NOTS test facility. Uninhabited except for Navy personnel and about 2000 wild goats and a few other animals, the island is only about 55 miles from the coast of Southern California.

During World War II, it was used as a training site for amphibious landings. After the War, the island was relegated to caretaker status for several

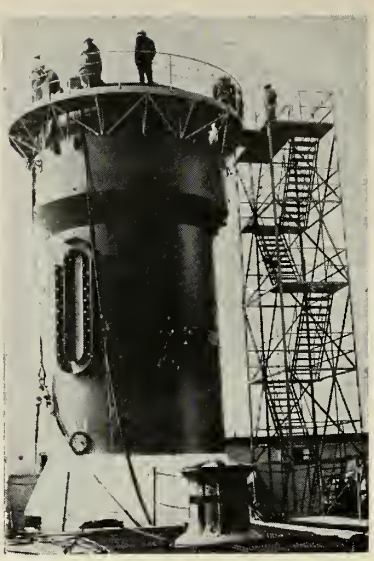
years. In 1949, Bureau of Ordnance started using San Clemente for development testing and evaluation of underwater ordnance. Several torpedoes, *Weapon Able*, and *RAT* (rocket-assisted torpedo) were all tested here during their development. The island's use as an underwater missile range began in March, 1958.

• **How it works**—The *Polaris* Pop-Up test facility centers around a concrete pad on the ocean floor just offshore from Wilson Cove. Directly over the pad—and attached to it by haul-down cables—is a launching tube which simulates the submarine launcher. This tube is installed in a barge which is the terminal point for the launcher instrumentation cable. Tanks on the sides of the launcher tube are flooded to stabilize the tube during lowering and while resting on the submerged pad.

A monitor barge is moored between the pad and the shore. This serves as an acquisition station for data gathered during a launch. Missile and launcher information is collected from 150 cable-telemetry channels. In addition, closed-circuit television cameras are monitored on the barge to check on launcher lowering and diver-inspection of instrumentation and firing lines. TV cameras also cover the underwater firing operation.

Movie cameras are installed on the tube and on shore to record water-exit angle, acceleration, and initial air trajectory of each vehicle. Other recording and measurement instruments are suspended from a small barge near the launcher tube.

A telemetry ground station and a radar plotting station are located on a hill overlooking the launch site. Approximately 80 men are stationed on the island to operate the equipment during firing.



TWO-HUNDRED-TON tube simulates the launcher in *Polaris* submarine. The tube is lowered to a concrete pad on the ocean bottom near San Clemente for firing the underwater-launched missile.

• **Recovery**—Two different methods are used to recover test vehicles after firing. One fall-back system consists of two horizontally buoyed nets which surround the launch area. After ejection, explosive bolts holding the nets open are fired to allow the nets to close and catch the missile when it falls back into the sea.

For tests where it is not desired for the missile to impact into the water, a special Fishhook crane catches the vehicle at its apogee. Crane cables attached to the missile are reeled as it is fired and stopped as it reaches its highest point. The test vehicle is thus suspended with no fallback.

During a launch operation, the missile is checked out and loaded by a staging vessel built on two barge hulls. This vessel carries a 50-ton crane to handle the missile, and supports to hold the 200-ton launcher in place during checkout and loading.

After checkout and loading is completed, the launcher vessel is lowered to the underwater pad by cables operated by a winch on shore. A charge of compressed air ejects the missile from the tube to exactly simulate its firing from a submerged submarine.

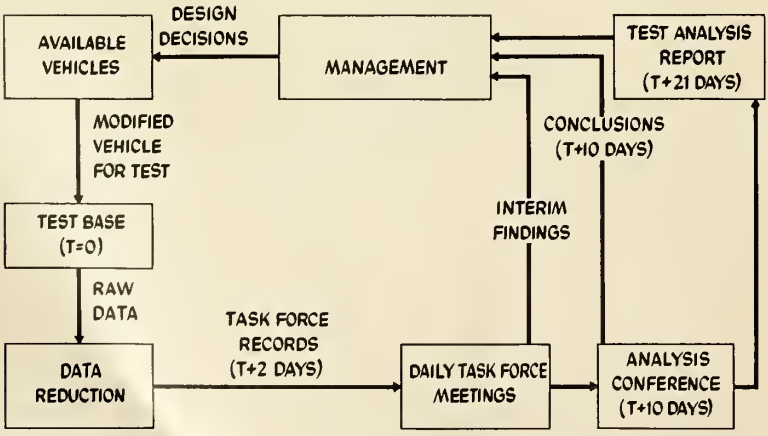
Results of test firings from the nation's only underwater missile range have been highly successful, according to the Navy. They give much credit to the San Clemente facility for its part in contributing to the overall success of the *Polaris* weapons system.

How Polaris Test Data is Sped to Analysis

Analysis time cycle of the loop between test and availability of reduced data to the design modification group is shown in the accompanying chart of Lockheed's data flow system.

Following test, raw data is flown from Atlantic Missile Range to Sunnyvale for data reduction, arriving within 24 hours after test launch. In parallel, flash reports are sent to Sunnyvale at five-minute, one-hour, two-hour, and 24-hour intervals after launch time.

These flash reports contain first impressions of test on the basis of limited pickoff available at AMR.



DATA HANDLING system extracts and digests key information within 10 days.

Within 48 hours after launch, initial reduced records, designated Task Force Records, become available to the Analysis Task Force. Reduction and compilation of complete reduced test data continues, resulting in a "Quick-Look" data report, the first important segment of which is issued within five days after launch.

Within 10 days, the cream of the results have been extracted and digested, being communicated to management and other people outside the analysis loop. This is done through communiques and by an Analysis Conference held about ten days after test.

Within approximately 21 days after launch, a substantial technical recap and interpretation of the test is published. Analysis and interpretation continues, in each design area affected, to insure maximum use of all data.

Meanwhile, the task force operation is being repeated with subsequent launchings. On occasion, LMSD says, there have been three task force teams operating simultaneously.

Special Report

Bigger, Better Subs Are Coming

Bigger and faster nuclear-powered *Polaris* submarines are now on the ways.

They belong to the new Ethan Allen class, 410 ft. long and displacing 6900 tons. This compares to the George Washington class, 380 ft. and 5600 tons.

The Ethan Allen being built at the General Dynamics Corp.'s Electric Boat Division, Groton, Conn., the first of four of the "new" class, is actually the first true *Polaris* submarine designed from the keel up to carry 1200-mile-range missiles. It will have a different hull configuration and will be roomier inside than the first Fleet Ballistic Missile subs.

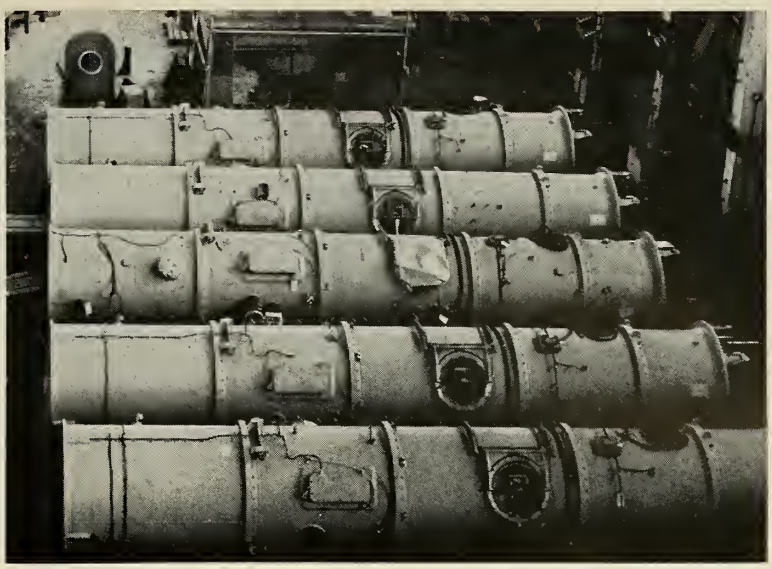
The George Washington and its four sister ships constructed during the past two years have Skipjack-type hulls modified to include a 130-ft. missile section amidships. The GW itself—under the *Sputnik*-forced acceleration of the *Polaris* program in late 1957—actually was created out of a keel already laid at Electric Boat for the Skipjack-class submarine Scorpion. The keel was cut amidships and the missile section was inserted, giving the completed vessel a slightly humpbacked silhouette.

Modification of the hull proved to be a tremendous timesaver. The George Washington was completed in a record two years—against three years normally needed to bring in the prototype of a new sub.

Speed and diving capability of all the FBM subs is classified. The Navy says they will travel "in excess" of 20 knots underwater and can go down farther than conventional subs, which have about a 650 ft. limit.

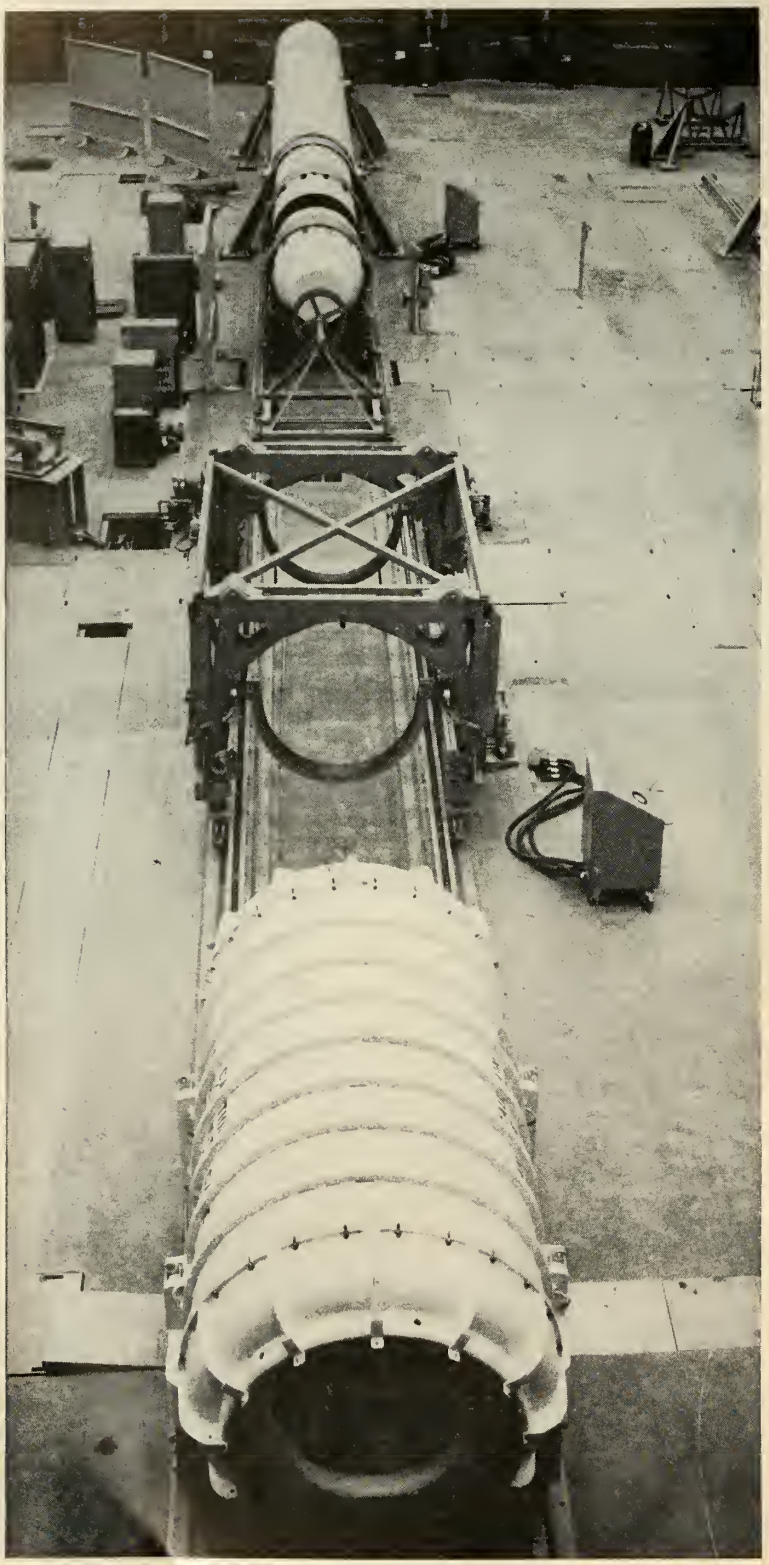
The Ethan Allen's extra weight will go largely into a thicker pressure hull, to make it even more deep-diving than the George Washington. It also is expected to be a little faster than its predecessors.

Down the line—starting at about the 15th FBM sub—the Navy is planning to go to a third, more advanced class. No details of this new design have been made public.



MISSILE LAUNCHING tubes move along the production line at Westinghouse-Sunnyvale. Note access hatches which open on *Polaris* first- and second-stage hydraulic section (for jetavator control) and on the guidance section.

FIRST POLARIS submarine, George Washington, as she was being constructed in a record-breaking two-year period at Electric Boat.



THREE LINES in Assembly Building can operate simultaneously to turn out operational *Polarises* for the fleet. Another depot may be built on the Pacific.

Special Report

Assemblin

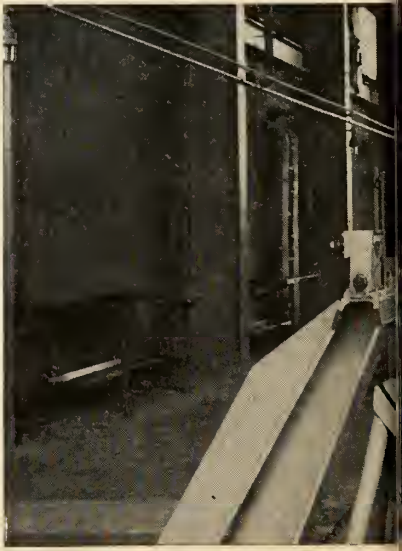
Operational *Polarises* are already being assembled at the *Polaris* Assembly Depot near Charleston, S.C.

From here all *Polaris* submarines will pick up their missiles before going on station. A similar facility may be constructed later on the West Coast.

The depot is operated by more than 200 officers and men. They are assisted by more than 100 Lockheed engineers, about 15 from General Electric and five from Aerojet-General.

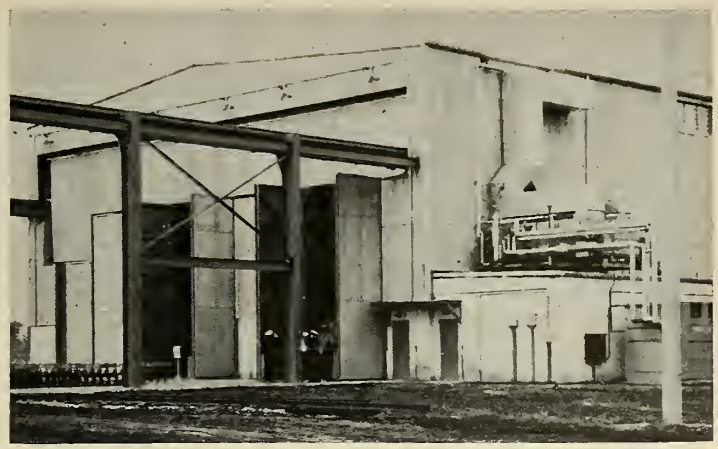
Components are shipped to Charleston by air and individually checked out in other specialized buildings at the depot before being assembled into operational birds in the 1500-square-foot Assembly Building.

Submarines and sub tenders take on their missiles at a pier several miles away on the Cooper River. The missiles



EMPTY LINE in the facility awaits arrival of missile components, flown in

nd Loading



MAIN BUILDING where operational *Polarises* are being assembled. The entire area is under heavy security. Its Navy personnel alone totals more than 200.

are shipped from the Assembly Building to the pier in doubled containers on railroad flatcars.

The missiles are lowered into the submarines' tubes directly from the containers. A half-million-dollar crane is used for the delicate operation. Initially, the loading of a single submarine is expected to take more than a week.

Loading time is expected to be much faster, however, as familiarity with the system increases.

All loadings by the first tender—the Proteus (see artist's conception)—will be in port. A converted merchantman, the Proteus can handle a score of missiles. It will replace missiles that are in need of major repair work which cannot be carried out by crews aboard the submarines.

• **Three assembly lines**—The 880-acre depot—called the Navy Weapons Annex—went into operation in March of this year. Built at a cost of $27 million, the sprawling installation includes facilities for checking out and servicing missile components before they are fully assembled, for inspecting the two-stage motors, and for installation of nuclear warheads.

Combat submarine crews which must tend the missiles preside over the final checkout of the assembled birds before they are gingerly lowered into the subs.

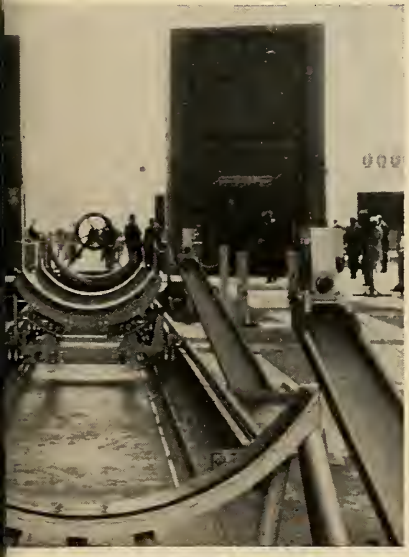
The Missile Assembly Building contains three assembly lines which can operate simultaneously. The missiles roll off the lines into special liners—to guard against possible adverse environmental effects—and then are placed in shipping containers for handling and stowage.

For the next several years, the Charleston depot will be the focal point of operational *Polaris* missiles in this country. And for this reason, the depot is now a maximum security area—with barbed wire fencing and Marine Corps patrols.

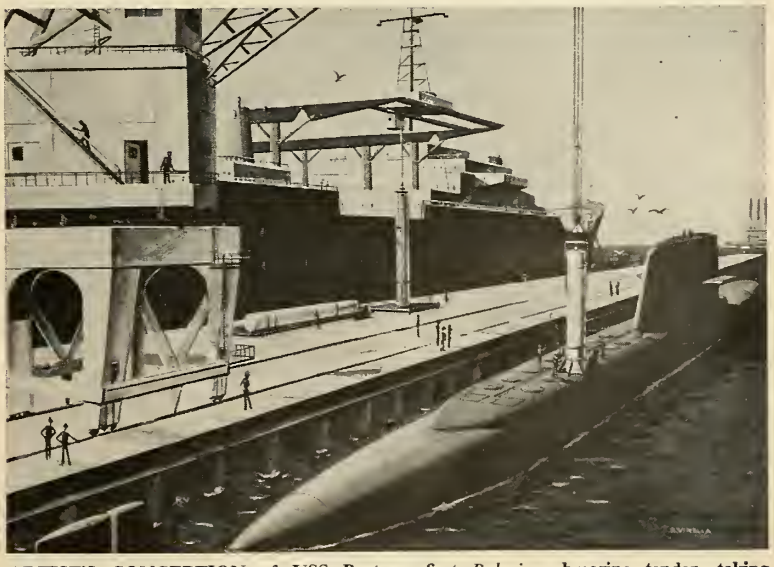
Selection of Charleston, which means that Fleet Ballistic Missile subs will be operating in the Atlantic, hinged on both economic and geographic factors.

The port is ice-free and well protected, and has easy access to the sea. It is also near the Charleston Navy Yard, which in the next year will be the home port of some of the *Polaris* submarines.

(The Charleston Depot was described earlier in M/R, April 4, pg. 12.)



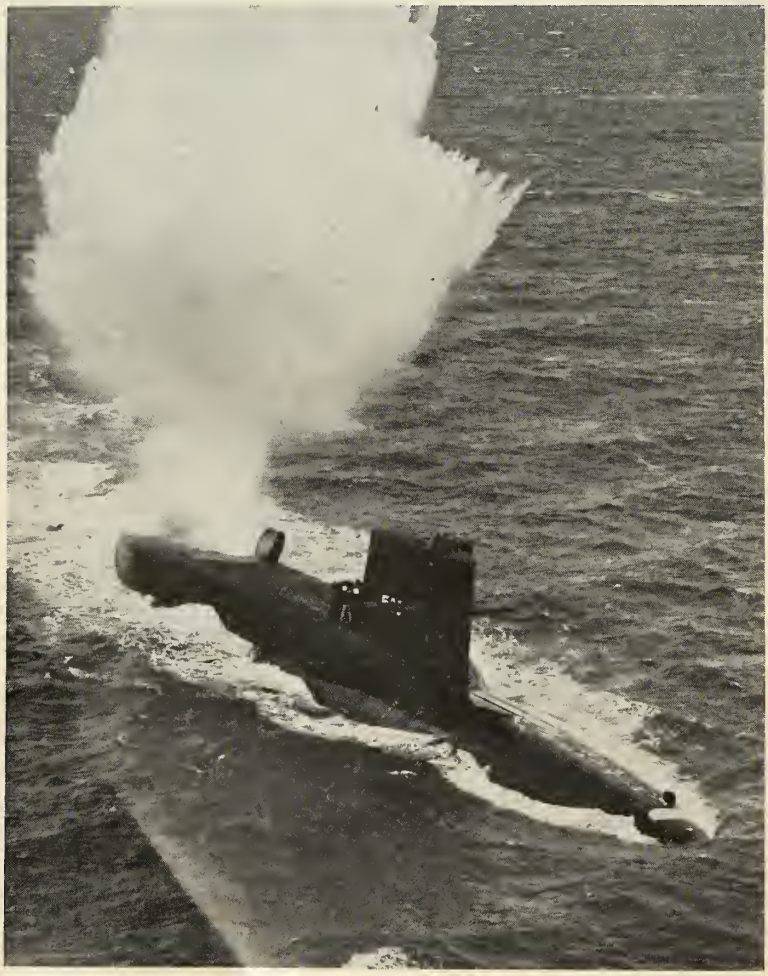
and checked out in other specialized buildings at the Charleston site.



ARTIST'S CONCEPTION of USS Proteus, first *Polaris* submarine tender, taking aboard a missile in its container. In foreground, a submarine receives a *Polaris*.

USS George Washington, foreground, and USS Patrick Henry steam down to Long Island Sound on trial run this spring.

Polaris Submarines Train for Action



ONE-TON Sabot "slug" is fired from a port missile tube of the George Washington during a drill in Long Island Sound.

Polaris Deployment

Missile-launching nuclear powered submarines sought by the Navy: about 45. Submarines authorized in part or whole 21 Missiles per submarine: 16 Initially operational: Fall, 1960. Administration plans call for laying three more keels in FY 1961 bringing number of subs commissioned or under construction to 12.

Polaris Submarines

George Washington
380 ft., 5600 tons, commissioned 1960, Electric Boat

Patrick Henry
380 ft., 5600 tons, commissioned 1960, Electric Boat.

Theodore Roosevelt
380 ft., 5600 tons, commissioned 1960, Mare Island

Robert E. Lee
380 ft., 5600 tons, commissioned 1960, Newport News Shipbuilding

Abraham Lincoln
380 ft., 5600 tons, commissioned 1960, Portsmouth Naval Shipbuilding

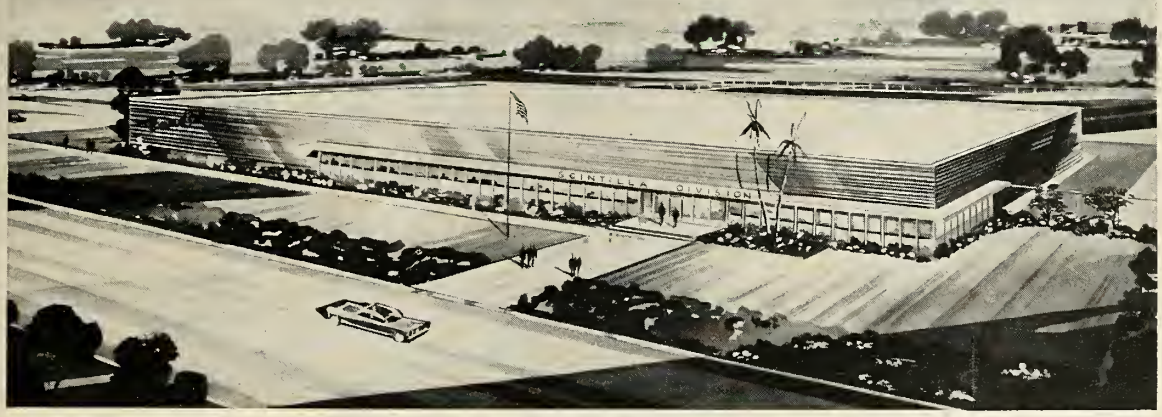
Ethan Allen
410 ft., 6900 tons, launching 1960, Electric Boat

Sam Houston
410 ft., 6900 tons, launching 1961, Newport News Shipbuilding

Thomas A. Edison
410 ft., 6900 tons, launching 1961, Electric Boat

John Marshall
410 ft., 6900 tons, launching 1961, Newport News Shipbuilding

BENDIX ANNOUNCES NEW AND EXTENSIVE WEST COAST FACILITY



FOR CABLING USED ON GROUND BASED ELECTRONIC EQUIPMENT

Scintilla Division of Bendix has scheduled for September completion this new 30,000-square-foot plant at 1001 S. Grand Ave., Santa Ana, Calif. It will offer West Coast users the finest, most complete facilities in the area devoted exclusively to development and manufacture of cabling used on ground based electronic equipment.

West Coast missile industry producers, particularly, will benefit by having this new facility "on their doorstep," bringing them the latest and best in cabling for missiles and supporting ground equipment.

Sales and service for *all* Scintilla Division products—including cables and connectors—will continue to be handled out of 117 E. Providencia Ave., Burbank, Calif.

Scintilla Division
SIDNEY, NEW YORK

THE Bendix CORPORATION

Circle No. 5 on Subscriber Service Card.

Aerojet Group Takes Overall View

SACRAMENTO, CALIF. — An Advanced Developments Division has been established at Aerojet-General's liquid rocket plant to evaluate new engine design concepts in the context of overall weapon system and vehicle requirements, rather than as propulsion systems per se.

R. C. Truax, head of the new group, said ADD will concentrate on high risk, high payoff ideas. Recruiting of personnel has been proceeding quietly for a year—with such high standards that only ten vacancies of the available twenty have been filled.

The hand-picked group consists of specialists in the fields of thermo and fluid dynamics, chemistry, structures, operations analysis, vehicle performance analysis, rocket engine design, and other disciplines, Truax said.

Current projects underway in the ADD program include a liquid rocket system equal in simplicity to a solid rocket but having appreciably higher specific impulse and propellant fraction. Work includes greatly simplified pumping systems, combustion chambers, rocket nozzles and controls.

• **Reusable boosters**—Sustained reusability of liquid rocket boosters is another area of concentration, Truax said. Existing information on service life of liquid rocket engines in non-expendable applications is being compiled with a view toward determining life limiting factors. Ultimate objective is to produce designs with the capability of making hundreds or even thousands of flights.

"If we are to make large-scale space operations economically," he said, "we must have re-useable vehicles. These will be rockets, not air-breathing types." The large size, re-useability and simplicity of such systems will be the controlling factors in reducing costs of astronautic missions, he added.

Truax, retired Navy captain and former American Rocket Society president, expressed doubt that either electric or nuclear propulsion would be needed to lower such costs. He pointed out that the prime difference between travel by rocket and travel by other means is the large amounts of fuel required by reaction engines.

"When cheap liquid propellants are used, the cost of the propellant is small," he noted, "and if the cost of the vehicle is amortized over many flights, the cost elements unique to rockets do not compare unfavorably with other types of transportation."

• **50,000 tonners**—ADD is studying rockets as large as 100 million pounds weight, and which use only force due to gravity and acceleration to feed propellants into the combustion chamber.

The Advanced Developments Division, headquartered at Sacramento, operates as an initiating, planning and management organization. Its concepts are expected to be put into practice by Aerojet's other operating divisions.

The liquid rocket plant, parent organization of ADD, was set up specifically to develop the engines for the *Titan* ICBM. With successful completion of this program in sight within a few years, LRP is increasing its efforts to round out its capabilities in the overall liquid rocket propulsion field.

mergers and expansions

CONVAIR DIV. of General Dynamics Corp. will build a space radiation facility in San Diego to study radiation effects on electronic components, guidance and control systems for nuclear propelled vehicles. An improved 3 million volt electron-ion accelerator will bombard test specimens with varying types and intensities of radiation in test areas with six-foot thick walls. The accelerator itself will be contained in room with four-foot thick walls. Dr. A. E. S. Green, chief of physics for Convair-San Diego is head of the program.

Radiation Dynamics Inc. of Westbury, L.I., New York will build the accelerometer. Installation date is set for March, 1961.

LINDE COMPANY, Division of Union Carbide Corp. has formed a Cryogenic Products Dept., with laboratory and manufacturing activities at Tonawanda, N.Y., and Speedway, Ind. Glenn A. Murray, former sales manager of Linde's Gas Products Dept. is manager.

GENERAL ELECTRIC will start construction in August on a $3-million plant for the manufacture of basic silicone intermediate chemicals in Waterford, N.Y. The facility, adding 15,000 sq. ft. to the Waterford site, will go into operation in late 1961.

EXPANDABLE PLANT—Rheem Semiconductor's new $2-million plant near San Francisco can be expanded in any direction with almost no loss of materials. Manufacturing areas are constructed of easily dissassembled concrete tilt-up walls, while the administration side (facing road) is built with Owens-Illinois-Thinlite curtain wall. The attractive glass-block panels can be unbolted and moved without destruction.

LEAR, INC. has established a $300,000 customer service center at Harrisburg, Pa. The 33,000-sq.-ft. building purchased by Lear will be modified to include a dust-free "clean room" and other facilities for servicing gyroscopic instruments, electronic components, pumps, electro-mechanical systems produced by Lear and other firms.

VITRO CORP. OF AMERICA has opened a West Coast facility with electronic marketing, maintenance and service operation, product showrooms and administrative offices in Los Angeles.

financial

Westinghouse Electric Corp.—First-half sales increased to $953.8 million, 4% over the first half of 1959. Net income was $40.4 million, compared with $34.1 million a year ago. Second-quarter sales were $495 million and second-quarter income was a record $21 million.

Eight Major Shots Remain On Mercury's 1960 Schedule

by Jay Holmes

Eight major launchings, leading up to the first venture of man into space, will make up the Project *Mercury* schedule for the remainder of 1960.

If all goes well on a series of McDonnell production capsule launchings from a *Redstone* booster, the third will carry an astronaut 125 miles up and 200 miles down the Atlantic Missile Range from Cape Canaveral.

Officially, the National Aeronautics and Space Administration will say only that the manned *Redstone* shot is scheduled for the last quarter of this year. However, it appears unlikely the shot will take place before December. And there is a chance it may slip into January or February.

The increased *Mercury* firing rate comes just as NASA goes into the 1961 Fiscal Year with an appropriation of $108 million for the project. Before completion, NASA expects to spend $350 million on this first major effort to get man into space.

The first *Mercury Redstone* launching—designated MR-1—is to take place next month. It will be a test of the capsule alone—with a dummy astronaut aboard.

If no hitches develop, the second *Redstone* shot—MR-2—is scheduled for early in the fourth quarter. This one will carry a monkey.

MR-3—according to present planning—will be the first manned shot.

• **Proceeding with caution**—NASA officials emphasize that slippage is entirely possible on such a series as this. Each shot depends on a complete success of the previous launching. And an extra degree of reliability is demanded of every component in a vehicle that will carry a man.

The entire *Mercury* program is supervised by NASA's Goddard Space Flight Center—a team of scientists and engineers built around the men who developed *Vanguard*. *Vanguard* experience is the key to the entire philosophy of the Goddard group. Their first aim in life is to avoid another humiliation like the first *Vanguard* failure—before the collective eyes of the world's press.

"If you think that *Vanguard* shot was a colossal flop," a Goddard spokesman remarked, "picture what will happen if we kill off an astronaut on the launch pad."

• **Number of shots undermined**—Concurrent with the *Mercury Redstone* shots is a series of launches of the McDonnell production capsule atop an *Atlas*. The first of these vehicles—the MA-1—is now on the pad at Cape Canaveral and will be launched soon.

MA-2 and MA-3 are scheduled to follow in September and October. And if this series goes well, MA-4 will carry a monkey into orbit before the end of the year.

No one—not even the engineers in charge of the project—knows how many *Mercury Atlas* shots will be necessary before a man is fired into orbit. The target for that shot is sometime in 1961. But the date is by no means settled.

Testifying before the House Space Committee last February, George M. Low, NASA chief of manned space flight programs, said there would be a sequence of *Atlas* ballistic shots, instrumented capsules in orbit, capsules containing an animal, and finally manned orbital flight.

At the February hearing, NASA Associate Administrator Richard E. Horner summarized the NASA approach to the *Mercury* launch schedule when he said:

"I had shaken my head at your suggestion that the primary purpose of the Project *Mercury* was one of national prestige and psychological advantage. We are not approaching the project in that manner. The primary purpose is to determine the feasibility and the utility of manned space flight, and this is in fact a prerequisite for most of our follow-on space program."

Liquid Ozone May be Safe as LOX

COLUMBUS, OHIO—Liquid ozone is as safe as LOX for rocket oxidizer applications when mixed with LOX in relatively low concentrations, an Armour Research Foundation specialist declared last week.

Charles K. Hersh of Armour told an American Rocket Society conference that liquid ozone-LOX mixtures are safe outside of the two-phase temperature and pressure region. Eventually, he said, he believes ozone concentrations up to 90% will become safe to handle.

At the ARS Propellants, Combustion and Liquid Rockets Conference at Ohio State University, Hersh said the major safety consideration in dealing with ozone is thorough cleaning of the system and avoidance of contamination. Hersh said he does not believe ozone will ever be practical for use in military rocket systems. But he said it should be practical for use in manned rockets used by NASA.

The Armour researcher, in a review of the properties of liquid ozone and liquid ozone-oxygen mixtures, recalled that specific impulse rises upwards of 5% when liquid ozone is substituted. He gave these examples for frozen equilibrium, chamber pressure of 1000 psia and exit nozzle pressure of 15 psia:

	Specific impulse, sec.	
Fuel	Ozone	Oxygen
JP-4	302	282
Ammonia	304	284
Hydrazine	315	301
Hydrogen	419	388

Liquid ozone and oxygen are not completely miscible over the entire composition range, Hersh said. Below –292°F, the mixture forms two layers, one ozone-rich and the other oxygen-rich. At the consolute temperature of –292°F, the ozone concentration is 41.3 mole percent.

Other differences between oxygen and ozone listed by Hersh included:

• Ozone's boiling point is –169°F, compared with –297° for oxygen.

• Ozone's liquid density (at –297°F) is 1.57 g/cc, compared with 1.14 for oxygen.

• Ozone has somewhat higher thermal conductivity and latent heat of vaporization than oxygen.

In other papers:

• Frank J. Hendel of Aerojet-General reported that specific impulse of a solid-propellant grain was raised from 225 to 246 seconds by injection of 18 to 19% by weight of liquid oxidizer in a hybrid system. A hypergolic slug between two burst diaphragms was used for ignition. The solid grain was one that would support combustion but was fuel-rich.

• Ernest Mayer of Rocketdyne Division, North American Aviation, reported studies showing that a refractory coating will improve the performance of a nozzle of a liquid rocket in the million-lb.-thrust range. He showed also that performance improves on shifting from stainless steel to Inconel X, and improves again on shifting to F-48, a columbium-based alloy.

• Dean Walter H. Bauer of Rensselaer Polytechnic Institute reported identifying an unstable partial oxidation product, $H_2B_2O_3$, in the oxidation of diborane, the same as in the oxidation of pentaborane. Dean Bauer declared that much more research on borane oxidation is necessary before the new propellant family will be understood.

Technical Countdown

ELECTRONICS

World's Largest Radio Telescope Planned

The largest radio telescope antenna ever built is being planned by the Benelux countries. The antenna will be built in the form of a cross, measuring almost two miles square. Each arm of the "Benelux Cross" will be made up of thousands of small individual antennas. Planned frequency is in the 300-600 mc range. The beam will have a half-power width of about one minute of arc.

Monstrous Magnet for MIT

The world's most powerful magnet—rated at 250,000 gauss—will be part of a new magnetic research laboratory planned at MIT. Construction of the research center—to be built and operated under a $9.5 million ARDC contract—is scheduled for completion in 1964.

Coiled Antennas for Canadian Satellite

Thirty-foot radio antennas which uncoil after orbital injection are being developed for the first Canadian satellite. The polar-orbiting vehicle will be launched by a *Thor-Delta* in 1961 to measure galactic radio noise and the influence of the aurora on the ionosphere.

GROUND SUPPORT EQUIPMENT

Automated Control for Missile Instrumentation

A real-time control console being built by Computer Equipment Corp. for ARDC will automatically program missile instrumentation to conduct an automatic countdown. The console will also provide monitoring displays, including a three-dimensional chart of the missile trajectory.

Faulty Radar Signal Scratches Scout

A spurious radar signal was blamed for the failure of a *Scout* satellite launch vehicle to reach its assigned altitude on July 1. The faulty—and unexplained—signal indicated a violent change in the vehicle's trajectory and led the safety officer to cut out fourth-stage firing.

Journeyman to Use Digital Telemeter

"Digilock" telemetry systems will be used in the AF *Journeyman*, four-stage 30,000-mile sounding rocket. The two-pound digital system built by Space Electronics Corp. will use a quarter-watt transmitter to telemeter radiation data and other measurements from space.

Automatic Checkout for Terrier/Tartar

Complete automatic checkout of six missiles can be accomplished in three minutes with system being built by Hycon Mfg. Co. for the Navy's *Terrier* and *Tartar* missiles. Production of the equipment will continue under a recent $6-million contract.

Big Ovens for Inertial Units

Three elaborate ovens developed by Sperry Gyroscope will protect temperature-critical inertial elements aboard *Polaris* sub tender Proteus. Replacement accelerometers and gyros for SINS will be stored at two temperatures. The ovens hold 16-18 elements each. An alarm on the ship's bridge rings if temperature varies as much as three degrees.

PROPULSION

New Aerobee Sounding Rockets

The *Aerobee-150A*—a four-finned modification of the *Aerobee-Hi*—is now in use for stellar and solar observations with sounding rockets launched from Wallops Island. Seven rockets have been launched to date. Each carries a 160-lb. payload to an altitude of 150 miles.

Javelins Boost Sled to Mach 3.5

Another record was set at Holloman AFB last month when a cluster of three Grand Central Javelin motors boosted a Northrop monorail test sled to 2688 mph in about two seconds. Braking fins brought the sled to a safe halt less than three-quarters of the way down the 35,000-ft. test track.

Free Radicals Excite Tremendous Disinterest

According to the Air Force, basic research in chemical kinetics has shown that attempts to trap hydrogen atoms on solid hydrogen are doomed to fail—a result that has hastened disinterest in stabilized free radicals as a fuel.

ADVANCED MATERIALS

Plastic Minuteman Booster Case?

A fiberglass-resin case is under consideration for the big *Minuteman* first stage. Young Development Division of Hercules Powder filed a recent bid with Thiokol to build 50 cases at a unit cost of $25,000. Hercules would set up facilities at Bacchus, Utah.

Spherical Powder Particles

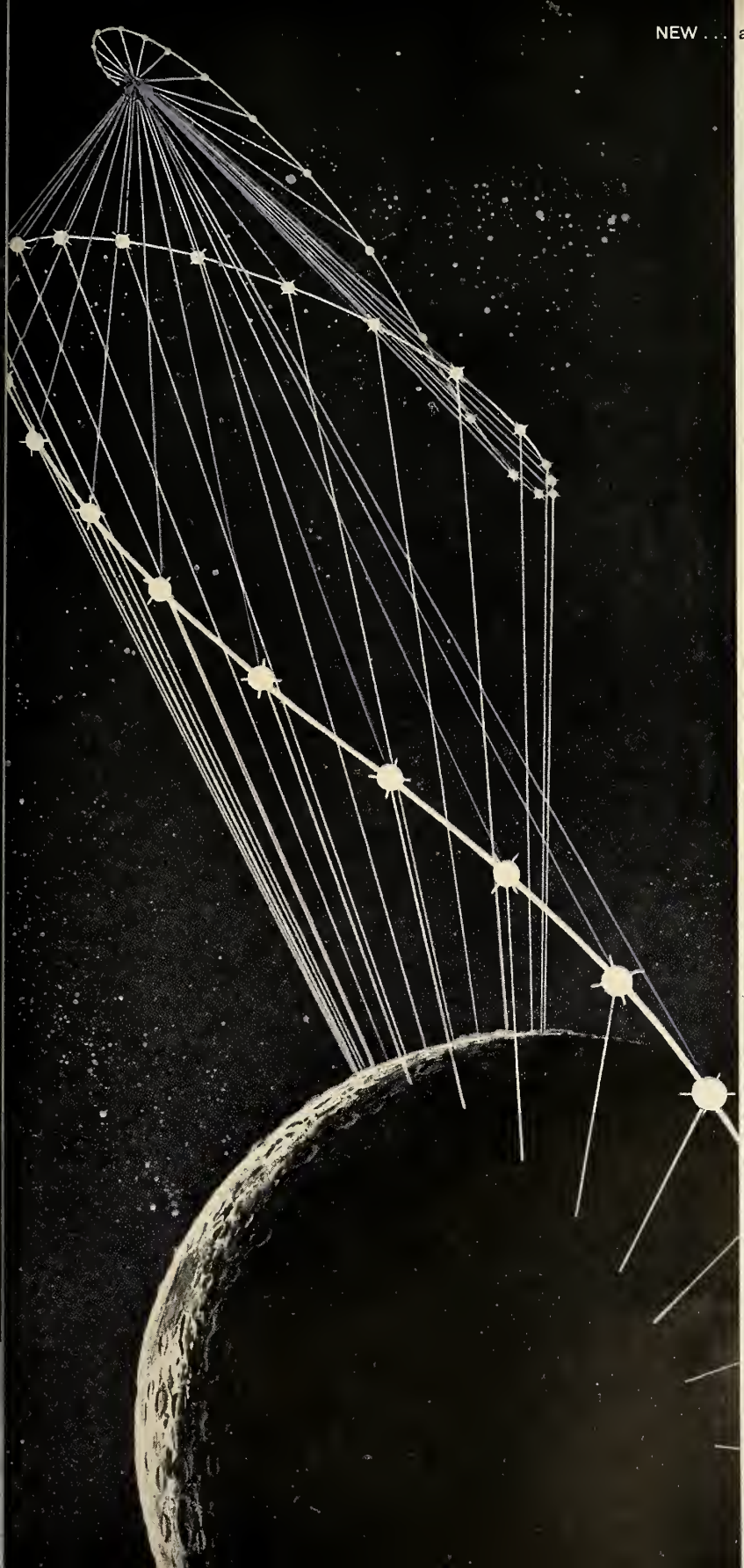
Particles ranging in size from 20 to 150 microns and produced as tiny spheres by Linde Co. Crystal Products Dept. may find application in propellants and sweat-cooled nozzles. Uniformity rates up to 98% are possible with copper, aluminum, nickel, 316 stainless, tungsten, and nichrome powders.

20 Gals. of Oxygen in ¾-gal. Can

Columbium modified steel from National Steel Corp. is being used in a miniature, controlled-flow oxygen breathing dispenser. The four-in.-diameter sphere holds an hour's supply (20 gals.) of oxygen at 1790 psi. The apparatus may find application as an emergency breathing source for astronauts.

Pedigreed Single Crystals

Each refractory single crystal produced by the Materials Research Corp. carries a "breeding sheet" noting its crystal orientation, dislocation count, hardness measurement, and chemical analysis.



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TI Moves Toward Standard Telemetry

by Hal Gettings

DALLAS—Off-the-shelf telemetering systems may well be the answer to one of the many problems plaguing the manufacturers of missile telemetry equipment.

Texas Instruments, operating on this premise, has made one of the first steps toward standardization with a company-sponsored program to develop an airborne PCM (pulse code modulation) system. Other standard units are in the works.

Although there is some reluctance on the part of missile makers to use standard equipment, short lead-time requirements make such a solution promising in many applications. Missile test programs have to be tailored to existing ground equipment; there is no really good reason why airborne systems can't be standardized, at least to a large extent.

• **Today's work aimed at future**—This is one approach that offers telemetry manufacturers a direction for future development. Other programed changes and expected logical advancements further broaden the target. In any case, progressive organizations in this field have something more than a crystal ball on which to base their R&D programs.

New frequency bands are already being assigned. New signal-to-noise requirements and increased information bandwidth will be necessary in the future.

PCM, for instance, is still a long way from general acceptance, yet the trend is undeniably toward digital techniques for their greater accuracy and information capacity. Most of the problems—weight, power, and reliability—have already been solved. Compatible receiving equipment—the major remaining problem—will undoubtedly follow as the benefits and necessity of digital data transmission are realized and accepted.

TI is one of those aiming present developments at future needs. The PCM system is but one example of such future-oriented projects. Other examples are also under development.

• **Telemetry overshadowed by transistors**—Although their work in telemetry has already been substantial, TI is not too well known in this field. In a recognition survey last year, they were rated number 12, well behind several other companies that have done considerably less. Based on volume of business in 1959, they should place well within the top four manufacturers of airborne telemetry equipment.

TI's achievements in telemetry have no doubt been overshadowed by its more widely known reputation as a top semiconductor manufacturer.

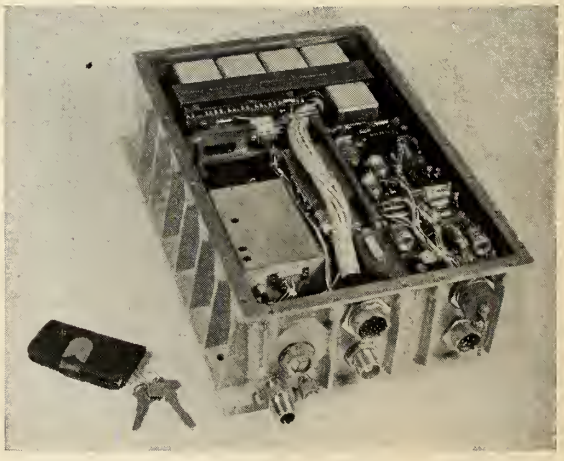
But the company's leadership in semiconductors has given it a definite edge in the design and development of airborne telemetering equipment. The small size and weight requirements for missile and space vehicle equipment naturally calls for the greatest degree of miniaturization and reliability. TI has capitalized on its background and knowledge in the art of making things smaller to produce the kind of equipment demanded for airborne telemetry.

• **Approach to universal system**—The standard PCM system mentioned earlier is a solid-state package one-half cubic foot in volume weighing 25 lbs. It contains a high- and low-level multiplexer, analog-digital converter, programer, and output register. As an approach toward a "universal" system, input configuration and output format may be varied to fit specific needs.

The more flexible such a system is, the better its chances of acceptance. Mission requirements vary widely (see table) and a practical universal system must meet these requirements.

A high/low-level solid-state commutator—or multiplexer—built for the *Bomarc* represents another challenge met and conquered by TI engineers. This unit, which replaced a mechanical commutator already in the bird had to fit in the space assigned the previous

STANDARD PCM system is solid-state throughout, will handle both high- and low-level inputs. Built-in flexibility offers variable bit rate, and trade-off between number of channels and channel information bandwidth.



CENTAUR TELEMETRY system is completely transistorized up to the r-f power stages. Specifications required small size, extreme reliability, and 500-hour minimum unattended operating life.

unit and perform a bigger function and do it better. It was the first true low-level solid-state multiplexer to be used in an operational missile. Actual life tests have yielded over 1000 hrs. continuous operation without failure.

The multiplexer is transistorized throughout. It uses highly reliable low-noise transistor switches and has no moving parts, eliminating a major source of trouble in time-sharing telemetering systems. It will handle low-level inputs of 2-42 millivolts with an overall accuracy of ±0.5 percent.

The standard PCM system has a low-level accuracy of ±0.1 percent—referred to a 50 mv full-scale input range—and a bit rate of 200 kc. The company claims techniques have already been developed that will permit 350 kc, or higher, bit rates with this same accuracy. A current research project is aimed at the multiplexing and encoding of microvolt signals with bit rates up to one megacycle.

• **Deep-space poses critical requirements**—Instrumentation for deep-space vehicles presents even more exacting requirements because high accuracy and reliability as well as long life are required. Telemetering equipment for a lunar-orbit or interplanetary mission may have to function, continuously or intermittently, for weeks, months, or even years without adjustment.

An example of TI's work in this area is the telemetry system for the NASA *Centaur*. Here, extreme reliability was the design goal. The system is conventional 220-260 mc FM/FM with a medium power output of 48-65 watts. A 500-hour life with no maintenance or attention plus tight packaging and weight considerations were the requirements for this system.

• **More reliability goal**—TI engineers feel that the state of the art in transistor circuit design has arrived at a point where equipment can be manufactured and guaranteed to remain within close electrical tolerances throughout its specified life. For this reason, and for better reliability, all adjustments were designed out of the subcarrier oscillator and power supply circuits of the *Centaur* system.

The same principle was applied to maintain optimum distribution of r-f bandwidth by extremely accurate and stable pre-emphasis scheduling. For a given power level and signal-to-noise ratio, maintaining optimum r-f bandwidth is of much more concern in deep-space transmission than would be the case in R&D missile applications where relatively high signal levels can be expected.

• **Signal-conditioning subsystems**—In addition to systems, TI has done much in transistorized subsystems—particularly in the field of signal-conditioning equipment. They are currently building signal-conditioning modules for the *Titan* ICBM and *Pershing* missile. The low-signal level amplifiers for *Pershing* are unique in that they, unlike similar units, operate from an unregulated power supply.

Other units being produced for missile/space applications include transistorized subcarrier oscillators designed for high reliability and low power consumption. These SCOs eliminate potentiometers in the interest of high reliability. They require only five milliwatts of power.

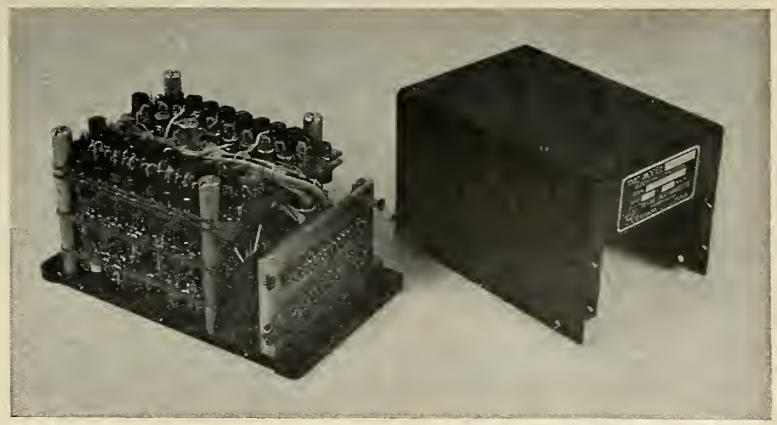
An example of one of the Company's unique high-accuracy components for an R&D missile is a true-RMS voltmeter. This discriminator is completely transistorized and is designed to produce an output of 0 to 5 volts dc for an input of 105 to 125 volts. It has a claimed accuracy better than 1.0 percent for any waveform which contains frequencies between 25 and 20,000 cps.

TI has built a large number of miniature telemetering transmitters. These have flown in the *Bomarc, Corvus,* and *Green Quail* missiles. Some models feature an integral power amplifier that combines small size with large power outputs. One such unit developed an output of 150 watts—well beyond normal telemetering requirements.

• **Functional semiconductor circuits**—Carrying miniaturization a big step further, TI's Semiconductor-Components Division has developed microminiature functional circuits on semiconductor wafers only 1/32 x 1/8 x 1/4 inch in size. One such tiny circuit introduced last year—a bi-stable multivibrator—combines all the functions of assembled transistors, diodes, capacitors, and resistors in the conventional circuits at component densities of up to 30 million per cubic foot.

Advantages of this development include not only the size-reduction benefit but the reliability jump—in part, from an 80% reduction in the number of solder joints—and manufacturing simplification as well. In developing airborne applications of "Solid Circuit" networks, the company has evolved welding techniques said to be more reliable than soldering.

TI's Apparatus Division is active in many areas of the missile/space business. In addition to telemetering systems and components for *Bomarc, Corvus, Titan, Minuteman, Mercury, Centaur, Pershing, Saturn, Atlas,* and *Thor,* the Division has done considerable work in other aspects of missile/space electronics. They have developed and built 10-ton radar systems and advanced equipment for combat surveillance and ASW. Their synthetic antenna and side-looking radars are probably the most advanced produced to date.



SOLID-STATE electronic commutator for *Bomarc* replaced mechanical unit and fit same space. Unit will handle 43 high/low-level information channels plus two sync channels, at a rate of 20 samples/sec. PCM version has sampling speeds up to 100 kc.

Varying Requirements

Vehicle	No. of channels	Accuracy	Sampling speed
MINUTEMAN	128 hi-level	0.1%	12 kc and all submultiples
	96 lo-level	0.2%	down to 33 cps
TITAN	90 hi-level	0.1%	900 cps
ADVANCED TITAN	64 hi-level	0.05%	8640 cps
BOMARC C-2	36 hi-level	1.0%	900 cps
	7 lo-level	1.0%	
BOMARC C-4	45 hi-level	1.0%	900 cps
CORVUS	(2) 45 hi-level	0.5%	900 cps

Mission telemetry requirements vary widely as shown above. A universal system must be flexible to meet such requirements yet be standard in other respects

debate among astronomers . . .

How to Contact 'People' in Space?

Those scientists who believe there is intelligent life on other planets are divided on the question of how to go about getting in touch with them; they agree that it's likely that other 'people' exist

If there is life out there, then where is everybody?

Dr. Edward Teller

by William Beller

There is a fight going on among scientists looking for ways to get in touch with intelligent beings outside our solar system.

The assumption is that people exist out there.

One astronomer right now is searching the skies for signs of extra-terrestrial life.

Another astronomer is informing him that he's not looking in the right places.

Both men are fully convinced that somewhere, somebody may be searching for us.

A third astronomer asks why all the fuss. "We'll know soon enough if anybody's out there. Meanwhile, are there lichens on Mars?"

Other scientists are entering the fray.

The fight going on is a velvet-gloved one but is nonetheless intense. If life, the extra-terrestrial type, is actually trying to locate earthlings, then the results of this local conflict could affect the beings' chances of finding us, and vice versa.

• **The division**—The scientists involved divide into three major factions. These reduce to two if disbelievers in extra-terrestrial beings are eliminated.

In the first faction, the members say that intelligent beings are sitting on their planets passively attending to about one thousand transmitters all beaming electromagnetic signals into likely areas of the universe.

Partisans of the second faction affirm that if these beings are truly intelligent they won't be waiting around hoping somebody will hear them. Instead, they'll be sending out probes and satellites. These will be actively querying every solar system within reach, hoping to get an answer back.

Unofficial leader of the first faction is Dr. Frank D. Drake, associate astronomer of the National Radio Astronomy Observatory, a facility perched near a mountain top in Green Bank, W.Va. Last April he began pointing his 85-ft.-diameter dish radio-telescope in the neighborhood of two nearby stars for a sign of life.

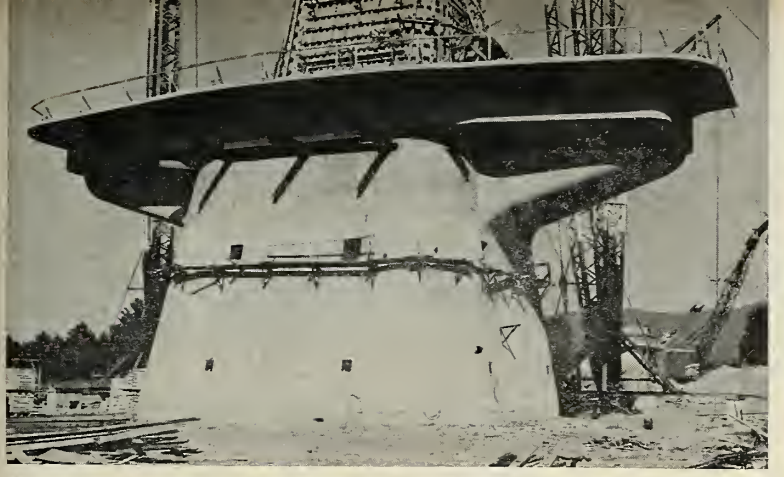
Heading the second faction, also unofficially, is radio astronomer Professor Ronald Bracewell of Stanford University's Radioscience Laboratory.

Both groups begin with the premise that somewhere in our galaxy there is a community at least as advanced as earth's. This is done with communities to spare in the following logic:

There are a vast number of stars in the Milky Way that have low angular momenta. One instance is our sun, which has given 98% of its momentum to its planets. Thus there are probably millions of millions of planets existing, thousands of millions of them standing in the same relation to their stars as the earth is to its star.

Life therefore would have evolved and be abounding in the Milky Way. Chances are that it would be incredibly more intelligent than our own. Although our sun is young, earth's civi-

SEARCHING FOR extra-terrestrial life, 85-foot diameter radio telescope listens for artificial signals emanating from stars 11 light years from earth.



INCREASED SEARCH range will come from 140-ft.-diameter radio telescope whose foundation is shown rising from a field in Green Bank, W.Va.

lization has already advanced technologically amazingly far, up to controlling atomic energy.

Imagine then the progress that would be made by communities on planets born out of the mature stars. millions maybe billions of years older than ours! Of course, such progress occurred only if the communities did not destroy themselves by their discoveries.

Whether such advanced civilizations would want to trouble themselves to get in touch with "dark age" societies like ours has been questioned. Bracewell thinks they would because "the prospect of catching a technology near its peak might be a strong incentive for them to reach us."

• **The Milky Way Club**—Except for a month taken out for conventional radio astronomy work, Drake has been monitoring Tau Ceti and the Epsilon Eridani, two suns about the size of our own but 11 light years away. These are said to be the only nearby stars that might have life-bearing planets. Double stars were not considered.

Double stars are two suns linked by their gravitational fields. Even if the suns have planets, the orbits would be so eccentric that the climate would most likely be too variable and extreme for life to evolve.

Drake is calling his search "Project Ozma," a name derived from Frank Baum's queen of Oz who lived in "a place very far away, difficult to reach. and populated by strange exotic beings."

It may be that nobody is trying to get in touch with us from there, Drake says. After all, the probability that a given sun will have a planet like earth is an extreme long shot. Still, our radio talk over the years could have been heard by some advanced community; or such a community might have a program to explore "outer" space.

Another possibility, according to Cornell University scientists Drs. Philip Morrison and Giuseppe Cocconi, is that there might be some sort of Milky Way Club composed of advanced societies in communication with each other. Random spacings could have placed such societies not too many light years apart.

The MWC may have agreed to query star after star in an effort to find new members.

What signals would these advanced societies use to get in touch with earth? Chances are they would operate on some very common electromagnetic radiation. What is a better choice than the emissions of ionized hydrogen, asks Drake? It is everywhere in the cosmic vacuum. Intelligent beings on a distant planet would presumably know that we had discovered this universal hydrogen line. And this is where Drake is listening, at 1420 megacycles.

Since hydrogen is continuously sending out noise signals from space, as this gas is ionized by colliding particles, the trick is to separate the noise from the artificial signals being sought. Through an ingenious technique, Drake is able to do this without resorting to months of tiresome correlation calculations.

Using a wide and narrow band detector simultaneously, he first focuses his telescope on the star under surveillance. Then he determines and eliminates much of the background noise by focusing on an area in space near the star.

• **Large dish holds more stars**—The work at Green Bank is being supported by the National Science Foundation, which has a second telescope under construction at the site and a third one about to be started. Both these new instruments are similar to the one already operating but have larger diameter dishes, 140-ft. for the second, 300-ft for the third.

The distance over which a signal can be detected is directly proportional to dish diameter. Specifically, if a signal emanating from a point in space were as strong as the strongest electromagnetic radiation an earth station could put out today, the 85-ft. dish telescope could perceive it up to about eight light years away.

Though the range increases linearly with dish diameter, it is important to remember that the number of stars available to the telescope increases as the cube of the diameter. This is one of the prime reasons for building larger dishes.

Drake estimates that the requirements of conventional radio astronomy will leave only about 10% of the Green Bank telescopes' time free to look for extra-terrestrial life. He commented that regardless of how much time is devoted to the task, luck is going to play an important part. "It's going to take a lot of patience and effort because we know so little about where to look and what frequency to try."

Contrary to pronouncements made by Bracewell, Drake stressed that he knows of "no emanations past or present that could be construed as coming from other intelligent beings."

In his writings, Bracewell has referred to signals coming in from space, which seemed to be echoes of those sent from earth and "were reported 30 years ago by Störmer and van der Pol and never explained."

• **Computers that talk**—Taking issue with Drake, Bracewell wrote in a recent *Nature* magazine article that he doubts that intelligent beings would waste their time beaming signals to us from their home bases, even if these beings knew where we were. "Remember that throughout most of the thousands of years of the earth's existence such attention would have been fruitless!"

Instead, Bracewell sees such beings "spraying" a thousand or so nearby stars with satellites. Each satellite would be put into a circular orbit around a star, would then be powered by the star's radiations, and would be at a distance from it that would place the satellite in a habitable zone. Bracewell believes that this method would be far more economical of time and energy than having to power a thousand transmitting stations on a given planet for an extended period.

On board each satellite or probe would be radio receivers, transmitters, and computers. Through these instruments. the probe would listen for signals, then echo them on the same frequency they were received. "To notify the probe that we had heard it, we

laser will be used heavily . . .

would repeat back to it once again," explains Bracewell. "It would then know that it was in touch with us." From here on, earthlings would be teaching the probe their language for transmission back to the superior community somewhere out in space.

Out of this Bracewell concludes that "we might better devote our efforts to scrutinizing our solar system for signs of probes sent here by our more advanced neighbors." Later, as we advance technologically, we can send out our own probes to explore and interrogate the Natural satellites of more distant suns.

Objections to Bracewell's thesis come from one of his colleagues. He notes that space probes are extremely expensive and undoubtedly fragile over extended periods because of meteorite bombardment. "Besides," the critic observes, "if a society can build the computers that Bracewell asks for, let's not have the devices waste time orbiting around us. Let them come right down to earth, have a couple of drinks, and talk things over man to . . . ah . . . computer."

• **Capture a star**—Intelligent beings may ultimately find themselves short of space on their home planet, says Freeman J. Dyson of the Institute for Advanced Study, Princeton. He expects Malthusian pressures to be driving the people to new habitats.

He envisions such people using their own star's energy to help them chop up what had been previously an uninhabitable planet. Such a one could have been in the relative position and of the size of our Jupiter. Chunks of the planet would be used by the people as the building blocks for a biosphere, a spherical shell completely enclosing a sun and at a life-sustaining distance from it.

The biosphere would be capturing all its sun's radiating energy. The hollow planet is seen having a diameter roughly equivalent to the earth's orbit and a surface temperature of 200° to 300°K. The most plentiful radiations would be in the far infrared, at about 10 microns wave length.

Dyson suggests that a search be made for sources of these infrared radiations along with the search for artificial radio signals. Unlike many other scientists, he sees the double stars as being particularly advantageous for supporting life. In effect, the weaker star would be surrounded by the spherical shell of a destroyed planet. The inhabitants would then be warmed from below and above.

Drake calls Dyson's scheme scientifically and economically sound.

The laser after further development will be playing an important part in infrared radiation detection (see M/R, July 18, p. 54). Such a light-amplifying device would be mounted in an earth-circling satellite in order to be above our atmosphere's noise, says Paul Johnson, Air Force Office of Scientific Research physicist. First the laser would look for high intensity, narrow band signals from space.

Failing to get these, and as the laser art progressed, the device would search for broad band emanations. It would try to detect "characteristic infrared signatures associated with life processes." Lastly, it would attempt to extract signals buried in a high background noise.

In the final analysis, probably the best way to attack the problem of searching for life in space is to look at as many areas as we can, near and far. At the same time, as one astronomer avers, "we should find every possible means to communicate available to us by the laws of physics and try them all."

ARPA Puts Real Money Into Research

The first real attempt at scaling the materials barrier is under way.

Project *Pontus,* a long-range basic research funding program, was initiated by the Advanced Research Projects Agency with a $14-million broadside.

Specifically aimed at providing needed basic knowledge in the several disciplines of the materials sciences and increasing the number of Ph.D.-caliber scientists, initial contracts were recently awarded to Cornell University, University of Pennsylvania and Northwestern University.

The program is the result of a recommendation of the Federal Council for Science and Technology that progress in materials could best be assured by setting up laboratories at qualified universities where separate scientific and engineering capabilities could be used collectively.

An added boost was supplied by the Committee on the Scope and Conduct of Materials Research set up by the National Academy of Sciences. This group, after a similar year-long survey, suggested that universities be strengthened in the dual role of training personnel and engaging in basic research.

The funding support levels are as follows:

• **Cornell—$6.1 million:** A materials research center will be established combining the efforts of portions of five departments in two colleges. Cornell will construct a $4 million building housing the administrative offices of the center, several common technical facilities and graduate research of the Laboratory of Atomic and Solid State Physics.

ARPA will reimburse Cornell for construction costs over a 10-year period. A larger building may be added later.

Disciplines covered include solid state physics, chemistry, metallurgy, mechanics and materials. The ARPA contract will run four years. Funding for the fifth year will be discussed next fall and further support annually.

• **U of Pennsylvania**—$4.4 million: The four-year contract will result in the erection of a three story building to house research activities in solid state physics, structural chemistry, inorganic chemistry, ceramics and all phases of metallurgy.

There will be substantial increases in the teaching staff and in the number of full time students.

• **Northwestern U**—$3.4 million: A materials research center wing will be established housing 18 specialized laboratories. Materials researchers will double in the first five years to 55. Graduate students in the materials sciences will be increased by a factor of 2.5 to 175.

Special equipment will be purchased by the three universities to aid in the program. Both Northwestern and Pennsylvania will obtain high power magnets—50,000 and 100,000 gauss respectively. Cornell and Northwestern will pick up new electron microscopes.

But the most valuable equipment will be the highly trained researchers.

In each case the contract runs for four years. Additional funding will be supplied as the program progresses. In some instances, private funds will funnel into the project.

The three universities were selected from among thirty interested institutions. ARPA has indicated that additional laboratories at other universities are being contemplated.

Chamber Simulates 250-mile Height

A huge ultra-high-vacuum chamber capable of simulating pressures equivalent to an altitude of 250 miles went into operation last week at the San Diego facilities of Convair Division of General Dynamics.

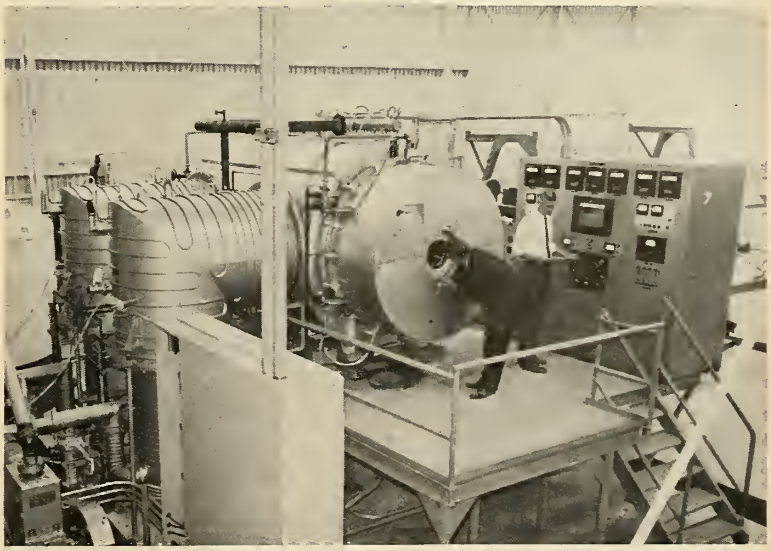
The installation will be used to test electronic components and pressure units for adaptability to space vehicles. Problems such as fluid leakage, lack of heat transfer and explosive decompression are also on the agenda.

The stainless steel chamber, 10 ft. long and 5 ft. in diameter, has a temperature range from −300° to 700°F. Full opening doors at either end facilitate test object handling. A 10-in. glass port permits visual observation during test runs.

The vacuum is created and maintained by a high-capacity oil-diffusion pumping system. Special liquid nitrogen traps and baffles freeze-out any undesired air or water vapor.

Company spokesmen said the chamber will probably be used almost entirely at its maximum pressure of 1×10^{-7} mm Hg. Two other high-performance vacuum tanks are now being tested at Convair.

The chamber was built by NRC Equipment Corp., Newton, Mass.



ULTRA-HIGH-VACUUM research at Convair will be performed in this stainless steel chamber. The installation simulates altitudes up to 250 miles.

NASA

RCA Communications, Inc., for a portion of the global communications network for Project *Mercury*. Amount not disclosed.

$806,500—Southwestern Engineering Co., Los Angeles, for vacuum system for heat transfer cooling and aerodynamic facility, Moffett Field.

$86,850—Radiation Dynamics, Inc., Westbury, N.Y., for ion source system.

$70,270—Linde Co., San Francisco, for liquid oxygen storage and dispensing facility installed at 3.5 ft. hypersonic wind tunnel, Moffett Field.

$69,910—General Electric Co., San Francisco, for services and materials for dismantling, cleaning, rewinding and reassemble rotor for 45,000 HP motor No. 4 unitary wind tunnel, Moffett Field.

NAVY

$6,000,000—Hycon Mfg. Co., Pasadena, for continued production of automatic checkout equipment for *Terrier-Tartar* missiles.

$2,000,000—Thiokol Chemical Corp.'s Reaction Motors Division, Denville, N.J., for continuation of the development of a liquid-rocket engine for the *Corvus*.

$1,500,000—Arma Division, American Bosch Arma Corp., Hempstead, N.Y., for compact anti-submarine missile systems.

$782,576—Republic Aviation Corp., Farmingdale, L.I., for building automatic guidance system for the *Bullpup*.

$105,000—Task Corp., Anaheim, Calif., for pump motors for use in the *Polaris*.

AIR FORCE

$40,763,711—IT&T's Federal Electric Corp., Paramus, N.J., for operating and maintaining 60 DEW lines spanning the northermost American continent.

$19,200,000—Westinghouse Electric Corp., Pittsburgh, for new high-powered, long-range search radar systems for the continental air defense network.

$15,625,000—General Electric Co.'s Heavy Military Electronics Dept., Syracuse, for production of AN/FPS-24 frequency diversity search radars.

$5,600,000—Massachusetts Institute of Technology, Cambridge, for design, construction and operation of a quarter-million gauss magnet installation for the conduct of a high-magnetic field research program.

$5,478,696—Douglas Aircraft Co., Inc., Santa Monica, for components, ground support equipment, spare parts and engineering data applicable to MB-1 rocket—*Genie*.

$1,400,000—General Electric Co., Syracuse, for work on a major silicon transistor reliability program in connection with the *Minuteman*. Subcontract from Autonetics.

$1,198,576—Collins Radio Co., Cedar Rapids, Iowa, for additional single-sideband radio communication equipment.

$400,000—Northeastern University, for design and evaluation of energy conversion storage system.

$291,500—The Martin Co., Baltimore, for 50 missiles and miscellaneous support requirements.

$248,946—General Dynamics Corp.'s Convair Astronautics Division, for design, development, fabrication and test of ultralightweight storable liquid-propellant tankage.

$107,185—Norair Division, Northrop Corp., Hawthorne, Calif., for research, development and fabrication of a rotational flight simulator for use in support of studies in bioastronautics.

$106,372—University of Illinois, Urbana, for conducting research into some of the basic physics of shock wave phenomena.

$95,030—Aerojet-General Corp., Azusa, for design and development of a rocket-borne attitude-sensing device.

$92,481—Thompson Ramo Wooldridge Inc., Canoga Park, for research on "Ion Beam Neutralization."

$90,377—Electro-Optical Systems, Inc., Pasadena, for research on materials exhibiting photovoltaic phenomena.

$70,000—Radio Corp. of America, Princeton, N.J., for continuation of research on "Plasma Acceleration by Electric Field Gradient."

$62,642—Texas Nuclear Corp., Austin, Tex., for research and reports on cellular bombardment.

$54,954—Stanford Research Institute, Menlo Park, Calif., for research investigation of the interaction of electromagnetic waves with a plasma.

$44,580—Aerojet-General Corp., for one thrust chamber assembly for sled runs in support of WS-133A and WS-107A programs.

$43,356—Ling Electronics Div., Ling Altec Electronics, Inc., Anaheim, for vibration test system applicable to the IM99A weapon system.

ARMY

Computer Equipment Corp., Los Angeles, for construction of two radar quantizers for the *Pershing* altimeter ground station. Amount not disclosed.

$10,000,000—Western Electric Co., New York City, for *Nike-Hercules* components.

$3,940,851—North American Aviation, Inc., Columbus, for target missile, type III-IV, supersonic, low and high altitude.

$2,000,000—ITT, Federal Division, for *Nike* missile support equipment.

$1,500,000—The Marquardt Corp., Van Nuys, for the design and fabrication of a ramjet propulsion system for a supersonic target missile system.

$1,030,255—Cubic Corp., San Diego, for performance and development, engineering design, fabrication and testing of necessary satellite payloads and associated equipment for mobile ground stations to be used for obtaining geodetic data.

$500,000—Instruments for Industry, Inc., Hicksville, N.Y., for research and development of electronic countermeasures equipment.

$323,464—Sperry Rand Corp., Salt Lake City, for furnishing and delivering repair parts for the *Sergeant* missile (three contracts).

$308,356—Westwood Construction Co., Denver, for construction of nosecone facilities at Lowry AFB.

$269,514—Thiokol Chemical Corp., Elkton, Md., for standard *Cajun* rocket engine, model III.

$191,679—Grand Central Rocket Co., Redlands, Calif., for research and engineering investigation of solid-propellant grains and methods of effecting thrust level control of solid-propellant motors.

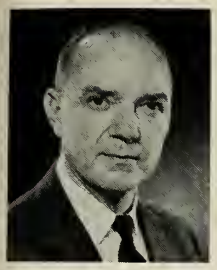
$126,235—Sperry Rand Corp., Salt Lake City, for *Sergeant* ground handling and test equipment.

$116,284—Telemeter Magnetics Inc., Los Angeles, for a high-speed digital memory system with clear control circuits.

Testing Minuteman Car

PRE-PROTOTYPE MODEL of the *Minuteman* rail car is getting shock-impact and checkout tests at American Car and Foundry's plant in Berwick, Pa. The car is designed to cushion the missile from transverse, longitudinal, and vertical shocks during rail transportation. After these tests are completed, it will be joined to an Air Force train for road testing.

names in the news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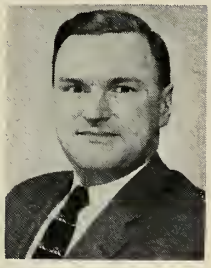
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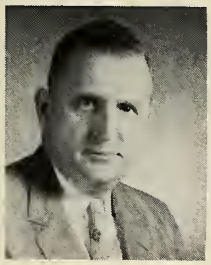
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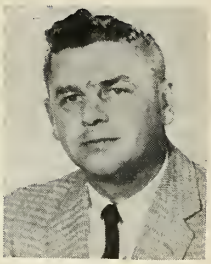

WOODHAMS

Col. E. T. Bullock (USA-ret.): Deputy Commanding General of the U.S. Army Electronics Proving Ground at Fort Huachuca, Ariz., joins Cook Electric Co. as director of planning for its new TransDigital Systems division.

Paul B. Black: Appointed marketing manager of the Systems Engineering and Management Operation of Sylvania Electronic Systems. Previously served as manager of the B-58 Hustler program at the Buffalo operations.

Dr. Martin Schilling: Elected vice president-engineering and research for Raytheon Co., succeeding **Dr. I. A. Getting,** who has resigned to become president of the newly-formed Aerospace Corp. Prior to joining the firm in 1958 as program manager of the Missile Systems Division, Dr. Schilling was chief of the project management staff of the Army Ordnance Missile Laboratories' Research and Development Division, Huntsville, Ala.

Donald K. Adams: Former project engineer for the U.S. Army Electronics Environmental Test facility joins Cook Electric Co.'s TransDigital Systems division as director of liaison engineering.

Ed Woodhams: Former measurement standards engineering specialist with the Measurements Standards Laboratory at Lockheed Missiles and Space Division, appointed laboratory director of National Astro Laboratories, Inc.

O. E. (Pat) Tibbs: Former Martin Co. chief test pilot and more recently head of the activation division in Denver, takes over the general manager's post of Martin operations at Cape Canaveral. He replaces **George E. Smith,** who will go to Martin-Denver.

Arthur S. Davis: Former sales manager for Westinghouse Electric Corp.'s Gearing Division, named customer relations manager of Elgin Micronics, a division of Elgin National Watch Co. He will be in charge of all marketing and sales for the division's plant in Elgin as well as the plant being built in Rolling Meadows, Ill.

N. S. Hopkins and **E. W. Bode:** Elected chairman and vice chairman of the executive committee of Holloman Test Directors' Council. Hopkins, manager of the Lockheed Missile Space Division AFMDC, succeeds **Thomas Bean** of Telecomputing Services, Inc. Bode is currently chief of the AFMDC Field Test Group of Radioplane.

John A. Garman: Named research and development director of Food Machinery and Chemical Corp.'s Chemicals & Plastics Division, succeeding **Sherman K. Reed,** now director of research for the Chemical Divisions.

Robert Seal: Former executive vice president named president of RS Electronics Corp., a subsidiary of Regan Industries, Inc. **Robert B. Parks,** former vice president named executive vice president and **Clinton O. Lindseth,** chief engineer, appointed vice president-engineering.

Dr. Joseph Rosenberg: Joins Tracerlab as head of the Organic Chemistry Dept. Was previously an organic chemist at the General Electric Laboratory, Schenectady and the G. E. Advanced Projects and Laboratories Operations, Erie, Pa.

Jerome L. Strauss: Budd Electronics, Inc.'s vice president for marketing, elected vice president and general manager.

Myron A. Tracy: Manager of The Garrett Corp.'s Washington sales office, appointed manager of military relations. He will conduct all prime military sales and contract negotiations for The Garrett Corp. and its AiResearch Manufacturing Divisions.

Leslie L. Alt: Joins the General Electric Advanced Semiconductor Laboratory as a physicist concerned with research in surface properties of semiconductor materials and devices.

W. E. Giberson: Named chief of the newly organized Guidance and Control Division at the California Institute of Technology Jet Propulsion Laboratory. Supporting Giberson will be: **Howard H. Haglund,** deputy chief; **Henry A. Curtis,** chief of electronic devices section; **Garth E. Sweetnam,** chief of space craft secondary power section; **Norri Sirri,** chief of guidance and control systems section; **John R. Scull,** chief of electromechanical devices section; and **Dr. John H. Laub,** chief of guidance and control research.

James W. Flynn and **Dr. Russell N. Clark:** Appointed vice president and director of marketing, and vice president and technical director, respectively, of Celanese Polymer Co.

Edward J. Querner: Named vice president and general manager of Daystrom, Inc. Transicoil Division. Was formerly Transicoil manager of manufacturing.

John P. Gaty: Vice president and general manager and director of Beech Aircraft Corp. will resign as of Sept. 30.

James V. Bitner, Jr.: Former technical director in charge of all engineering of the *Mace B* program at Martin-Baltimore, appointed assistant general manager, Instrument Division, of Lear, Inc.

Bernard R. Garrett: Former chief engineer, elected vice president, engineering and research, at Loral Electronics Corp.

Robert C. Boe: Former marketing manager and assistant vice president and general manager of Cook Technological Center, appointed marketing manager of the Buffalo Operations of Sylvania Electronic Systems.

William W. Pleasants: Appointed manager of the RCA BMEWS installation at Clear, Alaska.

Richard Cook: Joins the engineering staff of Technology Instrument Corporation of California as an electronic component engineer.

George J. Sbordone and **John Van Putten:** Named division general manager and manager of customer liasion, respectively, in the Military Products Division of Tempo Instrument Inc.

Lt. Col. Glenn Crane: Named project officer in charge of the Army's *Nike-Zeus* program, succeeding **Col. John G. Zierdt,** now commander of ARGMA.

Huntly P. Briggs: Appointed advertising and public relations director in the Military Products Division of Hoffman Electronics, succeeding **William H. Herrmann,** who has resigned.

Temperature Calibration

Conrad, Inc. announced the availability of a production model temperature-coefficient calibration chamber for thermistor and capacitor tests. The equipment capability is for stabilizing within plus or minus 0.005°C stability. The equipment is also available with additional controls to permit stability of plus or minus 0.001°C.

The temperature range available is from +250°C to −75°C. Instrumentation for recording the controlled condition can be supplied together with automatic temperature conditioning.

Circle No. 225 on Subscriber Service Card.

Solid-State Tape Rec/Rep

An all-solid-state magnetic tape recorder/reproducer has been developed by the DataTape Division of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co.

Up to 14 channels of direct-record or wide-band FM analog data can be recorded and played back bi-directionally. Head assemblies for two record and two reproduce heads of seven channels each can be plugged in. An accessory erase head is also available.

The Type PR-2300 records and reproduces at speeds of 60, 30, 15, 7½, 3¾, and 1⅞ in./sec. Speeds are changed in pairs by changing drive belts. Choice between the two speeds in each pair is made from push-button controls. Tape speed is held constant to within 0.25%.

Circle No. 226 on Subscriber Service Card.

Ultrasonic Spot Welder

An ultrasonic spot welder with a high-temperature, high-efficiency transducer construction and a unique self-tuning circuit has been announced by International Ultrasonics, Inc., an affiliate of Aero Supply Mfg. Co., Inc.

The spot welder is used for joining similar or dissimilar metals, of equal or different thickness. The top piece may be up to 0.006 in. in thickness. There is no limit on thickness of the bottom piece. Materials as thin as 0.00025 in. have been joined. Typical applications include joining leads to capacitor foil, joining foil tape for foil-wound transformers, attaching leads to transformer tape, making lead connections to transistors and diodes, and making attachments to copper and aluminum printed circuit boards.

Circle No. 227 on Subscriber Service Card.

Universal Circuit Cards

Development of a universal circuit card which can be prefabricated and adapted to different circuit requirements has been announced here today by Librascope, Inc.

The stock card contains a universal etched pattern which can be modified by interconnections to form any desired circuit function.

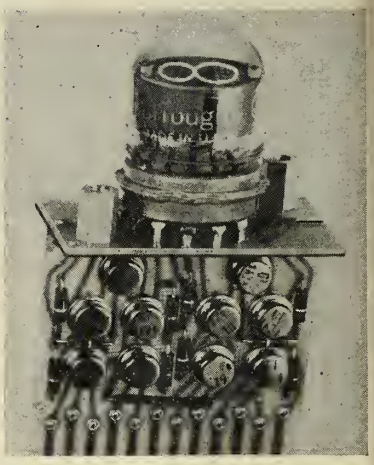
On the stock cards components may be added to form logic modules before the final design of a computer is ready, and then, when the design is firmed, these modules may be interconnected to form the required circuits.

Such a technique is particularly adaptable to short-run and prototype production, where lead time between design and actual start of production is usually excessive.

Circle No. 228 on Subscriber Service Card.

Low Power Visual Readout

The Burroughs Corporation's Electronic Tube Division has announced the addition of two low-cost transistorized driver modules to their TRIXIE driver line. The TR-40 has been designed to operate the miniature NIXIE(R) indicator tubes, and the TR-57 has been designed to operate standard and super NIXIE indicator tubes.



The TRIXIE readout comprises ten medium-voltage NPN transistors in a common emitter configuration with each transistor driving one of the NIXIE indicator tube's 10 cathodes.

Circle No. 229 on Subscriber Service Card.

High Voltage Power Pack

Era Pacific, Inc., has extended its present line of HYPAC high-voltage supplies with the addition of the MICROPAC series of subminiature solid-state high-voltage DC power supplies.

Units are available for operation from a 60- or 400-cycle line, in addition to a 26-29 VDC line. Line regulation of ±.5% for 20-100% load changes. Ripple is 1% RMS. Standard voltages available are 1000, 3000 and 5000 VDC at a maximum load current of 100 microamperes. Also available are units having the same input and output voltages but without the regulating circuit. These supplies are more inexpensive than the regulated series and provide regulation of approximately ±5% over 20-100% load variations.

Circle No. 230 on Subscriber Service Card.

Circuit Switching Board

A new circuit-switching/component interposition is being produced by Sealectro Corp.

Sealectroboard allows instantaneous set-up, or programing of circuitry logic between X and Y axes of terminations, without the use of patch-cords, and at the same time permits interposition of diodes, or other miniature electronic components between any X and Y termination.

Circle No. 231 on Subscriber Service Card.

Miniature Check Valve

Miniature in-line check valves, designed for applications too small to accommodate larger check and butterfly valves, are being produced by Barber-Colman Co. Available in sizes from 0.25 to 0.50 in., in-line check valves are designed for direct coupling into high-pressure, high-temperature air flow lines.

This check valve allows air to flow in one direction only and closes immediately upon air flow reversal. Maximum temperature is 900°F with a maximum internal leakage of 0.04 lb./min. at 300 psig. External leakage is zero. Weight is 0.12 lb. for 0.25 in. valve.

Circle No. 232 on Subscriber Service Card.

Wirewound Micropot

Borg Equipment Division, Amphenol-Borg Electronics Corp., has available a series of 7/8-in.-diameter, wirewound Micropots.

Designated the 2100 Series, this new Micropot will be available in ten-turn and three-turn models.

Assemblies of the 2100 Series can withstand more than 1,000,000 revolutions without exceeding total resistance of linearity tolerances. Total resistances to 100,000 ohms are offered.

Circle No. 233 on Subscriber Service Card.

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CLASSIFIED

editorial . . .

Khrushchev—How Long, Oh Lord?

SOME WEEKS BACK the dictator of the Soviet Union broke up the Summit Meeting, called the President of the United States back-alley names and revoked his invitation to the President to visit Russia.

Not long after that he proclaimed unilaterally a bit of international law little noticed in this country—his own mandate that any country suffering the overflight of a missile would forfeit its neutrality.

And he topped these outbursts, if topping them is possible, by openly admitting that Russian fighter aircraft had shot down an unarmed American weather plane—apparently over neutral territory.

Despite these events, our present Administration has indicated that the additional money voted by Congress for the U.S. military budget will not be spent—or at least the major part of it will not be.

The Administration's attitude is, to judge from the past, that our military programs are proceeding according to plan—that our deterrent posture is sufficiently strong without the extra money.

We should like to go on record as feeling that it is almost literally impossible to be *too strong* at this moment.

It is not so much that we are tired of Khrushchev's blustering threats, his insults and his overt armed terrorism; it is the fact that he is able to perform such acts with the complete sureness that nothing much will happen when he does.

Khrushchev respects only one thing and bends to only one thing—strength. And this is the thing we are lacking—visible, apparent, recognized strength. It can't be strategic alone, it must be tactical too. It can't rest alone with the Air Force or the Army or the Navy. It has to be inherent in all three services. It cannot be a strength capable of dealing with global wars only. It must be competent to handle limited conflicts as well.

One weakness is too many. The Russians will find it and exploit it, even as they are now concentrating on the nation's softest spot—the Administration.

Under Mr. Eisenhower we are living in an unreal and unrealistic climate where more cars must be built but not the roads to drive them on; where scientists are vitally important but not the schools to educate them; where space is recognized as the frontier of tomorrow but the exploration of it has a lower priority than preserving surplus grain; where military strength is a matter of survival yet we cannot spend the money to make us strong; where golf is more important than our political welfare.

And we continue to be pushed around, bullied and insulted by Nikita Khrushchev.

We cannot—looking back upon the U-2 incident, the summit collapse, riots in Japan, Cuba and the murder of the RB-47 crew—find one iota of hope for a lessening of the menace the Soviet Union holds for us and the entire free world.

WE see no reason to expect anything but a continuation or a worsening of the pressure Khrushchev will apply at every weak point he finds or suspects.

We as a nation don't want this menace and this pressure, nor do we have any desire to reciprocate. But when it becomes obvious that the menace and the pressure are something we must live with, then let's do everything we can to create a situation whereby we can live with it on our own terms.

There are many forms in which a nation can be strong; at the moment the one we are interested in first is the one the Kremlin recognizes—the brute variety. Let's be strong enough that an insult from Khrushchev will be a calculated risk and not merely a scornful gesture. This will take money, and don't think for a minute money can't be used to a good purpose right now. Money in military budgets buys hardware and time. It buys concrete strength. We can think of no better way to spend it.

Clarke Newlon

SYSTEMS INTEGRATION

Systems Integration, a major endeavor at Lockheed, involves the responsibility of establishing and maintaining composite system and subsystem characteristics within the parameters necessary for a successful development of weapon and satellite systems.

An outstanding example of this system's engineering approach is illustrated by the Navy POLARIS Fleet Ballistic Missile Weapon System. The Navy gave Lockheed Missiles and Space Division the basic overall weapon system requirements and the required operational date, and requested Lockheed to develop a missile system compatible with the other systems of the weapon system. This demanded an entirely new procedure in missile development: 1) The design had to be based on anticipated advances in the state-of-the-art to meet performance requirements. 2) Simultaneous development of missile subsystems in an independent fashion was required to meet time scale requirements. Not only is Lockheed meeting these requirements—*it is delivering an operational missile system three years ahead of the original schedule.*

Detailed functions of successful systems integration activities include: Establishment of basic system characteristics through use of preliminary design and parametric study techniques; sectionalizing the missile and defining interfaces and performance requirements for each subsystem; monitoring and counseling the design activities of subsystems and establishing interfaces and subsystem design parameters and tolerances; assuring and maintaining design compatibility of subsystems throughout the entire development of the missile into the weapon system.

From the development of advanced system proposals into the preliminary design and system requirements, on through to final missile production, demands highly trained engineers and scientists in missile and space technology concerned with the overall systems problems.

Engineers and Scientists: Work in the broad spectrum of systems integration functions provides a constant challenge at Lockheed Missiles and Space Division. If you are experienced in this area, you are invited to write: Research and Development Staff, Department G-29B, 962 W. El Camino Real, Sunnyvale, California.

U.S. Citizenship or existing Department of Defense industrial security clearance required.

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