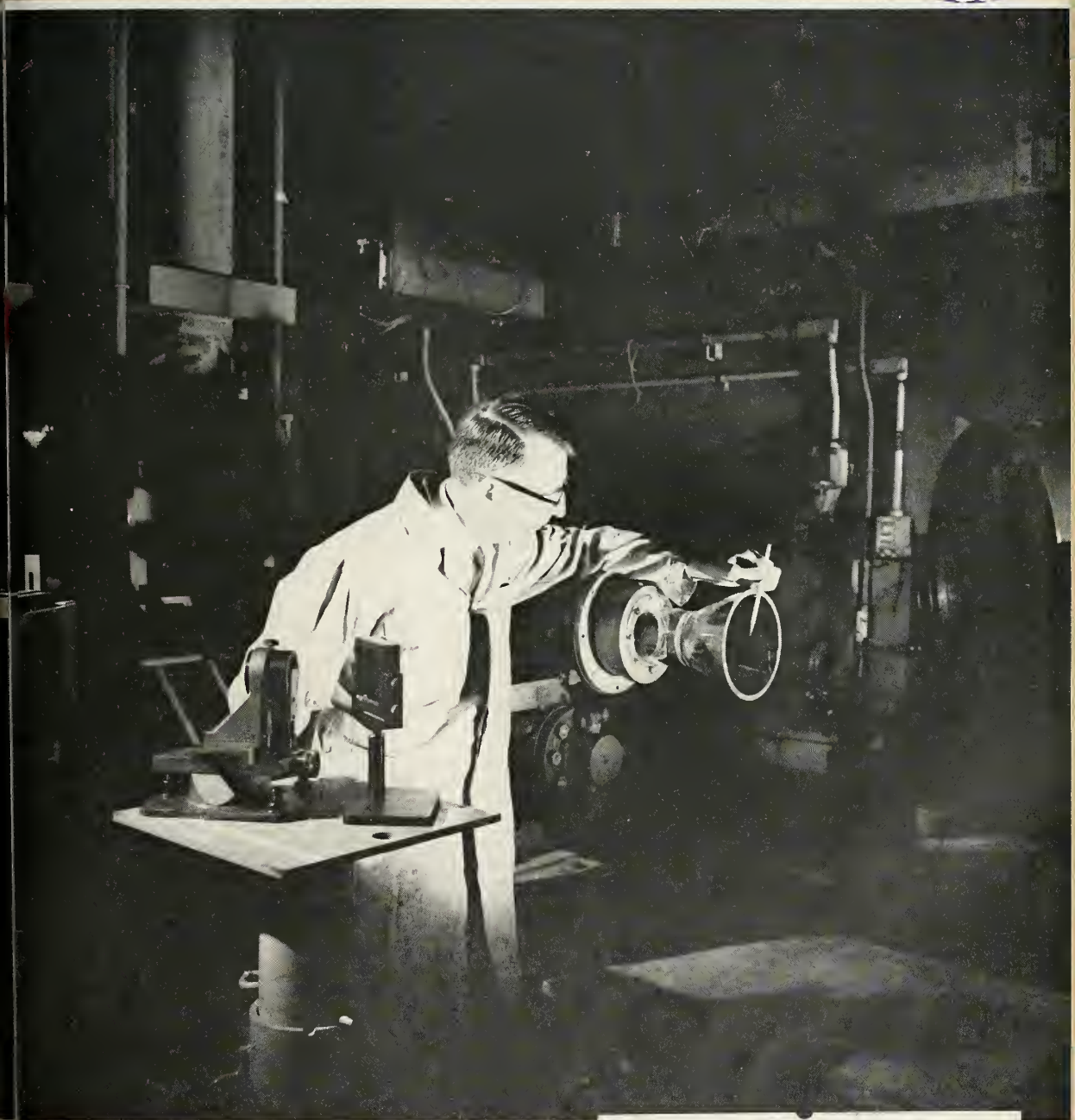
NOVEMBER 14, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY



Nozzle Contour Optimization at Allison

Is DOD Headed for Shake-Under New Administration? . . .

AN AMERICAN AVIATION PUBLICATION

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April, 1960: TIROS I. The sophisticated satellite, including its structural design as well as the electronic systems, and its ground stations were developed and built for NASA by AED under the technical direction of the U.S. Army Signal Corps. It accomplished its mission in meteorological observation, sending down over 20,000 TV pictures of earth and its cloud cover.

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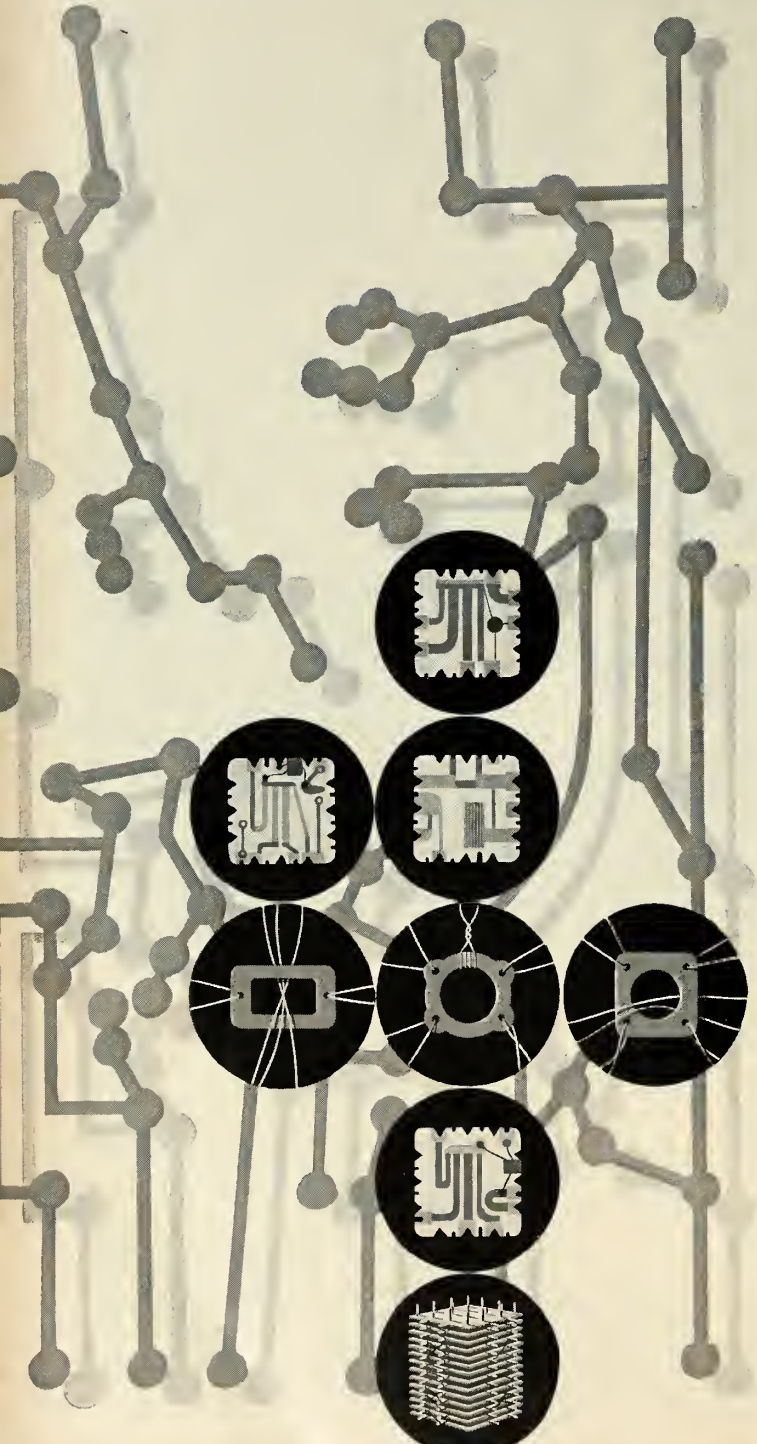

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THE MISSILE / SPACE WEEKLY

missiles and rockets

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THE COVER

Photo records of light variations caused by internal air flow through transparent nozzle models help Allison to achieve high-velocity exhaust flow. *See p. 22.*

NOVEMBER 14 HEADLINES

EXCLUSIVE: THE OUTLOOK UNDER KENNEDY

INDUSTRY

ENERGY CONVERSION

ELECTRONICS

DEPARTMENTS

31,802 copies this issue

The Countdown

WASHINGTON

Anti-Tank Choice May Be Near—Again

The secret recommendation of Army evaluators on which company should get the nod in the hot international competition to sell the Army anti-tank missiles continues to languish in top Army echelons. However, insiders again are saying an announcement may come soon. One possible straw in the wind: Army industrial officials are reported to be talking to Boelkow officials in West Germany about *Cobra*.

B-70, Skybolt Still Wed in AF Eyes

Despite the present B-70 R&D program's failure to include plans to carry the Douglas *Skybolt*, the Air Force has privately made clear that the *Skybolt* is still very much in the picture. Taking *Skybolt* away from the B-70 is nothing less than degrading sharply the big bomber's value as a weapon.

Minuteman Troubles Denied

Rumors that R&D guidance problems might force postponement of plans to launch the first test *Minuteman* with all major components in December are being scotched by the Air Force. As one informed source put it: "The December shot still stands."

Doubts on Neutron Bomb Warheads

The value of developing lightweight N-bomb warheads for tactical missiles is being questioned by some military experts. The drawback: The N-bomb, which kills by radiation, doesn't necessarily kill quickly. The result: The doomed victims become very, very angry and very, very brave.

Air-launched Satellites, Ahoy!

The Navy is understood to be planning a new attempt to launch a satellite next year with an airborne booster. The satellite will be carried in the nose of the new *Caleb* four-stage solid-propellant missile under development by NOTS at China Lake. Earlier NOTS airborne satellite launching attempts with other boosters were unsuccessful. However, NOTS has high hopes for doing the job with *Caleb*.

Sea Scout for Navy

The Navy is seeking its own version of the AF-NASA *Scout*. It would like to use the all-solid vehicle for a seaborne satellite launcher. Vehicle would consist of a *Polaris* booster and upper stages from the NASA *Scout*.

When There Were Six—Temporarily

An operation for removal of gall stones is expected to eliminate Astronaut Gordon Cooper as a prospect for making the first manned *Mercury-Redstone* ballistic shot. The Air Force captain will remain in the program, but the assignment probably will be given to one of the other six astronauts, if the shot goes as scheduled early next year. Cooper is expected to be back on flight status in six months.

INDUSTRY

Navy Eyes AF Project 3059 Launch

Hopes for the Navy's Project *Hydra* are now pinned on using the concept as a means of launching huge solid rockets—like the million-lb.-plus-thrust Project 3059 of the Air Force. With *Hydra*, such large vehicles would be launched while floating freely in the ocean, eliminating the need for costly launch pads (M/R, May 2, p. 12).

Build-up for B-70

"Gradual increase" in employment of high-level electronics engineers and scientists is forecast by Motorola with its reinstatement as a major B-70 sub. Motorola is developing mission and traffic control system for the Mach 3 bomber at its Scottsdale, Ariz., headquarters.

Testing Zeus 'Jet Head'

Lack of space at its White Sands Missile Range is forcing the Army to test the *Nike-Zeus* "jet head" terminal guidance component at Point Mugu, Calif., home of the Navy's PMR. Tests of the fully assembled bird against a missile will be conducted from Kwajalein Atoll in the Pacific.

INTERNATIONAL

Britain Buying Sidewinders

The Royal Navy's new Scimitar fighter will be equipped with U.S. air-to-air *Sidewinders*—instead of the de Havilland *Firestreak*. Main reasons for the switch: The Scimitar isn't suited to the *Firestreak's* launcher and cost (about $2500 per *Sidewinder* against $22,500 for a *Firestreak*.)

Improved Thunderbird on Way

Full development of English Electric's advanced (Mark II) *Thunderbird* air defense missile is being authorized by the British Government, with the intention of fully equipping the Army as soon as possible. Big improvement is said to be in the solid-fueled bird's 25-mile range. Mark I *Thunderbird* is now going into two heavy anti-aircraft regiments.

French Space Group Formed

France has created a space R&D organization called Comité d'Action Scientifique de la Défense Nationale. The new group will work with Centre National d'Etude des Télécommunications which has been involved in North African rocket tests.

Overseas Pipeline

The French are having second thoughts on joining Britain's "Space Club," if the *Blue Streak* is to be the club's satellite launcher. They don't think club members should have to pay for completing the development and conversion of the missile . . . A new mail rocket (containing 320 postcards) has been launched successfully by the Deutsche Raketengesellshaft of Bremen . . . British Aircraft Ltd. is making circuit boards for use in next year's U.S.-British satellite shots with *Scout* rockets.

EXCLUSIVE . . .

A Kennedy Priority:

How He Will Overhaul the Pentagon

by Clarke Newlon

A COMPLETE reorganization of the Department of Defense will be proposed by the Kennedy administration to the new Congress as one of the first orders of business in January, 1961.

The reorganization would include:

–Abolishing the positions of the three service secretaries—Army, Navy and Air Force.

–Appointing a single chief of staff for the Department of Defense.

–Establishing a single overall war plan for the three services.

–Retaining the three individual services but establishing integrated, unified commands by missions, with these five most likely: 1) Strategic; 2) Mobile Striking Force; 3) American Defense; 4) Research & Development; 5) Logistic. (Pacific and Atlantic Commands might be included.)

These moves will be included in a comprehensive bill to be introduced by Stuart Symington, senator from Missouri and member of the Senate Armed Services and Space Committees. The measure probably will encompass many other Pentagon changes.

It would propose identical effectiveness reports on military officers, with an integrated promotion system to follow.

It would abolish all of the present assistant secretaries of the services, as well as the secretaries.

It would strengthen and centralize the power of the Secretary of Defense, combining many of the functions currently under the services and placing them in DOD.

It would abolish the Joint Chiefs of Staff as a decision-making body and make the Chief of Staff of Defense the nation's top military officer.

The business of reorganizing the Pentagon has occupied Sen. Symington for several years, probably since his own tenure there as first Secretary of the Air Force, when DOD was formed as a small policy-making organization.

• **Key committee**—The reorganization which will be proposed in January, however, comes as the result of the work of a committee appointed by President-elect shortly after nomination. The group, under the chairmanship of Symington, is composed of:

Clark M. Clifford, lawyer, former Special Counsel to President Truman and one of the drafters of the National Security Act of 1947.

Thomas K. Finletter, lawyer, forme Secretary of Air Force and Chairma of the Presidential Air Policy Co mittee.

Roswell L. Gilpatric, lawyer, form Under Secretary of Air Force and me ber of The Rockefeller Special Studi Project.

Fowler Hamilton, lawyer, former with Attorney General and Justice D partment, former General Counsel Se ate Subcommittee on Air Power.

Marx Leva, lawyer, former Assi tant Secretary of Defense and Chai man, Civilian-Military Review Pan for Special Committee of U.S. Senat

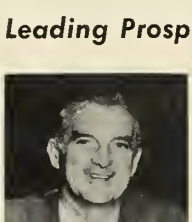
Executive Director of the commi tee is Dr. Edward Welsh, economi and present legislative assistant to Se Symington.

• **No new studies**—In naming t group, Kennedy said:

"The work of the Committee w be focused upon the administration an management of the Defense Depar ment and related defense agencies an organizations.

"The Committee will not make a other sweeping investigation or study defense, military policies and resourc such as have been so ably and thorough ly done in recent years by vario

Leading Prospects for Secretary of Defense



SYMINGTON

GILPATRIC

***SPECULATION** as to who President-Elect Kennedy will name to be Secretary of Defense centers on three men, all members of the committee Kennedy named to draw up a reorganization plan. They are:*

Stuart Symington, Senator from Missouri, first Secretary of Air Force and arch critic of the Defense establishment. Symington has said recently that he is "not interested" in becoming DOD Secretary, wants to stay in the Senate. Those close to him, however, know that he is itching to get his hands on the five-sided setup. His decision may depend on how much influence he might wield without becoming Secretary.

Thomas K. Finletter, another former Air Force Secretary, author and student of politics. Finletter is known to want State first, Defense second. His age (67 on Nov. 11) could be a deciding factor.

Roswell L. Gilpatric, former Under Secretary of Air Force, might be a dark horse. Kennedy named two committees relating to defense. One was Symington's reorganization group. The other was on foreign policy and defense and is headed by Sen. "Scoop" Jackson (D-Wash.). Gilpatric was the only man named to both committees.

ouse and Senate Committees, and by ch private groups as the Gaither and ockefeller Committees, the Council n Foreign Relations, the Foreign olicy Association, the Carnegie Corp- ration, the great universities and hers.

"Rather it will utilize their splendid ork as its primary source for facts, alyses and informed opinion on the arrow field of defense management d administration with which it is lled upon to deal.

"The crucial questions are those of dgment as to what changes should e made in the organization and ad- inistration of our defense agencies to iminate or at least to diminish the esent crippling effect of those prob- ms upon our defense power."

Kennedy forecast his reorganiza- on plan in his reply to the MISSILES ND ROCKETS open letter (M/R, Oct 0) in which he proposed establishment unified commands and said of the entagon:

"Certainly defense regulations and rocedures must be simplified, and the roliferation of secretaries, assistant ecretaries, undersecretaries, special as- stants and deputy assistants to secre- ries, boards, commissions, councils nd committees must be rolled back."

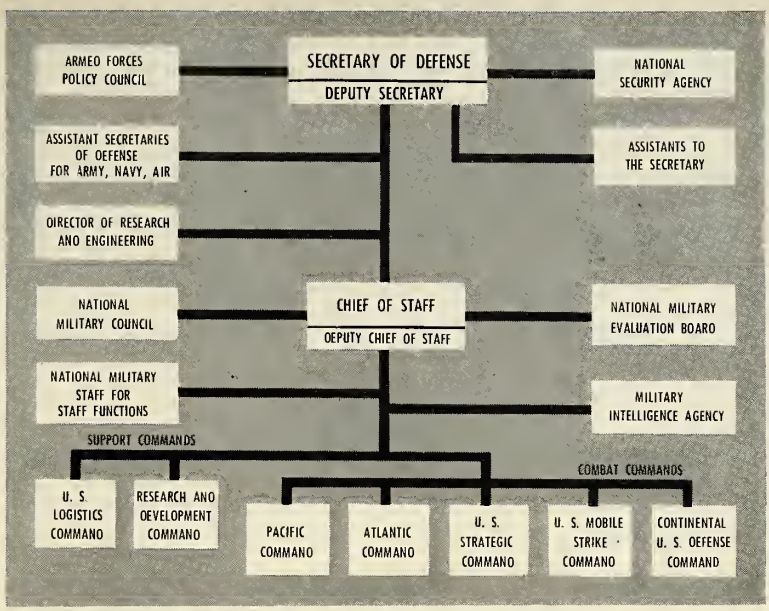
The Symington Committee has been ked to submit its reorganization plan y Dec. 31. Upon it, presumably, the Missouri Senator will base his legisla- on.

• **Stormy passage likely**—The re- ganization plan will carefully skirt ny move to put the military into either ne service or one uniform. Even so it ill face strong opposition from certain ements of both Congress and the ilitary.

The Navy has always been opposed any hint of a single service and has ot favored unified commands even ith Navy in the top position, mostly ecause it was establishing a trend to- ard ultimate unification of the Serv- es. Rep. Carl Vinson, the Georgia ongressman who is often called the ather of the Navy" is expected to le with Navy views. As chairman of e House Armed Services Committee hich he has run with an autocratic nd for years, he could put up formid- le opposition.

The Air Force has long favored a gle service and a single uniform, d present AF Chief of Staff General omas White has often so spoken. e Air Force considers it has the dom- nt military role in the U.S. and as h has little to fear from unification.

The Army would be somewhat op- sed, but less so than the Navy. Many my officers feel that the Army role a unified setup would be stronger n it is now. ⁂



How Symington Plan Might Reshuffle DOD

THE ACCOMPANYING CHART shows the present thinking behind the Symington DOD reorganization plan, although its details are subject to modification.

Reading from the top, the Armed Forces Policy Council and the National Security Agency would remain much as they are now.

The present Service Secretaries would become either Under or Assistant Secretaries directly on the staff of the Defense Secretary. Assistant secretaries of the services would be abolished.

The assistants to the Secretary would take over the functions formerly performed by the Service Assistants (and frequently duplicated on the DOD level, also.) These would include such functions as manpower, materiel, logistics, research and development, and financial management.

The Director of Research and Engineering would have greater representation from the Services, and greatly expanded powers.

• **JCS replaced**—*The National Military Evaluation Board would function for all Services and would have a greatly increased role of responsibility in military plans of all kinds and in ensuring that they are carried out according to directions of the DOD Chief of Staff.*

The National Military Council is perhaps the key to the success of such a reorganized establishment. The Council would replace the present Joint Chiefs of Staff as an entity, but might include them individually as heads of their services.

The Council would be the top military advisory group. It would do all strategic planning, prepare emergency war plans, logistic, materiel and weapons requirements, budget and personnel estimates.

The Military Intelligence Agency would combine the now individual intelligence organizations of each service.

The National Military staff would handle the normal staff functions for the Department of Defense—logistics, communications, personnel, comptroller, etc.

• **Functional commands**—*The commands are divided into two groups, combat and support. It is possible that in final realization the support commands would report to a civilian official rather than to the Chief of Staff.*

Otherwise, the commands would be functional rather than by service. The Strategic command would merge our present missile and long-range striking forces. The Mobile Strike Command would place the tactical forces of the three Services—probably including the Marines—into a highly mobile force designed for conventional or atomic combat—particularly for localized or small wars.

The Defense Command would encompass the present integrated NORAD and probably take in the present Alaskan and Caribbean Commands.

The Atlantic and Pacific Commands would do little more than unify and group these two into geographical areas, providing room for later expansion if and when it became necessary.

The Logistic Command envisions an ambitious unification of complete logistic functions of all three services into one organization for supply and distribution.

The unified Research and Development Command would propose an eventual amalgamation of all R&D functions under one organization, with personnel and facilities taken from the present military setups.

Exclusive . . .

Joint Strategic Targeting Tackl

New agency headed by SAC's Gen. Power will influence unification of arme services in Kennedy administration; mould future mix of forces

by James Baar and William E. Howard

THE COMING MISSILE GAP is already forcing a new unification of sorts in the Armed forces at the most sensitive level—strategic targeting.

Moreover, this unification is expected to have far reaching and continuous affect on the composition of the long-range strategic striking forces of all three military services under the Kennedy Administration.

This is the underlying significance of the new Joint Strategic Target Planning Staff that has been organized under the Joint Chiefs of Staff and set up at SAC Headquarters at Offutt AFB, Neb.

The Joint Targeting Staff—headed by Gen. Thomas S. Power, SAC commander, with Vice Adm. Edwin N. Parker as staff vice chairman—is responsible for assigning strategic targets for all weapons capable of striking them. One of its first jobs was assigning targets for the 16 nuclear-tipped *Polaris* missiles aboard the submarine George Washington which goes on station this week.

• **Guidance during Gap**—The coming deployment of the first *Polaris* submarines was the overt reason for establishment of the Joint Targeting Staff in late August. However, an even more important reason was the need for the careful husbanding and meticulous integration of all U.S. strategic weapons during the years of the Missile Gap in the early 1960's.

Formerly the assignment of targets for strategic nuclear weapons was handled on a far looser basis.

Officially the services told the Joint Chiefs of Staff what targets they hit and the Joint Chiefs in turn assigned targets to the Air Force and Navy for the bomber, carrier and missile forces. In operation, the services to a great extent prepared to fight their own war.

Under the new system, the Joint Targeting Staff, which is comprised of officers from all services, assigns the targets after thorough study of all available forces and submits the assignments to the Joint Chiefs for final approval. The result is an integrated war pla designed to make the best use of a available strategic weapons.

• **Varied arsenal**—At present, son 90% of the nuclear striking power carried by the SAC bomber fleet. Hov ever, an increasingly larger share wi be provided by SAC's ICBM forc and the Navy's *Polaris* submarines.

Moreover, these forces are suppl mented by the Navy's carrier-base bombers, USAF fighter-bombers an such air-breathing missiles as the *Snar Regulus I, Matador* and *Mace*. In th next few years there also will be th Army's 500-mile range *Pershing* an possibly the 1000-mile range *Pe shing II*.

The Joint Targeting Staff when con pletely organized is expected to be con prised of 40 to 50 officers.

Power, besides being chairman, co tinues to command SAC. Parker wa reassigned from his post as head the Defense Atomic Support Agenc the organization responsible to the ser ice chiefs for development of nuclea weapons, to take on the job of vic

Estimated Strength of Today's U.S. Strategic 'Mix'

OPERATIONAL MISSILES		OPERATIONAL BOMBERS	
Atlas (SAC)	12	B-47's (SAC)	1000+
Polaris (Navy)	16	B-52's (SAC)	550
Snark (SAC)	20	B-58's (SAC)	12
Matador-Mace (TAC)	250	Carrier Bombers (Navy) (6th and 7th Fleets)	400
Regulus Ships (Navy)	5 Subs & 2 Cruisers	Fighter Bombers (USAF)	2000

Missile Gap

chairman. Army Brig. Gen. Berton Spivey, Jr., serves on the staff as the representative of the Joint Chiefs.

Liaison is maintained with the British for coordinating targeting plans involving the four 15-missile *Thor* squadrons and RAF V-bombers based in Britain. Similar cooperation will be maintained with the Italians and Turks when they get *Jupiter* squadrons operational.

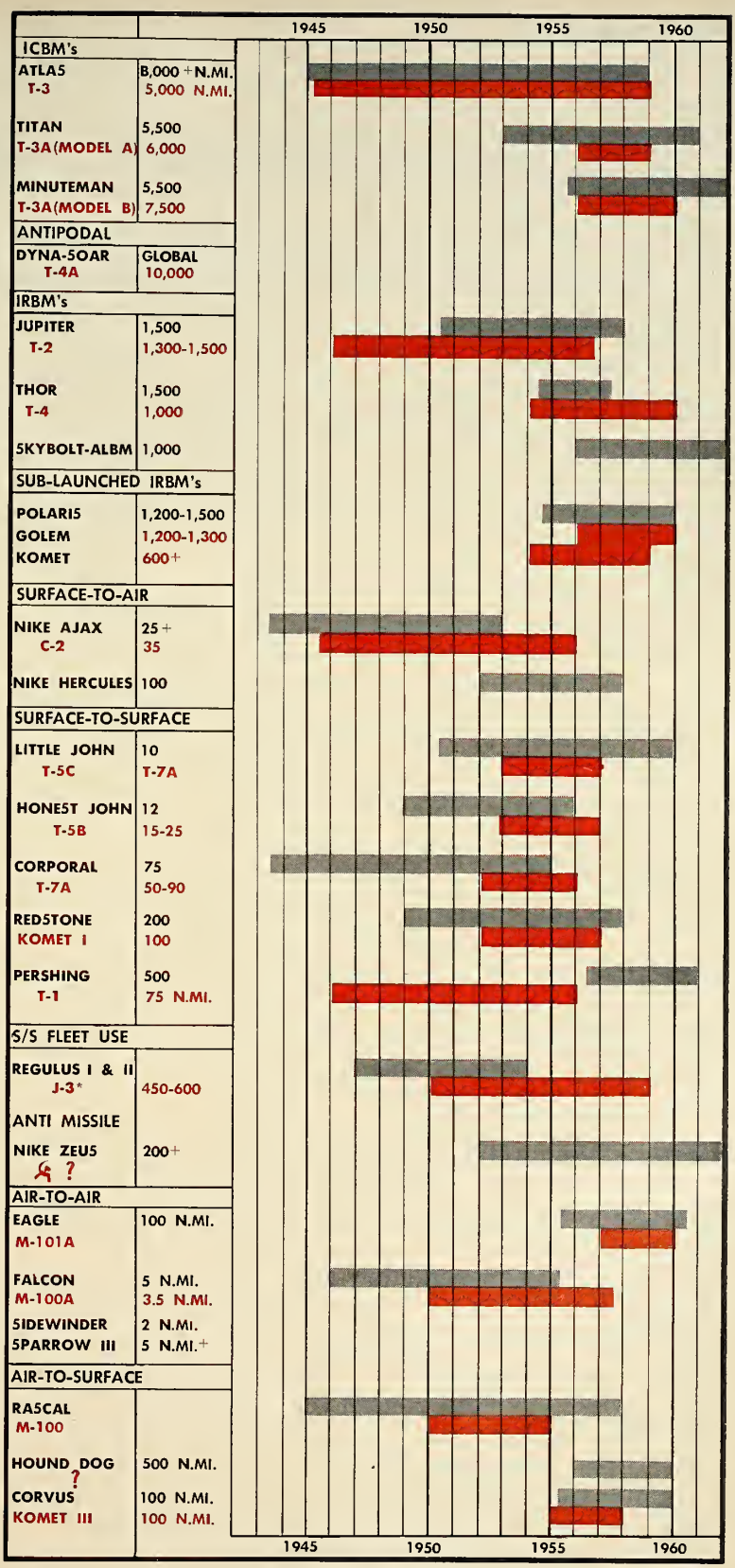
• **Voice in 'mix'**—Although the Joint Targeting Staff is physically located at SAC Headquarters, it is organizationally a staff arm of the Joint Chiefs in Washington.

It is decidedly not an operational organization. The targeting assignments are passed along to the various services and commands.

Specifically, this means that SAC's bombers and missiles will continue to be operated from SAC Headquarters and the various Air Force headquarters around the world.

The *Polaris* submarines will operate as part of the Atlantic Fleet under its headquarters at Norfolk, Va. The carriers will continue to operate as part of the various fleets in the Pacific, Atlantic and Mediterranean.

But the overall capabilities of all forces are being continually weighed and reassessed by the Joint Targeting Staff. And that staff's conclusions can be expected to have great weight in determining the "mix" in the years to come. ⁂



LEAD TIME LAG of operational missiles is major factor in target planning. The problem is graphically shown by comparing lead times needed for the development of U.S. and Soviet missiles of similar type. The comparative figures shown on the chart (right) were compiled by Mrs. Mary G. Page, a research aide at the Operations Research Office of Johns Hopkins University. The chart, compiled from unclassified sources considered most reliable, was extracted from a paper on the so-called "Deterrent Gap."

EXCLUSIVE . . .

Kennedy Will Bolster Space Staff

Pentagon reshuffle has priority, but new administration is expected to keep NASA busy: Space Council's future is uncertain

by Jay Holmes

PRESIDENT-ELECT KENNEDY can be expected to greatly expand the White House staff dealing with space policy.

Kennedy's defense/space advisers believe the bigger staff is necessary to help the new President rule on jurisdictional conflicts between civilian and military space programs. President Eisenhower has one space specialist, Douglas Lord, among the 20 persons in his science advisory office.

The new Administration plans no immediate major moves that would change the balance between military and civilian participation in space programs. Kennedy's advisers are urging him to move first to streamline research and development arrangements within the Department of Defense. Any change in the relationships between DOD and the National Aeronautics and Space Administration would wait until Defense's house is put in order.

Civilian programs will be affected, however, by the Kennedy Administration plan to centralize defense R&D in a single command with line responsibility. At present, the technical staffs of NASA and individual military services often work together on an informal basis, exchanging information and agreeing on apportionment of responsibilities at the lowest level. When the central defense R&D command is formed, defense personnel will probably be authorized to continue existing friendly relationships. But they may need clearance from the highest level before beginning new ones.

• **Plenty of work for NASA**—As for roles and missions, some of Kennedy's advisers believe the newly strengthened defense R&D command should have first call on any program it believes it needs to meet military requirements. The civilian activity would then have the remainder.

However, the new administration believes there will remain a large area of activity for NASA, perhaps even larger than the $1½-billion annual spending rate foreseen by the current administrator, T. Keith Glennan. Kennedy's advisers report most top military men are happy with an arrangement under which NASA supports expensive development projects they will be wanting in a few years, but for which they cannot show an immediate military requirement.

One could draw the conclusion from this attitude that NASA will continue to be responsible for large boosters such as *Saturn* and the bigger one that will follow.

• **New look at Mercury**—There seems to be no inclination to disturb the Project *Mercury* man-in-space program at this stage. However, as *Mercury* passes through the stage of the first demonstration flights in the next year or so, the time will come for consideration of expanding the number of personnel involved.

President-elect Kennedy may choose an industry executive as NASA administrator.

No specific names have emerged from early discussions, but there seems to be a general feeling the new administrator should not come from the present NASA staff.

Kennedy's advisers hope to settle on a man of high stature who will be the nation's No. 1 salesman for space exploration. Scientists and engineers can be hired for needed technical advice, they feel, but the boss should be a man with primarily administrative experience. Someone from another government agency is not wholly ruled out.

An obvious problem in hiring a man from industry would be conflict of interest. In campaign speeches, Kennedy has made clear that no one with the remotest interest in government contracts should have authority over an agency spending large sums.

At that time, the Kennedy Administration can be expected to take a hard look at the highest level to see whether the full capacities of the military services are being used. Certainly, Kennedy advisers indicate that when space exploration goes on an operational basis there is every expectation that military men will be in command.

As for the organization of the purely civilian aspects of space, Kennedy's advisers are thinking about two possible alternative approaches. They are:

–A space czar in the White House.

–Centralization of all non-military scientific research and development in one agency.

The space czar, if appointed, would obviously be in charge of the beefed-up White House staff that is expected to be appointed in any case.

If activities were centralized on a level below the White House, the new agency might take in non-military activities of the Atomic Energy Commission, scientific work in the Commerce Department, the National Science Foundation and some smaller operations in other government departments.

• **Council a question mark**—Completely up in the air is the status of the National Aeronautics and Space Council, a super-body created by the Space Act of 1958. The council, composed of several Cabinet officers and outstanding non-government scientists, was conceived by authors of the act as a policy-making group that would have authority to settle disputes without reference to the White House itself. In practice, President Eisenhower has had to rule on such disputes that have been settled to date.

Authors of the act conceived of a Space Council staff of up to 100 persons, including specialists in each major field. However, the Eisenhower administration appointed only an acting secretary, David Z. Beckler.

The decision on whether to activate the Space Council as originally intended presumably will be made on the basis of recommendations by whoever Kennedy names as NASA administrator. ⁂

Congress may be Critical . . .

Polaris Move to Scotland Stirs Ruckus

THE NUCLEAR-POWERED submarine George Washington—first of the Navy's fleet of *Polaris*-launching submarines—prepared to go on station this week amid international howls over her deployment.

The center of the controversy continued to be announced U.S. plans to establish an advanced *Polaris* supply base in the Scottish waters of Holy Loch in the Clyde Estuary.

Here was how the situation looked as the George Washington took aboard 16 nuclear-tipped *Polaris* missiles before departing:

–British groups demanding unilateral nuclear disarmament and Labor leaders in Parliament pressed their protests against the Conservative Government for agreeing to establishment of the base.

–Britain's Defense Minister Harold Watkinson and Prime Minister Harold Macmillan sought to quell widespread public opposition with assurances that the United States would not launch *Polarises* anywhere in the world "without the fullest possible previous consultations." However, they stressed that if the West came under surprise attack consultations might be impossible and undesirable.

–British Labor Party Leader Hugh Gaitskell said he was not satisfied with the assurances. He demanded sufficient British control of *Polaris* subs to prevent their use on "provocative missions" from British bases.

–Frol Kozlov, a top-ranking member of the Soviet Communist Central Committee, warned that by deploying the George Washington the United States and Britain were embarking on a "dangerous adventure." He called the ship's deployment a move "designed to aggrevate sharply the international situation"—a move "fraught with dangerous consequences."

• **Worth the trouble?**—The continued protests that began with the initial announcement of an Anglo-American agreement on the Scottish base earlier this month caused serious questioning in Washington as to the value of the Scottish base.

Some officials also questioned whether the views of the State Department and other government agencies concerned had been sufficiently taken into account by the Pentagon before seeking the agreement.

Polaris submarines will use Holy Loch for the periodic transfer of crews, taking on supplies and some repairs. The big *Polaris* Sub Tender Proteus, a floating drydock and auxiliary craft will be stationed in the Loch.

Use of the overseas facilities will enable the Navy to maintain a greater number of *Polaris* submarines on station continuously by reducing the time used in changing crews and taking on supplies. Without the advanced base, the submarines would have to take the extra time to return periodically to bases in the United States.

Some government officials now are saying that the time gained may not be worth the resulting international complications with the British.

• **Congress may balk**—Nor is this the only harm seen to be resulting from the Scottish base.

One of the attractions of the *Polaris* system is its ability to operate without relying on overseas bases. This has appealed particularly to a number of congressmen.

But now the Navy is establishing an overseas base for *Polaris* submarines anyway. The resulting complications can be expected to receive critical attention in the new Congress when the Navy presents its *Polaris* program for FY 1962.

Meantime, the Navy's Special projects Office proceeded with the development of the advanced 1500-mile *Polaris*. The first test launching was scheduled for later this month.

And at the *Polaris* Depot near Charleston, S.C., the crew of the George Washington made final checks on the big, 6000-ton submarine. Her scheduled sailing date: November 15. ⌗

New Details of Navy Plans for AUTEC Range

CONSTRUCTION OF THE NAVY'S $100-million ASW missile test range in the Bahamas now appears assured.

Britain last week granted the United States permission to survey the waters of Exhuma Sound and Tongue of the Ocean—where the Navy wants to locate the range (M/R, Oct. 24, p. 15; Aug. 1, p. 8). This means that there will be no hitch in Navy Bureau of Ships plans to let a $500,000 study contract next month, covering operation and development of the range. Building is expected to start next year.

Several companies are teaming up to become prime for the big new facility called AUTEC (Atlantic Undersater Test and Evaluation Center). There is also a competition under way for the oceanographic survey of the specific area selected for the range; this is expected to run between $2 million and $3 million.

Further details of plans for the range, first disclosed by MISSILES AND ROCKETS also became known last week. The project's request for proposals indicates that AUTEC is expected to be a vast consumer of instrumentation.

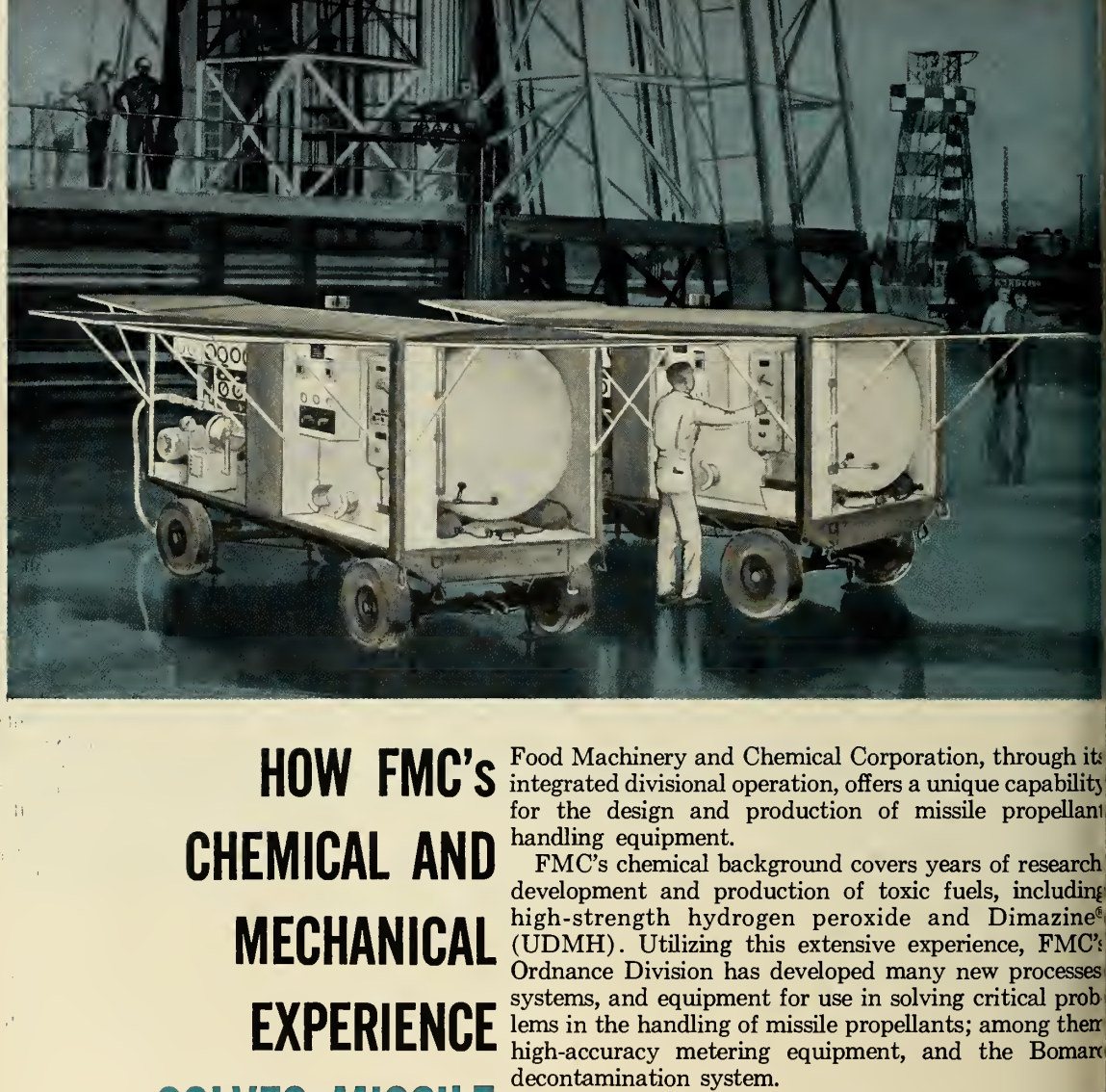
The study proposals being submitted this month are to make analyses of requirements for navigation, tracking and range measurement; communications systems and measurement systems for noise, target strength, and sonar calibration, as well as data transmission and reduction.

Other analyses are to show a layout of AUTEC's subsystems and ranges for testing various types of ASW missiles, in addition to base facilities, new buildings required for "special research," and personnel requirements.

Object of the study is to "insure that optimum systems, compatible and complementary in design, are so selected and planned that orderly development of the AUTEC will be assured with minimum duplication in features or facilities."

Moreover, the study must show projected requirements, capabilities and use-factors of systems proposed for development.

Sources close to the project have made it clear that the Navy is in a hurry to get the range built and in operation. The major consideration is the coming Soviet missile-launching nuclear-powered submarine threat. Many advanced ASW weapons are in the works—but there is no place to test them. ⌗



HOW FMC's CHEMICAL AND MECHANICAL EXPERIENCE SOLVES MISSILE PROPELLANT PROBLEMS

Food Machinery and Chemical Corporation, through its integrated divisional operation, offers a unique capability for the design and production of missile propellant handling equipment.

FMC's chemical background covers years of research development and production of toxic fuels, including high-strength hydrogen peroxide and Dimazine® (UDMH). Utilizing this extensive experience, FMC's Ordnance Division has developed many new processes systems, and equipment for use in solving critical problems in the handling of missile propellants; among them high-accuracy metering equipment, and the Bomarc decontamination system.

For more detailed information on these studies and for experienced counsel on missile fueling problems contact FMC, a leading developer and producer of chemical propellant compounds and the equipment to handle them.

For further information, write on company letterhead to Preliminary Design Engineering Dept., FMC Ordnance Division, P.O. Box 367, San Jose, Calif. Phone CYpress 4-8124.

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

Ordnance Division

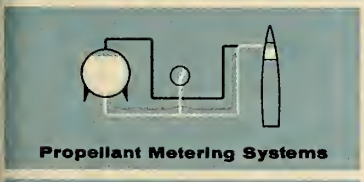
1105 COLEMAN AVENUE, SAN JOSE, CALIF.

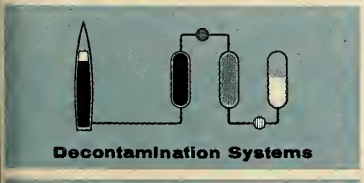
fmc

Illustrated below are some of the activities of FMC concerned with missile propellants and propellant handling equipment, which help define a few of the problems successfully solved by utilizing the combination of chemical and mechanical engineering talent available.


Propellant Handling Equipment

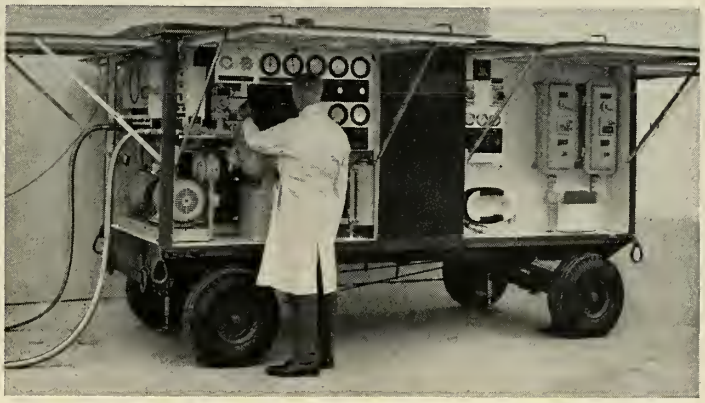

Missile Propellants


Propellant Metering Systems


Decontamination Systems


Ground Support Equipment

FMC's New Liquid Propellant Metering System Achieves Accuracy to ±0.1%


Mobile metering and control unit for fueling liquid propellant missiles.

The crucial reliability of multistage missiles is influenced by the accurate measurement and delivery of liquid propellant to the missile tanks. For example . . . a small error in fuel weight could adversely affect the in-flight performance of the missile, causing possible failure of the entire mission.

Food Machinery and Chemical Corporation's Ordnance Division has recently developed a mobile liquid propellant metering and handling system which promises to solve many missile fueling problems. The advantages offered by this unique new system are many.

Accurately measures and records the amount of fuel delivered to the missile tanks. Original specifications called for a metering accuracy of ±0.2%. Extensive tests, recorded by precision test equipment, show that the system is capable of metering and delivering missile propellants with far superior accuracy—to ±0.1%.

Automatically compensates for factors influencing fueling accuracy. The fuel is continuously sampled and the flow corrected for variations in temperature and density. In addition, the fuel which vaporizes in the missile tanks is returned to the system, condensed, measured, and an equivalent amount added by the metering unit.

Adaptable to many different missile fuels. The system is designed to handle such storable liquid propellants as hydrazine, nitrogen tetroxide, Dimazine® (UDMH) and nitric acid.

Economical to manufacture and safe to operate. To reduce development, manufacturing and operating costs, the system makes maximum use of standard, interchangeable, and commercially available components. The simple and safe design eliminates human errors and danger to operating personnel.

Mobile and compact. All metering, pumping and control equipment is mounted on a single, portable trailer. The complete unit may be easily transported, rapidly positioned, and provides a single station for the monitoring of fueling operations.

The successful development of this mobile metering and handling system by the engineering staff of FMC's Ordnance Division is another achievement made possible by utilizing the unique combination of chemical and mechanical engineering talent available at Food Machinery and Chemical Corporation.

The Missile/Space Week

Reds Rattle Rockets to Start 'Summit'

Crowded out of the public eye by the presidential election, Communist leaders gathered in Moscow last week presumably to straighten out ideological differences between the Kremlin and Peiping. Setting the tone for the Red "summit" presided over by Premier Khrushchev was a parade of tactical/medium-range missiles and anti-aircraft rockets and a warning from Soviet Defense Minister Malinovshy that Russian Missile might would crush anyone who started a war. The missile parade through Red Square on the 43rd Anniversary of the Bolshevik Revolution also showed off a silver replica of the rocket which the Russians claim downed the U-2 May 1 near Sverdlovsk. Khrushchev, at a Kremlin reception, stuck to booze and boasts—proposing eight toasts to the need for peace and "co-existence."

Report Hits 'Economic Gap'

A report prepared for the Army by Johns Hopkins University's Operations Research Office calls the Cold war "economic gap" with Russia a "threat of inferiority" for U.S. military power. Specifically the report contends that if respective U.S. and Soviet defense spending patterns are continued, by 1970 the U.S. will still be budgeting $46 billion a year against the Russian's $72 billion (in 1959 dollar equivalents.) The study was made last July and disclosed Nov. 5 by the *New York Times*.

AF Probes Titan Management

The Martin Co. management of the *Titan* ICBM program is the first of several major weapon systems undergoing a "management practice" investigation by the Air Force. Aim of the survey is to determine whether "present management methods will continue to keep pace with the rapidly advancing technology of modern weaponry"—and to hold costs at a "reasonable" level.

Super X-15 Still Trying for First Flight

Weather and technical difficulties this last week continued to plague attempts to test fly the *X-15* for the first time with its powerful new XLR-99 rocket engine.

But game North American and Air Force officials planned to try again in a week or so.

The sixth attempt to test fly the *X-15* with the 57,000-lb.-thrust engine was cancelled Nov. 7 when the landing field was left soggy by heavy rains. Five earlier attempts were cancelled by technical difficulties or bad weather.

Early Burnout Foils Blue Scout Jr.

The Air Force had its problems, too, with a *Blue Scout Jr.*

The slim so-called "poor man's rocket" failed Nov. 8 to place a 29.4-lb. payload on a trajectory that would have taken it on a 10-hour trip through space. The instruments were designed to test the possibility of checking up on nuclear tests in space. The payload—crammed with radiation measuring equipment—would have travelled 24,000 miles. However, the *Blue Scout Jr.'s* second stage motor burned out early and the small payload fell into the Atlantic 250 miles from Cape Canaveral.

For Space Communications Dial: UN . . .

There's an old diplomatic saying: If you keep talking, you don't start fighting.

James M. Skinner Jr., president of Philco Corp., has called on the United States to try it by offering to help the United Nations build an international satellite communications network.

Skinner said: "The United States now has the opportunity to give a convincing demonstration of its intention to use its technical achievements in space for peaceful purposes . . ."

New Shot Slated Soon To Test Mercury Escape

Another *Little Joe* booster will b launched soon to test the Project *Me cury* capsule pilot escape system.

The system failed in an Electio Day launching from NASA's Wallop Island, Va., facility. The escape rocke fired at 35,000 ft. as programed, bu a switch malfunction under high ai loading caused failure of capsul separation. The capsule and booste reached an altitude of 53,000 ft. be fore they plunged into 68 to 70 fee of water 13 miles offshore.

The National Aeronautics an Space Administration said a backu booster is available and that the weak ness in the switch will be correcte for the next shot. Last week's *Littl Joe*, the fifth fired, was to have bee the last.

Another *Mercury* test, the firs *Redstone* launching at Cape Canaveral was postponed until this week or later Both *Little Joe* and *Redstone* were t have been fired the day before Elec tion Day.

Douglas Uses PEP to Speed up Skybolt Program

SANTA MONICA, CALIF.—Development of the Air Force's *Skybolt* missile is being accelerated by use of the new electronic management technique originated for the Navy's *Polaris*.

Details of the new management program were reported last week by Douglas Aircraft Co., prime contractor for *Skybolt*. Titled Program Evaluation Procedure (PEP), the approach is a direct outgrowth of the Program Evaluation Review Technique (PERT) established for *Polaris*.

Its use on the *Skybolt* program was disclosed earlier in the COUNTDOWN M/R, Nov. 7, p. 7).

Douglas planning official R. A. Hall said PEP is successfully forecasting potential bottlenecks in the program, making it possible to speed up the job of arming B-52 bombers with the 000-mile-range air-launched ballistic missile.

• **Chart to computer**—The Air Force authorized Douglas to proceed with PEP six months ago. Under the program, each step in system development—design, tooling, testing, procurement, quality control and others—is hand-drawn on a large chart and related to all other factors influencing its completion by a specified date.

These activities then are assigned numbers and fed to a digital computer by experienced mathematicians. The computer, after analyzing the data, reports on an automatic printer those areas which might cause schedule slippage in the future unless immediate action is taken.

The first run-through of raw data revealed one activity which might have been 49 weeks behind schedule unless preventative action were taken. Not only was potential deficit erased, but the department has moved ahead of schedule, Douglas reported.

Direct benefits already achieved include cancellation of a thermoconditioning test which was found to be unnecessary, re-assignment of wiring development from fixtures to a mock-up, and re-assignment of some machining work from the Tulsa Division of Douglas to the Long Beach Division.

• **How it functions**—Data from seven major subcontractors, four Douglas Divisions, three outside locations and one associate contractor have been fed into the PEP system.

Inputs from the subcontractors are correlated to Douglas requirements and the firms are informed where they should concentrate their efforts. For example, Nortronics, which is developing *Skybolt* guidance, was shown exactly which pieces of factory check-out equipment required modification and what other engineering steps had to be taken to assure meeting certain completion dates.

In addition to evaluation at Douglas, all data produced by the IBM 709 computer are sent to the USAF *Skybolt* System Program Office, Wright Air Development Division, Ohio.

A Douglas computer technician there processes this and other program data through Royal-McBee LGP 30 or RPC 4000 computers to provide a computer-analyzed look at the entire WS-138A *(Skybolt)* program. The Air Force uses this to plan phasing-in of B-52 bombers and crews, training requirements, logistics support and other action necessary to make *Skybolt* operational in 1964.

• **PERT plus**—PEP improvements over PERT are said to include self-check capability of the computer to identify and pinpoint human errors in entering data into the machine, ability to store and analyze up to 20,000 events, and a system for easily incorporating changes in activity networks that had been processed previously by the computer.

Under Air Force direction, Douglas is providing technical information on PEP program construction to other missile and defense contractors beginning their own programs. These include *Dyna-Soar, Minuteman* and *Nike-Zeus*.

Small Firms' Subcontracts Rise, DOD Awards Drop

Small business' share of fiscal year 1960 Department of Defense prime contract awards slipped $343 million below 1959, but it received a record volume of subcontracts from large companies enrolled in the defense small business sub-contracting program.

Prime contracts awarded to small business in FY 1960 totaled $3.440 billion. This combined with the $3.578 billion in subcontracts brings total contract awards to small business to the four-year average rate of more than $7 billion annually.

DOD said the decrease in prime contracts was part of an overall trend. It also cited the increasing amount of awards going to research, development and production of missile systems and other complex weapons.

"The reported volume of subcontract payments to small business firms is understated," the Department reported. Since the small business subcontracting program was changed from a voluntary to a mandatory basis in January, 1960, it had little if any effect on the number of contractors reporting subcontract payments in the January-June 1960 period.

A total of 293 large companies were enrolled in the Defense Small Business subcontracting Program in FY 1960.

Sylvania Receives Army Quality Control Award

The Army Signal Corps last week presented its RIQAP (Reduced Inspection Quality Assurance Plan) award to the Semiconductor Division of Sylvania Electric Products. The award represents Army approval of Sylvania's quality control methods and test procedures.

Through RIQAP, the Army puts increased reliance on a manufacturer's control policies and practices, aiming at a reduction in the amount of end-product inspection by Government agencies.

AF, SRI Seek to Cut Human-caused Failures

The Air Force is working with design engineers to reduce the number of human-initiated failures in missile systems—estimated in a recent study at 20% to 53% of reported equipment failures and 16% to 23% of unscheduled holds.

The Air Force's Aerospace Medical Division and Stanford Research Institute reported that a "significant portion" of the 4248 malfunctions on nine programs were human-initiated.

Little if any systematic human factors performance testing is done, the report stated. The Air Force termed "critical" the inadequacy of present malfunction data in pinpointing cause or degree of human error.

The largest number of failure or hold reports for any one missile was 1391, smallest 130. The system with the largest number of failures had a 23% rate of human initiated failures.

Another independent report made by a major missile manufacturer attributed 30% to 50% of reported equipment failures and 15% to 25% of unscheduled holds to human error or omission.

For
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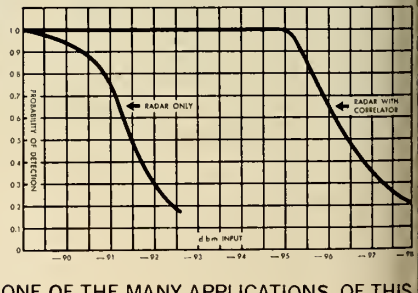
pounds...

WHAT AN IMPROVEMENT IN RADAR PERFORMANCE!

This new Video Correlator is now available as a plug-in unit for fire-control and search radars both airborne and ground-based. Flight and laboratory tests have proved that this compact, 0.3 cubic foot radar augmentation device: • makes target detection certain • serves as an effective counter-countermeasure • reduces interference from other radars • eliminates external and self-generated radar noise. Vought Electronics designed the unit for easy back-fitting into existing systems. It contains its own power supply and requires only a simple rigid mounting somewhere in the aircraft.

HERE'S HOW VOUGHT ELECTRONICS' VIDEO CORRELATOR INCREASES THE PROBABILITY OF DETECTION WITH ONE EXISTING FIRE-CONTROL RADAR.....



FOR FURTHER DETAILS ON ANY ONE OF THE MANY APPLICATIONS OF THIS RADAR ENHANCEMENT DEVICE, WRITE:

CHANCE VOUGHT ELECTRONICS DIVISION DALLAS, TEXAS

ANTENNAS • AUTOMATIC CONTROLS • NAVIGATIONAL ELECTRONICS
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Technical Countdown

ELECTRONICS

Dyna-Soar Guidance Draws 12 Contenders

Twelve proposals for the *Dyna-Soar* inertial guidance system prime contract have been submitted to the weapon system project office for evaluation. The award is expected by early 1961. Among those bidding are AC Spark Plug, American Bosch Arma, Eclipse-Pioneer Div. of Bendix, Burroughs and Astro Space Corp., Litton Industries (also chosen as backup by Boeing, associate prime for the weapon system), Kearfott Div. (with Librascope) of G.P.I., General Electric, Hughes, and Sperry Gyroscope.

Smaller Paramp for Space Application

A new type of parametric amplifier developed by RCA shows promise of reducing the size and weight of paramps for satellite communications systems, telemetry, and radar. The device uses a helix as a slow-wave structure distributively coupled with variable capacitance solid-state diodes. Net gains as high as 38 db and terminal noise figures down to 4.5 db have reportedly been measured with the amplifiers.

ECM Nose Cone Being Evaluated

An ablative nose cone with built-in electronic countermeasures is being evaluated by Sperry Rand. Developed by an Australian scientist, the proposed nose cone is reported to have a special skin structure and contains an electronic device to confuse enemy radar.

PROPULSION ENGINEERING

Three-engine Start a Weighty Problem

A three-year development program of 10 flights has been laid out for the *Atlas-Centaur* launch vehicle, beginning next year. All will be primarily for vehicle development, although some payloads will be carried as excess baggage. Big *Centaur* problem is the three engine starts for the upper stage: first to get into a low orbit, next to lift to a 24-hour orbit, and finally to brake into the 24-hour orbit.

Scout Payload Increase Possible

NASA figures it can improve the 150-200-lb. orbital capacity of *Scout* by about 40% by uprating the two upper stages. Latest word is that the first two stages will remain unchanged.

ADVANCED MATERIALS

Re-entry Studied for Anti-ICBM

Maximum effectiveness of anti-missile defense systems will depend on relating physical phenomena of vehicle re-entry to down-range observations. For this reason, GE scientists at MSVD are taking a detailed look at re-entry under the Army's sponsorship. Adequate information on the characteristics of a vehicle can lead to knowledge of its probable mission.

Army Gets C_2H_2 From JP-4

The old calcium-carbide method of producing acetylene gas may be rendered obsolete with the development of an Army field unit weighing 40,000 lbs. Developed by the Institute of Gas Technology, the plant has a design production capacity of 500 cu. ft./hr. of the gas, generated by thermally cracking JP-4 jet fuel.

GROUND SUPPORT EQUIPMENT

Bullpup Simulator Now in Use

Bullpup mission simulators now in use reportedly have almost doubled effectiveness of pilots. Developed by Radiation, Inc. for Martin-Orlando, the AN/ARW-T2 Ground Pilot Trainer is used by the Navy to instruct pilots in the operational aspects of the air-to-ground missile. "Miss distance" is displayed automatically following each simulated mission. Primary electronics in the TV-size console is an analog computer that provides real-time simulation of missile dynamics.

Refraction Error No Problem in Transit

Results of experiments conducted with *Transit 1B* and *2A* R&D navigation satellites has shown researchers that refraction in medium latitudes and under most conditions poses no problem in attaining desired accuracies. Follow-on work will study the refraction problem in auroral zones and during periods of intense auroral activity.

Checkout for Future Weapons Studied

Motorola and Douglas have teamed to conduct a study to establish next-generation design and maintenance criteria for future Air Force weapon systems and associated test and checkout equipment. Results could have major influence on AF planning for support of future weapons.

Giant Radio Telescope Has Troubles

Construction of Navy's big 600-ft. radio telescope at Sugar Grove, W. Va., has run into both time and money problems. The job, originally estimated at $60 million, is now expected to cost close to $97 million. Completion date has been moved up to 1964. No basic design changes are contemplated.

Navy Antenna Being Improved

Modifications under way on Navy's Maryland Pt. 84-ft. antenna will change its size to 85 feet, improve the reflecting surface, and increase its focal length to permit higher frequencies for use as a radio telescope. Improvements are not expected to be completed in time to try a radar bounce off Venus next Spring.

ASTRONAUTICAL STUDIES

Drag Brake Considered for Apollo

Avco's variable geometry drag brake will be one of the solutions considered for the *Apollo* re-entry vehicle under a subcontract with Convair, which has one of three competing studies on the NASA 3-man space ship.

Space-Rendezvous Bids Due Next Week

Atlas-Agena B will be used to test early NASA space-rendezvous concepts a year or two from now. Meanwhile, the civilian agency hopes to benefit by fallout from the more urgent Air Force *Saint* program. Bids on rendezvous studies are due Nov. 21 at NASA-Huntsville.

An M/R Exclusive . . .

ANNA to Spot Targets within 50 Ft.

Pentagon takes over former NASA project, prepares to push geodetic satellite shots which could vastly improve accuracy

by William Beller

WITHIN A YEAR, U.S. missiles could be made able to descend on Soviet targets with nearly pinpoint accuracy. This is one of the big arguments pushing the Pentagon into giving a fast go-ahead to Project *ANNA*, a geodetic satellite program.

It probably is also one reason why the project has been taken away from the National Aeronautics and Space Administration, which is concerned strictly with non-military aspects of space.

"It's just about a going project now," a high government official told M/R, and most likely will be getting final approval within the next few weeks.

A staff member in the Director of Defense Research and Development's office added that "details about the project are classified."

The three services plus NASA are expected to be joint monitors of *ANNA;* hence its name—an acronym for Army-NASA-Navy-Air Force.

The high value of a geodetic satellite lies in using it to find precise distances between land masses. For instance, because of the present uncertainty in measuring the distance between a point in North America and one in Europe, the error in locating Moscow with respect to New York may be as much as 100 meters. This is the estimate of the eminent geodesist Floyd Hough, president of Geonautics, Inc., Washington, D.C.

Hough says that with the aid of a geodetic satellite, the error could be reduced to between 10 and 15 meters—less than 50 feet.

Military quarters are almost certain that if the Soviet has not already used one of its *Sputniks* for geodetic purposes, the country surely intends doing so with a future orbiter.

Until recently, NASA has been planning to send up a geodetic satellite on its own. In fact, during 1961 NASA appropriation hearings last February before the House Committee on Science and Astronautics, the agency director of space flight programs, Dr. Abe Silverstein, testified that NASA's fourth *Delta* vehicle would be used for the job.

NASA now says that its intent has changed "after renewed analysis, and we have no plans for a geodetic satellite at this time." The fourth *Delta* will be used as a backup for *Tiros,* according to the agency.

• **Details of the orbiter**—Considering unclassified studies, we can surmise this much: The proposed geodetic satellite will probably be modest-sized, weighing only between 50 and 100 pounds. Most likely it will be spherically-shaped in order to keep its drag low and make possible an accurat ephemeris.

If both optical and radar-tran ponder equipment is used for trackin the satellite, the scientific payloa would be close to the 100-lb. figur The apparatus on board might includ a transponder for receiving and sendin signals, a doppler radio system, strob lights or pyrotechnic flares for use wit fixed and ballistic cameras, and an a curate clock which would control th timing of light flashes.

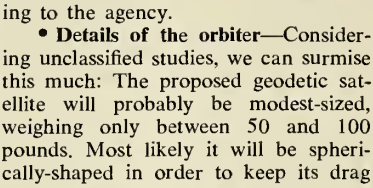
NASA's *Scout* could be the launch ing vehicle. This all-solid four-stag rocket had its first successful flight la month, and is thought capable of pu ting between 150 and 200 pounds int a nominal orbit—300 nautical mile This payload is probably more tha a geodetic satellite would need b could be traded off for a higher orbi

The Air Force's *Scout* with guid ance in its fourth stage, *Blue Scout I* would carry a lesser payload and woul have the advantage of putting it into more precise orbit—a significant ad vantage for a geodetic satellite.

• **Eratosthenes called it round**—It strange that for man to know the siz and shape of the earth, he must leav the earth. Still, remarkable approxima tions have been made of the measure ments of the planet, dating back t the work of the Greek geographe philosopher Eratosthenes, who live during the third century B.C.

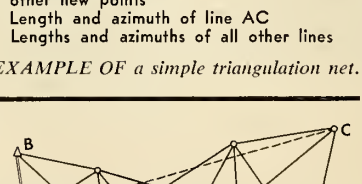
He said that the earth is a spher and on the basis of additional assump tions, observations and "true" facts, h calculated its circumference to be 24 660 miles. This figure is surprisingl close to the currently accepted valu for the earth's circumference at th equator of 24,899 miles.

Nineteen hundred years later, a international scientific controversy aros about the shape of the earth. To hel settle the argument, The French Acad emy of Sciences in 1735 sent a geodeti expedition to the Spanish province o Peru—later to become Ecuador—t measure the length of a meridian de gree close to the equator; and anothe expedition to Lapland to make a simila measurement near the Arctic Circl



Known Data:
Length of base line AB
Latitude and longitude of points A and B
Azimuth of line AB
Measured Data:
Angles to new control points
Computed Data:
Latitude and longitude of point C, and other new points
Length and azimuth of line AC
Lengths and azimuths of all other lines

EXAMPLE OF a simple triangulation net.



Known Data:
Length of base line AB
Latitude and longitude of points A and B
Azimuth of line AB
Measured Data:
Length of all triangle sides
Computed Data:
Latitude and longitude of point C, and other new points
Length and azimuth of line AC
Azimuths of all other lines

EXAMPLE OF a simple trilateration net.

he longer length of the degree-arc in ıe north proved that the earth was attened near its pole. It was then greed that the earth was an ellipsoid.

Measurements taken from satellites ıow the earth to be pear-shaped, hav- ıg more mass in its southern hemi- phere than in its northern. The aver- ge amount of flattening at the poles s derived from the data is given by ıe formula: $a-(b/a)=1/298.3$, where is the earth's semi-major axis; and b, s semi-minor.

• **Measuring long distances**—There re two ways a satellite can geodetically e two points together: the intervisible ıethod and the orbital method.

The first one requires that simul- ıneous sightings be made from each f the two base lines that are to be onnected. This is merely an extension ıto space of the conventional means of iangulation.

The orbital method calls first for ıe precise determination of the satel- te orbit, including minor variations rom the Keplerian ellipse caused by nomalous gravity and atmospheric ffects. Then by using the calculated phemeris as an interpolation device, ne can find to high accuracy the rela- ve positions of the observation points.

Because the intervisible method alls for the satellite's being visible imultaneously by each datum, the orbit ıust be a high one. This results in a veak geometric figure for determining ıe satellite position.

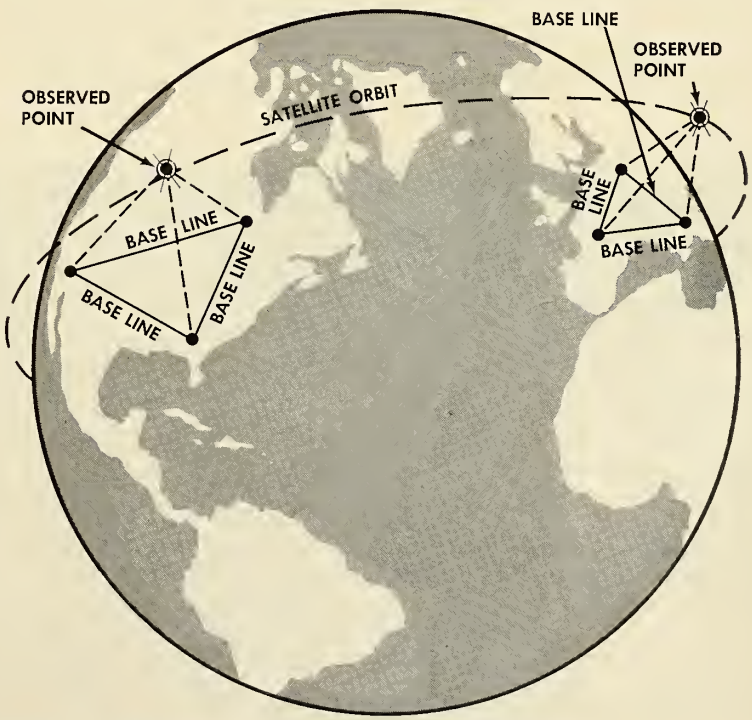
The geometric figure used in the rbital method would be enhanced by low orbit. Another advantage is that ong ties are possible because there is o intervisibility requirement. Also, pace coordinates can be used, thereby ielding direct corrections to geocentric oordinates. On the other hand, with ıe intervisibility method only relative ositions in geodetic coordinates are btained.

One weakness in the orbital method that uncertainties in knowing at- ıospheric effects and the local values f gravity may cause uncertainties in etermining the orbit and therefore in ıterpolations by means of it; however, or low orbital altitudes the effects of ıe uncertainties are quite small.

The intervisible method needs no phemeris. Detailed calculations of the rbit are thereby skirted. Happily, too, ıe requirement for timing accuracy much less severe.

The need for classifying a geodetic atellite project is not quite clear. It is aid that the explanation lies some- here in the field of international rela- ons and the fact that NASA is a non- ilitary agency. This might explain the ımor that the services will be footing roject *ANNA's* bill, while NASA as- sts only as an interested observer. ⌗

INTERVISIBLE METHOD calls for simultaneous sightings of satellite.



ORBITAL METHOD requires a precise ephemeris of the satellite.

Cover Story

Energy Conversion Is Allison's Business

GM Division broadens basic operating concept to fit needs of missile/space era

by John Judge

THE NEW LOOK at Allison Division of General Motors stems from an enlarged conception of the firm's basic business—energy conversion.

Long a respected name in aircraft propulsion, Allison is moving into the missile/space market with a series of programs emphasizing research and experience.

Research and development covers such areas as the preliminary design and development of lightweight compact military reactor power systems, adaption of the Stirling heat engine to space purposes, and magnetofluidynamic rocket research.

In addition, programs are under way in nuclear propulsion, vehicle attitude controls and nozzle cooling systems for solid rockets.

Approximately 40% of Allison's entire effort is tuned toward missile/space and government activities.

• **Liquid metal cells**—Most of the programs involve the indirect conversion of energy. But work is progressing in at least one area of direct conversion —a thermo-electric converter.

The particular converter, or fuel cell, is a thermally regenerative liquid metal system developed by Dr. Bernard Agruss, Chief, Chemistry Section. It has been operated continuously for as long as an hour.

Mobile or stationary units could operate in conjunction with a heat source similar to the compact reactor currently under joint development by Allison and Nuclear Development Corp.

Using a nuclear conversion process, the reactor would be cooled with liquid metals, thus providing a heat sour The heating would cause the separati of the various metals at their boili points. Their recombination would g erate an electrical current.

• **Upgraded steels**—Allison was c of the firms that spearheaded the dr for premium quality "clean" steels. began by trying to upgrade the clea ness and uniformity of steels used aircraft engine gears and bearings.

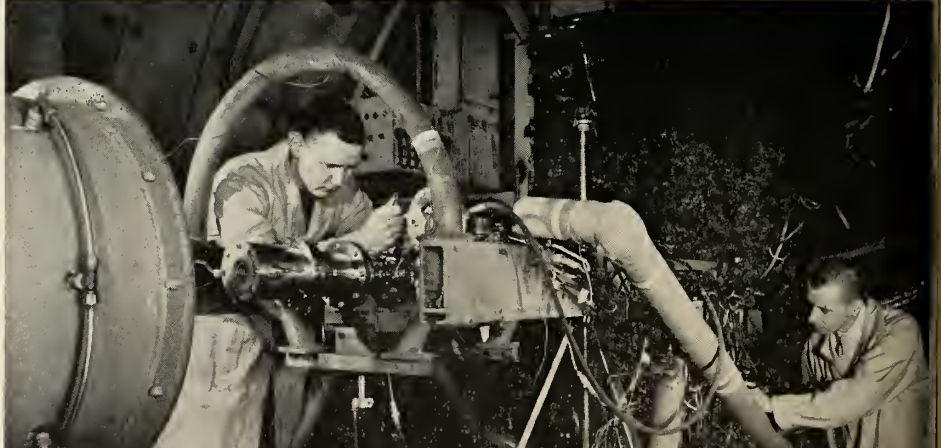
Backed by management, Allis metallurgists embarked on a qual control program that extended ri back to the ingot. A thorough inve gation led to the adoption of steels p duced by the double melt-consuma electrode process.

The campaign resulted in increa reliability and life in highly stres aircraft engine parts. Allison then s the clean steel idea to the Governme At the time, there was a large price d ference between this premium mel steel and the ordinary melt; today costs are substantially the same.

The same type of reasoning v applied to the *Minuteman* case progr and has contributed heavily to the p gram's current reliability figure 100%.

Here Allison metallurgists and gineers worked closely with the Lad Co., Cudahy, Wis. on Ladish's D6 st the raw ingredient of *Minuteman's* fi stage motor cases. Not a single case been rejected for lack of cleanliness

The steel used in current pre-p duction *Minuteman* cases is essenti the Ladish composition. Allison me lurgists made some changes, larg



EXPERIMENTAL rocket engine designed and built by Allison is powered by pyrophoric fuels.

onsolidated in the lower sulfur, and in he carbon and vanadium range. But hese changes produced a profound ffect on the finished product's major hysical properties.

Allison's work was in part respon- ible for the drawing up of specifica- ions on AMS 2300, premium aircraft teel.

In the motor case field, Allison is lso looking at roll forming as a pos- ible means of fabricating metal pres- ure vessels. Several studies into rein- orced plastics are being made, with articular emphasis on fundamentals. he basic aim is to reach a strength ensity ratio of 2.5 million to 1.

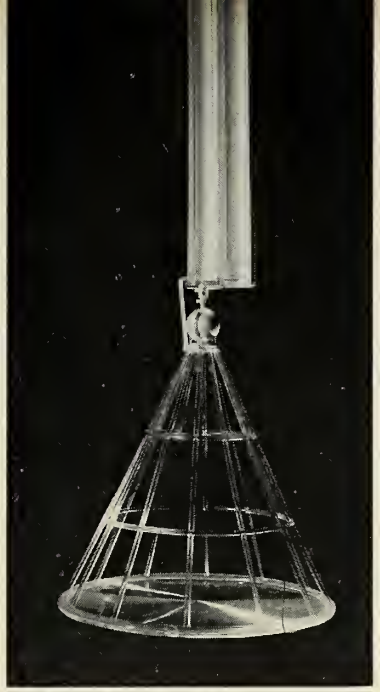
Facilities for winding large bodies ill be in operation early in 1961. These ill be devoted to research and devel- pment.

• **Space power systems**—Robert tirling, a Scottish clergyman, invented nd built a two-piston, closed-cycle, ex- ernal combustion engine in 1816. Its fficiency was poor, and the Rankine, tto and Diesel cycles effectively ren- ered it obsolete.

In 1938, N. V. Phillips Gloeilampen- abrieken, Netherlands, decided to ap- ly modern thermodynamics and heat ransfer theory to the Stirling cycle.

By 1954, a 20-cu.-in. displacement ngine was built, using hydrogen as the orking fluid. It delivered 40 hp at the redicted thermal efficiency of 36% ith a maximum cycle temperature of 300°F.

Under agreements with Phillips, llison is continuing the development f the engine for space power.



STIRLING-CYCLE engine and Fresnel collector such as this could remain unattended and operational for years.

In an ideal situation, considering the relation of efficiency to temperature ratio, the Stirling engine efficiency is identical to that of the Carnot cycle—the highest attainable for any heat engine.

In the Stirling engine, the adiabatics of the Carnot cycle are replaced by constant volume curves and the heat rejection and addition is handled by a regenerator.

Obviously, the regenerator assumes vital importance in the operation of the practical engine. In actual practice, regenerator effectiveness values in excess of 98% have been achieved by Phillips.

The main selling points of the Stirling cycle are that it is a closed cycle system with a wide heating potential, and it is reliable. In addition, the engine is quiet—a desirable quality for certain Military applications.

A consideration of the engine for space auxiliary power brings in several other pieces of hardware—such as a solar collector, an absorber, a generator and a heat rejection system.

Allison is convinced that the best solar collector is a Fresnel reflector. Since the mirror lies practically in a single plane, it lends itself to compact folding. The division has perfected a method of manufacturing these reflectors through electrical deposition.

An ultra-high-temperature laboratory has been in operation for some time. Allison's involvement with refractory metals has resulted in the development of the Plasma-Tung, a spraying instrument capable of running continuously for two to three days.

Further along in this area, the Division has fabricated large pieces of refractory metals with the Plasma-Tung, using a removable mandrel. The physical properties of these pieces, when they are properly heat-treated, have excelled those created by other methods of processing. ⁂

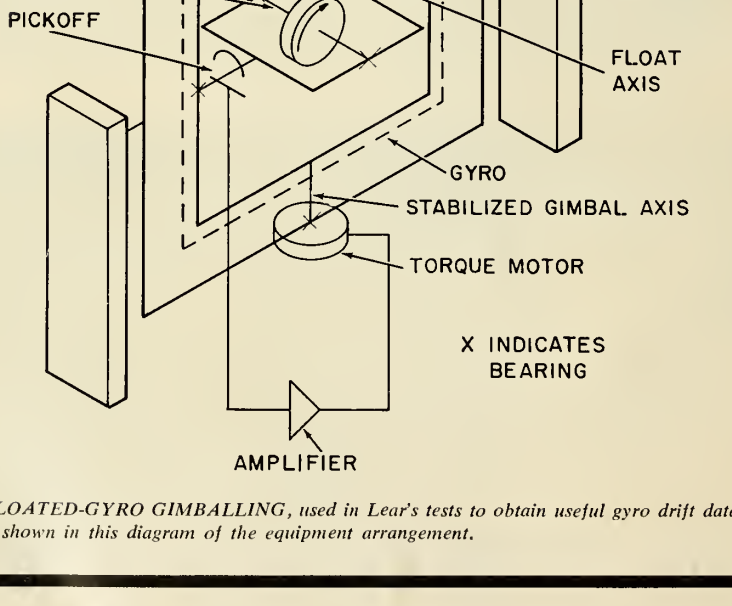
OWER STEERING for missiles is function of this set of solid- ropellant attitude control rockets. A number of methods are nder study at the Division's Rocket Propulsion Section.

HEAT GENERATED by the arc light is collected by a Fresnel lens and concentrated on the head of a laboratory-model version of the closed cycle Stirling system.

Rigid Drift Tests Give Useful Gyro Data

Lear believes its techniques—already in use in missile programs—can eliminate unexpected drift

by Wilbur A. Carrington*



FLOATED-GYRO GIMBALLING, used in Lear's tests to obtain useful gyro drift data, is shown in this diagram of the equipment arrangement.

GRAND RAPIDS, MICH.—Gyro gineers, at Lear, Inc., have develo drift tests for bench use that simul the most severe missile environme and yield truly meaningful data.

Techniques throughout industry drift evaluation of gyroscopes h varied widely as knowledge has creased, design techniques have gro more sophisticated, and application quirements have become more string In testing gyros for severe envir mental missile applications, Lear lieves it has developed significant r techniques for obtaining the types data most pertinent to in-flight p formance analysis.

There are no tougher drift tests modern industry.

These same tchniques also apply gyroscopes intended for "easier rid and might assist in pinpointing cau of drift more quickly than ear methods, since the evaluations yi components of the total drift attrib able to specific mechanical charac istics of the structures.

• **Functions simulated**—A ben testing technique is the approach u most. Designed to yield the maxim feasible amount of environmentally duced drift information, it also sir lates the function of the gyro in particular application.

For this illustration, a stable-p form floated gyro will be considered.

Two factors of interest in dr producing acceleration are "sensiti and "insensitive" drift sources. T first includes mass unbalance and a soelestic mass shifts; bias and randc ness are sources of insensitive dr (There are other sources, but th illustrate the methods used in the g drift tests.)

Before discussing our test pro dures, these sources of gyro d should be defined to provide mut understanding:

–*Mass Unbalance* is the drift-p ducing element in a gyro which ma fests itself as a drift rate proportio to applied accelerations having cc ponents parallel to the plane of the s and input axes. In a floated gyro, t error may result from lack of coir dence of the center of gravity or cen

**Instrument Systems Engineer, Le Incorporated.*

INSTANT FLIGHT

Varied stresses of programmed flight will soon be duplicated at ground-level. A $10 million static test facility, designed by Vitro for the U.S. Air Force, will shortly begin operations at Wright-Patterson. Here, major components will be subjected to programmed aero-dynamic heating and dynamic loading of supersonic flight. ■ In eleven major Vitro projects, the precise simulation of unusual environment was vital; twenty-one Vitro projects required design of nuclear containment. This is Vitro know-how.

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READING AN INFERNO'S SECRETS...
Missile "silo" concept proved practical by Lockheed Electronics

The U.S. Air Force came to Lockheed Electronics with an extremely complex and urgent problem. Could the tremendous shock and heat of a missile blast-off be accurately measured in launchings from an underground silo?

Lockheed Electronics designed and built a special data-gathering system to analyze, through instrumentation, the searing heat and violent shock of more than 40 test firings. During each test more than 200 measurements were made simultaneously.

Results have produced new understanding of missile stresses, acoustics, thermal radiation, shock and vibration. This vital information is already being applied to the design of "hard" launching sites.

The capabilities of Lockheed Electronics, Information Technology Division extend to all phases of data handling—a fact well worth remembering when you encounter tough problems in this field.

CAPABILITIES—INFORMATION TECHNOLOGY DIVISION

Data processing
Data storage • Telemetry systems
Data reduction and display
Special-purpose computers
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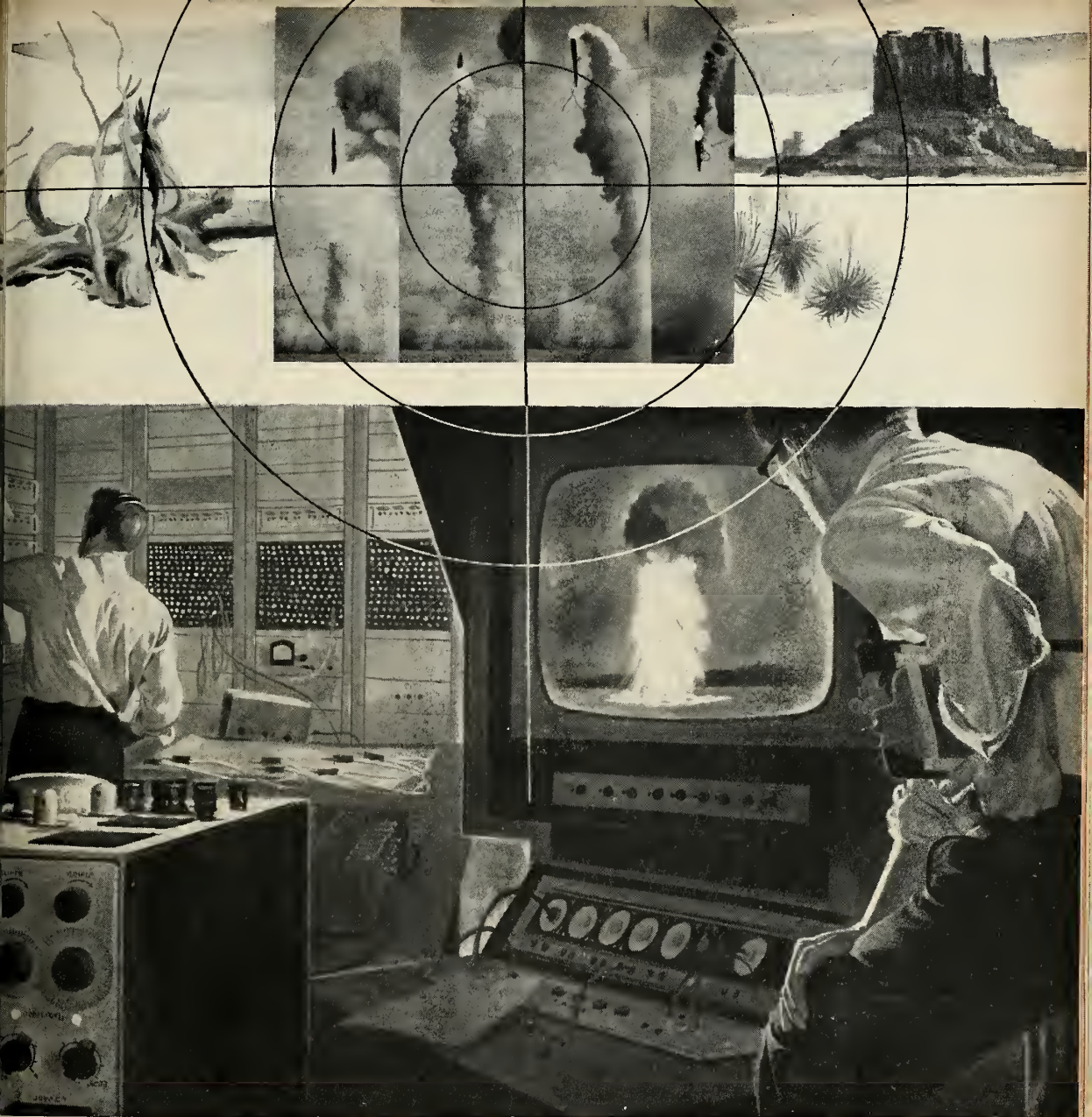

MINDING THE FUTURE

LOCKHEED ELECTRONICS COMPANY

LEC

INFORMATION TECHNOLOGY DIVISION, METUCHEN, N. J.

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of buoyancy (accompanied by misflotation) and the output axis-bearing centerline.

–Anisoelastic Mass Shifts concerns that drift producing element which manifests itself as a drift rate proportional to the square of applied accelerations. It is caused by elastic deflection of the center of gravity in a direction not parallel to the accelerating force which, in turn, is due to a difference in spring rates along input and spin axes.

–Bias is the component of gyro drift that is independent of applied acceleration and is determined by the average of a number of drift tests during which the direction of the acceleration due to gravity is varied in a periodic fashion about the output axis.

–Randomness is a measure of the lack of repeatability of gyro drift under identical conditions, or a measure of deviation among drift readings with constant gyro inputs. In this case it is expressed statistically in terms of a "composite" standard deviation found by extracting the root-mean-square of the standard deviations for each group of readings at a constant input position.

• **Floated gimbal used**—In performing the drift tests, the gyro is installed in a gimbal structure designed to introduce an additional degree of freedom relative to an earth-bound frame (see diagram).

This gimbal is often tailored to simulate the inertia, and possibly the friction, anticipated in the gimbal to be stabilized in the application. Angular motions of the floated-gyro gimbal, sensed by a float axis electrical pickoff, are translated into torques about the stabilized gimbal axis through use of a suitable electronic amplifier and torque motor with a polarity that tends to maintain the gyro spin axis perpendicular to the stabilized gimbal axis.

The frame of the test assembly is, in turn, installed in an angular indexing stand capable of positioning the stabilized gimbal axis in any angular position about an axis parallel to the gyro float axis.

Relative angle between the stabilized gimbal and the frame is sensed by a synchro or resolver which, in conjunction with an external, adjustable control transformer or resolver, can yield an electrical null signal. This signal is converted to a visible recording by means of a moving-pen recorder. Motion of the pen versus time from an initially set position is proportional to the sum of two quantities: earth rate and gyro drift. The first of these being accurately predictable, the second is readily calculated.

An initial attitude is chosen with the spin and float axes horizontal and the stabilized axis vertical. Drift runs, generally of 2-minute duration, are performed at 30-degree increments of stabilized gimbal axis relative to vertical, rotating through 360 degrees about the float axis.

The closed loop system acts to maintain the spin axis perpendicular to the gimbal axis during these runs; thus gravity acts at a series of attitudes relative to the float. The gyro is deliberately disturbed between runs.

This procedure is repeated two or more times. Additional runs with the float axis vertical serve to evaluate thrust bearings.

• **Reduction of data**—A plot of drift rate versus gravity angle is fitted by a Fourier series approximation carried out through the second harmonic terms, thus:

Drift rate $= d_0 + d_1 \cos\theta + d_2 \sin\theta + d_3 \cos 2\theta + d_4 \sin 2\theta$ where d_x = drift coefficient, θ = gravity angle. In this expansion, d_0 is the average drift or bias, d_1, d_2, d_3, and d_4 are the amplitudes of their respective curves expressed in degrees per hour, and have the following significance: d_1 represents the component of mass unbalance parallel to the gyro spin axis, d_2 represents the component of mass unbalance parallel to the stabilized gimbal axis, d_3 and d_4 represent components of anisoelastic drift.

The maximum mass unbalance drift is represented by:

$D_m = \sqrt{d_1^2 + d_2^2}$ degrees per hour per g.

The maximum anisoelastic drift is given by:

$D_a = \sqrt{d_3^2 + d_4^2}$ degrees per hour per g^2.

• **Repeated tests necessary**—The interpretation of data derived above yields significant information to the designer concerning major drift causes but is, in itself, only an approximation of drift characteristics. This is the result of random errors in the gyro being tested as well as in the test equipment and procedures. Statistical approaches to the error problem have yielded techniques for handling these variations.

An important parameter is defined as Random Error, determined by repeated performance of drift runs at the 30-degree incremental positions referenced above. It is then possible to estimate randomness by the following expression:

Randomness:

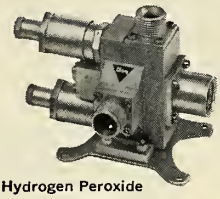
$$\delta e = \pm \sqrt{\sum_{i=1}^{n} Y_i^2 - \frac{1}{n}\sum_{J=1}^{N/n} T_j^2} \text{ deg./hr.}$$

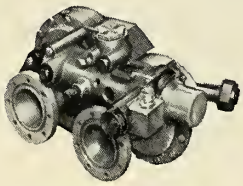
$$\frac{\frac{N}{\frac{1}{n}}(n-1)}$$

24 valve problems solved by Clary!

These are just a few of the valves engineered and manufactured by Clary Dynamics.* Each represents an original solution to a different problem. When you have a valve problem, call on Clary -one of the nation's leading suppliers of space craft valves.


LOX Propellant Valve (Titan Missile)


Hydrogen Peroxide Relief Valve (X-15 Space Plane)


Acid-Aniline Propellant Valve (Corporal Missile)

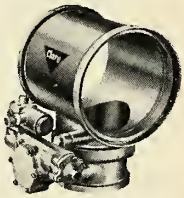

Pneumatic Actuated Valve (Hound Dog Missile)


Hand Loader (Jupiter Missile)


Restricter Valve (F-100 Interceptor)


Drain Valve (C-130 Transport)

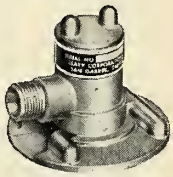

Toggle Valve (Hound Dog Missile)


LOX Fill & Drain Valve (Titan Missile)


Shuttle Valve (Jupiter Missile)

Clary DYNAMICS
San Gabriel, California

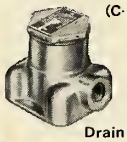

Drain Valve (C-130 Transport)


Fuel Drain Valve (Electra Airliner)


Pressure Regulator (F-100 Interceptor)

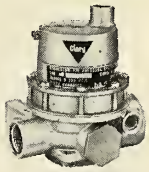

One-Way Restricter Valve (F-100 Interceptor)

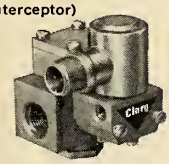

Two-Way Restricter Valve (Jet Star Transport)


Drain Valve (Constellation Airliner)

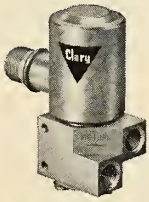

Pressure Regulator (F-104 Interceptor)


Vacuum & Relief Valve (Firebee Drone)

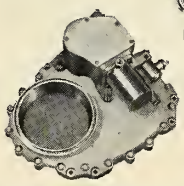

Pressure Regulator (A3J Vigilante)


Pilot Actuated Solenoid Valve (In-Flight Refueling)


Manual Drain Valve (P3V-1)


Solenoid Valve (B-52 Jet Bomber)


Squib Valve (Discoverer Satellite)


Blade Valve (Titan Missile)

wholly-owned subsidiary of Clary Corporation

where: Yi = a drift reading at any position,

Tj = the sum of the drift readings at a position,

n = the number of drift readings at each position, and

N = the total number of drift readings.

The standard deviation of the calculated drift coefficients may be shown to be:

(1) Bias: $\sigma d_o = \frac{\sigma e}{\sqrt{n}}$ degrees per hour, and

(2) $\pm \sigma (d_1, d_2, d_3, d_4)$ degrees per hour (for 30° increments) $= 2 \sigma d_o$.

An estimate of the error in fitting the data plot to the drift rate formula mentioned above with the limited number of Fourier Series terms used may be obtained by the following.

Residual Sigma:

$$\pm \sigma r = \sqrt{\frac{\Sigma (y_i - y_j)^2}{\frac{N}{n} - 1}} \text{ degrees per hour}$$

where: y_i = magnitude of fitted curve at a position, and

y_j = average of the drift readings at a position.

• **Significance of tests**—Through the use of these techniques for determining and processing data, Lear believes that drift rates can be accurately determined.

Improvement over methods used previously is assured, since the gyro is tested in the same manner as ultimately used. Moreover, the tests permit covering a wider range of acceleration direction relative to the gyro than through conventional test procedures.

The tests do not employ Scorsby motion or "concrete pilings" in tests, because the company feels that resulting impact conditions do not simulate the variety of forces experienced in an actual missile in-flight environment.

Although they are being employed on several classified programs, it can be said that these tests have been used on high-performance, ground-to-air missiles now under development. These impose conditions of severe vibration and sustained acceleration on the missile born gyros, tending to contribute heavily to the drift problem.

• **Advantages**—Lear feels that it has proven that employing these techniques eliminates unexpected drift from new gyros—so that performance can be satisfactorily predicted.

A major advantage lies in the fact that identical results can be obtained prior to missile installation with the bench tests described—or compared with those obtained from actual firings. ⌗

—expansions—

NORAIR DIVISION, Northrop Corp. has officially opened its new advanced research center in Hawthorne, Calif.

MARSHALL INDUSTRIES, INC. of San Marino, Calif. has formed a new subsidiary, Marshall Laboratories, for development and manufacture of electronic equipment. Stuart Baker, formerly with Space Technology Laboratories, heads the new firm. The Marshall subsidiary will be located in Torrance, Calif.

ELECTRO-OPTICAL SYSTEMS has formed an Advanced Power Systems Division for research and development in basic energy conversion and application of such activity to advanced power systems.

INTERNATIONAL RECTIFIER CORP. has combined forces in Italy with Piemontese Sviluppo Industriale S.P.A. to form a projected multimillion-dollar semiconductor manufacturing facility on the European continent. A new 16,000-sq.-ft. facility at Turin, Italy, will house the initial venture. Production is scheduled for April, 1961.

COMMUNICATIONS ELECTRONICS, INC. has been organized by four former employees of Nems-Clarke Co., Division of Vitro Corp. of America. John F. Whitchead, former sales director for Nems-Clarke, is president of the new company, which has taken offices at Bethesda, Md. Ralph E. Grimm, Paul R. Mattix, Jr. and Edward M. Gearing are executive vice president, vice president and secretary-treasurer respectively.

APPLIED ELECTRONICS CORP. has established a West Coast office in Santa Monica, Calif. Lawrence Hermes has been named vice president in charge of the West Coast Division. He is former vice president of General Devices Inc. of Princeton, N.J., and recently has become president of the International Communications Corp., also in Santa Monica.

financial

Airwork Corp.—Sales for the year ending July 31 topped FY 1959 by some 25% at $12.5 million. Net income reached $420,688, compared with the $259,018 earned in 1959.

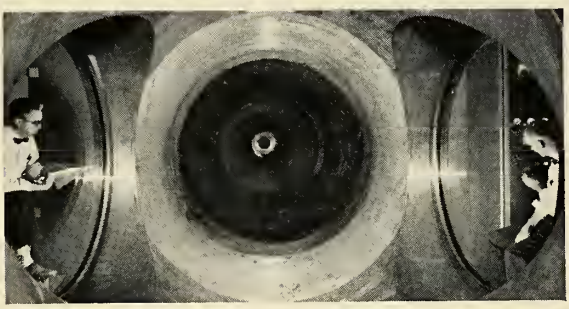
Litton Industries—Earnings of $7.5 million for the year ended July 31 compared to $4.96 million in FY 1959. Sales amounted to $187.8 million, as compared to 1959 sales of $125.6 million.

BULLETIN FROM BOEING ...

WHERE CAPABILITY HAS MANY FACES

Minuteman, the nation's first solid-fuel ICBM, blasts from underground silo, left, in tethered firing test. Successful Minuteman firings cut test program, saving millions of defense dollars. Boeing is weapon-system integrator of the 6000-mile-range Minuteman missile, now under development.

FLYING COUSINS. You can cross a continent or an ocean in brief hours by Boeing jetliner, then fly to local airport or center-city in a helicopter built by Boeing's Vertol Division. Vertol helicopters are flown by the U.S. Air Force, Army and Navy as well as by the commercial carriers and armed services in many countries. Boeing 707s and 720s—most proved jetliners in the world—have already carried more than 10,000,000 passengers.



HOTSHOT TUNNEL. Here, in largest privately owned wind tunnel facilities in the world, future aircraft, missile and space-vehicle models can be tested at speeds up to 18,000 miles an hour. Many space-flight conditions can be simulated during tests. Decades of emphasis on research have enabled Boeing to pioneer nation-benefiting advances in vital areas of manned and unmanned flight.

SEAGOING TURBINES. Boeing gas-turbine engines power this high-speed oil company personnel boat as well as U.S. Navy minesweeping launches and landing craft. Light, powerful, compact Boeing shaft-drive turbines have scored many firsts: first turbine to power highway truck, fire engine, helicopter, locomotive and light airplane. Boeing turbines also serve in jet-engine starters used by U.S. Air Force and commercial airlines.

BOEING

JET AIRCRAFT, MISSILES, HELICOPTERS, TURBINES, WEAPON-SYSTEM MANAGEMENT, SPACE-FLIGHT VEHICLES AND SYSTEMS.

If Cold War continues . . .

$49 Billion DOD Budget Seen by '70

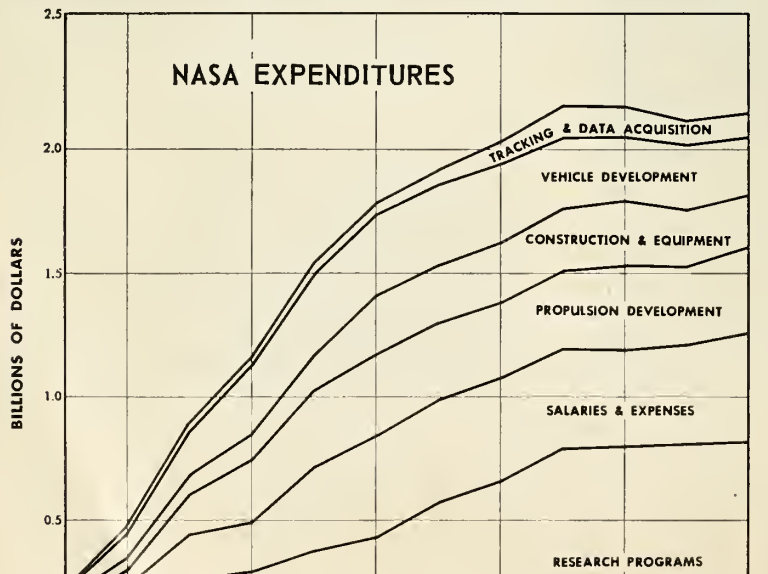
- DOD expenditures are estimated to rise at a slower rate than the GNP, from $41 billion in 1950 to $49 billion in 1970.
- Within the military budget, R&D is expected to continue receiving an increasing share of the total. Overall: approximately one-half of the military budget is likely to be devoted to procurement of hard goods.
- Shift in AF procurement from aircraft to missiles and astronautics is expected to continue with a "cross-over" in 1963. Thereafter missiles and astronautics will dominate
- Expenditures for ships and subs will again replace aircraft as main element of Navy budget in the '60's.
- Army expenditures are likely to continue at presen low levels with the bulk of funds devoted to tactical and defense missiles
- NASA expenditures are estimated to rise from les than $500 million in 1960 to $2.2 billion by 1967 and level off as existing programs phase out.

MUCH HIGHER defense spending may be anticipated under the new administration, but a Boeing Airplane Co. economist predicts that actual DOD budgets will rise on a steady line to about $49 billion by 1970.

Dr. Murray L. Weidenbaum bases his forecast on the growth pattern established during the past decade. Although there has been much comparing of military spending to the percentage of Gross National Product, Weidenbaum believes it is unrealistic to base any projection on set figures. For outlays in percent years have shrunk percentagewise in relation to the GNP.

Over the next 10 years, barring any radical change in the international political climate, the Boeing economist sees more money being pumped into the military as the result of sudden crises. But these bulges will be offset by inevitable economy drives.

Defense spending has been rising absolutely—but on a declining percentage of GNP and the Federal budget. It would seem reasonable, therefore, to base estimates of future market potential on a continuation of this trend.



• Military market analyzed—A analysis of the military market mus proceed on the basis that it is vastl different from the consumer market Four factors make it unique:

The military market . . .

–Has doubled in the past decad alone.

–Is the customer for one-third of al capital goods produced.

–Is the customer for one-half of al industrial R&D.

–Is a one-customer market.

The following analysis of the mili tary market is:

–A projection of the over-all leve of economic activity.

–A projection of the military budge on the basis of the economic forecast and

–An analysis of the composition o the military budget.

The long-term ability of a nation t sustain a defense effort depends on th growth of the economy and the shar devoted to military needs. Hence, th economic forecast is the starting poin for our analysis.

Four strategic factors will be operat ing in the 1960-1970 period to stimu late economic growth: a rapidly ex panding population, a very substantia increase in the average standard of liv ing, an unprecedented rate of ne product introduction, and an expansio of governmental non-defense programs

The massive wave of research an development projects in the decade o the 1950's is a tremendous force fo future change in the national economy Commercialization of major technolog ical advances in military and spac programs undoubtedly will continue However, these may take the for mainly of utilization of the ne methods and processes developed rathe

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han merely adaptations of the military nd-products. Our analysis, on the basis f these factors, yields a Gross National roduct of approximately $700 billion n 1970, which is well within the range f estimates prepared by other com-anies and by various research institu-ions.

• **Military spending level** — The verall level of military expenditures is rojected on the assumption that the urrent state of international tensions—he Cold War—will continue, that no fringe" wars will develop involving J.S. military forces, and that a work-ble disarmament program will not be dopted during the 1960's.

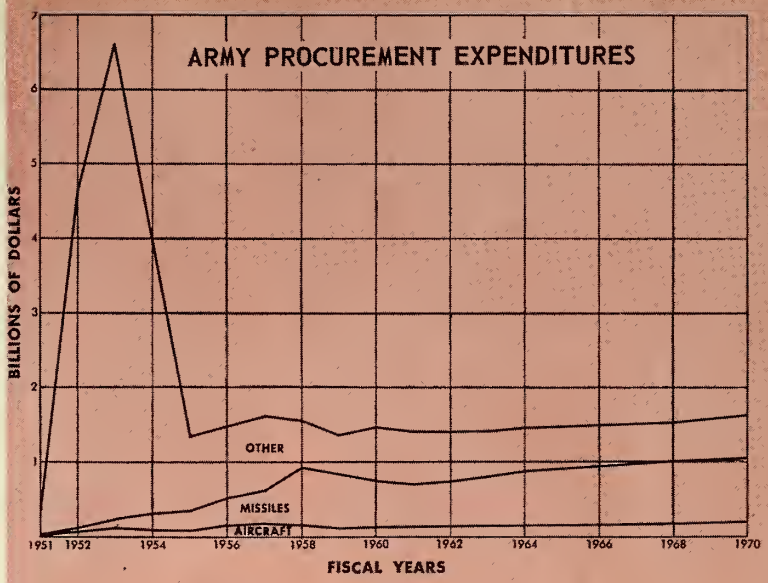
It is anticipated that the 1960's will ee the occurrence of international inci-lents resulting in increases in defense pending. Likewise, "economy" drives re likely to occur from time to time. The net result of these opposing—and ssentially unpredictable—forces is a low, upward long-term trend in defense pending.

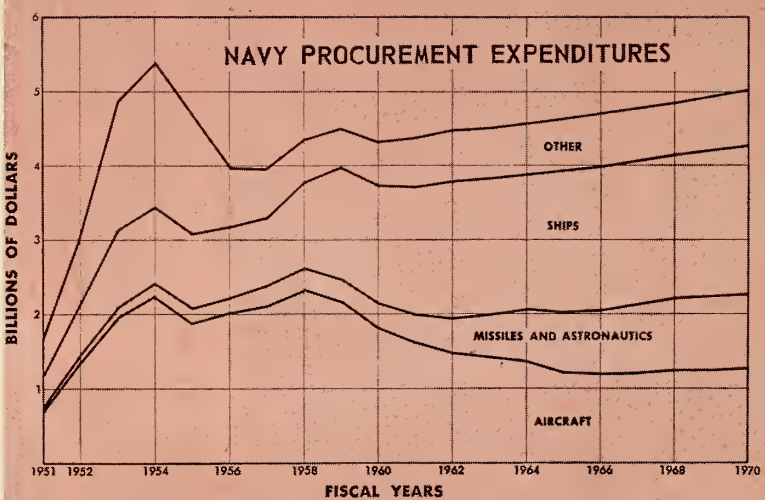
The composition of current and lanned military programs indicates that he proportion of procurement and ther "capital" expenditures will main-ain the current share of about one-half he military budget. Some small further eductions are projected in the operat-ng categories, mainly as a result of the ontinued declines in the numbers of nilitary personnel. The R&D category s expected to rise as a result of the roportionately larger development vork on missile and space programs.

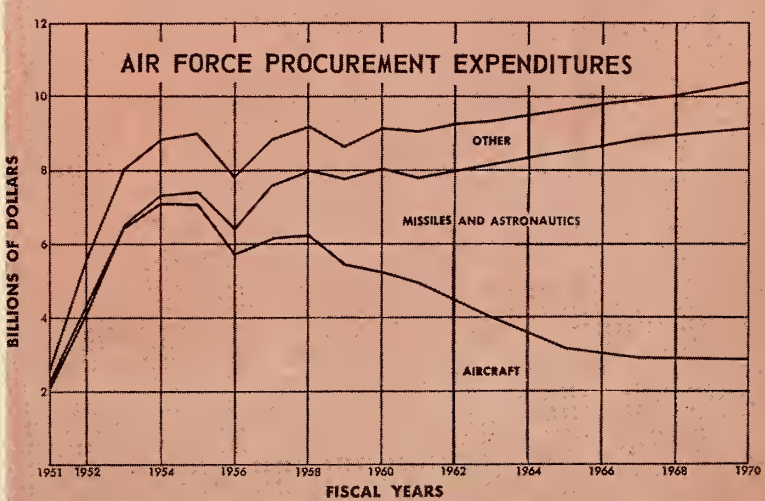
• **Trend of procurement outlays**— Aircraft and missiles account for ap-roximately 70% of total military pro-urement expenditures at the present ime, and dominate the procurement udgets of the individual services. Three najor procurement categories—aircraft, nissiles, electronics—account for 80% f total military expenditures. The re-naining procurement funds are divided mong ships, trucks, artillery, rifles, and ther traditional Army and Navy veapons.

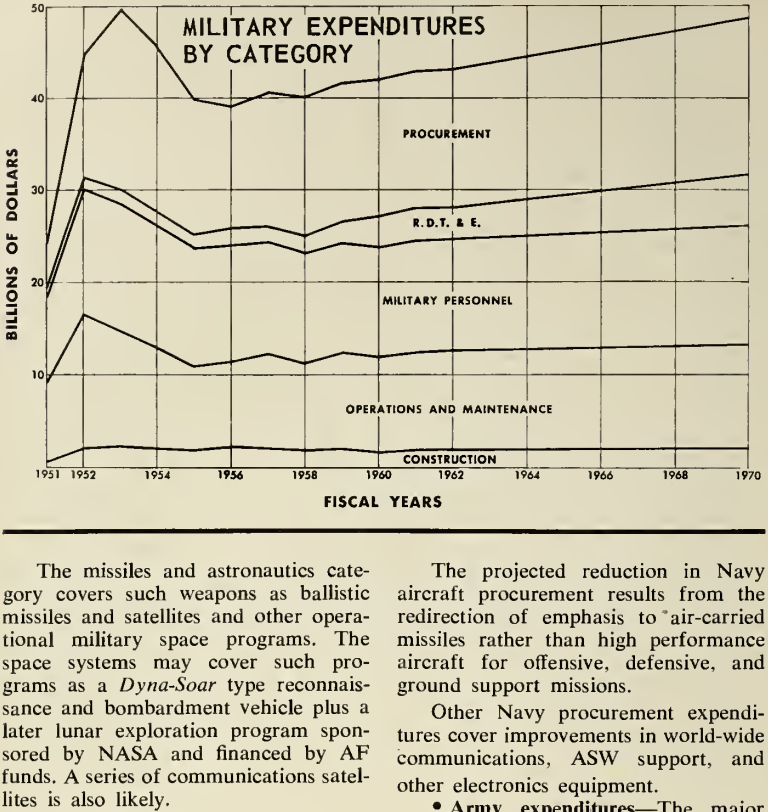
Except for ships (which includes ubmarines), each of these items has hown a major decline in recent years s a result of the shift from conven-onal equipment to advanced air and pace weapon systems.

• **AF expenditures** — Procurement y the Air Force has been one of the astest growing segments of the military udget. It is anticipated that the over-ll category will continue to rise, but nat major changes will occur in the omposition of programs. Aircraft ex-enditures dominated AF procurement uring the entire 1950's. This trend is xpected to reverse about 1963, when xpenditures for missiles and astronau-cs are expected to exceed total aircraft roduction outlays.









The missiles and astronautics category covers such weapons as ballistic missiles and satellites and other operational military space programs. The space systems may cover such programs as a *Dyna-Soar* type reconnaissance and bombardment vehicle plus a later lunar exploration program sponsored by NASA and financed by AF funds. A series of communications satellites is also likely.

It is expected that aircraft will require approximately one-fourth of AF funds in the 1960's. Some of the strategic programs—such as the B-52, the B-58, and the KC-135—are expected to continue until the middle of the decade. The available funds indicated on the chart could cover a new tactical fighter-bomber, at least limited quantities of a B-70 or other advanced supersonic bomber, and modernization of the MATS fleet with jet equipment.

The "other" procurement category includes outlays for SAGE, DEW, BMEWS, and related support programs.

• **Navy expenditures**—Procurement by the Navy is expected to continue the post-Korean rise, reaching an annual level of $5 billion by 1970. The major change envisioned is a shift in expenditures from aircraft, which was the largest naval procurement category in the 1950's, to ships which are expected to account for almost half of production funds by 1970.

The projected increases in the ship category cover accelerated construction of *Polaris* submarines, ASW craft, and guided missile ships. Increases for missiles and astronautics also result largely from the *Polaris* program and a follow-on. The Navy is also expected to make significant expenditures for astronautics, in its assigned area of navigation satellites.

The projected reduction in Navy aircraft procurement results from the redirection of emphasis to air-carried missiles rather than high performance aircraft for offensive, defensive, and ground support missions.

Other Navy procurement expenditures cover improvements in world-wide communications, ASW support, and other electronics equipment.

• **Army expenditures**—The major development in Army procurement expenditures occurred with the termination of the Korean War; the expenditure level of over $6 billion in 1953 was reduced to under $2 billion by 1955. In more recent years, Army expenditures have shown some fluctuation but give no evidence of the growth trends apparent in AF and Navy procurement. Only a very slight projected increase in Army procurement outlays in the 1960's appears likely, with the annual total still under $2 billion by 1970.

In recent years, missile expenditures have dominated the Army budget. This relationship is expected to continue with field missile programs competing with *Nike* and other air defense programs for Army procurement funds.

Army aviation, although growing, is not expected to reach the $200 million annual level until after 1970. Army aircraft are expected to continue to perform primarily utility, reconnaissance, and close support logistics functions. "Other" Army procurement includes electronics systems and ground mobility items.

• **Research and development trends**—By its very nature, military R&D is directed toward new weapon systems and related military purposes. The greater part of the expenditures is devoted to military weapons—aircraft missiles, ships and, increasingly, space vehicles. As shown in the chart, the missile category has been dominant in recent years and the space category has come into its own. The cross-over between missiles and aircraft occurred in the early 1950's and the cross-over between space and aircraft is occurring now—a harbinger of trends in procurement in the 1960's.

It is estimated that about one-fourth of military R&D is devoted to "research"; three-fourths of the funds are devoted to the development of weapon systems. The amount devoted to basic research comes to a little over $100 million a year.

• **NASA budget**—Civilian space expenditures are not a part of military expenditures, but are budgeted separately. NASA has the responsibility for the scientific investigation of space for civilian applications. Total NASA expenditures through 1970, on a cumulative basis, are estimated to be $17½ billion, mainly for large booster programs such as *Saturn* and *Nova*, plus vehicle and payload development.

Research programs include all basic research and expenditures for manned space flight, meteorological satellites, interplanetary probes, lunar unmanned explorations, scientific earth satellites, communications satellites, sounding rockets and spaee rendezvous techniques.

Propulsion development includes all expenditures for solid and liquid fuel engines, and nuclear, ion and plasma propulsion systems. Vehicle development covers the development of the *Saturn, Nova,* and *Nova* follow-on *(Arago)* boosters, exclusive of engines. Tracking and data acquisition includes all expenditures for the maintenance and operation for tracking and data handling facilities.

Salaries and expense represent approximately 25% of NASA expenditures each year through 1970. This category includes all outlays for the construction and operation of NASA facilities, the procurement of equipment and all personnel costs.

• **Trends rather than specifics**—Projections such as these are designed to convey ideas of future trends and relationships and to provide general orders of magnitude, rather than to forecast specific values for individual years. Analyses of the military market may provide important background information for management decisions on product lines, research and sales efforts, and investment programs. However, the utilization of market research data is a function in good measure of management's acceptance of and confidence in the market research activity.

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AF Hoping for 'Cheap' SAINT

- *Heavy reliance foreseen on existing hardware; may use Atlas*
- *First details of Norair's plan*
- *'Parking' orbit may be one way to intercept enemy satellites*

by Frank McGuire

LOS ANGELES—The Air Force appears to be hoping this week that the Missile/Space Industry can turn out *Saint*—the secret anti-satellite system —as cheaply as possible.

As the Ballistic Missile Division moved toward a decision on award of a development contract, informed sources made clear that the Air Force sought to cut as many corners as possible by capitalizing on other programs and using much existing hardware.

Some of this hardware is understood to include Convair's *Atlas* and Lockheed's *Agena B*, as well as a variety of already designed sensors that might be improved.

• **Delicate mission**—*Saint*, short for "satellite inspection technique," consists of two phases, inspection and destruct, with the same contractor not necessarily responsible for both. The destruct phase is considered relatively easy compared with the extremely difficult task of rendezvous and inspection.

Proper determination of the suspect satellite's mission is extremely important, since a wrong guess could send a scientific payload to destruction and trigger an unnecessary international incident.

The Air Force is currently seeking ways to determine the mission of a satellite, discriminate between decoys and live payloads, and also to discriminate between scientific and military payloads which may have some similarities.

Most likely way of accomplishing these ends, informed sources say, is to measure the mass of a satellite and determine what kind of electronic activity, if any, it is engaged in. A small mass would indicate a decoy, while a massive, passive payload might indicate an orbital weapon awaiting a signal from ground stations. At present, no instrument is believed available which can specifically measure mass at any distance.

• **Much already done**—The *Saint* program will be a continuing one, with improvements cranked in as soon as they become available. AFBMD is reported readying a shot in the *Discoverer* program to check out rendezvous techniques within the next few months. About 20 satellite vehicles are reportedly required initially for the *Saint* program.

Saint will undoubtedly use already existing techniques for the rendezvous phase of its mission. These techniques, required for any type of vehicle rendezvous in space, have been worked out by a number of companies now in the satellite research field.

Considerable work in this area has been carried out by Norair's Astro Systems and Research Laboratories in Hawthorne, Calif. Dr. Geza S. Gedeon, head of the Astrodynamics lab at the Northrop facility, worked out the necessary trajectories in connection with other programs, but they are applicable to *Saint*.

Numerous categories of satellite rendezvous techniques exist, depending on the parameters set up for the operation. The intercepting satellite, ("intercepting" used in its broader sense) can be powered by a low-thrust engine operating continuously, or it can be unpowered and operate ballistically.

Additionally, it can be launched from the surface of the earth in a point-to-point rendezvous or it can b placed into a parking orbit in the sam plane as the target satellite ("targe also used in the broad sense), the alter velocity to assume the same alt tude and a rendezvous.

Still again, the intercepting satelli can achieve a co-linear rendezvous if is launched into the plane of the targ satellite, and velocities are then alter appropriately to complete the maneuve

• **'Parking' advantages**—P a r k i n orbits are generally most favorabl time permitting, due to the less stri gent requirements on launch tim Parking orbits are usually closer to t earth than the orbit of the target sat lite, with acceleration bringing the i tercepting payload up to proper altitud

In cases where the target is in t lowest possible circular orbit, the i terceptor can be placed in a high parking orbit, then use retro thrust drop out of this orbit and onto t target. There it matches velocity, pla and altitude for inspection purpos and possible destruction.

The parking orbit has the advanta of using ground-computed optimizati techniques to cut down fuel useage a avoid great angular or velocity chang from the initial track. The particul conditions affecting the situation at a given time can be considered befo the actual rendezvous operation begi

• **'Parking' trouble**—However, t disadvantage of a parking orbit principally one of time. When elaps time is a vital element in a rendezvou it may well be desirable to plan a poi to-point intercept directly from t earth's surface. This method is wast ful of fuel and often requires extren angular change, but just as often sav time and is favorable when peculi orbit considerations make the parki orbit method impractical. Point inte ception is applicable when only tw maneuvers are allowable.

Aircraft-launched satellite inte ceptors are not considered feasible, d to the relatively low velocities gene ally obtained by such methods. T B-70 may perhaps change this situ tion (M/R, Aug. 29, p. 13), but ai craft-launched satellite interceptors a not seen possible with what is cu rently available, and the B-70 is f from currently available.

The coplanar rendezvous requir that the intercepting trajectory be

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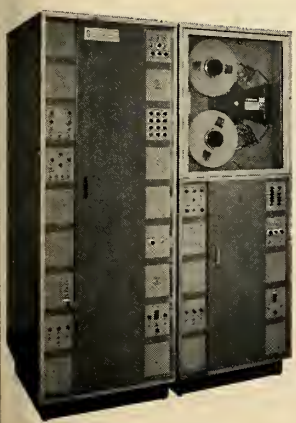

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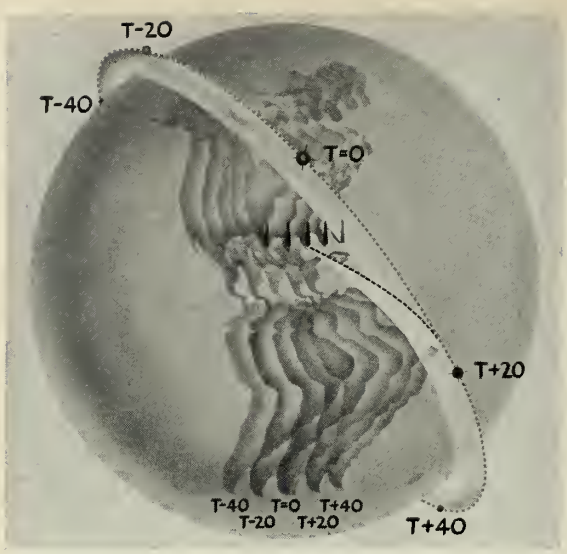


POINT INTERCEPTION of a satellite in a north-to-south track.

POINT INTERCEPTION of a satellite in a south-to-north track.

the same plane as the target orbit before the terminal maneuver is begun. Four maneuvers are needed in such a coplanar intercept when the interceptor is surface-launched: boost launch into an arbitrary plane; change of plane at a nodal point with the target plane, then injection into a coplanar parking orbit; take-off from this parking orbit into a transfer orbit which intercepts the target and, finally, the terminal homing maneuver.

For a coplanar interception from an already established parking orbit, only the last three maneuvers are required.

Co-linear interception requires merely velocity changes, which are made during maneuvers, with the stipulation that the launch from the earth be made into the same plane as the target satellite. Subsequently, a co-tangential transfer orbit is made, and finally the velocity of the interceptor is increased to the level of the target's velocity.

Again, when executed from an established parking orbit, the co-linear rendezvous requires only the last two maneuvers, due to the requirement that the "waiting" orbit must be coplanar with the target for this type of mission.

(Research conducted at Grumman Aircraft Engineering Corp. indicates that the transfer requiring least fuel between coplanar orbits is carried out by means of two tangential impulses, only when the terminals have zero radial velocities. In this case, the Hohman transfer between circular orbits is best.)

• **Saving not worth it**—Co-tangential transfer between elliptic orbits, though not a minimum fuel transfer method, is almost optimum for small eccentricity orbits. "In the case of satellite rendezvous, where the orbits will be very nearly circular, the extreme complexity of the rigorous optimum solution can hardly be justified by the insignificant amount of fuel saved," Dr. Gedeon said.

The three principal methods of satellite rendezvous have modifications, including changes of plane in several steps, multi-parking orbits, dog-legging during boost, and other alterations. These, however, depend on peculiar restrictions of the situation, such as limited firing azimuth.

Overall optimization of the entire rendezvous operation would require simultaneous optimization of all phases. Since the powered flight trajectories, as pointed out, must be substituted by zero-length instantaneous velocity changes or by the burnout conditions to overcome the mathematical problems involved in the rendezvous, the phases cannot all be optimized simultaneously with the preliminary and ballistic phases.

Individual optimization and subsequent establishment of interface consistency is feasible, however. This will not provide the overall optimum, but it is unlikely that any great deviation will result.

• **How to choose**—According to Dr. Gedeon, the parameter to be optimized is either fuel or time. In the case of point-to-point rendezvous, the fuel should be optimized, since only two maneuvers are permitted in such a trajectory. The shortest time would be achieved by launching at the highest possible velocity immediately at the arbitrary initial time previously chosen, but this would result in such impractical circumstances as rendezvous from a head-on meeting, fuel requirements several times the launch weight, or other intolerable parameters.

From his calculations, Dr. Gedeon has established certain conclusions, indicating the methods most applicable to various situations:

–For plain interception, a two-maneuver, point-to-point method is recommended. Fuel requirements should be optimized by finding the optimum launch and arrival time.

–For rendezvous, both the point interception and a four-maneuver co-linear interception technique is recommended. In the first case the fuel should be optimized by finding the optimum launch and arrival times. In the second case, time should be minimized by finding the optimum parking orbit altitude and shape.

–The boost phase has to be substituted by individually optimized burnout conditions and interface compatibility between the phases will be achieved by an integration procedure.

B-70 Flight Simulation Facilities Near Completion

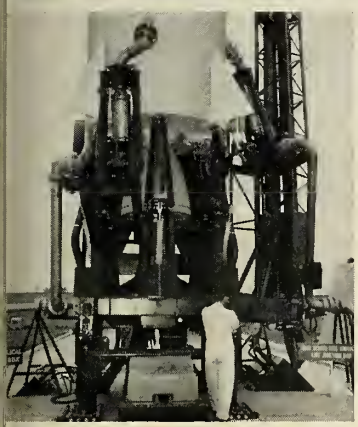
A $7.7-million addition to the ground test facilities at Wright Air Development Division, ARDC, will be used to check out the flight stresses and temperature effects on full scale B-70 bombers and *Dyna-Soar* space vehicles.

Hydraulic actuators connected by aluminum linkages to thousands of tension patches on the test crafts will simulate actual flight loads.

At the same time, radiant heat lamps will produce specimen temperatures up to 3000°F.

3M Materials Memo

News of materials for the aerospace industry—selected from the 27,000 products of the 3M Company



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"Kel-F" Plastic has a number of welcome surprises bound up in its tough little chain. Not the least of these is its chemical inertness. This not only gives it resistance to corrosive chemicals and aggressive organic solvents, but in combination with its low temperature properties makes it a safe playmate for liquid oxygen. Other phases of its agreeable personality include good impact and compression strength and resistance to cold flow. What's more, it's a snap to polish or machine to required dimensions.

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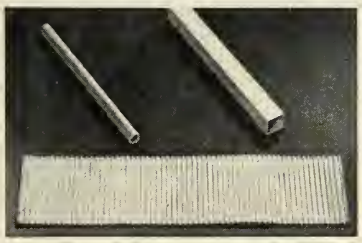

the original mica. The final product in tubular form of varying sizes (⅜" to 1⅛" O.D.) offers an extremely uniform high dielectric strength — approximately 650 volts/mill for 1/16" wall. Arc resistance is so high that the standard ASTM test goes off scale. It's also been approved for use where resistance to gamma radiation is required.

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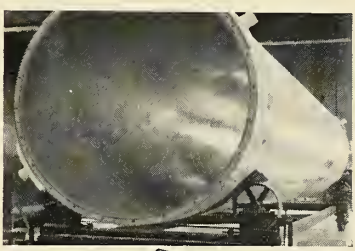
Bird Under Glass

A delicate delight for an epicure's palate? Well, hardly. The bird in this case is the Polaris IRBM — and the case, which is the whole point of our little dissertation, a tough *glass* reinforced plastic shipping container.

Built by our subsidiary, the Zenith Plastics Company, it's the largest one piece reinforced plastic cylinder ever fabricated. More than 25 feet long with a 57 inch I.D. and weighing less than 2400 lbs., it offered a significant weight reduction (with equivalent strength) over the metal case is replaced. In case you're wondering, ovality and straightness tolerance throughout the cylinder were less than ±.015". In addition the structure included an integral electric heating element for environmental control.

The Polaris case is an excellent example of the kind of structural magic that can be worked when the right materials and fabrication technology are combined in one facility. The raw materials, 3M's "Scotchply" unidirectional filament systems, assure top uniformity in composition and an excellent strength to weight ratio. Zenith, a fabricator (of many years standing) of large precision structures, is now even better equipped to provide quick, versatile and reliable service for you. Through expansion of their facilities and refinement of techniques, they're able to produce even larger such units — either as cylinders or complete rocket motor cases, and do so economically. Even if your requirement is a bit "offbeat," don't be afraid to discuss it with them. Chances are pretty good that they've already had worse. For current data on facilities and capabilities, check the box below.



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Third success for Juno II . . .

Explorer VIII Probes Ionosphere

Data transmitted will aid in designing nuclear and ion rockets and tell more about radio wave performance

THE *EXPLORER VIII* ionosphere measurements satellite will provide extensive data needed for advanced communications experiments and for the design of nuclear and ion rockets.

The 90-lb. satellite, launched into an elliptic orbit early Nov. 3 by a *Juno II* vehicle, is expected to continue transmitting for two to three months. The orbit had an apogee of 1422.65 statute miles, a perigee of 258.44 statute miles and a period of 112.75 minutes.

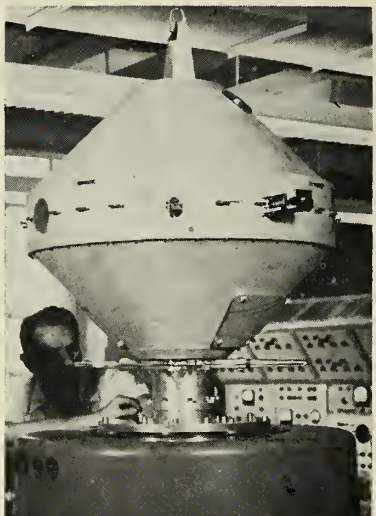
The National Aeronautics and Space Administration was trying for a nominal orbit of 1785 statute miles apogee and 245 statute miles perigee, and a period of 119.2 minutes.

• **Prelude**—Two hours after the shot from Cape Canaveral at 12:23 a. m. EST, NASA's Morton J. Stoller told newsmen the micrometeorite experiments aboard *Explorer VIII* are a necessary preliminary to solving the problem of dissipating heat from nuclear and ion rockets in space. The advanced rockets will be cooled by radiators, whose design will be controlled by the structure necessary to protect it from micrometeorites.

The ionospheric measurements will provide direct information that will add detail and check inferences on how radio waves are carried around the earth. This information will help communications experts choose frequencies for long-distance communications. Until now, ionosphere information has been inferred from radio propagation characteristics.

The spacecraft carries eight experiments, mostly for measuring positive ion and electron composition of the ionosphere. It is powered entirely by batteries. Thus there is no problem of turning off the transmitters when information is no longer needed. Without solar cells to recharge the batteries, they are bound to go dead.

• **Comparatively costly**—*Explorer VIII* is the third space success for *Juno II,* developed by NASA's Marshall Space Flight Center (when it was part of the Army Ballistic Missile Agency) as an early booster vehicle. However, the vehicle will phase out after two or three more shots because of its relatively high cost per pound of payload in orbit.



EXPLORER VIII is given a vibration test at the Marshall Space Flight Center in Huntsville in preparation for launching.

Stoller figured a cost of $2½ to $3 million for a *Juno II,* including part but not all of the launching expense and field support. This compares with an expected cost of about $1 million for the all-solid *Scout,* when it goes operational and is handled completely by the prime contractor, Chance Vought, within a year or so. The *Scout* has about the same or slightly greater payload capacity.

Juno is more expensive primarily because it uses a modified *Jupiter,* with a liquid-propellant engine, as first stage. The upper three stages are clusters of 11 and three and a single scaled-down *Sergeant* rocket developed by Jet Propulsion Laboratory.

Explorer VIII carries these experiments:

–Radio frequency impedance probe, a dipole antenna with arms 10 ft. long, which measures electrical capacitance o the sensor, which by comparison wit the sensor's free-space value gives in formation on electron concentratio surrounding the satellite.

–Single-grid ion trap, an arrange ment similar to the internal working of a radio tube, which collects varyin quantities of ions according to a gri voltage that varies between –5 an +25.

–Four multiple-grid ion traps, t provide information on positive io concentration and mass distribution a three points on the satellite equator an one at the upper cone near the spi axis, for comparison with data from th single trap on the upper cone.

–Langmuir probe, to measure elec tron temperature, a collector in th form of a circular plate insulated fron the satellite's aluminum skin, whic measures total diffusion current.

–Electric field meter, a rotating shutter type device that measures th static field due to the ion sheath tha forms around the satellite. Because o the high current drawn by the mete motor, it operates only on comman from ground stations and is programe to operate about six minutes for ever 100 minutes of orbit.

–Micrometeorite photomultiplier which transmits pulses resulting fron light energy given off as micromete orites hit the surface of an aluminum coated sensor.

–Micrometeorite microphone, whic measures frequency and momentum o impacts by converting the sound t telemetry signals.

–Four thermistors to provide tem perature readings.

All telemetry is on a real-time basis A single transmitter on 108 megacycle doubles for telemetry and tracking.

Stoller said the remaining *Juno I* shots will be S-45, an ionosphere bea con satellite, which contains radio fre quency transmitters for propagatio through the ionosphere, and S-15 which will measure the intensity an rough direction of gamma rays in th universe. A third *Juno II* is availabl as backup.

reviews

OLARIS! THE CONCEPT AND CREATION F A NEW AND MIGHTY WEAPON, ames Baar and William Howard, Harcourt, race and Co., New York, 245 pp., photo- raphs, $4.50.

The first encounter of William Francis aborn, Jr., with the Navy occurred hen he met two midshipmen home on ave from Annapolis, showing off their ghtly cut white summer uniforms to the arm boys in Marlow, Oklahoma.

Raborn fell in love with the Navy and was a mutually happy affair which car- ed through the Naval Academy, flight aining, and into combat at Pearl Harbor nd World War II in the Pacific.

It still continues, mutually, with the klahoma boy now a vice admiral, fight- ng not the enemy but inertia blocking the ation's newest strategic weapon.

"Polaris!" by James Baar and William loward, both editors of MISSILES AND OCKETS Magazine, is as much the story f the carrot-topped Raborn as it is the tory of the first U.S. ballistic missile to be red from a submerged submarine.

From the beginning, when it started as sea-going version of the old liquid- ueled Army *Jupiter*, the Navy's deter- ined plan to join the U.S. strategic forces as beset with difficulties.

The *Jupiter* was too big, too danger- us, too uncertain, too everything—but aborn tried his best to make it work. hen solid fuel came along, and Raborn ade the dangerous switch on which ested the success of the program as well s the future of Raborn himself.

There is the story of the fight for unds, of adopting the new missile to the lso new atomic submarine, of Admiral ickover, Mr. Atomic Submarine, himself. aar and Howard carry you through the itter disappointments of failures, the rials and errors, the fight against time, he opposition of the other services, the thargy of the Administration, the never- nding battle for funding; through the rst five launching failures and the final ictory of pure determination.

If the book has one main theme it is point up clearly and relentlessly that eveloping new techniques, new metals nd new fuels for a new weapon system re not the main problems.

The great frustrations which drive men f action half crazy are the indecisions of he men who have the power to delay, to old up funds, to vacillate month after ong month—these are the main factors. Quick and firm decisions at the right time hould have given us a fleet of *Polaris*- quipped subs more than a year ahead of me the nation will now have them.

Polaris! is written largely from a Navy iewpoint; some readers will find in it a ias in the Navy's direction. Some of the notivations and some of the decisions are ecessarily oversimplified. But Polaris! will e recognized as the record of a heroic chievement. The authors have succeeded, hrough interviews, anecdotes, flashbacks nd an incredible amount of research in aking Polaris! a valuable addition to the Navy's recorded history—C. N.

HANDBOOK OF LAPLACE TRANSFORMATION: TABLES AND EXAMPLES, Floyd E. Nixon, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 115 pp., $6.00.

This little book is an excellent "How to Do It" for the engineer having to solve linear differential equations. The mathematics is simple—a standard course in calculus being all that is needed—, and the presentation is tutorial. A reasonably backward technical student with ambition to apply Laplace transformations, will with the aid of this book be able to do so within an hour.

MECHANICAL PROPERTIES OF SELECTED ALLOYS AT ELEVATED TEMPERATURES (PART II: DESIGN CRITERIA OF SILICON CARBIDE), H. A. Pearl and others, Order PB 161723 from Office Of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C., 134 pp., $2.75.

Nondestructive tests of silicon carbide were conducted to determine, in broad parameters, the areas where a brittle, nonmetallic body such as silicon carbide might be used in aircraft construction.

The tests were selected on the basis of usefulness in evaluating silicon carbide as an aircraft and missile leading-edge material. Included are manufacturer's property data for various types and forms of commercially available silicon carbide.

PROCEEDINGS OF THE SECOND CONFERENCE ON REACTIONS BETWEEN COMPLEX NUCLEI, held in Gatlinburg, Tenn., May 2-4, 1960, edited by A. Zucker, E. C. Halbert, and F. T. Howard, John Wiley & Sons, New York, 319 pp., $7.00.

The editors are to be congratulated for the speed with which they put between hardback covers the Conference papers, including a Russian one whose author was not permitted to deliver it personally. Presumably, there was State Department intervention in spite of the strenuous efforts of the conferees.

The editors see their volume as being of primary use to heavy-ion physicists and chemists as a "sort of status report of their field," and more generally to nuclear physicists interested in those aspects of their craft related to heavy ions. The book will also help the scientist "who finds himself at loose ends to evaluate the possibilities in this line (heavy ions) of research."

contracts

NASA

$114,815—**The Martin Co.,** Baltimore, for study of operational modes of the future second-generation *Saturn C-2* space vehicle.

NAVY

$9,400,000—**Federal Electric, subsidiary of IT&T,** for PMR range operations over the next three years.

$8,000,000—**Vitro Laboratories,** Silver Spring, Md., for coordination and testing of *Polaris* weapon systems on nuclear-powered submarines.

$5,500,000—**Yardney Electric Corp.,** New York City, for manufacturing Silvercel propulsion batteries for the experimental submarine "Albacore."

$1,775,000—**Northrop Corp's Radioplane Div.,** Van Nuys, for the production of 500 *KD2R-5* radio controlled aerial target drones.

AIR FORCE

The Whirlpool Corp., St. Joseph, Mich., for designing and building a space kitchen which would provide all foods and beverages required by 3 space pilots on a 14-day mission.

Lockheed-Brown Associates, Van Nuys, for production of improved shipping containers for the *Hound Dog* guidance system. Subcontract from **Autonetics Div. of North American Aviation.** Amount not disclosed.

Poly-Scientific Corp., Blacksburg, Va., for installing a reliability program for components for the *Titan*. Subcontract from **General Motors Corp's AC Spark Plug Division.** Amount not disclosed.

$1,775,000—**Northrop Corp.'s Radioplane Div.,** for *KD2R-5* aerial target, spare parts and data.

$1,399,033—**Sperry Rand Corp.,** Phoenix, for E4 automatic flight control system, spare parts and ground support equipment.

$1,150,853—**Goodyear Aircraft Corp.,** Akron, O., for additional contractor maintenance work and supplies for the TM76A *Mace* missile program.

$740,855—**Beckman Instruments, Inc.,** Fullerton, Calif., for 17 electronic units to be used with the *Minuteman* missile. Subcontract from **North American Aviation's Autonetics Division.**

$190,000—**General Dynamics Corp., General Atomic Div.,** San Diego, for development of a high-temperature thermionic converter for use in nuclear auxiliary power systems.

$160,000—**Space Electronics Corp.,** Glendale, Calif., for research investigation of ultra-low-frequency electromagnetic wave propagation.

$110,000—**University of California,** Berkeley, for continuation of research on "Chemical Effects of Radiation."

$79,994—**Cornell Aeronautical Laboratory, Inc.,** Buffalo, for research on "High Temperature Phenomena in Hypersonic Flows."

ARMY

$3,130,009—**Sperry Rand Corp.,** Salt Lake City, for research and development on the *Sergeant* missile system.

$903,000—**Ford Motor Co.,** Newport Beach, Calif., for design, development, test and demonstration of combat vehicle weapon system.

$900,000—**Sperry Rand Corp.,** Salt Lake City, for production engineering services for *Sergeant* missile system.

$800,000—**Sylvania Electric Products Inc., Electronic Defense Laboratories,** Mountain View, Calif., for fabrication of advanced radar equipment, scatter communication equipment and research covering the study of electromagnetic wave scattering (four contracts).

$218,025—**Reed and Shine Construction Co., Inc.,** Melbourne, Fla., for construction of electronic test shop systems at the Air Force Missile Test Center.

$176,856—**Raytheon Co.,** Waltham, Mass., for replenishment repair parts for the *Hawk*.

$99,983—**Firestone Tire and Rubber Co.,** Los Angeles, for engineering services for the *Corporal* missile and ground handling equipment.

$58,197—**Accessory Products Co., Div. of Textron, Inc.,** Whittier, Calif., for valves for *Nike* missile system.

Data Recorder Transducer Equalizer

The Tranqualizer, a transducer-equalizer manufactured and marketed by Data Instruments division of Telecomputing Corp. provides a method to receive and observe in real time, as well as to accurately record analog data otherwise masked and destroyed by the limitations of the measuring system.

Tranqualizer virtually eliminates undesirable ringing which results from the excitation of the transducer at or near the natural resonant frequency. It effectively extends the system's frequency response by several octaves, allowing a more accurate presentation of the stimulus function. Essentially an analog computer, the Tranqualizer performs by inserting into the data a complex transducer function which is the reciprocal of the transducer transfer function.

Circle No. 225 on Subscriber Service Card.

Single Component Epoxy

A 100% solids, epoxy, single-component coating for continuous operation up to 155°C is available from Columbia Technical Corp. HumiSeal Type 1F56 requires no mixing and may be used directly from the shipping container. Viscosity may be adjusted to yield build of 10 mils and thicker and the coating may be applied either by dip or brush.

Circle No. 226 on Subscriber Service Card.

Transistor Heat Sink

A modular aluminum sink has been introduced by Astro Dynamics, Inc. Model 2401 makes use of a light, compact, integrated blower and permits use of power transistors at 2 to 3 times previous achievable ratings. While dissipating almost 60 watts at 25°C, this heat sink has a thermal resistance between transistor shelf and air of less than 0.8°C/watt.

Through a high-pressure fin assembly process which produces a strong metal-to-metal bond and extremely high thermal conductivity, Astro Dynamics can vary size and spacing of fins to match specifically the requirements of a wide variety of systems and blowers.

Circle No. 227 on Subscriber Service Card.

High G Trimming Pots

Helipot Division of Beckman Instruments, Inc., has added two cermet models to its line of HELITRIM trimming potentiometers. Just released are Model 53, a unit with pins for printed circuitry, and Model 54, with solder lugs. They are virtually insensitive to vibration and can ride out 100 g's shock.

Circle No. 228 on Subscriber Service Card.

Airborne Digital System

The Electronics Division of Curtiss-Wright Corp. has developed a versatile, low-cost airborne digital data system, Model ADS-1. The ADS-1 features a highly accurate digital presentation of "yes-no" type of information not degraded by transmission media. The system includes input multiplexing, an analog-to-digital convertor, output switching, channel identification and parity checking. The ADS-1 has twelve channels, a sampling rate of 120 samples a second, conversion accuracy ±0.2% over the operational temperature range, a 10 millivolt resolution and repeatability and total weight of only 9.5 lbs.

Circle No. 229 on Subscriber Service Card.

Resolver Standard

A resolver standard, offering functional accuracy of 2 seconds of arc, eliminating the null detector and a resolver transmitter mounted in an index stand, has been developed by Astrosystems, Inc.

The Astrosystems Resolver Standard is manually switched to discrete positions when used in resolver testing.

When utilized as a control, the Standard is an extremely accurate forward speed control input device for machine tools, computers, radar simulators and flight simulators.

Circle No. 230 on Subscriber Service Card.

Crystal Transmitter

Vector Manufacturing Company, Inc., has developed a transistorized crystal controlled transmitter, hexagonal in form, weighing approximately four ounces, and of low power consumption. It is an all-silicon transistorized, crystal-controlled phase-modulated unit, capable of transmitting the intelligence from any telemetry subcarrier system.

Circle No. 231 on Subscriber Service Card.

Infrared Cryogenic Cooler

The Model FW-22 Cryogenic Cooler is available from ITT Laboratories. Designed for cooling dewar-type infrared detector cells with liquid nitrogen, liquid oxygen, or liquid air, the ITTL Cryogenic Cooler will operate continuously for 22 hours from filling, 16 hours after 24 hours standby, or proportionate times up to 82 hours

otal. The unit may be operated at reduced exhaust pressures to obtain colder temperatures (down to 63°K with liquid nitrogen). Various cool-down times and operating times are possible by regulating the storage tank pressure.

Circle No. 232 on Subscriber Service Card.

Tiny Hysteresis Motor

A Size 8 hysteresis synchronous motor developed by Kollsman Motor Corp. is only 0.960 in. long.

Designated Model A3361, the 400-cycle unit provides high efficiency and hunt-free synchronous rotation. Torque (pull-in) is 0.025 oz. in.; weight, 1.25 oz. Synchronous speed is 8000 rpm. at 55 Volts. Single-phase and two-phase designs are available. Total power is 5.1 watts.

Circle No. 233 on Subscriber Service Card.

Recording Thermobalance

An automatic recording thermobalance which performs thermogravimetric studies in vacuum or controlled atmospheres at temperatures to 1000°C, is available from American Instrument Co., Inc.

The Thermo-Grav measures and automatically records changes in weight as a function of temperature programed for a selected linear heating rate, or as a function of time at a constant temperature.

Designed to overcome past deficiencies and offer the analyst maximum versatility, the Thermo-Grav removes reaction products as formed, minimizing or eliminating their effect on the reaction of interest.

Circle No. 234 on Subscriber Service Card.

High Purity Servovalve

A new high in reliability of automatic control is available from Raymond Atchley Inc.

The Jet Pipe principle, a design feature incorporated in servovalves, has virtually eliminated contamination as a factor in reliability and performance.

This greater capability assures positive automatic control in all airborne or ground electro-fluid and gas systems without painstaking and expensive contamination control measures.

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new literature

MAGNETIC MEMORIES—Technical Bulletin 59-J describing series 3100 Magnetic Memories for data processing applications, with capacities ranging from 128 to 4096 words and from 4 to 64 bits per word, has been published by Rese Engineering Inc. It contains a full description of the memories, a block diagram and timing chart, step-by-step operating procedure, and the availability of apertured ferrite plate or core stack plug-ins.

Circle No. 200 on Subscriber Service Card.

BACK-UP RINGS—A 12-page booklet of design, dimensions, and other data on Parbaks, Parker Seal Co.'s continuous and contoured back-up rings, is available from the firm. The booklet describes the characteristics of back-up rings, and discusses the advantages of contoured and continuous rings. Complete dimensions and operating media data are also included.

Circle No. 201 on Subscriber Service Card.

MANIFOLDS AND REGULATORS—Oxweld industrial gas regulators and portable manifolds are described and illustrated in a catalog (Form 55-085) available from Linde Co., Division of Union Carbide Corp. The catalog includes complete specifications and ordering information for regulators that are available for all industrial gases and completely portable manifolds for use with oxygen and acetylene. Inlet and outlet connections are listed according to the American Standards of the Compressed Gas Association. Recommended uses and installations are included in the description of each regulator.

Circle No. 202 on Subscriber Service Card.

ENVIRONMENTAL TESTING—Advanced propulsion and environmental test and research facilities are described by Aerotest Laboratories, Inc., in a 26-page brochure. Complete space orientated laboratory facilities, for functional and environmental testing of components and systems, from sub-miniature electronic to gas turbine engines, are summarized in detail.

Circle No. 203 on Subscriber Service Card.

names in the news

RAMBUSEK

DOWNS

BAILEY

John B. Montgomery: Vice president d general manager of General Electric's ht Propulsion Division, resigns as of c. 15 to become president of Daystrom, c. He is a retired Air Force general and s executive officer to Air Force Secre- y Stuart Symington, director of opera- ns for Strategic Air Command and com- nder of the Eighth Air Force. **Thomas y Jones,** former president of Daystrom, s been named chairman of the firm.

Joseph Rambusek: Former vice presi- nt in charge of sales for Bogue Electric anufacturing Co., joins The Siegler rp.'s Magnetic Amplifiers Division as les manager.

Charles L. Spencer: Named special gineering advisor for Systems Evalua- n for the Development Engineering rp. Since 1954 Spencer has been a con- ltant to the U.S. Navy's Bureau of ips.

Arthur D. Coleman: Joins Interna- nal Resistance Co. as senior quality surance engineer in the firm's high-re- bility resistor project. Was formerly anager of reliability and quality assur- ce with the Systems Division of Clifton ecision Products Co. Inc.

Charles G. Chisholm: Former general les manager, elected vice president-mar- ting of Haynes Stellite Co., a division Union Carbide Corp.

Thomas M. Robertson: Named to the w post of manager of Antisubmarine arfare Planning, at Vitro Laboratories. **illiam L. Freienmuth** replaces Robert- n as acting head of the Systems De- lopment Dept.

George L. Downs: Appointed manager the *Minuteman* program office at the mherst Laboratories of Sylvania Electric oducts Inc. **Robert D. Gray** was named chnical program manager responsible for ordinating the system design.

William H. Bailey: Appointed execu- ve vice president of Nuclear Corpora- n of America. For the past three and e-half years he has acted as business manager of several weapons systems projects at Martin-Orlando.

Jerry Gabriel: Former vice president in charge of research and product marketing for Dyna-Therm Chemical Corp., joins Jack & Heintz, Inc., as director of long-range market and product planning, a newly-created post.

Charles K. Hersh: Former research engineer, promoted to senior engineer at Armour Research Foundation.

William J. McClenahan: Former sales manager, promoted to marketing manager for Sperry Rand Corp.'s Sperry Electronic Tube Division.

Henry Burlage, Jr.: Former director of the Propulsion and Aerodynamics Laboratory of Case Institute of Technology, and associate professor of aerodynamics engineering, joins the National Aeronautics and Space Administration as manager of advanced technology programs for liquid-propellant rocket engines.

Dr. Sidney A. Bowhill: Associate professor of electrical engineering at Pennsylvania State University, elected to the board of directors of Dorne and Margolin, Inc.

Arthur E. Rowland: Joins Autonetics, a division of North American Aviation, Inc., as chief, Sales Engineering for Armament and Flight Control Products. Was formerly Western region manager of General Precision Equipment Corp.'s Kearfott Division.

Paul N. Bertness: Former advertising manager of Consolidated Electrodynamics, joins Microdot Inc. as advertising and public relations manager of the firm's four divisions: Connector, Cable, Electronic Transformer and Instrumentation.

Dr. Louis R. Lavine: Assistant manager of programing research and development, succeeds **Dr. Saul Rosen** as manager, programing research and development, for the Computer Division, Government and Industrial Group, Philco Corp.

when and where

NOVEMBER

National Aeronautics Association, N tional Convention, Indio, Calif., N 14-16.

Institute of Radio Engineers, Mid-Am ica Electronics Convention, (MA CON), Hotel Muehlebach, Kan City, Mo., Nov. 14-16.

Sixth Annual Conference on Magneti and Magnetic Materials, ONR, II AIME, AIEE, AIP, Hotel New York New York City, Nov. 14-17.

IRE Professional Group on Product Techniques, Fourth Annual Conf ence, Boston, Nov. 15.

Engineering Applications of Probabil and Random Function theory, Purc University, Lafayette, Ind., Nov. 15-

Air Force, Navy, Industry Propulsion S tems Lubricants Conference, (uncla fied) co-sponsored by ARDC's WAI and Southwest Research Institute, I ton Hotel, San Antonio, Nov. 15-1

British Interplanetary Society, One-I Joint Symposium on Space Navigati with Institute of Navigation, Ro Geographical Society Lecture H London, Nov. 18.

Conference on Electro-Optical and Ra ation Devices, sponsored by IRE Pr Group on Electron Devices and AI Stanford Research Institute, Me Park, Calif., Nov. 20-21.

American Physical Society, University Chicago, Chicago, Nov. 25-26.

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Geneva, Switzerland—10 Rue Grenu Geneva 321044

Paris, France—11 Rue Condorcet; TR 15-39

Advertisers' Index

EMPLOYMENT

editorial . . .

Reorganizing the Pentagon

PRESIDENT-ELECT KENNEDY'S Reorganization plan for the Department of Defense and the military services will shake the Pentagon to its five-sided foundations.

There have been seven Secretaries of Defense. James Forrestal was sworn in as the first on Sept. 17, 1947. His successors were Louis Johnson, Gen. George C. Marshall, Robert A. Lovett, Charles E. Wilson, Neil H. McElroy and Thomas S. Gates, the incumbent.

They have been good, indifferent or bad according to the viewpoint, and each has left the mark of his methods or convictions on the military establishment.

But none of them—not even Forrestal, who put the organization together—faced the job which lies ahead of the new Democratic Defense chief under the reorganization plan which will be proposed by Kennedy (see page 8).

In this drastic overhaul, which the president-elect has forecast in his campaign speeches, three major points stand out. They are 1) abolishing the three service secretaries and their assistant secretaries, 2) disbanding the Joint Chiefs of Staff as a unit and 3) substituting one Chief of Staff for the Department of Defense—to be the nation's highest uniformed official.

Kennedy feels, we understand, that the service secretaries are both a symbol of disunity and a waste of manpower. Their authority has been greatly down-graded since DOD was organized until now they are simply petitioners, a channel through which papers move on the way to DOD. Kennedy feels the services will be better represented by either assistant or under-secretaries working directly with the Secretary of Defense.

With the service secretaries will go what Kennedy has called the "proliferation" of assistant and under-secretaries. Their jobs would also be combined under DOD.

Disbanding the Joint Chiefs of Staff and replacing them with one Chief of Staff for Defense is a move which the new President hopes will help restore the decision-making processes in the military.

Many, if not most, of the really important problems which have come before the JCS in the past few years have reached a two-to-two vote stalemate. Important decisions, ranging from the choice of new weapon systems to strategic planning, have been referred to study groups. In some instances the decision of the study group has then been referred to another study group, with the actual decision going to the Secretary of Defense or the President after long delay.

Under the planned reorganization the National Military Council, which would probably include the Service Chiefs of Staff, would make recommendations but the decision would be up to one military man—the Chief of Staff for Defense.

Much of the Kennedy plan is being recommended by a committee of public officials and private citizens with considerable experience in the Pentagon's intricacies. It will be presented to Congress, we are told, as one of the first orders of business in January.

WHETHER THE PLAN, or what goes through after the inevitable compromises, will cure the major ills of our military system is difficult to foresee.

But one thing is certain. Something must be done to restore the decision-making processes in the Pentagon. Something must be done to prevent the delays of referrals to study groups, the compromise of passing to committee. Something must be done to eliminate the layer upon layer of little officials who can always stop action but seldom approve it, who have the power of the lower-drawer veto.

If the new plan will just give the man on the job the authority and the confidence to say "do it"—then the plan will be good.

Clarke Newlon

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engineers, physicists and mathematicians

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Patrick Air Force Base, Florida

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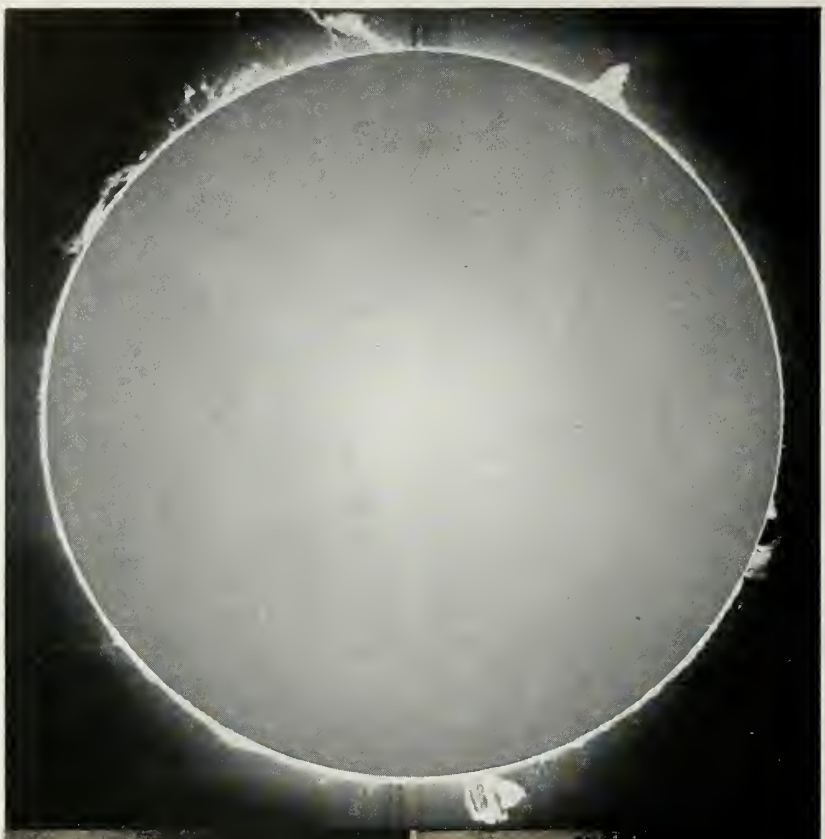

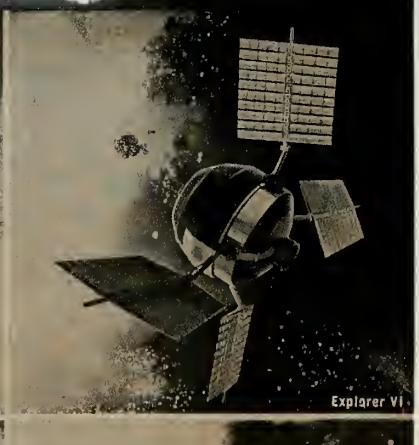

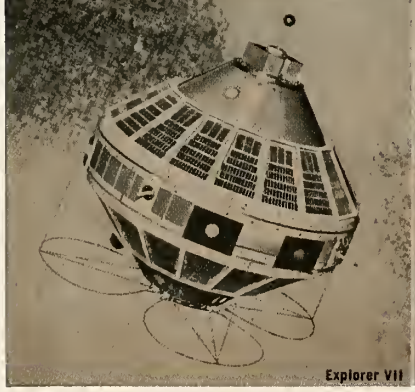

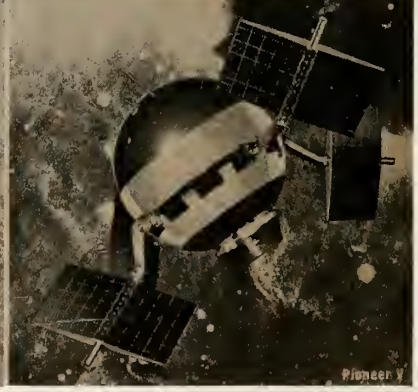

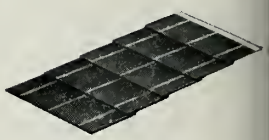

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