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AIR FORCE

and **SPACE DIGEST**

The Magazine of Aerospace Power / *Published by the Air Force Association*

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Annual
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ALMANAC



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A. LARSON AFB, WASH.—

A Huskie hovering over the burning wreckage of a B-52D used its rotor downwash to keep flames away from the bomber's 128,000 pound fuel load until all 10 crewmen had been safely evacuated. (Air Force Photo)

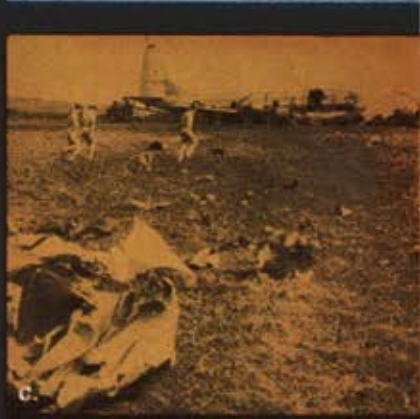
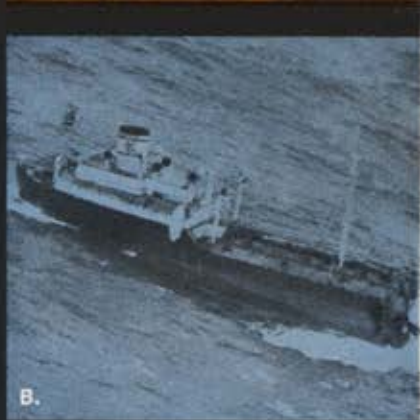
B. CAPE HATTERAS, VA.—

When the tanker Pine Ridge broke up off shore, a Kaman HUK operating from the Valley Forge rescued 9 crew members and returned them safely to its carrier base. (U.S. Coast Guard Photo)

C. RANDOLPH AFB, TEXAS

USAF H-43 on standby alert reached the crash scene of a KC-97 tanker and worked with fire fighting crew to prevent flames from spreading to 4,000 gals. of spilled fuel, saving the aircraft. (San Antonio Field Photo)

THE KAMAN AIRCRAFT CORP., BLOOMFIELD, CONN.



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This demonstration photo became a reality at PLATTSBURG, N.Y., when one of the crewmen who bailed out of a crippled B-52 was injured when landing in an isolated area of 100 foot trees. The crew of a Huskie saved his life by hovering over the spot and lowering a medic to give first aid until rescuers on foot reached the scene.

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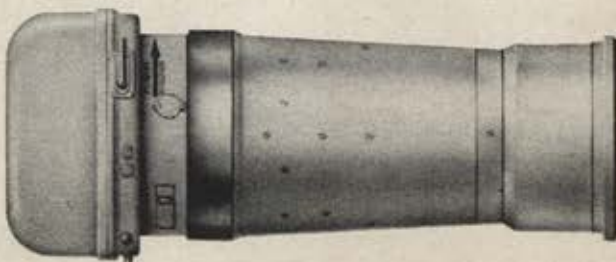
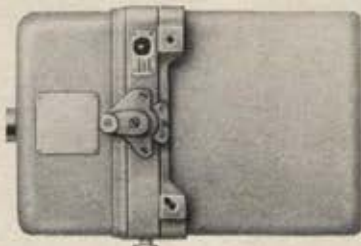
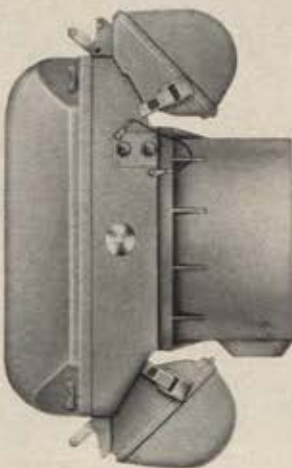
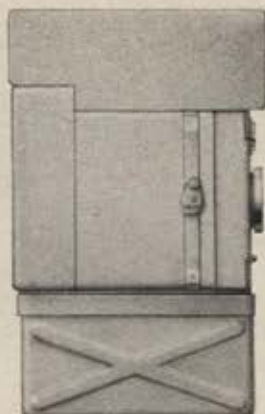
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AIR FORCE

and **SPACE DIGEST**



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"Spring," says the song, "will be a little late this year."

Likewise this April issue of AIR FORCE Magazine and SPACE DIGEST—our annual "Missile and Space Almanac" issue. Putting together a magazine of this size is always a task of no mean magnitude. This year the Air Force complicated matters by inconsiderately timing the announcement of the reorganization of AMC and ARDC into two new commands (*see page 39*) on the Friday we normally would have had things pretty well wrapped up. We would have preferred it a week earlier, if we had had our "druthers." On the other hand a week

later would have been catastrophic, so we are thankful for small favors. Some sections of the magazine had already gone to press with now-obsolete terms such as ARDC and BMD, but we have made all the changes that were physically possible. Two pages of charts, already engraved, went into the hell box and a new one was cranked into the editorial and mechanical mills. New copy was written addressed to the new state of affairs. Editorial deadlines normally are sacred things, and it is an indication of the importance with which we view the reorganization that we took the heretical approach.

We are often asked, usually by prospective authors, "What is your deadline?" The answer is not as simple as the question, for it is physically impossible to have *one* deadline for a large magazine. We go to press in bits and pieces, each section with its own individual deadline, all carefully timed to come out even with the presstime allotted us at McCall's big printing plant in Dayton, Ohio, where literally millions of individual copies of many different magazines are printed every week. Like the new Air Force Systems Command, we operate under the concept of concurrency, with many projects in various stages of completion at the same time, complicated somewhat by the fact that different months have different lengths. This April issue of 1961 marks the 120th on which I have worked, and I must say it's been a rouser.—J.F.L.

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Technological Milestone

JOHN F. LOOSBROCK

Editor, AIR FORCE/SPACE DIGEST

TWO RECENT decisions—the Department of Defense directive which names the Air Force as the primary executive agent for military space systems development, and the internal Air Force reorientation of systems research, development, procurement, and production—are considered together, as they must be, the most important milestone which has been passed since the Air Force was established as a separate service in the Unification Act of 1947.

The Department of Defense directive concerning management of the nation's military space effort is far, far more than a decision designed primarily to resolve a single point of interservice bickering. And the internal Air Force reorganization, while affecting primarily the responsibilities and functions of Air Materiel Command and Air Research and Development Command, is far, far more than just another reorganizational effort aimed at increased efficiency. Together they represent, for the first time, topside recognition of the full impact of the technological revolution upon traditional ways of doing military business, with maximum emphasis on effectiveness and a minimum number of genuflections before the twin altars of tradition and vested interest.

"Technological unification" might be a good name for the end result. Deputy Secretary of Defense Roswell L. Gilpatric put it another way before the House Committee on Science and Astronautics, when he said in reference to the space directive, "We [Mr. McNamara and Mr. Gilpatric] do not feel that important decisions affecting the national security can be deferred pending attempts to work out a *modus vivendi* which will be satisfactory and pleasing to everyone."

In this approach we can see a definite and encouraging swing toward a functionally oriented defense effort for which planners of more than one service have been pleading for years. A mechanism is established to retain the virtues of intellectual and technological competition while eliminating the vices of waste and duplication. Each service is still perfectly free to propose new space systems in fulfillment of its mission. Thus competition occurs at the level where it is both highly desirable and comparatively inexpensive. The decision as to whether an individual system goes beyond the feasibility study, or idea, stage rests where it belongs, at Department of Defense level. Here it can be weighed against available resources, the state of the art, and the needs of the nation. If the Secretary of Defense gets the nod from his Director of Defense Research and Engineering, he designates the proposed space system

a Department of Defense system—not, repeat *not*, an Air Force system, an Army system, or a Navy system. It then becomes the Air Force's job to conduct the research, development, test, and engineering for the system.

Mr. McNamara has made it quite clear that the assigning of these tasks to the Air Force for all military systems does not involve a predetermined assignment of the operational responsibility for any specific system. The Air Force's customer is the nation, not the service which made the original proposal. And, in point of fact, the Reorganization Act of 1958 long since shifted operational responsibility from the individual services to the unified commands (e.g. NORAD) and the specified commands (e.g. SAC). The services, *per se*, have not had operational responsibility for almost three years, although there are many in the Pentagon who refuse to look this fact in the eye in the dwindling hope that it, somehow, will go away.

In another way, this directive is the Defense Secretary's way of saying, "Shoemaker, stick to your last." It is designed to avoid future anomalies of the kind which have plagued the Pentagon in the past—with basic service missions suffering because of preoccupation with the glamor, and the budgets, of space systems. To thinking officers of all services, seriously concerned with their basic roles and missions, the directive should come as a welcome relief.

While the reorganization within the Air Force makes sense in the context of the Defense Secretary's directive, it would also make sense had the directive never been issued. In fact, initiation of the management studies on which the reorganization is based preceded the directive by a good two years. Once the concept of concurrency was accepted as a time-collapsing device to get weapon systems from the drawing board to the launching silo in the shortest possible time, some such approach became inevitable. If research, development, test, engineering, procurement, production, and site construction for a given system are being pursued concurrently, it is logical to make one man responsible for the full cycle. This fact, incidentally, was underscored in the report by President Kennedy's space task force, headed by Jerome B. Wiesner, now chief scientific adviser to the White House.

Previously, the problem had been met gingerly, rather than head-on, with procurement-production "opposite numbers" set up in support of their research and development counterparts—e.g. AMC's Ballistic Missiles Center vis-à-vis ARDC's Ballistic Missile Division. But the dichotomy was, of necessity, an artificial

one, and the new organization, spelled out in detail beginning on page 39, tacitly recognizes this fact and slices a superhighway of direct command channels through the old traffic circles of "coordination."

In addition, the continuous requirement to replenish the pools of scientific knowledge through basic research programs is recognized and dignified through the establishment of the new Office of Aerospace Research, reporting in the same status as a major command directly to the Chief of Staff.

It is interesting that the reorganization ties the site construction activities of the Army Corps of Engineers quite tightly to the new Ballistic Systems Division. Army Brig. Gen. Alvin C. Welling will be Deputy for Site Activation, reporting to the Commander of the Air Force Ballistic Systems Division. Recent problems in site activation undoubtedly prompted this arrangement although those who interpret criticism of the site program as the motivation for the entire reorganization are wrong. But in this arrangement we see another chink in the wall of separation between the services.

Surely it is no more daring to think of a future date when the colors of the various uniforms blend to match the functional organization than it would have been to predict, a few years ago, that procurement and production would someday be put in the same package with research and development.

More and more, we predict, the pressures of technology will be guided and harnessed, rather than resisted, by Pentagon management. Elements of all services and of all parts of all services will be assembled to fit the task to be accomplished. The systems approach, so necessary in meeting the challenge of individual weapons, will be applied to the broad task of national defense. Tradition will continue to play a role for morale and ceremonial purposes, like the kilts and pipes of the Scottish Highland regiments, but it will be as a means and not as an end.

We are not in love with decisions for decisions' sake. We will examine those to come on their own merits and disagree if we think they are wrong. But these two make sense to us.—END

Responsibility Is A Personal Thing

AS WITH any reorganization, the space directive and the reorienting of the Air Force technological effort will be a source of unhappiness and inconvenience to many individuals.

This will also be true of other decisions which are sure to follow. It is part of the price one must pay for change. Our own editorial effort has already felt the impact of the Air Force reorganization announcement, coming, as it did, just when we were closing this big, special "Missile and Space Almanac." We know, even as we go to press, that there is some obsolete terminology in portions of this issue which had to go to press earlier for mechanical reasons. This is but another indication of the kind of world in which we are living, a world of restive ferment and remorseless change.

Gen. Thomas D. White set the tone, we think, in his brief statement concerning the new Air Force role in military space development. He said, in part, "... The Air Force will have a heavy responsibility to the nation and especially to the Department of Defense and the Army and Navy. ... I am impressing on all our people the importance and the difficulty of the task that lies ahead. I am confident that the Air Force will be equal to the job."

We share General White's views, both as to the Air Force responsibility and Air Force capability. And we wish to emphasize the fact that collective responsibility is but the sum of the individual responsibilities that repose with each man and each woman who wears the Air Force blue, and with each civilian who accepts an Air Force pay check. The Air Force, in the sense of General White's statement, is not a faceless thing built of organization charts and regulations and directives. It is the total of the talents, the devotion, the

energies; yes, even of the deficiencies, of the human beings who are banded together under its aegis in common effort for a common cause.

Thus, those who serve the Air Force, who love it, who believe in it, all share the responsibility which General White so soberly describes. The load is not equally distributed, that is true, but distributed it is, and Air Force life will never again be quite the same as a result.

One may ask, quite humanly, "But what can I do? Just what is this new responsibility of mine—as a fighter pilot, as a crew chief, as an Air Force wife, as an Air Force Reservist or Guardsman, as a member of the Air Force Association?"

There is one area in which individual responsibility can be met immediately—no matter what your job or wherever you may be. This is the matter of education—of self-education, if you will. Each of us has an obligation as a citizen to learn all he can of the implications of the new technology and the imprints it is making on our way of life. This is the responsibility of a democratic electorate to enlighten itself. Within the Air Force this same responsibility is delineated with a new sharpness by recent events.

It means work—reading beyond the routine news and the best-sellers, watching beyond horse operas and baseball games, listening beyond stereophonic hi-fi and cocktail gossip. We of AIR FORCE/SPACE DIGEST and Air Force Association are pledged to help in every way we can—with special issues like the one you are now reading, with every issue of the magazine, with books, with seminars, with television programs, with every educative tool that the mind of man has devised. This is our *raison d'être*. It is a responsibility that is as stimulating as it is heavy.—END



Space-Age Project "HEAT FOIL"

A CHEMICAL EXPEDITION...



...searching for plastics materials that can "take" temperatures of 20,000° F. plus

Monsanto has developed high-heat-resistant resins for laminates that remain intact for upwards of 2-3 minutes at temperatures as high as 20,000° F.; that maintain integrity for 200 hours at 600° F. Under evaluation are plastics laminates that hold promise for rocket nose cones, nozzles, and other components exposed to high heat.

By applying basic knowledge of polymer chemistry to the problem of service life under heat, Monsanto is making new breakthroughs on the problem of high-heat resistance with plastics. One of the most promising plastics now being evaluated is a silane-modified phenol-formaldehyde resin which makes laminates and moldings that retain integrity after hundreds of hours of exposure to temperatures of 500-600° F. Still other polymers under development hold promise of broadening temperature resistance for increasing lengths of time.

MOLECULAR DISSOCIATION SETS UP COOLING ACTION

Some resins under study form a char layer which insulates the interior and reradiates a large portion of frictional energy. Plastics laminates made from such resins provide insulating walls for interior surfaces or areas.

HEAT RESISTANCE—PLUS STRENGTH AND LIGHT WEIGHT

As in many other fields, laboratory tests for space-vehicle science are hard to correlate with actual field performance. In standard Oxyacetylene Tests and Stabilized-Arc Tests, heat-resistant plastics laminates show adequate retention of

structural integrity under high-heat stress.

Like other, more common reinforced plastics, the new heat-resistant laminates have exceptional mechanical strength. The following table indicates some of the mechanical properties obtained with a 1/8" section of a laminate made with a Monsanto silane-modified phenol-formaldehyde resin.

Property	Results	MIL-R-9299 Specifications
Flexural Flatwise Standard Condition 75° F. 30-Day Water Immersion 1/2 hr. @ 500° F. 100 hrs. @ 500° F. 200 hrs. @ 600° F.	73,800 psi 73,400 psi 62,900 psi 57,600 psi 22,600 psi	50,000 45,000 40,000 20,000 No Spec.
Modulus of Elasticity Standard Condition 75° F. 30-Day Water Immersion 100 hrs. @ 500° F. 200 hrs. @ 600° F.	3.72 x 10 ⁶ 3.65 x 10 ⁶ 3.28 x 10 ⁶ 1.48 x 10 ⁶	3.0 x 10 ⁶ 3.65 x 10 ⁶ 2.5 x 10 ⁶ No Spec.
Tensile Strength Standard Condition 75° F. 30-Day Water Immersion 100 hrs. @ 600° F.	45,600 psi 45,400 psi 23,100 psi	40,000 38,000 No Spec.
Edgewise Compression Standard Condition 75° F. 30-Day Water Immersion 100 hrs. @ 600° F.	50,800 psi 42,000 psi 8,240 psi	35,000 30,000 No Spec.
Barcol Hardness	76	55
Flammability	Self-extinguishing	1.0 max.

Mechanical Properties of Resinox® SC-1013 Laminates. (1/8" section; E.C.D. 225-181 glass cloth; 12 ply; 200-psi pressure cured 1 hr. at 250° F.; post cured in gradients of 50° F./24 hrs. each to 500° F.; resin content 29%)
[Tests carried out as specified by MIL-R-9299]

COMMERCIAL PROMISE, TOO!

In addition to the properties described, the plastics laminates created for high-heat resistance are practically immune to fuels, oils, and solvents.

(Please turn page)

OUTSTANDING ELECTRICAL PROPERTIES

Heat-resistant plastics laminates have also shown outstanding performance in electronic applications wherever frequent cycles of heat and cold are a problem. While maintaining mechanical strength, plastics laminates (as described) showed no degradation of dielectric constant or loss tangent. The following table shows results on a typical panel after various numbers of cycles of heating for one hour at 550° F., then cooling ¼ hour to room temperature.

ELECTRICAL PROPERTIES AFTER CYCLING
(Approximately 9 KMC Resonant Cavity)

Room-Temperature Electrical Properties		
No. of Cycles (1 hr. at 550° F.; ¼ hr. to 77° F.)	Dielectric Constant	Loss Tangent
0	4.8007	0.0217
100	4.7289	0.0218
150	4.7347	0.0218
200	4.7218	0.0214

OPTIMUM PARTS PERFORMANCE

In fabricating parts for optimum performance under high-heat conditions—fibrous glass, asbestos, or nylon is impregnated with resin, is molded, filament-wound or laminated by any of several methods, then cured.

THE CONTINUING SEARCH

Project "Heat Foil" is a continuing study of resins for high-heat resistance and of resins whose energy of dissociation makes them outstanding for high-temperature applications. This search will continue to develop materials that will help answer the high-heat requirements of a space age, in defense and industry. MONSANTO CHEMICAL COMPANY, Department AF-2, C Building, St. Louis 66, Missouri.

Monsanto Space-Age Projects for Government and Industry

- * High-Temperature Hydraulic Fluids
- * Coolant-Dielectrics for Electronic Equipment
- * High-Temperature Plastics
- * Improved Nitrogen Oxidizers for Solid Propellants
- * Fire-Resistant Structural Plastics
- * Hydrocarbon Fuels for Jets and Missiles
- * Fire-Resistant Hydraulic Fluids for Ground-Support and Missile-Launching Equipment
- * Radiation-Resistant Heat-Transfer Fluids
- * High-Temperature Lubricants and Additives
- * Radiation-Resistant Reactor Coolant-Moderators
- * Intermetallic Semiconductor Materials
- * Pure Silicon for Transistors, Rectifiers, Diodes
- * Ultra-Fine Metal Oxides
- * Materials for Vibration Damping
- * Heat-Resistant Resins for Laminating and Bonding
- * Inorganic Polymers
- * High-Energy Solid Propellants

You are invited to work with Monsanto on your materials needs in the above fields.



The Washington Scene

Gentlemen: Claude Witze has done it again! I always find his articles timely, accurate, and interesting. His item in the February issue of *AIR FORCE Magazine* on "Cost Is Related to Strategy," is timely and accurate. When one considers this was written some time before the magazine was printed, it shows considerable forethought on Mr. Witze's part. As a matter of fact, the day an item appeared in the newspaper indicating a study was to be made by Messrs. Hitch and Nitze, I was seeking more information; and when I arrived home that evening and opened up the *AIR FORCE Magazine*, which had arrived that day, it was spelled out for me on page 16.

R. J. Watson
Washington, D.C.

Also on the Team

Gentlemen: In the "Aerospace World" article in the February '61 issue on pages 29-31, the B-52H is properly identified as a Boeing product, the Skybolt as Douglas, the A3J as North American, the U-3B as Cessna, the Atlas Mercury booster as Convair, but the Project Mercury capsule apparently had its genesis in space and not at McDonnell Aircraft.

Although Mercury is a NASA and not an Air Force project, we are all on the same team so please, how about putting McDonnell's name in the program?

Edward J. Regan
McDonnell Aircraft Corporation
St. Louis, Mo.

Set-the-Record-Straight Department

Gentlemen: Please correct the picture caption on page 23 of your January '61 issue.

First of all, MATS has no C-130s! Secondly, the C-130s used on the Dacca lift were those assigned to the Troop Carrier Squadrons stationed at Evreux-Fauville AB, France. These three squadrons are under the operational control of the 322d Air Division, which in turn is directly under the control of General Smith, Commander of USAFE and not MATS.

Again for the record, it is not

MATS that is doing the job over here such as lifts to Agadir, the Congo, and Dacca, but equipment from the three tactical squadrons (C-130s) at Evreux. It is true that some C-124s are being used to augment these lifts, but they are under the operational control of 322d Air Division and not MATS. It has been a 322d show all the way—ask the UN.

Lt. Col. John Paul Jones,
Commander
39th Troop Carrier Sqdn. (Med.)
USAFE
APO, N. Y.

Gentlemen: . . . I do not wish to detract from the assistance which MATS gave to the Commander in Chief, USAFE, and the 322d Air Division (Combat Cargo) by loaning us their aircraft, crews, and support personnel. They have done a wonderful job in supporting us in the Congo and on the continent. However, [the picture on page 23, January issue] was of a 322d Air Division (Combat Cargo) C-130 aircraft from Evreux-Fauville Air Base and should have been so captioned. As you know, the 322d is a subordinate command reporting directly to the Commander in Chief, USAFE.

I would appreciate it, as would the entire 322d Air Division (Combat Cargo) now deeply involved in flying another mercy mission—an "airlift against hunger" to the Congo—if you would publish a correction.

Col. Tarleton H. Watkins,
Commander
322d Air Div. (Combat Cargo)
USAFE
APO, N. Y.

Gentlemen: I am sitting here in an airplane reading your magazine and I have just come to the statement in "Fact or Fancy" on page 41 of your January issue, "History's dictators have seldom been generals." So I borrowed this paper and will try to comment on this. (This is not relevant to the reorganization plan and its arguments. I just think Air Force people ought to have a little better history thrown at them.)

"Napoleon was a captain of artil-

lery," it says. As a matter of fact he had been a general since twenty-four years of age when, at twenty-nine, he became dictator, and had campaigned in Italy and Egypt.

"Hitler was a corporal." Had been a corporal, that is true. But his conquest of Germany was engineered on purely political grounds.

"Castro . . . took the civilian road to power." Nonsense. He had no regular military rank, but was, in fact, the general of an army which overthrew the elected, legitimate, and orderly regime of President Batista.

" . . . Peron . . . took the civilian road to power." Again nonsense. He was a career colonel in the regular army who took over someone else's revolution.

The truth is that history's dictators have commonly been generals. Indeed, the original "dictator" was a temporary job for a Roman general of the republic when it was threatened. Marius, Sulla, Pompey, Caesar, and Augustus were a succession of generals who imposed their will on the dying Roman republic. Charlemagne was a usurper's son, and a general. Cromwell was a general who took power by making war.

It is true that there are quite a few "political" dictators nowadays, and it is also true that there are "military" dictators who did not achieve power when "generals," such as Nasser, Batista, Trujillo, and Jimenez. But even today these are at least equaled by the purely military "general" dictators such as Vargas, Tojo, Larrazabal, Chou, Mao, Chiang, Gursel, Ataturk, and others, especially in the oriental countries. Even those who gained power before gaining rank, like Jimenez, commonly become "generals" when they become boss.

I think it is important for Air Force people to know some history, and I don't think that the statement "History's dictators have seldom been generals" should be allowed to stand uncorrected. Pretty soon you will have some of our young men quoting this—and believing it.

Col. H. B. Webb, USAF MC
Otis AFB, Mass.

(Continued on following page)

Gentlemen: Your January issue cites the impending transfer of C-124s to Air Force Reserve squadrons around the country ["Ready Room," p. 104]. In the interest of accurate reporting, I have some commentary on your description of the operational capacity of "Big Shakey."

This aircraft is still being widely flown by the Troop Carrier and Air Transport Wings of MATS, the Strategic Support Squadrons of SAC, and the Logistics Support Squadrons of AMC. There are upwards of 300 C-124s still in everyday use, and if your description of them is accurate, there is no pressing need to replace them. However, the C-124 is not the aircraft you make it out to be, and with this in mind, the Air Force is moving to replace it with more sophisticated equipment. The purchase of Boeing 707s and Lockheed C-130s of the "B" and "E" categories is imminent, and these aircraft should begin arriving at the using squadrons sometime in the second quarter of fiscal year 1962.

To correct your description of the C-124, the maximum cargo capacity is actually far below the 74,000 pounds you state. Such a figure ignores Zero Fuel Weight, Flight Plan Gas Load, and Maximum Allowable Landing Weights, and is based solely on a comparison on Maximum Allowable Takeoff Weights and Basic Operating Weight. In four and a half years and 3,700 hours of flying the C-124, the largest load I ever carried was 42,000 pounds, and the running average is nearer to 33,000, or less than half of your figure. I assume that your reference to an airspeed of 300 mph concerns a True Airspeed in a cruising configuration. This is twenty-two knots over the absolute maximum allowable speed in the C-124, and is well above the standard cruise condition of 200 knots.

For the time being, the C-124 still offers a great deal in air transportability from the standpoint of gross capacity and reliability, and will remain the backbone of mobility for the Strategic Army Corps for a good long while. The transfer of such aircraft to the Reserve units heralds the end of an era, but I suspect that history will describe the Douglas Globemaster in the same flattering terms that were heard when the DC-3 (C-47) passed from the scene. The records of such a history will doubtless cover the presence of C-124s at every location of political strife for the past several years.

As the history is compiled, I honest-

ly hope the recorders include all sides of the story, not the least of which are the humanitarian accomplishments of C-124 organizations throughout the Air Force. From the tetanus patients of St. Helena to the earthquake victims of Agadir and Puerto Montt, heartfelt gratitude is a common emotion. The crew members involved in these missions may have called them "strictly routine," but in these days of defense stature and international prestige, their efforts have done a great deal to erase the stigma of "Ugly American," and will have a lasting affect. In their globe-girdling mission, these people had a dual role of military professional and ambassador-at-large; the success of their efforts is extensive and laudable. . . .

Arthur C. Menadier
Burlington, Vt.

Gentlemen: If Major Marcott (IFF letter in "Airmail," February '61 edition) will pay a visit to the nearest Air Route Traffic Control Center, he will indeed find his old friend of World War II days, or a reasonable facsimile.

The ATCRBS (Air Traffic Control Radar Beacon System) is used somewhat in a manner as Major Marcott suggested; e.g., for identifying and separating aircraft.

Also, radar controllers do give traffic advisories to aircraft under their control when other targets are approaching on a collision course, when traffic load permits, and provide radar vectoring at the request of the pilot.

Maj. Sam J. Ballard
Chalmette, La.

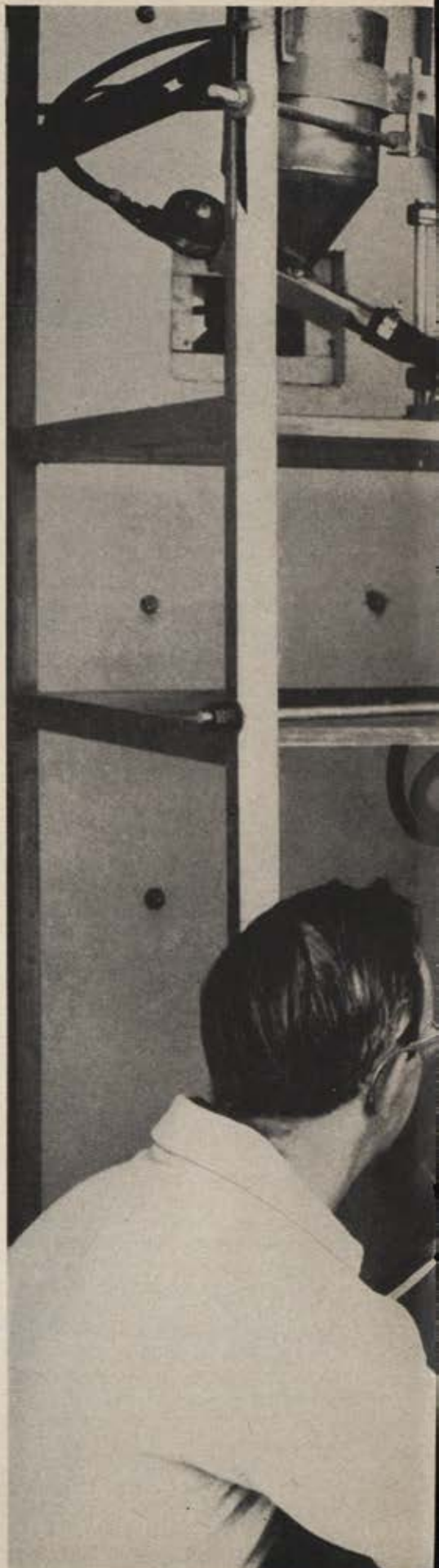
Gentlemen: The suggestion advanced by Major Marcott, USAFR, in the "Airmail" department of your February issue is indeed a worthy one. I am certain he will be pleased to know that the procedures he outlines—with greater sophistication, in fact—are "old hat" in the control of both civil and military air traffic.

This information is readily available in the US Flight Information Publication (Planning, AFM 51-37), and appropriate FAA publications.

I am rather surprised that this letter was published without editorial comment of so noteworthy an application of equipment to air safety.

I hope I am not being unduly critical when I remark on your omission of comment, but I often wonder, when confronted with curiously inaccurate and/or archaic aircraft information—particularly in your Annuals—whether

(Continued on page 14)





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AIRMAIL CONTINUED

the technical editor is sufficiently up on the force in being as he is on the esoterics of the future.

Don't take an old airplane driver too seriously. We have a tendency lately to holler for recognition among the reams of rocketry reporting. Congrats on your astute remarks re McKone and Olmstead.

Capt. Robert J. Powers
Bossier City, La.

● *Please don't blame the Technical Editor. He wasn't asked—but should have been.*—THE EDITORS

Too Much Complacency

Gentlemen: I would like to compliment you on the excellent editorial in the February issue of AIR FORCE entitled "Doesn't Anybody Get Mad?" I was particularly impressed by the fourth and last paragraphs and only hope that the good sense shown in these will become the "National Mind."

The realization that communism will do anything and everything to further its cause is a fact that is too often not publicized and, when brought to mind, too quickly forgotten. I am sure that many Americans, including myself, could stand a good examination of conscience on the "let-George-do-it" attitude. I sincerely hope that you will continue in your good work along these lines.

A/2C Vernard Korchinski
McChord AFB, Wash.

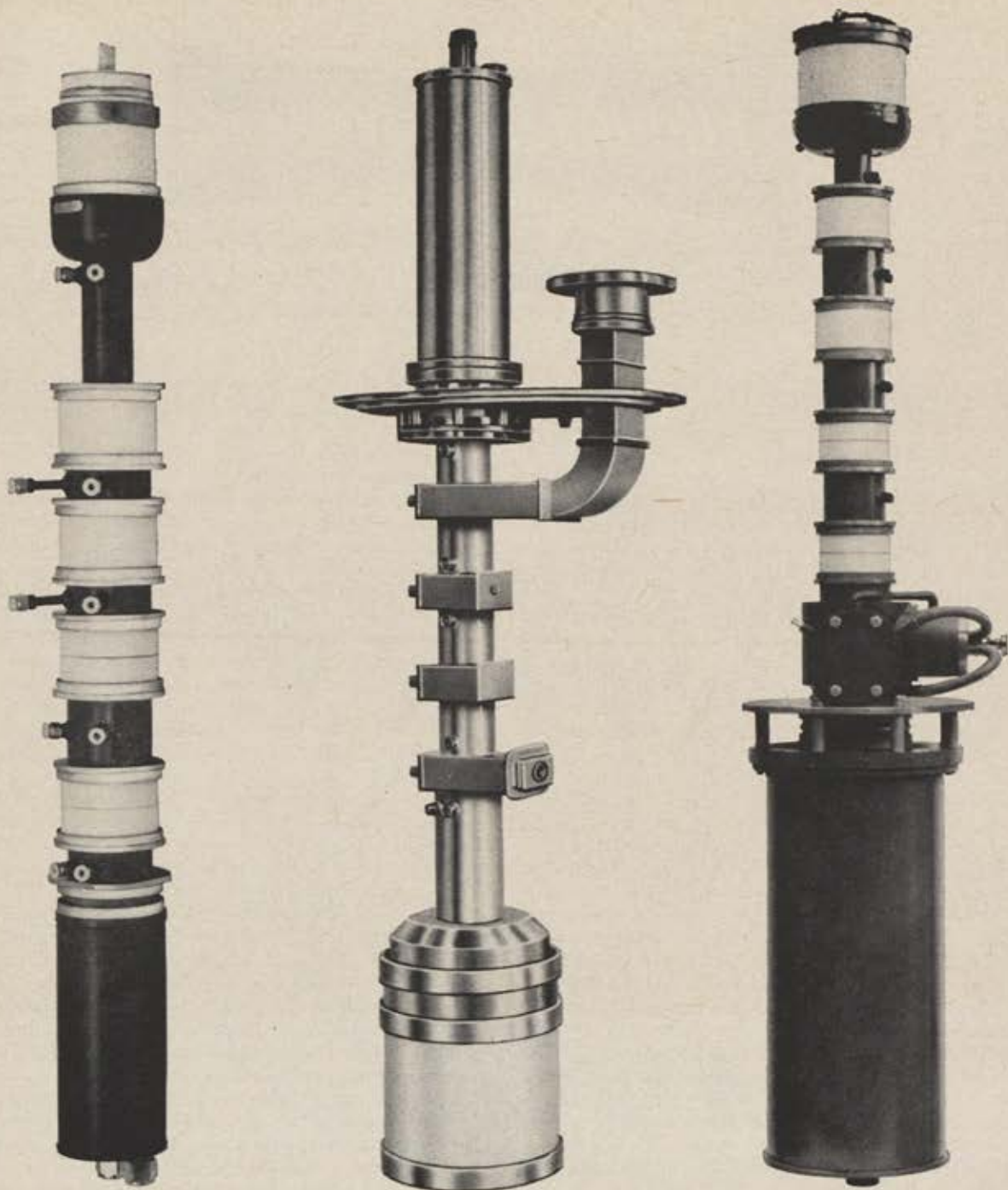
Proud Member

Gentlemen: . . . Congratulations on the 15th Anniversary of AFA. The Association has been a leader and has shaken other service organizations out of their complacency in an effort to equal its accomplishments. Even other periodicals have acknowledged the AIR FORCE/SPACE DIGEST leadership in matters dealing with the US Air Force. . . .

I have watched the organization grow from its infancy to an influential and powerful proponent of airpower and the Air Force. Much is still to be done, particularly with a new Administration, tighter defense dollars, and the ever-increasing costs of hardware. Over all this hangs the ever-present threat of communistic expansion and increased demands for sacrifice by our Air Force personnel, particularly those in SAC crews.

I am proud to be a member of AFA, proud to have been a charter member.

Lt. Col. Roy J. Hopper
Silver Spring, Md.



There are 3 ways to design a klystron. Which is best?

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For the 4K50,000LQ, left, *external-cavity* design is best for producing 10 kw power output at 755-985 Mc. (Proof: more than 25,000 hours of near unattended service in troposcatter systems!)

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AIRPOWER in the news



Claude Witze

SENIOR EDITOR, AIR FORCE MAGAZINE

The Talent Requirement

WASHINGTON, D. C.

There have been a few days, here in the Ides of March, when the sideshows seemed to threaten the success of the main act. Ed Sullivan and Jack Paar, a couple of shy types who work in television, were trying to make their war look more important than the situations in Laos and the Congo. President Kennedy's proposal for a long-awaited federal-aid-to-education program whipped up almost as many divergent opinions as the first Sputnik. The Peace Corps got started, by Executive edict, and there was more public discussion about it than the serious efforts to make some progress toward disarmament and arms control. This cock-eyed sense of values has permeated the halls of Congress, where there is a sorry lack of interest in speeding action along the New Frontier and an atmosphere of lackadaisicality that contrasts sharply with the direct approach favored over at the White House. There is more and more suspicion that the Kennedy legislative program is in for sticky going. There is a threat or a promise that the Chief Executive will turn to the people via TV and radio. This time he will do it without benefit of the Washington press corps, whose televised press conferences are so cluttered with oafish questions that their value, once the President has made the day's headlines with his opening remarks and announcements, is highly dubious. There is a growing number of observers who suspect that one reason Mr. Kennedy introduced the televised press conference was to let a few million Americans see what he has to put up with. White House mail indicates he has been getting the point across. Sam Rayburn, you may remember, has long been on the record in violent disapproval of efforts to bring TV cameras any closer to Congress than they can get in the corridors with the doors closed tight. This has a lot of merit from the standpoint of the members, whose weak moments are not portrayed in black and white or color in the living rooms of their constituents.

If we had television coverage of Congress these days there would be some shots of the scramble to get on bandwagons while the cameras ignored, in their fashion, the useful good works that are going on. There was, for example, a terse report from Sen. Henry M. Jackson's Subcommittee on National Policy Machinery. It said something must be done about the obstacles that hamper enlistment of outstanding private citizens for key jobs in foreign policy and defense. The report called for some kind of action to revise the conflict of interest laws, which it found designed for the world of 1860 and not 1960. This is what Senator Jackson said:

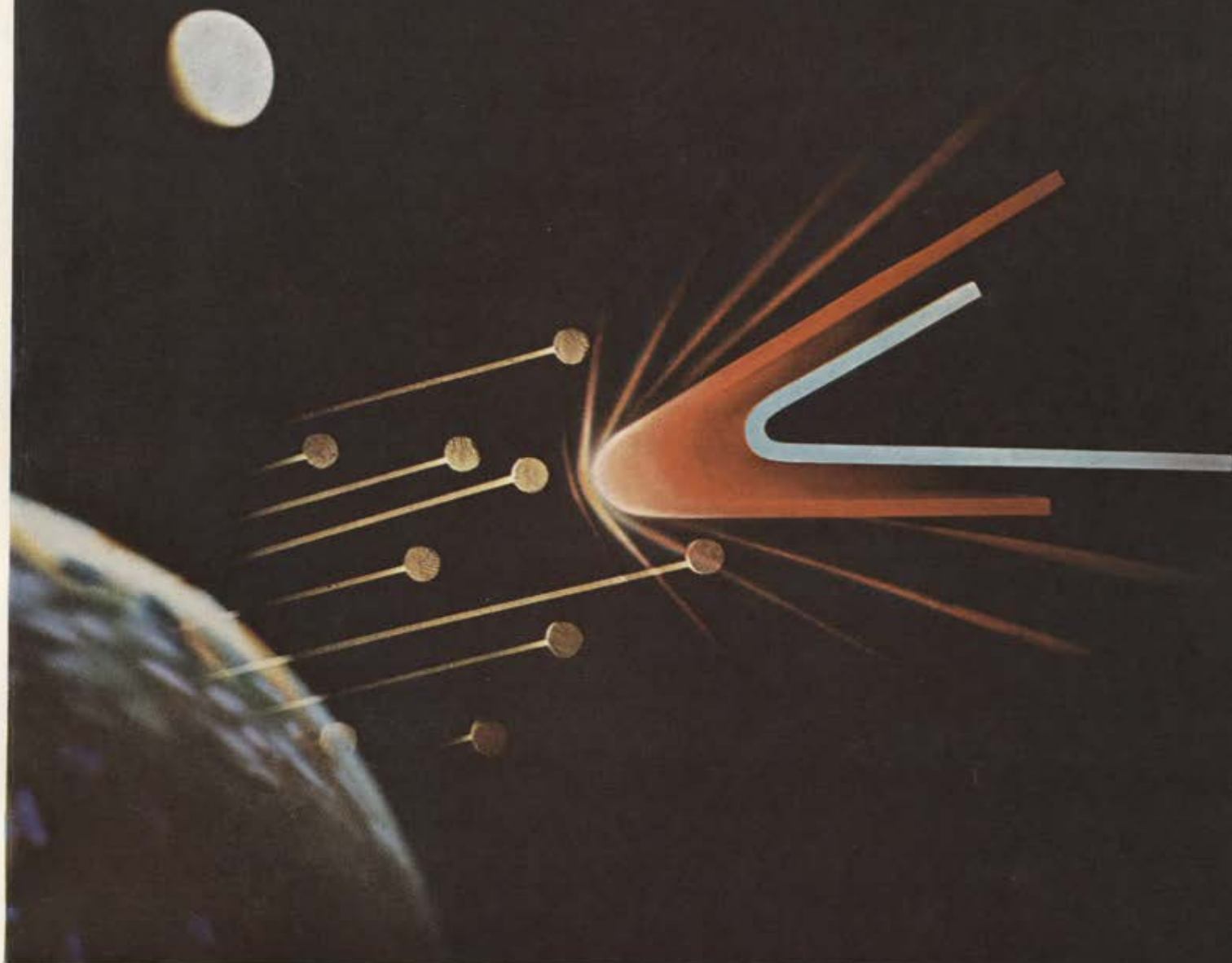
"Both the turndown and turnover rates among top-level national security officials have long been excessively high. Few businesses could avoid bankruptcy if the turnover rate of their ranking officers compared with that of the Executive Branch. . . . In hot war we sweep aside barriers to national service. But in this time of equally fateful cold war

we place needless roadblocks in the path of outstanding citizens asked to serve in Washington."

While Mr. Jackson was making this plea to improve the quality of some people in government other members of Congress were broadcasting on a different channel—one that has a better rating. Rep. Overton Brooks, the Louisiana Democrat who heads the House Committee on Science and Astronautics, announced that he is launching a study of private nonprofit organizations which handle research and development for federal agencies. This decision has all the earmarks of an idea that he got out of the newspapers after the Senate Committee on Interstate and Foreign Commerce, the Senate Civil Service Committee, and the House Subcommittee on Manpower Utilization had kicked up some dusty headlines with the subject. It has been pointed out before that Mr. Brooks's committee has a charter that does not limit, within reason, the realm of its interest. He can investigate anything from union cures to the possibility of life on Mars and assume competency for the committee and its staff over the entire spectrum. The burden of the Brooks case about nonprofit organizations, which had been in the papers from other sources, is his suspicion that they pay top scientific talent higher salaries than Uncle Sam can offer under Civil Service. For background on this subject the House Committee on Science and Astronautics can study the 1959 and 1960 hearings of the Military Operations Subcommittee of the House Committee on Government Operations, headed by Rep. Chet Holifield (D.-Calif.). Spokesmen from the Department of Defense and the armed forces explained at length why they are forced to hire outside brains, just as the practice is followed also by the Atomic Energy Commission, the National Aeronautics and Space Administration, and the Federal Aviation Agency. There is nothing new about this procedure and the operation has been examined, reexamined, revised, and examined again by congressional committees. One of the newest nonprofit management corporations was created, as a matter of fact, at the instigation of Mr. Holifield's committee.

So far as the Brooks complaint is concerned, it is that these organizations sometimes pay their scientific and professional personnel salaries greatly in excess of Civil Service pay scales. Thus, the nonprofit organization has come to be labeled as a device for circumventing government ceilings. Mr. Brooks says this is "obvious." Well, if the difference is between \$15,000 and \$40,000 a year, and the chairman uses these figures, it seems somewhat strained to speculate that a scientist would find it difficult to make a decision on where he wanted to work. This sort of dilemma, however, must be rare. A more likely choice for the scientist is between employment by a nonprofit organization and orthodox industry. For top-flight talent, which is what we need for the space-age developments ahead, the competition will stay outside Civil Service, with few exceptions. Nobody has suggested that government salaries can be increased to the point where they compete with industry levels.

(Continued on page 21)



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It's All Down in Print

As we go to press there is sound speculation in the capitol that the Kennedy Administration is about to ask Congress for an addition to the Eisenhower defense budget. The sum mentioned is in the neighborhood of \$2 billion, and there is an assumption, soundly based, that it will be sought to bolster our capability to fight limited wars. We have had a bit of a flap in recent weeks over a newspaper report that the Secretary of State, Dean Rusk, favors restricting the role of nuclear weapons in the defense posture, that he would confine them to deterrence of attacks on this country. Also, that he would favor an announced policy of meeting any threat to our European allies only with nonnuclear weapons. If true, this would be a reversal of US policy. It now appears that Mr. Rusk's opinion was exaggerated, to say the least, and that he was suggesting only that the conventional weapons and limited-war capability should be improved. The whole affair, which involved an alleged leak of a Rusk memorandum, had serious international aspects and has led to a new tightening of information sources, at least in the Pentagon. It should be made clear that so far there has been no new official and proclaimed policy restricting news sources. But the effect of the storm has been to inhibit some officials who were in the habit of chatting with newsmen. This kind of chatting, as *The Reporter* magazine pointed out, can create a difficult problem "for an Administration that is trying to take a fresh and objective look at some of the policies that have become dogma in recent years. It is an equally difficult and delicate problem for the free and responsible press."

In this connection it is a little hard to understand why there is so much reliance on gossip, leaked commentaries, and other surreptitious devices. One Sunday, earlier in the days of the New Frontier, the *Washington Post* printed a list of the top Kennedy appointees and gave the titles of the books each man had written. Here was the homework all laid out for any reporter, congressman, staff worker, or foreign agent who wanted to find out how these people think. It took two-thirds of a column of agate type to list the volumes and there is no doubt that Washington bookstores felt the effect. Kissinger, Hitch, Wiesner, and Kahn are selling well, and their studies can be seen any morning on the buses coming in from Bethesda, Chevy Chase, Arlington, and other Washington suburbs. Despite this, there was confusion and misunderstanding about what the Secretary of State was thinking about. In Henry Kissinger's newest volume, *The Necessity for Choice*, he speculates that if the arms-control/disarmament effort is at all successful—and this will take a long time—limited wars may become more likely and increase in intensity. He says that "as arms control reduces the possibility of surprise attack, forces for local defense must be increased." This is a matter of opinion, and it sounds like a respectable one. Now, over in the State Department Mr. Rusk has been joined by John J. McCloy, a Republican and one-time associate of Henry Stimson. Mr. McCloy is President Kennedy's Adviser on Disarmament. If these gentlemen have read the Kissinger book they have examined deterrence as it looks to a scholar in 1960, they have reappraised limited war, they have studied our shifting problem in Europe, and looked at other facets of their mission for Mr. Kennedy. It is common knowledge that Professor Kissinger's ideas are taken seriously in New Frontier circles.

Failure to fill this requirement for reading, which was not a taxing demand in the previous Administration, can leave a void that gapes, usually because of what is unknown and ignored. For example, there was a little atten-

tion given recently to a study of the outlook for future federal expenditures that was made by the Bureau of the Budget in the last days of the Eisenhower Administration. The report speculated that we could cut \$23 billion off the annual bill for national security if an agreement can be reached on disarmament. If you look at it from the viewpoint that we could cut the armed forces and stop building weapon systems, this is true. But Thomas C. Schelling, a Professor of Economics at Harvard, argues with conviction that if an arms-control program is achieved it will *not* necessarily save money and may cost *more* than we are putting into the present defense establishment. Professor Schelling poses an extreme example. Suppose, he says, there were some way to contaminate all fissionable material and make nuclear explosions impossible. What would be the effect on the US budget?

"Like the Russians, we should have to spend 'more bucks per bang.' This is because we could not rely on the threat of nuclear retaliation to deter aggression around the world. We could not rely on the tactical use of nuclear weapons to keep our participation in limited war cheap and efficient."

"It is quite possible that our conventional forces would be urgently increased, to an extent outweighing the cut-back in obsolete nuclear forces. And to those advocating 'nuclear disarmament' the increases in conventional forces would not necessarily contradict the purpose of their scheme. They would probably argue that they had disposed for all time of the most dangerous weapons; that their kind of 'disarmament' comes at a price and that part of the price is an increase in the defense budget."

In addition to the aspect of costs that would mount as the most efficient weapons were outlawed, or diseased in the imaginative example cited by Professor Schelling, there is the matter of the systems that would be used if we were to attempt to control the peace. Here is a whole new area of research and development and procurement, followed by command and control, logistics, and all the other impedimenta of weapon systems. At least one of the major manufacturers of missiles and space vehicles—The Martin Company—has declared its confidence that real disarmament would not put it out of business. If the weapon line was ground to a stop the company believes it would more than offset the loss in business with its contribution to the tools that will control the peace.

So far as national defense is concerned there is not much being suggested or contemplated by the New Frontier—with the possible exception of the Peace Corps—that could not have been anticipated. Intellectuals are popular in Washington in early 1961 and they cast their shadows over the city before Jack Kennedy ever took the oath of office. The things already in the record are a better harbinger of what is to come than the best leak out of the Pentagon, state, or Capitol Hill.

Straightening the Record

The formula is simple. A newspaper prints a story that is idle rumor or a quotation out of context or simply in error. A congressman or committee staff member reads the story. Then a \$20,000-a-year executive or military officer has to go up to Capitol Hill and face a grilling. The new Defense Department directive giving USAF responsibility for space research and development projects was pregnant with possibilities for exploitation of this technique. And the House Committee on Science and Astronautics was the ideal setting for the show.

There was, for example, the interest in how the decision

(Continued on following page)

was reached. This was aroused, in the main, by a report in a Chicago newspaper that the Army's Gen. Lyman L. Lemnitzer, who also is Chairman of the Joint Chiefs of Staff, was at serious odds with the Administration on how policies are formed. The yarn said the general had protested a bypassing of the JCS and quoted him as unhappy about the fact that they were able to comment only through their service secretaries. There was some comment from the Pentagon about this, to the effect that the general was giving his opinion about the first draft of the directive. In that version USAF would have been given development control of Army's Advent satellite program and the Navy's Transit. In the final directive it was made clear that these services are retaining control of systems already assigned to them. As we go to press there has been no evidence that the JCS Chairman has voiced objection to the directive in its final form.

At the same time, Roswell L. Gilpatric, Deputy Secretary of Defense, had to give a substantial part of his attention before the House committee to a refutation of the criticism implied in the Lemnitzer story. He said:

"A major criticism of the Department of Defense, which has been made for many years both in the Congress and elsewhere, has been the slowness of the decision-making process within the Department.

"Secretary McNamara and I believe that it is imperative, if we are to have a defense adequate to meet the needs of this nuclear and space age, that decisions be made as promptly as possible.

"We do not feel that important decisions affecting the national security of the United States can be deferred pending attempts to work out a *modus vivendi* which will be satisfactory and pleasing to everyone."

He suggested that when a decision is given long periods of deliberation the participants have a chance to act so that the final policy is compromised when it does come out. On the other hand, if all action is held up for a protracted argument, vital programs can be damaged.

A second Defense Department official to appear before the hearing was Charles J. Hitch, the Assistant Secretary, Comptroller. It was clear from the outset that he was called only because the *Washington Post*, earlier

in the week, had printed a few carefully selected quotations from a book of which he is coauthor. They were printed to show that Mr. Hitch did not approve of the space directive.

The Comptroller said he was ill at the time the directive was considered and had no opportunity to offer an opinion, pro or con. He said his office, in his absence, concurred in the directive. He said the implication that he opposed the directive—it was more than an implication, it was a "defense-sources-reported" statement as fact—was clearly in error. Mr. Hitch showed that the newspaper had quoted the book, *The Economics of Defense in the Nuclear Age*, out of context. He said he was not in any way against the order giving most space development projects to the Air Force. He quoted an adjoining passage, following the one selected for use in the newspaper, to show that the space directive was entirely compatible with what he had written.

Under questioning, Mr. Hitch said he had no doubt that the new order would tend to dampen the enthusiasm of Army and Navy research officers for projects in the space arena. He also reiterated a thought dropped earlier by Mr. Gilpatric, that one of the purposes of this Administration is to obtain more emphasis on weaponry for limited war and antisubmarine warfare, and that the space directive should have a beneficial effect on what is done in these areas.

Almost as these events were taking place there were new alarms being raised by newsmen and the House Subcommittee on Government Information that there is another attack in the making on the freedom of information. Center of the controversy is the Pentagon, where Secretary McNamara has ordered a check of leaks that pit one part of his department against another. There is no evidence, so far as we know, that his agents will tackle the job of trying to make newspapers spurn leaked material that is idle rumor, a quotation out of context, or a simple error. That job is up to the press itself.—END



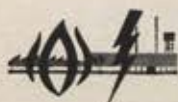
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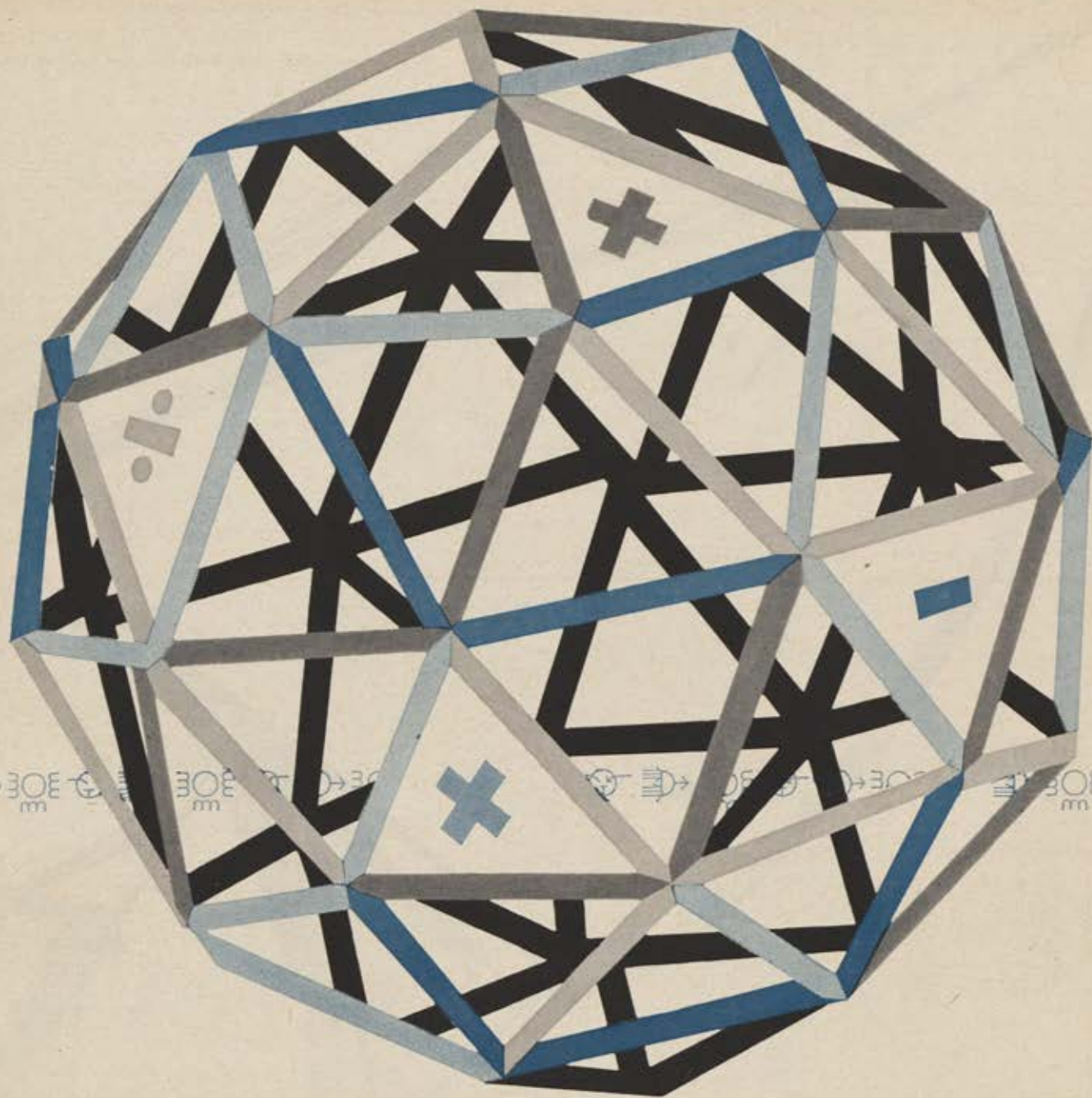
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AEROSPACE WORLD

Frederic M. Phillips

ASSOCIATE EDITOR, AIR FORCE MAGAZINE

Maj. Robert M. White, the crack Air Force X-15 test pilot, has now flown higher and faster than any other man. Major White this month set, then reset, the world speed record in the rocketplane. He had previously established an altitude mark of 136,500 feet in the X-15 at Edwards AFB, Calif., last August.

On February 7, Major White set a speed record without half trying while conducting X-15 stability con-

630 mph. It was literally a colorful flight. Heat-indicating paint on the plane's nose turned from green to blue, yellow, black, then brown as friction temperature got to something in the neighborhood of 700 degrees. Actually, the X-15's giant new engine was throttled down to about two-thirds its maximum for the flight. It is believed capable of taking the X-15 to an altitude of 100 miles and a speed of 4,000 mph—and should be

the other armed forces and precise response to their needs. It will require, as well, continued support of and cooperation to the fullest with NASA.

"I am impressing upon all of our people the importance and the difficulty of the task that lies ahead. I am confident that the Air Force will be equal to the job."

With these measured words the Air Force Chief of Staff, Gen. Thomas D.



Wide World Photos, Inc.

trol tests at 60,000 feet over Edwards. The test pilot reached what he believed to be a velocity of 2,112 mph in a shallow dive, a shade under the record speed of 2,196 mph flown by NASA test pilot Joe Walker, also in August. A few days later, however, a study of flight data showed the February 7 maximum speed to have been 2,275 mph—topping Walker's August performance.

Then, on March 7, Major White flashed across the Southern California sky at a far more spectacular 2,905 mph to raise the record by another

called upon to do so later in the program.



"Under the directive announced today by Secretary of Defense McNamara concerning the development of military space systems, the Air Force will have a heavy responsibility to the nation and especially to the Department of Defense and the Army and Navy.

"This responsibility demands and will receive our maximum effort. It requires maximum coordination with



One of three gentlemen above, chosen this month from the seven Project Mercury Astronauts, will make first US man-into-space effort. Left to right, Marine Lt. Col. John H. Glenn, Jr., USAF Capt. Virgil L. Grissom, Navy Cmdr. Alan B. Shepard, Jr. All have distinguished wartime records.

◀ USAF Maj. Robert M. White stands by blistered nose of X-15 rocketplane at Edwards AFB, Calif. Crack USAF test pilot set world speed record of 2,905 mph on March 7.

White early in March spelled out USAF's response to a Department of Defense directive assigning primary responsibility in military space system development to USAF. Under the new directive, all three military services are still authorized to conduct preliminary research and feasibility studies in military space technology. When studies result in proposals for research and development projects, all services are to submit the proposals to the Director of Defense Research and Engineering, who will recommend to the Secretary of Defense

proposals he considers ought to be developed (see page 40 for text).

On approval of the Secretary of Defense, management of the research and development programs then is to be the responsibility of the Air Force, unless "unusual circumstances" justify assignment of the project to another service. The directive covers research and development. It stresses that operational responsibilities for space systems will be assigned by the Secretary of Defense on a project-by-project basis.

The directive does not affect space research and development projects already assigned among the services, such as the Army's Advent communication satellite program and the Navy's Transit navigation satellite system.

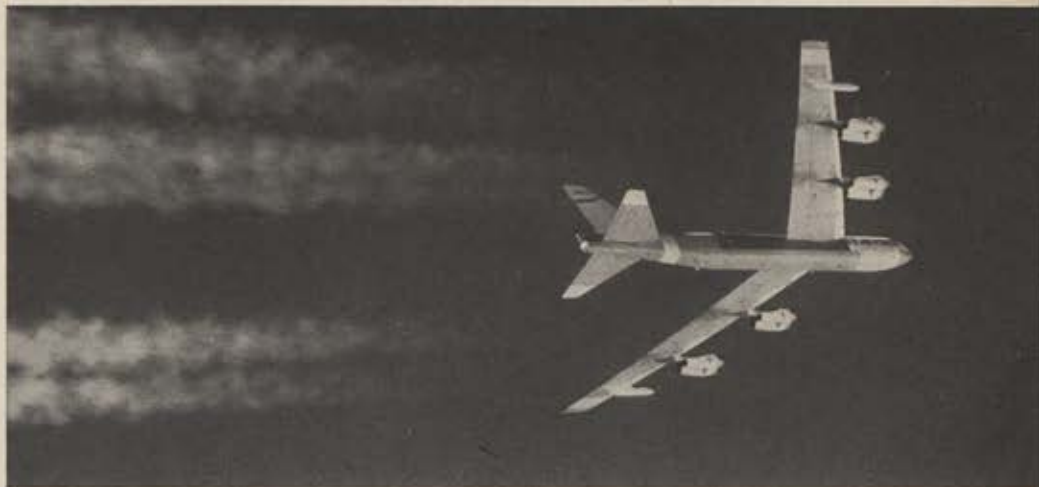


Russia, in further major developments this month, (1) space-launched a spaceship toward Venus, and (2) once more orbited and recovered a dog. USAF's developmental, data-gathering Discoverer satellite program moved effectively on its way with two more shots. The Air Force threw an impressive "Long Pass" across the Pacific. And the field of candidates to be America's first man in space was whittled to a gallant threesome.

★ Russia, which never doubted there was a space race, on February 12 orbited a new Sputnik carrying a 1,415-pound piggyback satellite. On command from the ground, the satellite was detached on a course for the planet Venus carrying a Soviet flag. It was scheduled to reach the planet, or at least arrive in its vicinity, late in May, some three months after launch from earth. The distance between Venus and the earth varies between twenty-six million and 160 million miles as both planets orbit the sun. It will be about fifty million miles in late May when the Russian vehicle is slated to arrive "to carry out a program of physical observations in outer space." Within a few days after launch, trackers on both sides of the Iron Curtain announced that they had, at least for the time being, lost electronic touch with the Venus shot.

This was mankind's first major space launch from space itself. If man is to travel in space, the use of space stations, space-fueling and supply depots, and space-landing and launching platforms will very likely be necessary. The Russian shot was a major step in this regard.

On March 9, the Russians put into orbit a five-ton space vehicle carrying a female dog. Some hours later, on ground command, the capsule bear-



New turbofan-powered B-52H bomber was flown for first time by Boeing crew at Wichita, Kan., Boeing plant March 6. B-52H joins SAC in coming months.



SAC airborne command post, a modified KC-135 jet tanker, in operation. The command announced this month that one of these aerial control posts, able to act as mobile SAC headquarters in emergency, is now in air at all times.

ing the animal was released and the dog safely recovered "somewhere in the Soviet Union." The shot, with obvious connotations regarding Russia's man-in-space potentialities, appeared similar to a Red two-dog orbit-and-recovery launch last August. The US has yet to orbit and recover a living creature.

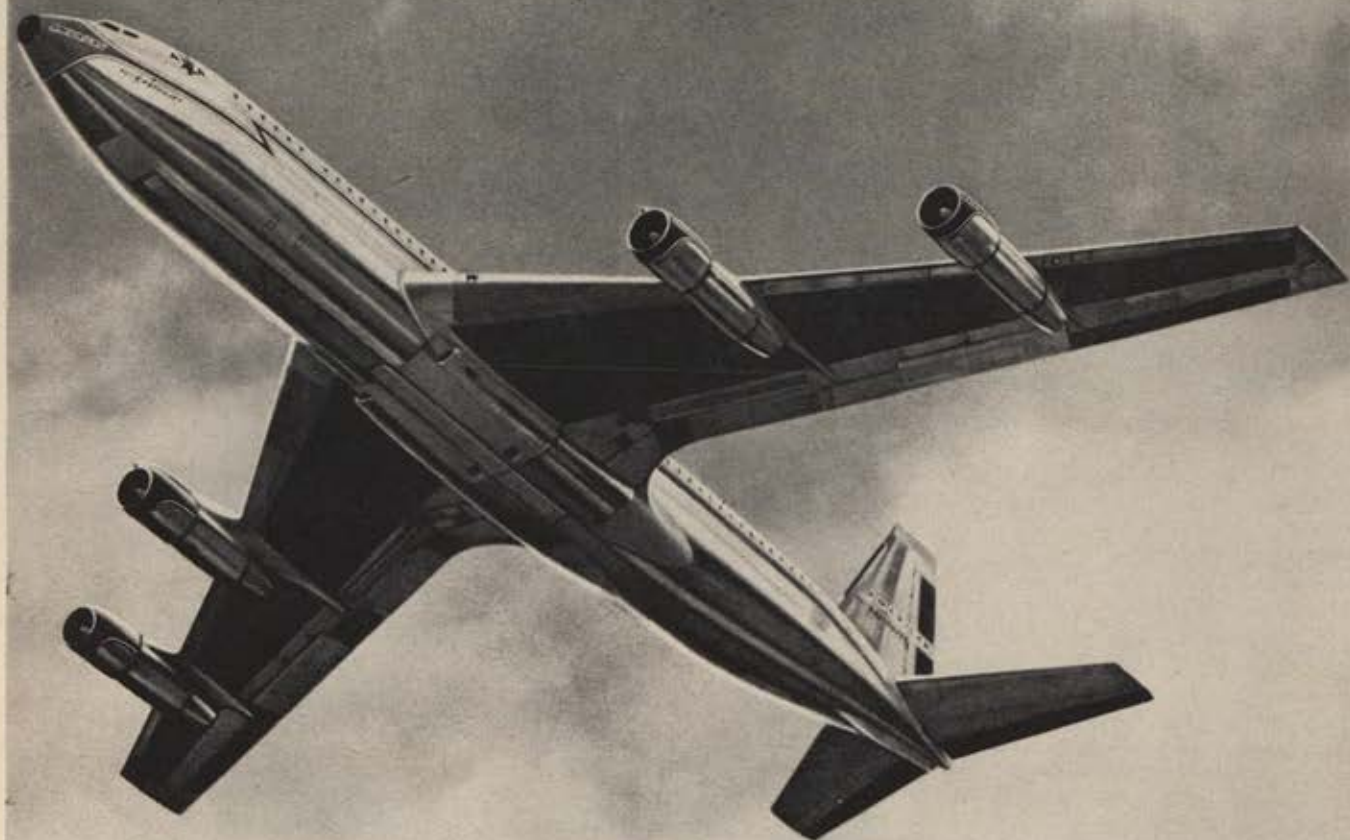
The February 12 Venus shot followed by eight days the launching of seven-ton Sputnik VII in low orbit around the earth. Initial speculation had been that this one could have carried a human passenger. It apparently did not.

★ Discoverer satellite after Discoverer satellite has lifted from Vandenberg AFB, Calif., since the program got going twenty-six months ago. The Discoverers have yielded thick volumes of data, priceless experience that has fed into a broad range of

other missile and space activity, a number of "firsts" including the first recovery of a man-made object from orbit last August 10. This was the capsule of Discoverer XIII. Two more satellites joined the family this month, Discoverer XX on February 17 and XXI on February 18. The interval between the firings was only twenty-seven hours. Discoverer XXI marked an important advance in the direction of "in-space" capabilities—parallel to, if less sensational than, the Russian piggyback space launch toward Venus.

XXI was boosted into orbit by a Thor IRBM. After about four minutes the craft's Agena-B rocket second stage separated from the Thor. It coasted without power for a minute and a half before the engine started, then stopped as planned. On the first

(Continued on page 29)



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pass over Kodiak, Alaska, the Agena-B was reignited by ground signal, boosting the satellite into a new and wider orbit around the poles. This was the first aerial restart and orbit change for US space hardware.

Discoverer XX took aloft an instrument capsule that was to be recovered from space a few days later. A malfunction, however, prevented release of the capsule this time. On the heels of these two Discoverers, USAF was expected shortly to put a small monkey into orbit aboard Discoverer XXII.

In other hardware news:

★ USAF's new turbofan-powered B-52H bomber was flown for the first time by a Boeing test crew at Wichita, Kan., on March 6. The extended-range B-52H was rolled out at the Wichita Boeing plant on January 5. The H model will carry the 1,000-mile-range Douglas ALBM Skybolt, air-launched ballistic missile. The plane is scheduled for delivery to the Strategic Air Command in coming months.

★ A USAF Thor-Able-Star rocket placed a pair of satellites in orbit on February 21, at Cape Canaveral, Fla. The main one was the Navy's Transit III-B, another in the series to develop operational navigation satellites for ships and airplanes. A smaller hitchhiking satellite named Lofti, for Low Frequency Trans-Ionospheric, went aloft seated on the 250-pound Transit. It was instrumented to measure the intensity of radio signals in space.

★ Atlas and Titan ICBMs performed three test shots. On February 10, a Titan completed a 5,000-mile fully successful test flight from the Cape, striking a South Atlantic target half an hour after launch. It was the first fully successful launch in three shots for the advanced almost-operational Titan. Another firing three weeks later, on March 3, was partially successful. An early shutdown of the second stage caused the shot to fall far short of its planned 6,100-mile goal. Titan distance record is 6,100 miles, set last October. The Titan, it is hoped, will be operational later this year.

On February 24, an advanced Atlas "E" carried a dummy warhead 7,000 miles down the Atlantic range. It was the first success in four "E" efforts. Target for the shot was 400 miles west of Capetown, South Africa. Two earlier "D" Atlases flew more than 9,000 miles in tests last year, setting world distance records for missile shots. Russia's longest recorded missile distance was 8,500 miles into the Pacific early last year.



Wide World Photos, Inc.

Veteran aviator Max Conrad raises hands in victory salute after landing in Miami, Fla., to complete record 'round-the-world flight in eight days, eighteen hours, forty-nine minutes—eclipsing earlier lightplane mark of late Peter Gluekman by twenty days. He landed his Piper Aztec in Miami March 8.

A bad accident befell workmen constructing an Atlas silo site at Roswell, N.M., on February 16. A thirty-five-ton crane went over the edge of a silo pit and fell 172 feet to the bottom. There its fuel tank exploded, killing six men and injuring fourteen others. The silo was one of twelve being constructed in the vicinity of Roswell.

★ USAF sent a four-stage Blue Scout II rocket 1,580 miles into space from the Cape on March 3 to study radiation and radio back information.

Its mission completed, it plunged to a fiery death over the Atlantic forty minutes after launch. This was the initial flight for Blue Scout II, new model of a family of low-cost, all-purpose rocket vehicles.

★ NASA put a small, balloon-type space vehicle into orbit with a low-cost Scout booster on February 16 from Wallops Island, Va. It was a highly satisfactory test of the civilian space agency's four-stage Scout, which
(Continued on page 31)



U. S. Army L23D produced by Beech Aircraft—equipped with AN/APQ-86 all-weather, high resolution reconnaissance radar, developed and built by TI in cooperation with the U. S. Army Signal Corps.

TI IN SURVEILLANCE SYSTEMS

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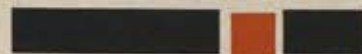
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**Based on Q-2C operations at Air Force Missile Development Center*

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is expected to play a major role for NASA in the future. It and USAF's Blue Scout are similar in concept and hardware. This was also the first US space-orbit launch from a site other than Cape Canaveral, Vandenberg, or the Navy's Point Arguello, next door to Vandenberg.

★ The first operational T-39 Sabre-liner radar and navigational trainer was delivered to the Tactical Air Command by North American on February 15. It was a "B" version of the twin-jet plane for TAC's needs. T-39As now in flight testing, will go to the Air Training Command as jet instrument trainers.

★ The Navy fired an operational Polaris IRBM from a surface vessel at sea for the first time on March 1. It went 1,600 miles over the Atlantic after liftoff from the vessel *USS Observation Island*.

★ Three Thor IRBMs, the Air Force announced, were launched from Vandenberg last year after having stood a full year at their British Royal Air Force bases. RAF crews performed the firing. Missiles and crews were airlifted from Britain to Vandenberg.

★ "Long Pass" was an Air Force-Army swift deployment exercise to a "battle" area in the Philippines. It took place from February 14 to 22. MATS and TAC distinguished themselves in the operation, in which 6,000 USAF and Army personnel took part. TAC Composite Air Strike Force F-100s made the 8,000-mile hop across the Pacific in eighteen flying hours. They refueled in-flight from KB-50J tanker planes five times, and made two rest and briefing stops at Hickam AFB, Hawaii, and Guam en route to Clark AFB, P.I. Two hours after arrival there, they were taking part in operational sorties. MATS C-124 Globemasters, C-133 Cargomasters, C-118 Liftmasters, C-121 Super Constellations, and CASF C-130 Hercules transports supported the operation, landing and airdropping troops and supplies into the "brushfire-war" area. MATS had 120 planes in the operation.

★ Capt. Virgil L. Grissom, USAF . . . Cmdr. Alan B. Shepard, Jr., USN . . . Lt. Col. John H. Glenn, Jr., USMC. . . These are the three Mercury Astronauts who have been selected from an original seven for America's first manned spaceflight. It will be a ballistic flight in a McDonnell-manufactured Project Mercury capsule boosted by a Redstone rocket reaching some 300 miles down the Atlantic range and about 100 miles up at the highest point. The flight



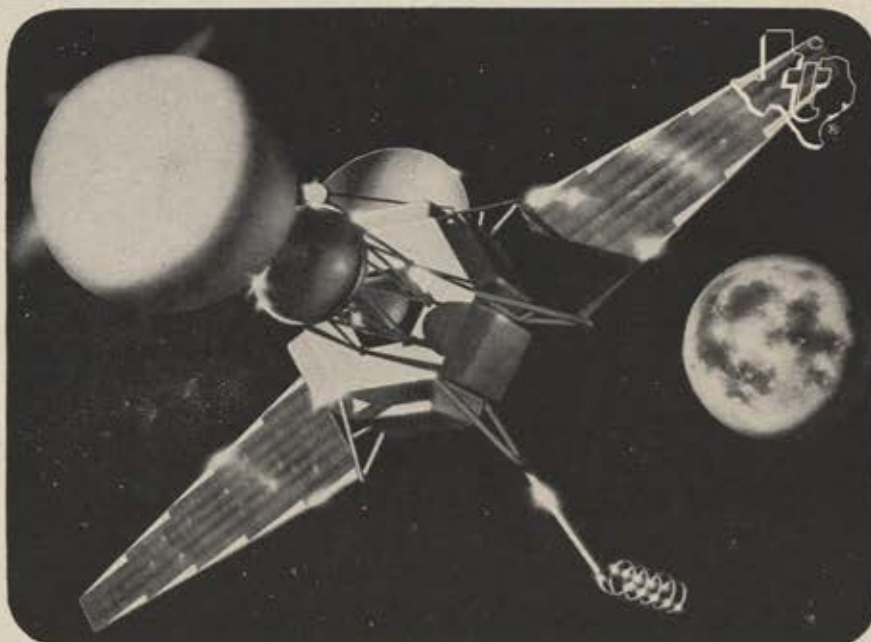
Air Force names in the news. Left, the Inspector General, Lt. Gen. Joseph F. Carroll, assigned to conduct a study of military news "leaks." Center, Maj. Gen. Harold W. Grant, AF Director of Telecommunications, named to head new major command, the Air Force Communications Service. Right, Col. Howard L. Burris, appointed aide to Vice President Lyndon B. Johnson early this month.

should take place in the immediate future. Ham the space chimp made such a ballistic trip with no obvious ill effects on January 31. Choice of the three officers from among the seven original Project Mercury Astronauts was announced by NASA February 21. The remaining four were said to be candidates for later spaceflights into orbit and perhaps beyond. Captain Grisson flew 100 jet combat missions in the Korean War. Colonel

Glenn and Commander Shepard also had outstanding combat records in World War II and during the Korean War.

A few hours before the February 21 announcement, NASA sent an unmanned Mercury capsule on a 1,425-mile flight over the Atlantic with an Atlas ICBM booster in preparation for sending up one of the three Astronauts.

(Continued on page 33)



RANGER III — National Aeronautical Space Agency space vehicle for a United States lunar probe — uses digital command decoder developed and built by TI for the California Institute of Technology and Jet Propulsion Laboratory.

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NORTHROP
Northrop Corporation, Beverly Hills, California

What was life like in Russian captivity for the two now-returned RB-47 pilots, Capts. Freeman B. Olmstead and John R. McKone? The two Air Force officers were released January 24 after almost seven months as prisoners of the Soviets. A Red fighter shot down their electronic recon plane last July over international waters. They answered the question in a press conference at Forbes AFB, Kan., their home base, on March 3.

In substance, the picture they presented added up to this: They were held for most of the seven months in austere, physically chilled solitary confinement at Moscow's Lubyanka Prison, forced to undergo persistent interrogation, threatened, deprived of news, denied knowledge of the fate of their four comrades in the downed RB-47—all of whom were presumably killed when the plane plunged into the sea. Many of the letters and packages sent from home never reached them. Food consisted of "small but regular quantities of rice, macaroni products, and boiled meat."

"While we were not subjected to physical punishment, living and sleeping conditions were poor, and we were continually subjected to persistent questioning," Captains Olmstead and McKone declared in a joint statement. One of the features of their sleeping conditions was that bright lights shone in their separate cells twenty-four hours a day. A feature of interrogation was that they were asked to sign statements that they had been ordered to cross the Soviet border. The aviators emphatically told the assembled newsmen at Forbes that they had *not* been ordered to cross the border, were, in fact, some fifty miles off the Red coast when attacked—and they refused to sign the Soviet-prepared documents under pressure. The Russian jet fighter, they reported, actually opened fire on their plane as it turned northward, or away from the Soviet mainland. The RB-47, two of its six engines afire, went out of control. The US plane, the two flyers said, returned the Red fire before it went down.



ELSEWHERE IN THE AEROSPACE WORLD:

A French jet on February 9 buzzed and fired on a Soviet transport carrying top Red officials including Russian President Leonid Brezhnev across the Mediterranean on a state visit to the west African state of Guinea. The plane was undamaged. Russia protested. France termed the incident



Staff photo by Herb Kalish

James H. Straubel, AFA's Executive Director, receives badge as honorary Cub Scout early in February in conjunction with Boy Scout Week. Cub is Bill Brown of Washington, son of Andrews AFB TSgt. T. F. Brown, who looks on.

"regrettable," said the Red plane had altered flight plan and was proceeding too close to the French Algerian coast.

SAC announced that it now has a KC-135 airborne command post in the air at all times. SAC currently keeps a portion of its B-52 bomber force in the air around the clock.

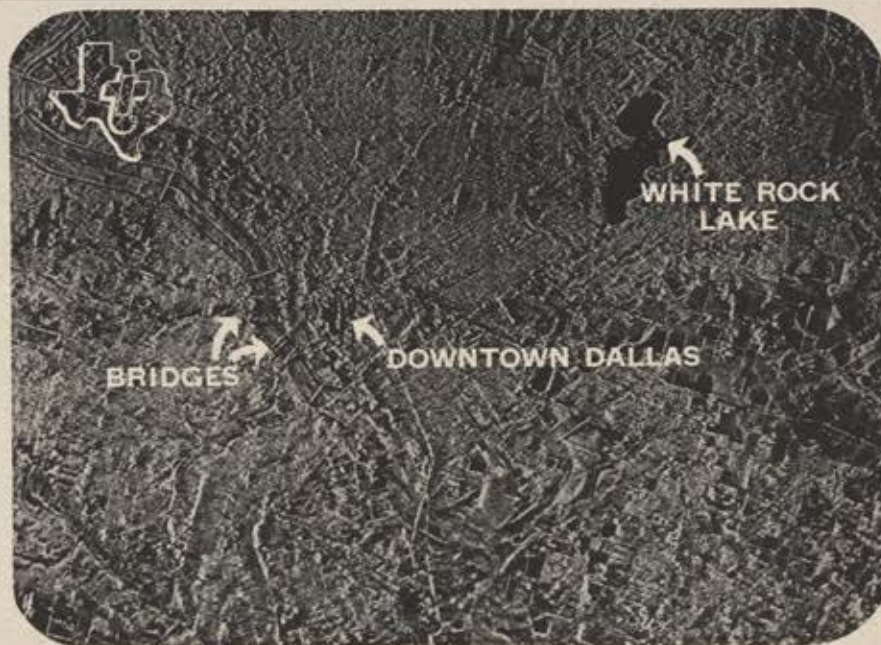
President Kennedy chose University of California physicist Dr. Harold Brown to succeed Dr. Herbert F. York as DoD Director of Research and Engineering. The President also

appointed an aviation task force under Fred M. Glass, former aviation director of the Port of New York Authority, to develop a set of national objectives and recommend action in the field.

Vice President Johnson named USAF Col. Howard L. Burris as his Air Force aide. He said he might appoint other military aides as well.

Defense Secretary McNamara ordered a crackdown on military news "leaks" and assigned USAF's Inspec-

(Continued on page 35)



Radar image of Dallas, Texas and vicinity, taken by an all-weather, day or night combat surveillance radar system—developed by TI for the Department of Defense

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tor General, Lt. Gen. Joseph H. Carroll, to study the matter.

Maj. Gen. Harold W. Grant, who has been Director of Telecommunications, DCS/O, Hq. USAF, was named first Commander of USAF's new major command, the Air Force Communications Service. AFCS goes into operation July 1 with headquarters at Scott AFB, Ill.

The Thompson Trophy, annually awarded symbol of supremacy in closed-course speed flying, went at the end of February to the three-man crew of a SAC B-58 which set a new

As this issue of AIR FORCE/SPACE DIGEST went to press, the Air Force Association was preparing to move from its present quarters in the Mills Building, 17th and Pennsylvania Ave., Northwest, in Washington, D. C., to offices on the second floor of a new building at 1901 Pennsylvania Ave., Northwest. The move was scheduled for April 8.

world's record of 1,284.73 mph for a 1,000-kilometer closed-course flight in mid-January. They were Maj. Harold E. Confer, pilot, Maj. Richard H. Weir, navigator-bombardier, and Capt. Howard S. Bialas, systems operator. The trophy, first presented at the Cleveland Air Races in 1929, is sponsored by Thompson Ramo Wooldridge, Inc., administered by the Air Foundation.

MATS established a USAF flying safety record in 1960 with a low 1.45 accidents per 100,000 flying hours. USAF last year recorded a new overall low of 5.7, SAC a low of 2.19.

The services have invited more than thirty potential contractors to submit proposals for a small number of VTOL aircraft under a triservice developmental program. The Bureau of Naval Weapons will act as development agency for the project.

SAC made a nearly clean sweep of the 1960 USAF Worldwide Base Newspaper Contest, taking first place in four of the five categories. SAC victors were Westover AFB's *Yankee Flyer*; Lockbourne AFB's *Skyhawk*; Whiteman AFB's *Skywriter*; and from England the *Greenham Herald*. ARDC's *Newsreview*, published by Hq. ARDC, Andrews AFB, took the other top spot. One of the five judges in this year's competition was Air Force Magazine Managing Editor Richard M. Skinner.

PROMOTIONS: President Kennedy has nominated twenty-six brigadier generals for promotion to the rank of major general. They are: William J. Bell, John B.

Bestic, Richard L. Bohannon, Render L. Braswell, John M. Breit, John W. Carpenter, Cecil E. Combs, Paul S. Emrick, Francis C. Gideon, Joseph E. Gill, Robert E. Greer, Perry M. Hoisington, II, James B. Knapp, Marvin L. McNickle, Jack G. Merrell, Theodore R. Milton, Thomas E. Moore, Nils O. Ohman, Clifford H. Rees, Allen W. Rigsby, William L. Rogers, Austin J. Russell, Avelin P. Tacon, Jr., Robert H. Warren, Delmar E. Wilson, and William H. Wise.

Forty-eight colonels have been nominated for promotion to brigadier general. They include: Rollen H. Anthiss, Wilbur W. Aring, Fred J. Ascani, Abe J. Beck, John H. Bell, Murray A. Bywater, James W. Chapman Jr., Willis F. Chapman, John H. Chick, John T. Fitzwater, Jack A. Gibbs, Alvan C. Gillem, II, Gordon T. Gould, Jr., Linscott A. Hall, Horace A. Hanes, George M. Higginson, Donald E. Hillman, Boyd Hubbard, Jr., John M. Hutchison, David M. Jones, Gerald F. Keeling, Arthur W. Kellond, and George H. Krieger.

Also Baskin R. Lawrence, Jr., Lewis E. Lyle, Stewart S. Maxey, John R. McGraw, Paul W. Norton, John W. O'Neill, Kenneth R. Powell, Oran O. Price, William S. Rader, Kyle L. Riddle, Charles H. Roadman, John A. Roberts, Robert R. Rowland, Arthur G. Salisbury, Harry J. Sands, Jr., Marion C. Smith, Pinkham Smith, William T. Smith, Jack E. Thomas,

William W. Veal, Tarleton H. Watkins, Thomas B. Whitehouse, Adriel N. Williams, Douglas E. Williams, and Benjamin G. Willis.

STAFF CHANGES. . . . Brig. Gen. Theodore C. Bedwell, Jr., from Chief Surgeon, Hq. SAC, Offutt AFB, Neb., to Commander, USAF Aerospace Medical Center, ATC, Brooks AFB, Tex. . . . Maj. Gen. John B. Bestic, from Deputy Director, to Director of Telecommunications, DCS/O, Hq. USAF, Washington, D. C. . . . Brig. Gen. Richard F. Bromiley, from Deputy Commander, WESTAF, MATS, to Commander, 1501 Air Transport Wing, (H), MATS, Travis AFB, Calif. . . . Maj. Gen. Harold W. Grant, from Director of Telecommunications, DCS/O, Hq. USAF, Washington, D. C., to Commander, AF Communications Service, Scott AFB, Ill. . . . Brig. Gen. Edgar W. Hampton, from Commander, Hq. 1501 Air Transport Wing (H), MATS, to Deputy Commander, WESTAF, MATS, Travis AFB, Calif. . . . Lt. Gen. Robert M. Lee, from Vice Commander to Commander, ADC, Ent AFB, Colo. . . . Brig. Gen. Arthur J. Pierce, from Deputy Commander, to Commander, 1125 USAF Field Activity Group (Aerospace Technical Intelligence Center), Hq. Command, USAF, Wright-Patterson AFB, Ohio.

Retired: Lt. Gen. Joseph H. Atkinson, Maj. Gen. Carl A. Brandt.—END

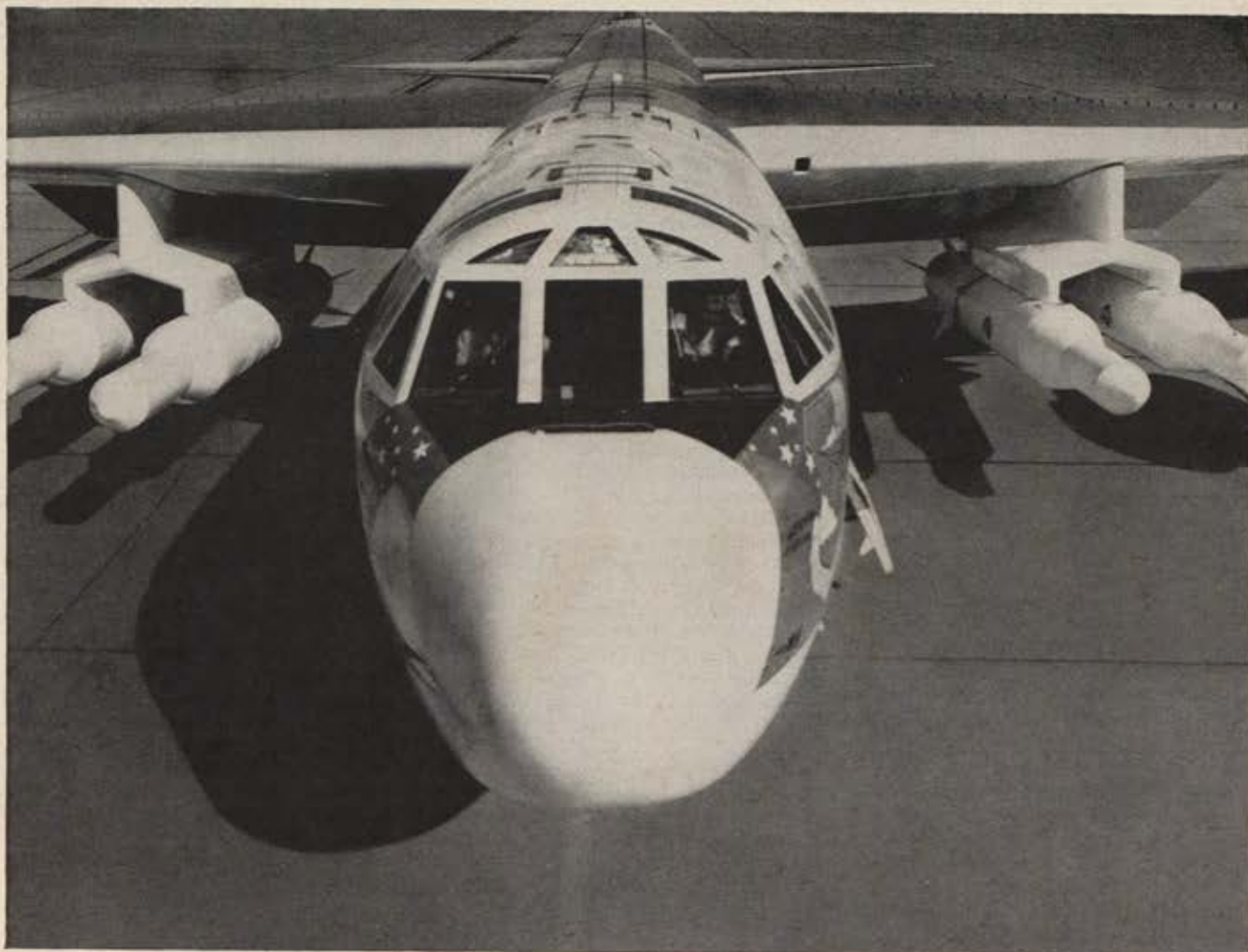


TI developed FM/FM transmitters and power supplies operated in "Ham" MERCURY spacecraft test. TI will supply FM/FM systems for later MERCURY shots.

TI TELEMETRY IN MISSILE SYSTEMS

APPARATUS
DIVISION

TEXAS INSTRUMENTS
INCORPORATED
P. O. BOX 6015 • DALLAS 22, TEXAS



MISSILE BOMBER. New "H" model is latest version of famous Boeing B-52 missile bomber, most versatile long-range weapon system in U.S. Air Force arsenal. B-52H here carries mock-ups of four Skybolt air-launch ballistic missiles. B-52s can also carry

supersonic Hound Dog missiles for in-flight launching toward distant targets. Flying high or low, B-52s will provide an almost undetectable launch pad for missiles. They can also carry regular load of gravity bombs, and strike up to five targets on single mission.

Capability has many faces at Boeing



RESEARCH STATION. Model of space research station designed by Boeing to accommodate 12 men and remain in earth orbit, serving as research station or interplanetary launch site.

SPACE CHAMBER. Boeing multi-stress chamber simulates six conditions of space travel in research to develop protective environments required for space vehicle crews. Chamber will also be used to test conditions in moon stations.



"FLYING" BOAT. Drawing of 115-foot hydrofoil craft Boeing is building for U.S. Navy. Riding out of water, hydrofoil will "fly" on underwater wings at speeds up to 45 knots. Powered by two 3000-hp gas turbine engines, craft will be the biggest hydrofoil ever built.

BOEING

THE SPACE AGE IN PERSPECTIVE



SPACE

DIGEST

VOLUME 4, NUMBER 4 • APRIL 1961

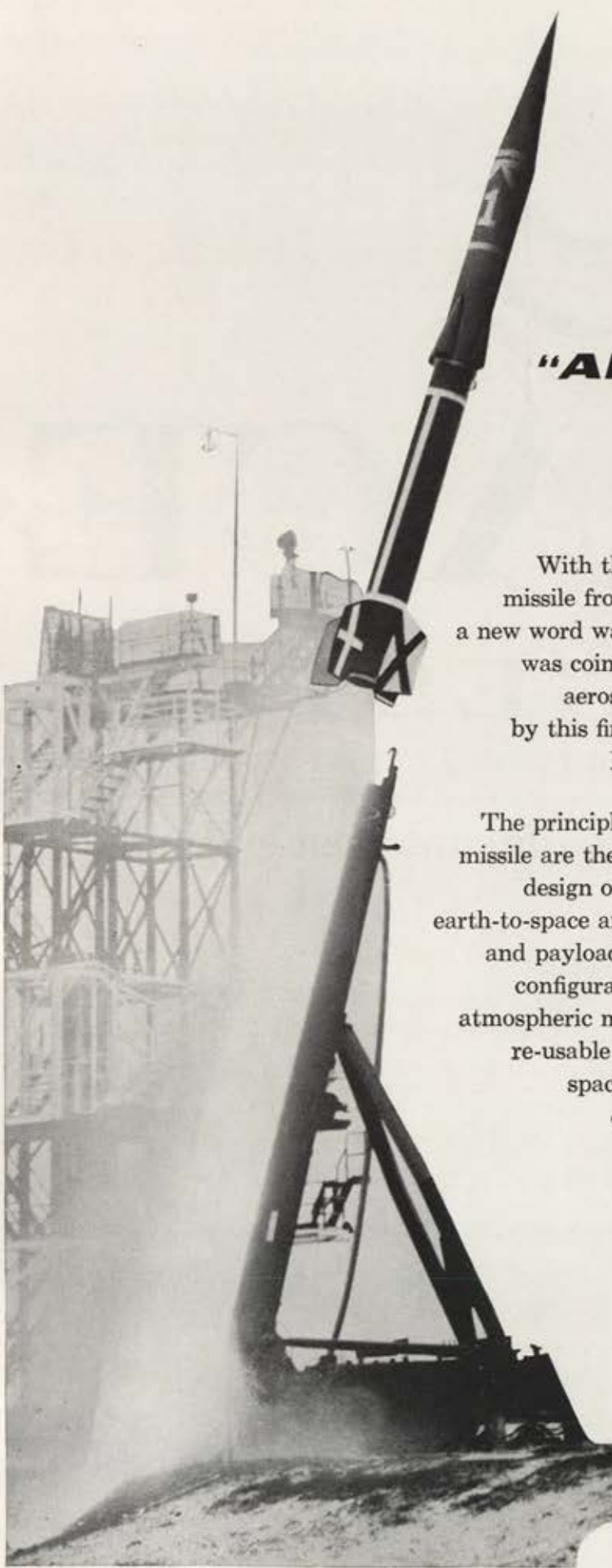
Second Annual Missile and Space Almanac

AEROSPACE is truly America's Newest Frontier, not only for the enhancement of scientific understanding of the vast cosmos in which we live but more immediately for the achievement of peace with freedom. It

is perhaps an indication of the complexity of the new technology that the military-political potential of space achievements is not as well understood or accepted as it should be in a society that proclaims its role as the chief defender of freedom in a threatened world. Yet realism requires such understanding, if we are to survive and prevail in the continuing struggle with the pragmatists of "Socialist Science."

In this special issue of *AIR FORCE/SPACE DIGEST*, we have tried to provide significant food for thought on important space-age questions, with a special emphasis on the national-security importance of space technology. In addition, we have included a comprehensive listing of all military missiles, a list of US space projects, a missile and space glossary, and a comprehensive bibliography—useful information for today's informed reader. We trust you will find this special issue of lasting utility.

—THE EDITORS



"AEROBALLISTIC"

With the firing of this unique hypersonic missile from Cape Canaveral in February 1959, a new word was born. The word, AEROBALLISTIC, was coined by McDonnell to describe the new aerospace vehicle concepts demonstrated by this firing. Level flight was achieved at over Mach 5 within the atmosphere.

The principles proved by McDonnell's Aeroballistic missile are the first major breakthroughs in the design of multi-mission spacecraft for earth-to-space and space-to-earth transport of men and payloads. Low lift-off weight, efficient orbital configuration, low heat re-entry and precise atmospheric maneuverability are provided in a re-usable Aeroballistic vehicle. The Aeroballistic space mission terminates with a conventional runway landing.

MCDONNELL

*Phantom II and F-101 Fighter and Attack Aircraft •
Project Mercury and Aeroballistic Spacecraft •
Talos Airframes and Propulsion Systems •
Quail Decoy Missiles • Rotorcraft •
Electronics Systems • Automation*

MCDONNELL AIRCRAFT • ST. LOUIS, MO.

Organizing for the Space Age

CLAUDE WITZE

Senior Editor, AIR FORCE/SPACE DIGEST

IN TWO gigantic steps the Defense Department has revolutionized its management concepts to catch up with space-age technology and further unify the national security effort.

The US Air Force has, in effect, been named the Department's single manager for the development of military space systems. In turn, USAF has reorganized to centralize direction of all its development and procurement programs and improve the management of both its own projects and those it will develop for the Army and Navy.

Robert S. McNamara, Secretary of Defense, made it clear in announcing the first decision that the assignment of space development projects to USAF does not "predetermine the assignment of operational responsibilities for space systems which will be made on a project-by-project basis."

The assignment, essentially related to the issue of roles and missions—a subject not mentioned in the Defense directive—will be made when a project gets close to the operational stage, the Secretary said, on the basis of the "competence and experience of each of the services and the unified and specified commands." This raised the probability that future assignment of space-age weapons will be to commands such as Strategic Air Command or North American Air Defense Command, which operate in combat under direct supervision of the Joint Chiefs of Staff.

The Secretary said he recognized that all of the military departments—Army, Navy, and Air Force—may have requirements in space. For this reason each is permitted to explore preliminary research and development requirements through feasibility studies. Such projects will be reviewed by the Director of Defense Research and Engineering. They will become defense projects only if approved by the Secretary of Defense. With few exceptions, they will be developed by the Air Force.

USAF's reorganization, while following closely the DoD directive, climaxed studies of systems management that go back about two years. In short, USAF will concentrate all development and procurement of systems—space, aeronautical, electronic, and ballistic—in a single new command. It will be called the Air Force Systems Command and will be headed by Lt. Gen. Bernard A. Schriever of the now-defunct Air Research and Development Command.

This means, of course, that the traditional role of the old Air Materiel Command will be changed. The

huge headquarters at Wright-Patterson AFB, Ohio, no longer will have responsibility for purchase of systems; the new Systems Command will take charge from concept to delivery. AMC's name is being changed to the Air Force Logistics Command. It will remain under the leadership of Gen. Samuel E. Anderson. Eugene M. Zuckert, the Air Force Secretary, estimates that about thirty percent of the dollars formerly spent by AMC will go over to the new Systems Command. The latter office, which will remain at the old ARDC Headquarters at Andrews AFB, Md., will have a budget of about \$5.8 billion for hardware in fiscal year 1962.

There has been no estimate offered on how this figure will change as the Air Force takes on the research and development of space projects under the unified program set up by the Defense Department. The directive giving USAF responsibility for almost all work in this area said only that projects approved for development for any of the three services will be chosen on a project-by-project basis and that this kind of consideration will be maintained until the system is assigned to a using command. It seems clear, however, that for budgeting purposes the USAF Systems Command will be given allocations for work on space system developments carried on for the Defense Department, even when the project originates in a sister service and may be assigned to it.

Basically, the USAF reorganization, like the Defense Department directive on development of space programs, is a huge step ahead in the management of modern technologies. What USAF wants to do is:

- Provide rapid decisions and accelerated action on designated system programs. This includes the entire ballistic missile program.
- Ensure efficient, responsive management of the space development mission now assigned to USAF.
- Provide for close integration and participation of the Army Corps of Engineers in the ballistic missile site-activation program.
- Provide for effective liaison and active participation by the Army, Navy, and National Aeronautics and Space Administration on projects being developed for those agencies by USAF.

In the past ARDC has been responsible for research, development, and testing. AMC has been in charge of procurement, production, and support.

The new USAF organization (see chart, pages 42-43) has redistributed the resources and realigned
(Continued on following page)

functions and responsibilities. The task of providing all system programs from development and test through production, installation, and checkout—delivery to the using command—will be up to the new Systems Command. It will have four management divisions:

- **Ballistic Systems Division**, at Inglewood, responsible for the Atlas, Titan, and Minuteman programs.

- **Space Systems Division**, also at Inglewood, responsible for military space programs assigned to USAF and for development projects in support of the Army, Navy, and NASA.

Both of the above are to be made up of elements of the old ARDC Ballistic Missile Division and AMC Ballistic Missiles Center.

- **Aeronautical Systems Division**, at Wright-Patterson AFB, responsible for such programs as the B-70 Mach 3 bomber, the new jet transport to be built by Lockheed, and the GAM-77 Hound Dog air-launched missile. It will contain elements of the old ARDC

Wright Aeronautical Development Division and AMC's Aeronautical Systems Center.

- **Electronic Systems Division**, at Hanscom Field, responsible for command and control systems such as the Ballistic Missile Early Warning System (BMEWS) and the Air Defense Control System used by NORAD. It will be formed from elements of the old ARDC Command and Control Development Division and AMC's Electronic Systems Center.

General Schriever will have a Deputy Commander of his Systems Command at Inglewood to ensure prompt decisions on the spot. In addition, the Army, Navy, and NASA will have resident representatives located at headquarters of the Space Systems Division to make sure these agencies have proper liaison and are not impeded in monitoring progress on their projects. The Commander of the Ballistic Systems Division will have a Deputy Commander with full responsibility for site activation. He will be in charge of installation and checkout as well as actual construction of the sites. This is one of the few jobs that was filled on the day the reorganization was announced. The deputy is Brig. Gen. A. C. Welling of the US Army Corps of Engineers.

General Anderson's new Air Force Logistics Command, no longer responsible for systems procurement, will continue to buy and supply an immense list of items used by the Air Force. It will concentrate on supply and maintenance activities to support systems in service and keep them operational after delivery. Under this command will be the nine Air Materiel Areas, the depots, and other support installations.

USAF's own basic research, the kind of activity that looks to the weapons of tomorrow and, under the new Defense space directive, is still within the purview of each branch of the armed forces, will be done by a new USAF Office of Aerospace Research. This unit, like the two new commands, will report directly to the Chief of Staff.

Provision has been made in the reorganization to speed review and approval of some high-priority systems, such as the Minuteman ICBM and the B-70 bomber. Projects like this will have a direct channel from the System Program Director to Hq. USAF.

The Defense Department's directive on space systems development brought an instant and frequently heated reaction in Washington. There were widespread reports that the Army and Navy had been deprived of just prerogatives and that their talents would be neglected with USAF holding full developmental responsibility. Fears were voiced, particularly in the early newspaper reports, that USAF would neglect Army and Navy requirements and try to retain the right to operate all space systems that went through development.

These apprehensions continued to be voiced in the weeks that followed, despite the fact that Gen. Thomas D. White, USAF's Chief of Staff, had given immediate reassurance that his commands were conscious of their new responsibility and the requirement to meet the needs of the sister services. Within thirty-six hours of the announcement by Secretary McNamara, General White also had called a meeting of all his major commanders and impressed upon them the seriousness of USAF's new role.

Setting Course for Space

Here, excerpted, are significant portions of the new Defense Department directive establishing space development responsibilities:

Purpose

This directive establishes policies and assigns responsibilities for research, development, test, and engineering of satellites, antisatellites, space probes, and supporting systems therefor, for all components of the Department of Defense.

Policy and Assignment of Responsibilities

A. Each military department and Department of Defense agency is authorized to conduct preliminary research to develop new ways of using space technology to perform its assigned function. The scope of such research shall be defined by the Director of Defense Research and Engineering in terms of expenditure limitations and other appropriate conditions.

B. Proposals for research and development of space programs and projects beyond the defined preliminary stage shall be submitted to the Director of Defense Research and Engineering for review and determination as to whether such proposals, when transmitted to the Secretary of Defense, will be recommended for approval. Any such proposal will become a Department of Defense space development program or project only upon specific approval by the Secretary of Defense or the Deputy Secretary of Defense.

C. Research, development, test, and engineering of Department of Defense space development programs or projects, which are approved hereafter, will be the responsibility of the Department of the Air Force.

D. Exceptions to paragraph C will be made by the Secretary of Defense or the Deputy Secretary of Defense only in unusual circumstances.

E. The Director of Defense Research and Engineering will maintain a current summary of approved Department of Defense space development programs and projects.

Up on Capitol Hill, Rep. Overton Brooks (D-La.), Chairman of the House Committee on Science and Astronautics, hastily called hearings and summoned top Defense Department and military executives to testify. After the flying rumors and apprehensive headlines, buttressed with smatterings of misinformation, it was here that the Administration explained the history and intent of the space directive in clear language. Top spokesman was Roswell L. Gilpatric, Deputy Secretary of Defense.

Mr. Gilpatric pointed out that, in his opinion, the directive contained at least three safeguards to preserve the effectiveness and capabilities of the Army, Navy, and Air Force. He listed them:

1. Each branch of the armed forces can carry on preliminary research to develop ways of using space technology to perform its mission.

2. No space project can be developed beyond the preliminary stage unless it has been approved as a Defense Department project.

3. Under unusual circumstances, an exception can be made and a service other than the Air Force can carry on development.

Mr. Gilpatric emphasized that USAF has nothing to say about which projects will be developed, not even its own. Also, he observed that there is nothing in the directive about operational responsibility. This was, as has been noted, reserved for future action. In view of the fact that unified and specified commands will be responsible for operations in event of war, this appeared to leave them open for the assignment in addition to the three branches of the armed forces (see *"Airpower in the News,"* page 16).

Under cross-examination by the committee, Mr. Gilpatric made it clear that this Administration considers firm management of the space program a vital necessity in order to keep Army and Navy scientific talent busy on projects of primary importance to those services. He cited specifically the Navy's important underwater task, the antisubmarine mission. And he pointed to the Army's Nike antiaircraft missile systems and the research and development needed to improve the tools of ground warfare. Firm management at the top, he said, was the way to ensure that these vital needs are taken care of. At the same time, such management would eliminate the overlapping of interests and service straying from areas of primary missions.

The directive on space came out of Secretary McNamara's new Office of Organization and Management Planning Studies. This is a unit within the office of the Department's General Counsel. Its mission is to "provide timely and effective solutions to defense management and organizational planning problems."

Their study, Mr. Gilpatric said, showed that USAF already "was responsible for over ninety percent of space research and development and that with respect to projects not assigned to the Air Force for research and development, the Air Force was playing a considerable part in the development of those projects through provision of the boosters, launch facilities, and services."

It was decided that good management called for assignment of all space research and development to USAF unless an exception were granted. At this point, according to Mr. Gilpatric, a draft of the directive—

an early version—was circulated to the Army, Navy, Air Force, and other Defense Department offices, as well as to the Chairman of the Joint Chiefs of Staff. The Joint Chiefs, he said, were not asked to comment collectively, but each member had an opportunity to join in the deliberations of his own service. A week was allowed for this process, during which Mr. McNamara and Mr. Gilpatric discussed the draft with the service secretaries.

At another session, USAF Generals White and Schriever appeared. The Chief of Staff shot down a rumor that he favored having USAF swallow NASA. This was accomplished by declassifying a memorandum of April 14, 1960, which General White called "a sermon from the chief to the staff." The sermon preached the doctrine that USAF was under obligation to cooperate to the maximum extent with NASA and that he wanted this policy made "crystal clear." He ordered his subordinates to "supply all reasonable key personnel requests made on it by NASA." General White disclosed that there are seventy-seven USAF officers now working for NASA, all of them there by specific request of the civilian space agency. He said he will send more if they are requested, adding that USAF's relations with NASA are "optimum."

Queried about his attitude on how space systems will be allocated to the armed forces for operational purposes, General White emphasized once more that air and space are an indivisible continuum. He said traditionally the Army has had the antiaircraft artillery mission and that he considers any weapons analogous to this artillery should properly be used by the Army. He put Nike Zeus and any other point defense system in this category.

On the other hand, General White claimed for USAF any weapon system for area defense and analogous to the traditional fighter-interceptor mission. He said area defense could be a responsibility of either service, but he considers it corresponds more closely to the USAF mission.

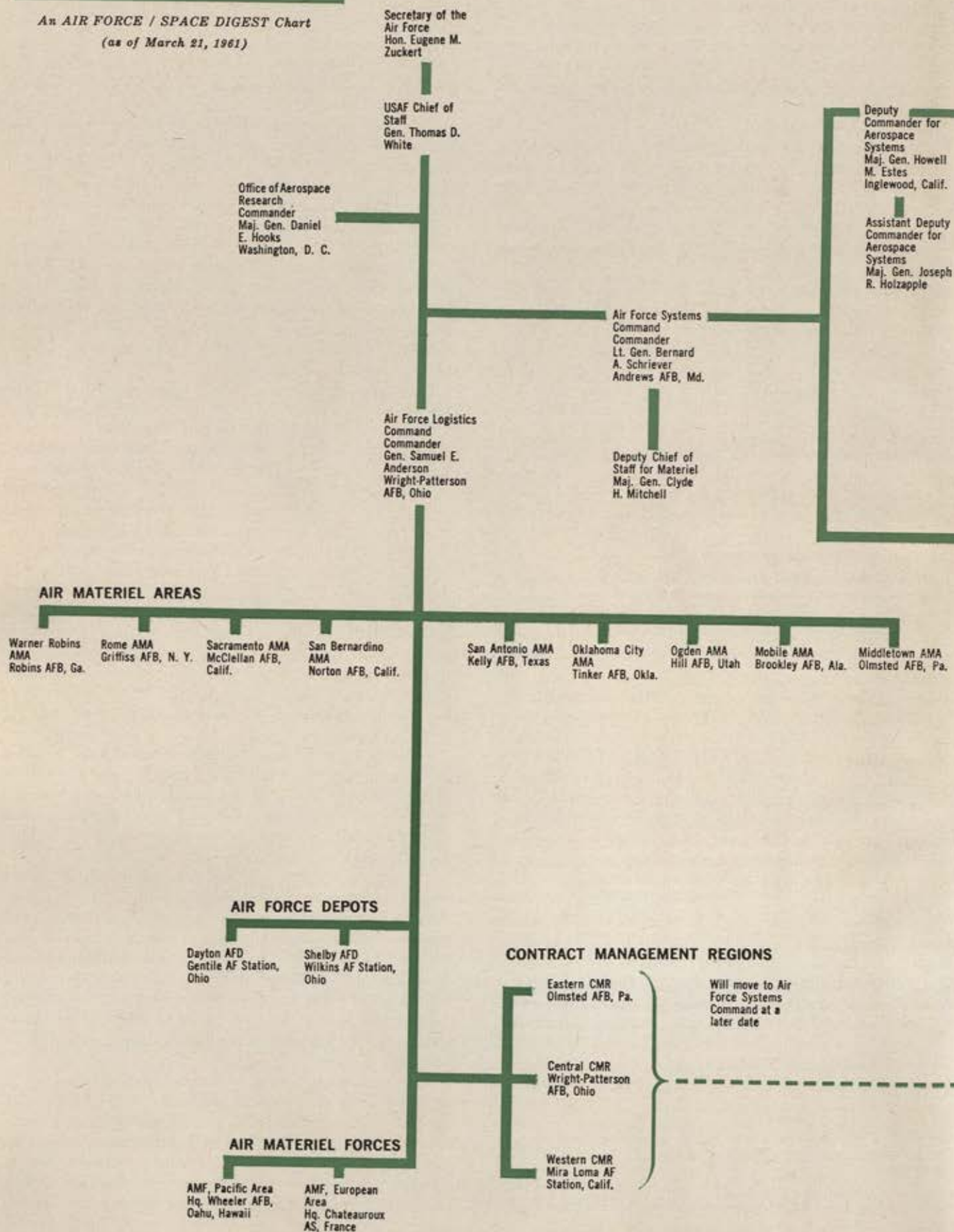
Neither the DoD space directive nor the Air Force's own reorganization should be looked upon as sudden moves brought about as the simple result of a change in political Administrations. These organizational changes result from changes in technology more than they do from changes in the civilian hierarchy.

The space directive, it has been pointed out, does not in reality alter the existing situation to any great degree. The Secretary of Defense already had the prerogative of determining which systems will be developed. The services already had the right to conduct feasibility studies and examine the state of the art. The Air Force already was spending most of the money and doing most of the development work in space. The Army and Navy already were engaged in "exception" projects.

So far as the USAF reorganization is concerned, it results from a two-year examination of USAF's problems in an era when technical advances have threatened to overwhelm established organizational capabilities. The new Systems Command will be the major development and system procurement agency of the space age. It will handle USAF's biggest challenge, biggest opportunity, and biggest responsibility to the cause of freedom.—END

USAF's NEW COMMANDS

An AIR FORCE / SPACE DIGEST Chart
(as of March 21, 1961)



THE CARE
AND FEEDING
OF A
SPACE
WEAPON.



ATLAS AT VANDENBERG . . .

BY JAMES R. DOHERTY

USAF PHOTOS

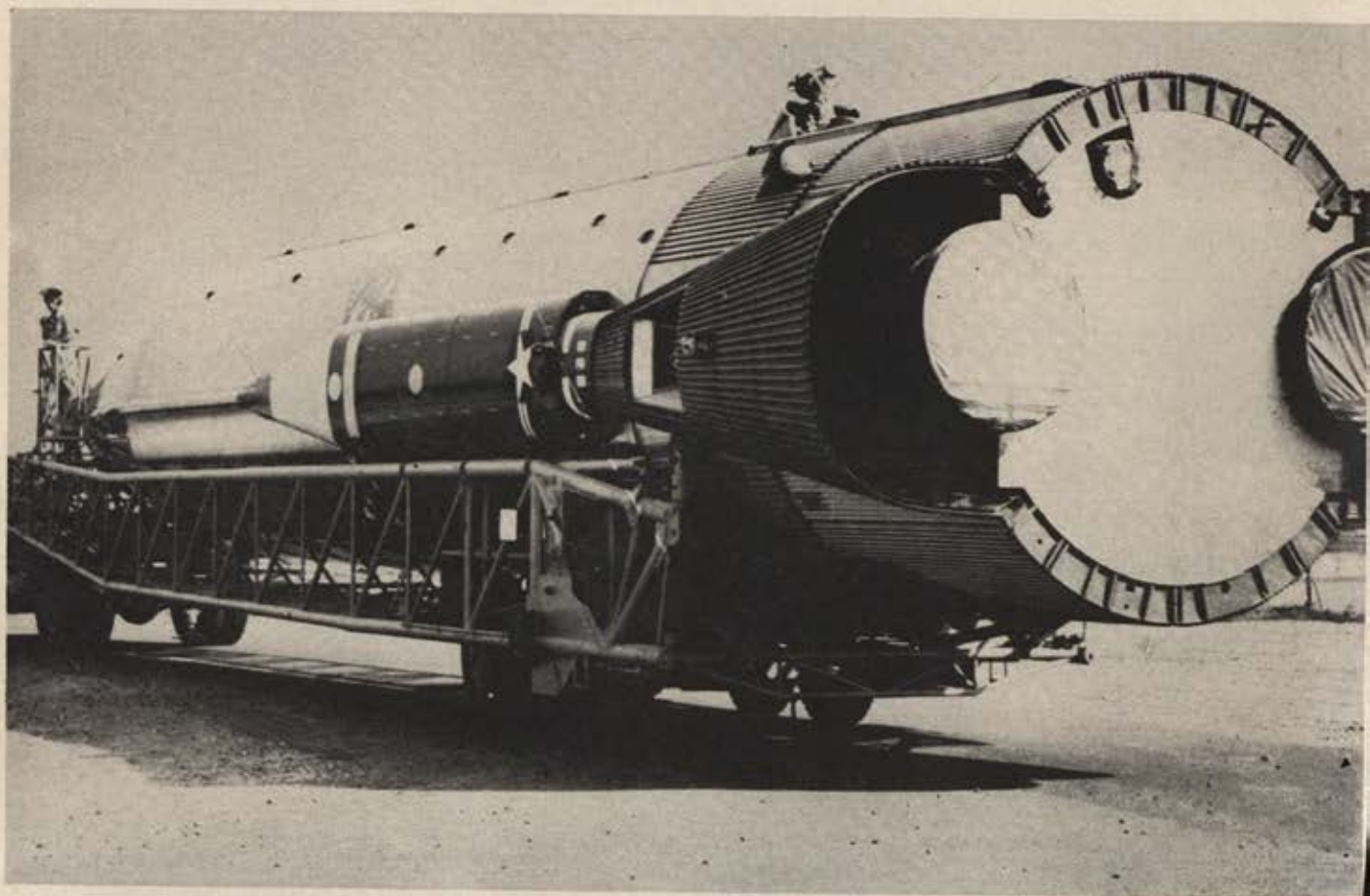
Handled with the care normally accorded a fine watch, Atlas, America's first operational ICBM, is the hub around which life revolves for hundreds of technicians at Vandenberg AFB, Calif. In the course of a day . . . a week . . . a month, what happens to the big stainless steel birds upon which America and the free world have pinned such high hopes? Here's a missileman's-eye view of the big bird.

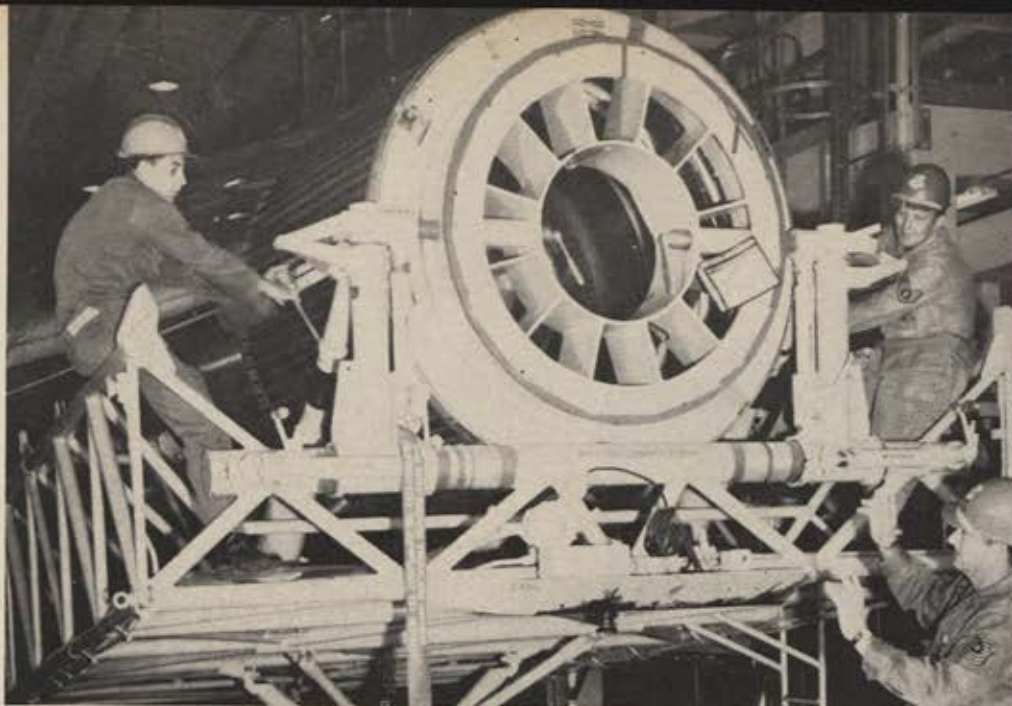
It arrives shrouded in wet mystery, a giant cocoon being disgorged from the belly of a C-133 Cargomaster in an operation that is performed with infinite care. The slightest wrench could cause a disastrous misalignment in the seventy-two-foot-long bird. To prevent such mishaps, the missile is pressurized, or maintained "in stretch," at all times . . . in transit or on the launching pad. Early deliveries of Atlas were made by trucks, towing specially designed trailers. Today's birds arrive at Vandenberg . . . as good birds should . . . by air.



ATLAS AT VANDENBERG . . .

On its way to Vandenberg's missile assembly building, Atlas is unmasked so that technicians can better observe its gleaming, inert length for signs of damage or malfunction. As he creeps along base roads, the driver is in constant telephone communication with the technician in charge, who stands at the missile's nose, and with two other "drivers" ensconced in tiny cabs immediately behind the trailer's rear wheels. Visible here on top of the missile is one of Atlas' two small vernier engines, used to trim the birds' velocity when it has reached a speed of approximately 15,000 miles per hour. After verniers have been shut down, the reentry vehicle is separated and arcs downward in its deadly ballistic curve.





To guard against the possibility of collapse, the Atlas is put in stretch immediately upon its arrival at the assembly building.

In addition, an interior pressure of six to nine pounds per square inch is maintained in both the cavernous liquid-oxygen and RP-1 fuel tanks.

Here under the direction of a noncommissioned crew chief, technicians turn struts that exert force on either side of the nose ring, stretching the bird a life-saving fraction of an inch under a force of 10,000 pounds. Rhythm in the operation is mandatory.

An ounce too much pull—at the wrong time, on the wrong side—may result in serious damage from warping. The crew chief counts a steady, even cadence. Slowly, a quarter turn . . . another . . . then another. At last, with the missile's skin at drumhead tautness, the job is done. Now the real work can begin.

Air Force enlisted men, possessing among them forty-seven different skills, are utilized to prepare a single Atlas ICBM for hookup to its launching pad.

Several among them are missile engine technicians, one of whom is shown at right making minute adjustments to the powerplant labeled "sustainer."

Helium gas is used to maintain pressure in both of the main tanks . . . pressure that forces explosive liquid oxygen and RP-1 into engine combustion chambers. A far cry from the work of the World War II "grease monkey"

is the task of these highly trained and skilled airmen.

Yet, mechanical brains to the contrary, man is still the decision-maker . . . in the assembly building . . . or on the launching pad.



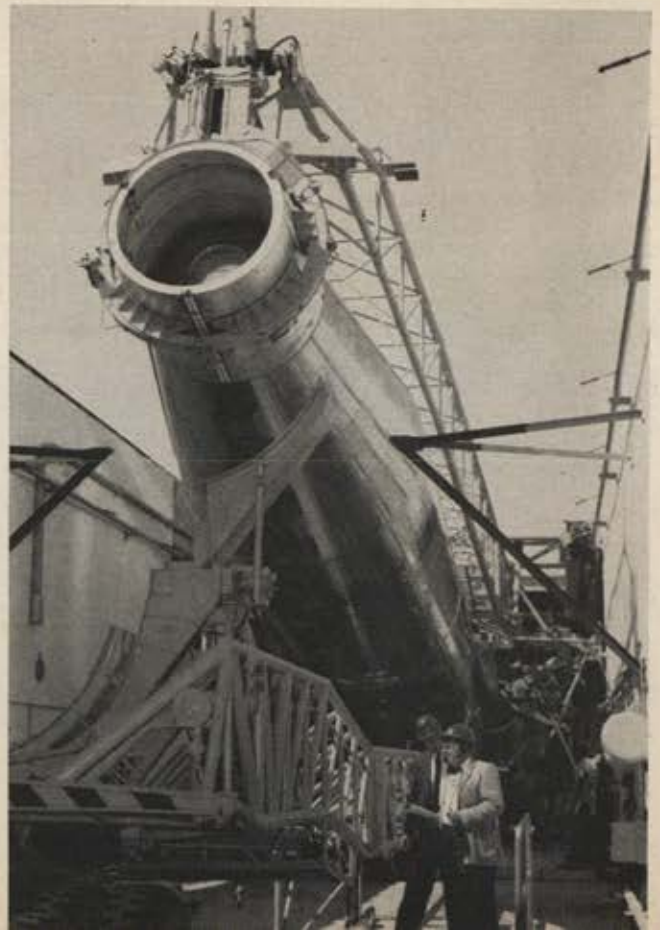
ATLAS AT VANDENBERG . . .



In the final stages of its technical ordeal in the assembly building Atlas' plumbing is checked with the aid of this hydraulic pumping unit. Earlier in the missile's brief operational history, many of these time-consuming checks were performed manually. Nowadays, thanks to the ingenuity of dedicated engineers, machines have been developed that immeasurably shorten the missile's march from manufacturer to launching pad. In the process, technicians have been relieved of many a tiresome and repetitious chore. This tester is a portion of APCHE (Automatic Programed Checkout Equipment), an electronic brain of sorts, that enables technicians to "see" the missile's complicated innards at long range. It may never have left home, but, by means of APCHE, Atlas may be "flown" its full range at a technician's convenience.

Now, at long last, Atlas is ready for mating to its launching pad. Thousands of electrical circuits have been tested and found functional. Subsystem after subsystem has been checked with the painstaking attention to detail upon which a successful launching will inevitably depend.

Engines have been prepared for flight. And, finally, assembly technicians are finished: The missile is **trundled** across Vandenberg proper to the "576-B" area, a brushy California hillside pockmarked by semihardened Atlas launching sites. Here, the weapon, on its unique trailer, is backed into position and its base clamped firmly into the spidery launching mechanism. Throughout the operation, of course, interior tank pressures must be maintained and care taken that the missile's tender skin remains unbroken. Then, at a signal from the pad chief, Atlas is raised slowly upward. . . .





Upright in its steel and concrete bed, Atlas points for the first time toward the big emptiness: space. Ahead, somewhere in its operational or training future, there could lie a one-way trip to flaming oblivion via the airless void.

But such a fiery end is a future matter.

More checks and rechecks are its immediate business. Linking bird and blockhouse are thousands of electrical circuits that must now undergo tests. Elaborate consoles that monitor fuel flow and engine starts must be hooked up, the airborne guidance system test flown, all the myriad subsystems inspected yet again.

To the taxpayer, this burnished steel finger pointing at the heavens represents an investment of nearly one million dollars.

SAC missilemen, well aware of this salient budgetary fact, are determined that Atlas will pay its way. Each well groomed bird constitutes a sizable premium on our policy of deterrence. The technicians take no chances.

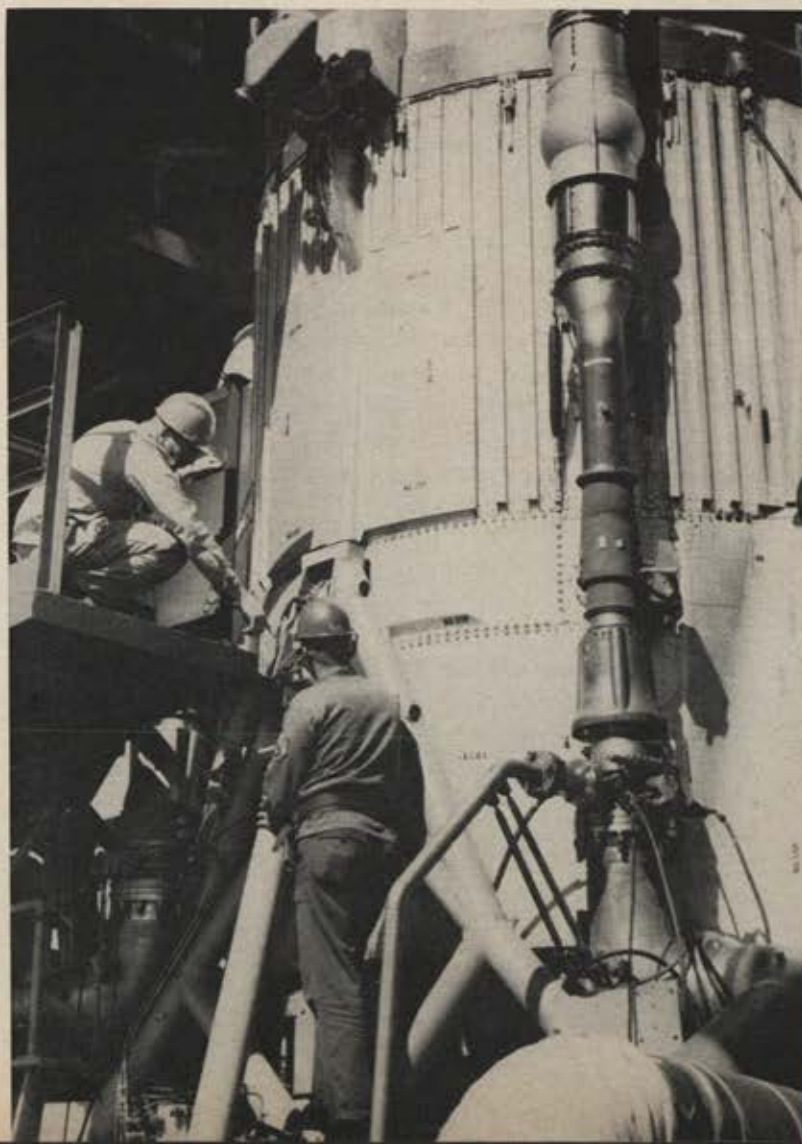
A finishing touch . . . the Strategic Air Command's colorful crest is affixed to the missile's tankside.

Planning for inclusion of Atlas into the SAC weapon systems inventory began several years ago. Eventually, it is planned that three categories of missiles will become operational throughout the command: Intercontinental Ballistic Missiles (ICBMs); Intercontinental Cruise Missiles (ICCMs); and Air-to-Surface Missiles (ASMs). ICBMs, the Atlas and Titan, are both powered by liquid fuel, boast ranges in excess of 6,300 miles. Atlas is a stage-and-one-half vehicle; the Titan is a two-stage rocket. To date, the latter has been successfully fired in research and development tests only, but is slated to make its operational bow at Vandenberg in the near future. Minuteman, a solid-fuel ICBM, will enter the SAC inventory in approximately twenty-four months. Snark is an example of the cruise missile, or pilotless aircraft. Powered by a turbojet engine, it flies at near-sonic speeds a distance of 5,000 miles. Hound Dog and Quail are both air-to-surface missiles. The former, tucked beneath the wing of a B-52, is capable of carrying a nuclear warhead, is powered by a J52 engine that generates a maximum of 7,500 pounds of thrust. Quail is also launched from an airborne carrier, but will be employed as a decoy missile—to confuse, not destroy—enemy defensive weapon systems.



ATLAS AT VANDENBERG . . .

Complexity of the Atlas weapon system is apparent in this glimpse of the missile's tethered end, with its maze of pipes and tubes and cable that interlace the launcher mechanism itself. Liquid oxygen and fuel lines snake their way among the ducts that supply constant heat to sensitive guidance controls; smaller hydraulic lines wind like spaghetti through the whole. Each is a possible source of malfunction, each must be leak-checked periodically. Projecting from the base of the pod is one of Atlas' two "tiny" vernier engines—of the power of 1,000 horses each. Also visible are several removable panels that permit access to the missile's main powerplants. The noncommissioned pad chief (below left) is a veteran of World War II, who cut his mechanical eyeteeth on the famed B-17 Flying Fortress, the deadliest weapon system of its time. He's still in the business—and still responsible for the deadliest thing that flies.





Entrances to all Vandenberg blockhouses are tightly guarded and, as the sign points out, each area is patrolled regularly by burly air policemen and their extremely unsociable canine companions. Before every firing, two sets of heavy steel doors are swung shut to seal the buildings, which are buried beneath many feet of packed earth. The walls are constructed of steel-reinforced concrete. Each structure boasts its own ventilation system and is deemed capable of withstanding any and all blows—short of a direct hit by a nuclear weapon.

Chief of the blockhouse firing team is the launch control officer, shown here seated at his centrally located console. The LCO in this case is Major Earnest E. Bankey, Jr., who superintended the initial Atlas launch by a SAC crew at this West Coast base. His assistant is Master Sergeant Wesley M. Sorum, a missile analyst technician. And now the weeks and months of training are at an end—for the moment. The bird on the pad outside is ready for firing.

The weather is clear, ideal for maintaining visual contact with the ascending missile. At 0500 the readiness countdown begins. At a signal from the 1st Missile Division Command Post, the machinery is set in motion that will culminate in a combat training launch. The countdown clock is started. Time: "T" minus 180 minutes. In rapid-fire order, all agencies that must be read in prior to a peacetime firing are notified. High on the list is the range safety officer. Then, additional words of warning are flashed across the Pacific . . . from Point Arguello . . . to Hawaii . . . to Wake Island . . . to Guam. Shipping has already been cleared from the intervening sea lanes. The impact area is deserted. More calls . . . more voices . . . more people. And the clock moves on . . .



ATLAS AT VANDENBERG . . .



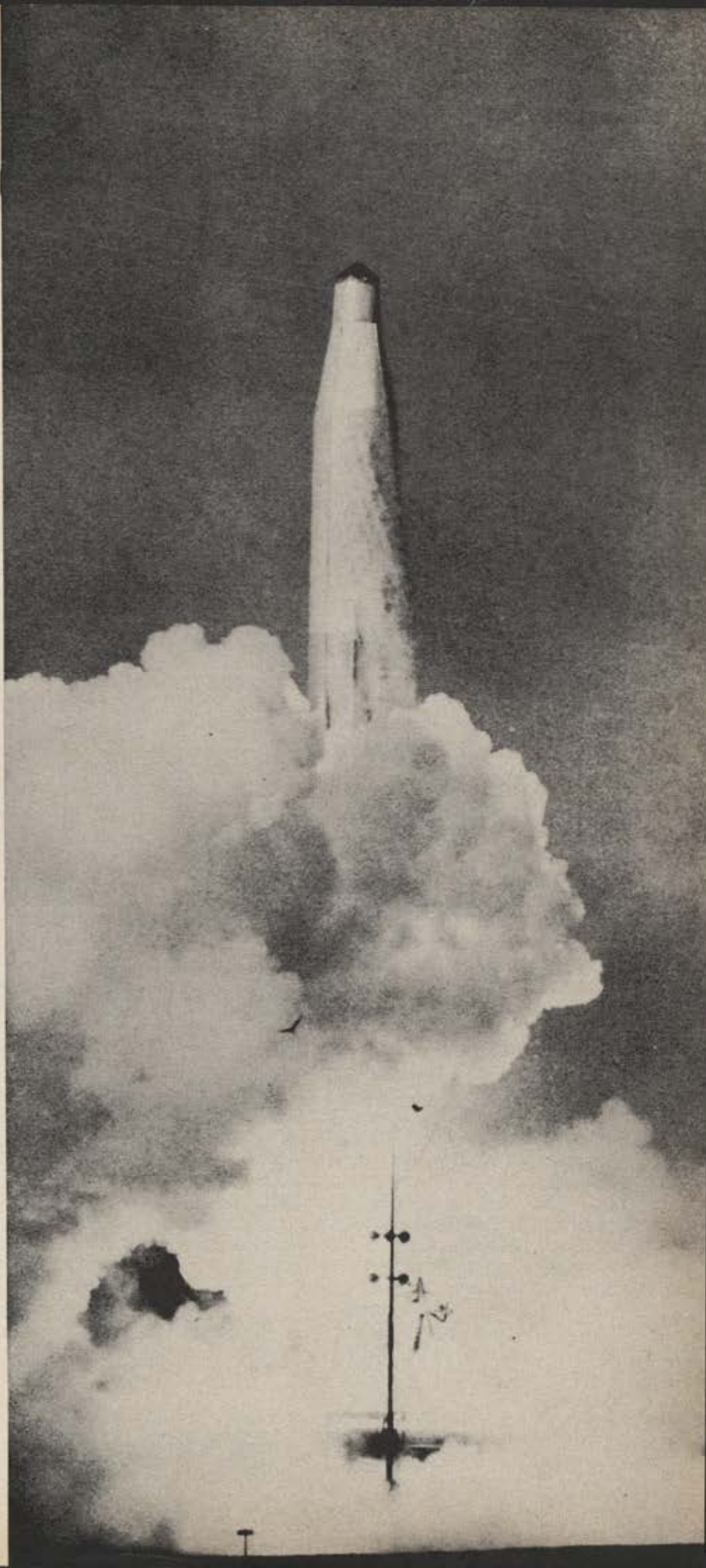
Now the complex facilities operator swings into action. At his fingertips are controls that distribute power throughout the entire pad and blockhouse system. An electrical generating plant, large enough to accommodate a fair-sized city and utilizing six electro-diesel generators, supplies the power. During launch and immediately following, the complex facilities operator will deluge the flame bucket beneath the pad to keep blast damage to a respectable minimum. At the left is Master Sergeant Bethal C. Boisky, of Athens, Ga., who alone is responsible for ascertaining the position and state of readiness of dozens of supporting facilities. For example, a battery of TV cameras must be operable and directed. Firefighters and disaster control teams must be alerted. Voltages and pressures must be maintained, both on the pad and in the launch control center itself. And the complex facilities operator must be prepared—in the event of malfunction or disaster—with a plan for counteraction.

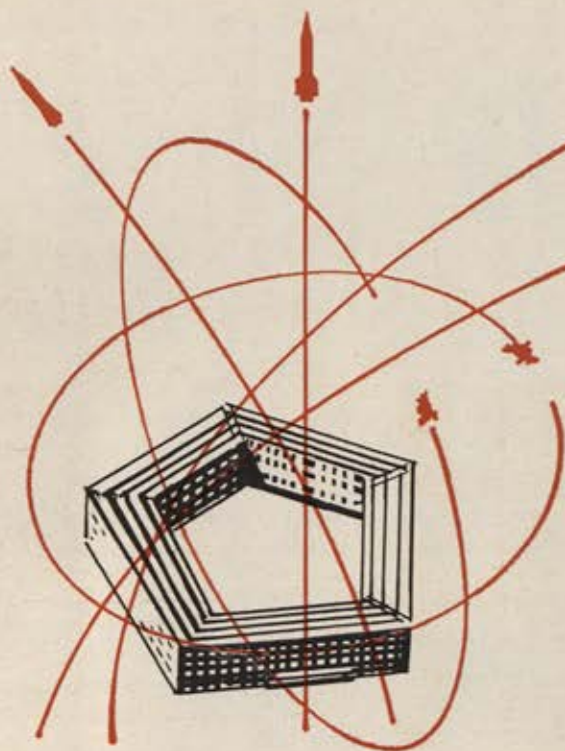
While Atlas trembles at the ready, a cameraman atop Vandenberg's guidance control center aims his battery of glittering lenses at the launching pad. At the instant of liftoff, in the same manner a gunner might track a distant target, the technician will begin following the rising rocket. In addition to conventional cameras, a number of the high-speed variety will film Atlas for a period of approximately twenty seconds after blastoff. Should it become necessary to destroy the missile, valuable clues as to what went amiss may be captured on film. An uneventful flight, documented by extensive film footage, may supply confirmation of a successful Atlas modification or perhaps an innovation in launching techniques.

Missilemen are still learning . . . and the cameraman's contribution on launch day cannot be overestimated.



Today's launch is trouble-free. Inexorably, the countdown moves toward its fiery climax. Again the LCO's voice is heard: "On my mark, we will pick up the final commit sequence. MARK!" Less than two minutes remain before liftoff. The guidance system analyst tolls off the seconds "... on my mark 50 ... 40 seconds, MARK. ... 30 seconds. ...". Suddenly, furiously, the tension begins to build. Now, pressure is being transferred internally from the pad to the bird. Airborne batteries are being activated. Flight and hydraulic pressures are building up. The end ... or the beginning ... is at hand. And now the key is turned. With an angry bellow that vibrates ponderous blockhouse walls, five Atlas thrust chambers roar to life. "Three ... two ... one ... zero ... LIFTOFF!"





Space and National Defense

BALANCING THE POWER EQUATION

JOHN F. LOOSBROCK

Editor, AIR FORCE/SPACE DIGEST

and

WILLIAM LEAVITT

Associate Editor, AIR FORCE/SPACE DIGEST

MUCH time and trouble has passed since those arid days in the late '40s and early '50s when a farsighted but rather lonely minority of military planners, in and out of uniform, was scoffed at for proposing serious attention to the idea of extending national military power beyond the thin mantle of the atmosphere. Today, there is increasing recognition, not only within the Department of Defense, but in Congress and the White House, of viable military missions in space.

The most recent indication of this recognition is the March 8 announcement by Secretary of Defense Robert S. McNamara that henceforth research and development of space-oriented military projects will be the responsibility of the Air Force unless in the opinion of the Secretary or Deputy Secretary "unusual circumstances" justify assignment of the particular project to either the Army or Navy. The Air Force has already acted to reorganize its research and development activities (see page 39) to meet its new responsibilities in military space project development and systems planning. The new order leaves room for feasibility studies by all three services, and requires the services to submit the proposals to the Director of Defense Research and Engineering, so that he may recommend to the Secretary those proposals he judges ought to be further developed. Also, the new order stresses that when systems reach operational capability, the Secretary will decide to which service they will be assigned. Further, space research and development efforts already assigned to the Army or Navy will stay where they are.

What led to the evolution of the recognition, slow as some critics have described it, but sure at any rate, of the military significance of space?

Sputnik I, of course, served as a major catalyst for

this change of view. It was a visible portent of the fact that the Soviet Union—despite her disclaimers that Russian space spectacles were but a dramatic illustration of the superiority of peaceful "Socialist Science"—would not hesitate to use space technology as a military tool of her international truculence when and if the occasion called for it. Ballistic blackmail from space as well as earth, for example, became a serious possibility, and realists at American military planning tables could not ignore such dangers. It was necessary to chart military space systems which could serve our purposes as the nonaggressive, primarily *defensive* factor, in the international power equation. It was agreed that by all means, through such agencies as the civilian National Aeronautics and Space Administration, we should pursue vigorously a program of purely scientific space research, but that this effort, vitally important as it was in the international propaganda struggle, was but one side of the coin. In addition, the peaceful space program depended heavily, as it does today, on the boosters, launch facilities, and technological base afforded by the military ballistic missile program. A military capability in space, responsive to operational needs that could not be met by nine-to-five scientists in mufti, had to be developed.

Yet, in the relaxed days of the Eisenhower Administration, which now seem so long ago, such a point of view was difficult to proclaim publicly. The emphasis was on peaceful uses of space, certainly a laudable goal, but one stressed to a degree which almost literally forced military space system planners underground, where they pursued their projects quietly but tenaciously against the day when a new realism would emerge in the halls of government.

The realization was most gradual on the highest

(Continued on page 57)

WESTINGHOUSE IMAGING SYSTEM ENABLES PILOTS TO SEE HOSTILE GROUND TARGETS ON DARK NIGHTS



J1-02327

Installed in combat aircraft or missiles, the new Westinghouse low-light level imaging system clearly pictures tactical targets normally obscured on cloudy, moonless nights. The system is equally effective for target-viewing systems in tanks or submarines.

Military pilots can see moving ground targets and terrain features at night, instantly, with a new low-light level electronic imaging system being developed at Westinghouse.

The new system will see hundreds of times better than the human eye under darkest night conditions. It is simple, compact, and rugged, utilizing advanced versions of the small Astracon light amplifying tube, a product of Westinghouse research. Systems using this tube will automatically track-while-scan, and simultaneously present a full field of view.

Westinghouse, at its Air Arm Division in Baltimore, is also applying results of its years of research in electronic imaging sensors to infrared and ultra-violet systems, planned for space programs.

The new imaging systems, coupled with traditional Air Arm capabilities in fire control, reconnaissance, surveillance, and missile guidance, offer potent new levels of military strength for the free world . . . They are another demonstration of how science is serving Defense at



Westinghouse



Advanced Westinghouse thermal imaging systems for space applications permit accurate detection and tracking of ballistic missiles, satellites, or spaceships. These systems feature high scan speeds, high resolution, and inherent reliability. Low power consumption means weight and space savings.



Weather mapping the world is but one of the many jobs which can be performed with advanced Westinghouse infrared systems.



Westinghouse Uvicon ultraviolet imaging system will enable man to see a UV picture of the universe, taken from above the atmosphere.

Infrared, Ultraviolet imaging systems being developed for new space missions

Advanced imaging systems utilizing infrared and ultraviolet spectra are being developed at Westinghouse for a variety of military and scientific uses.

At the Air Arm Division in Baltimore, active and passive thermal imaging systems are being planned around advanced infrared devices, including the Westinghouse Space Thermicon. Missions include target detection, tracking and guidance, reconnaissance, surveillance, and mapping. A key factor in these systems is the successful application of ultrathin infrared-sensitive membranes developed by Westinghouse scientists.

Westinghouse has also developed the Uvicon imaging tube, sensitive to shortwave ultraviolet rays such as those emitted by celestial bodies but which are absorbed by our atmosphere. In space vehicles, systems using Uvicon will give man a new view of the universe.

These new IR and UV imaging systems, plus unparalleled advances in visible light systems, offer America potent new military and scientific capabilities. They are another demonstration of how science is serving Defense at



Westinghouse



DoDs McNamara and York: New realism in the Pentagon.

DoD levels. It is hard to believe that—even after Sputnik—DoD pragmatists saw no immediate need for military million-pound-thrust capability and nearly allowed the Saturn program to die, prior to its transfer from the Army (which, to its credit, fought for it) to NASA.

Today the new realism is beginning to emerge, and there is progress in the direction of creating true military space capabilities for the country. This does not mean, though, that we will have a formally organized space force tomorrow. The Department of Defense is too complicated for that.

How has DoD described its effort in military uses of space? The recent testimony of Dr. Herbert F. York, Director of Defense Research and Engineering, before the House Committee on Science and Astronautics, is a good indicator, since Dr. York's office is without a doubt the prime source of military technological decision in the Pentagon today.

"... The objectives of the defense efforts in space," Dr. York told the Committee members, are "(1) the development, production, and operation of space systems where it can be demonstrated with reasonable certainty that the use of spaceflight will enable us to better accomplish our basic defense mission, and the development of components which would be needed in systems which cannot be clearly defined at this time but which will develop as the future unfolds in this new sphere of activity."

"Thus," he went on, "the Department of Defense continues to be primarily interested in applying this new capability for spaceflights to achieve a more effective force for the United States and its allies. Our space efforts are an integral part of the over-all military programs complementing or supplementing other military activities."

This was carefully couched terminology, but in essence, Dr. York, who always measures his words, was saying that the Department of Defense is today contemplating spaceborne extensions of terrestrially or at least atmospherically bound traditional military functions, particularly of support nature. Military communications will go into space. Navigational systems will go into space. Reconnaissance and warning systems will go into space. Command and control systems likewise. All depending, of course, on the necessary demonstration that such supportive systems based



USAF's Schriever



Navy's Hayward



USAF's Ritland



Army's Trudeau

in space do the military jobs required of them better than the traditional ways. The stress today is definitely on support systems, essentially passive in nature.

Money, in view of the enormity of cost for almost any technological development today, is by no means unlimited. Although the need for military space systems is literally around the corner, there is heavy competition for funds between tomorrow's needs and today's force in being.

Dr. York reported to the House Committee, on the matter of money:

"You will recall that the fiscal year 1960 funding for Department of Defense space projects was about \$400 million. For FY 1961, the funding was slightly under one-half billion dollars. Of the fiscal year 1962 Research, Development, Testing, and Engineering budget that has been submitted to the Congress, approximately \$850 million is provided for military space projects. A word of explanation is needed here because one cannot directly relate the half billion dollars in fiscal year 1961 with the \$850 million in fiscal year 1962. The reason for this is that within the broad scope of research and development conducted in many technical areas, efforts are applicable to atmospheric as well as space environment systems. This year, we tried to estimate what portion of the funding in these broad areas is devoted primarily to space systems. On the same basis, while the Atlantic and Pacific ranges support missile firings primarily, we have tried to estimate the portion of these supporting expenses that should be applied to space activities. The \$850 mil-

(Continued on following page)

lion represents those projects which can be directly charged to space effort as well as estimates of the space-related portions of others not so clearly identifiable. . . . You will note [he showed a chart] that the Air Force programs constitute about eighty-seven percent of the total Department of Defense effort. If you add to this the portions of the [Navy's] Transit [navigation satellite system] and the [Army's] Advent [communication satellite system] projects relating to boosters and launch support for which the Air Force is responsible, this percentage is increased to about ninety-one percent. . . ."

Although Dr. York freely acknowledged that the Air Force comes as close to being the nation's space force as it is possible to be without having it actually spelled out, the decision is yet to come from the Department of Defense as to the formal organization of future military space operations. The new directive mentioned above, giving research and development primacy to the Air Force, settles the research and development hassle, yet at the same time reflects a philosophy that it is still too early in the game to think of a formally organized space command.

Since Sputnik, there has been a visible tug of war among the three services on this question. The Air Force has in a surprisingly conservative manner stressed its concept of the indivisibility of air and space, i.e., aerospace, and its consequent interests in the infinite vertical frontier. The Army and Navy have been busy demonstrating their own space-oriented capabilities and pointing out the inadvisability of considering the Air Force as the future space force. This has led to some bitterness, especially since 1959 when the Department of Defense assigned the military space-launch and booster-development mission specifically to the Air Force.

The Army, which earlier, on the strength of its famous Von Braun team at Huntsville, Ala., [now transferred to NASA] had made a strong bid for the military space mission, admits to a small role these days, and warns against overglamorization of space activities at the expense of nonnuclear limited-war capability.

In the words of Richard D. Morse, Army Assistant Secretary for Research and Development, before the House space committee:

"While the Army's role in space activities is very minor compared with that of the Air Force or NASA, speaking first as an American and a modest taxpayer, I am concerned with the total space expenditures of our country. From my viewpoint, a billion dollars is still a billion dollars, regardless of whether assigned to one government agency or another. I would remind you that our total national space expenditure [including NASA] approaches \$2 billion per year. . . . While I recognize the need for this country to maintain a position of scientific and technical leadership in any new and promising area, the total Army research and development budget is approximately \$1 billion, and half is committed to four missile programs. The remaining \$500 million must serve to meet our needs for general war as well as increased emphasis on firepower

and mobility for limited war. In short, we must view our over-all national space effort in terms of a reasonable percentage of the total national economy and defense effort.

"Our military departments, as well as our scientific and industrial communities, in many instances, overemphasized the glamorous aspects of space, and not unnaturally in view of the increased availability of funds for programs in this new and exciting medium. I want to emphasize that the Army looks upon space solely as a medium in which more appropriately to perform its tasks on the surface of the earth. . . ."

It is worth noting how markedly these present views differ from the immediate post-Sputnik days when Army green was being advertised as the color of tomorrow's spacesuits.

The Army has stoutly opposed the assignment of the military space mission to any one service. In the words of Lt. Gen. Arthur G. Trudeau, Chief of Army Research and Development, speaking before the same House committee, the military uses of space "should come within the jurisdiction of centralized military control at the Department of Defense level, separate from the services."

The Army's principal present stake in the military use of space is in communications satellites, notably the Advent communications satellite program which it has formally received from the Department of Defense's Advanced Research Projects Agency. Readers will recall that ARPA was created within DoD after Sputnik to keep alive and eventually parcel out among the services' on-going space-oriented military projects. Advent is the proposed 22,000-mile-altitude active-relay communication satellite system which would appear stationary to the earthbound observer. The Army is also closely involved with some of NASA's programs, particularly NASA's Tiros and follow-on weather satellite programs, and the Courier communications satellite program, a delayed repeater system, which was originally a phase of the over-all ARPA communications satellite program within the Department of Defense.

The Army also is stressing Army needs and capabilities in geodesy, and reconnaissance from space, as areas in which it can contribute.

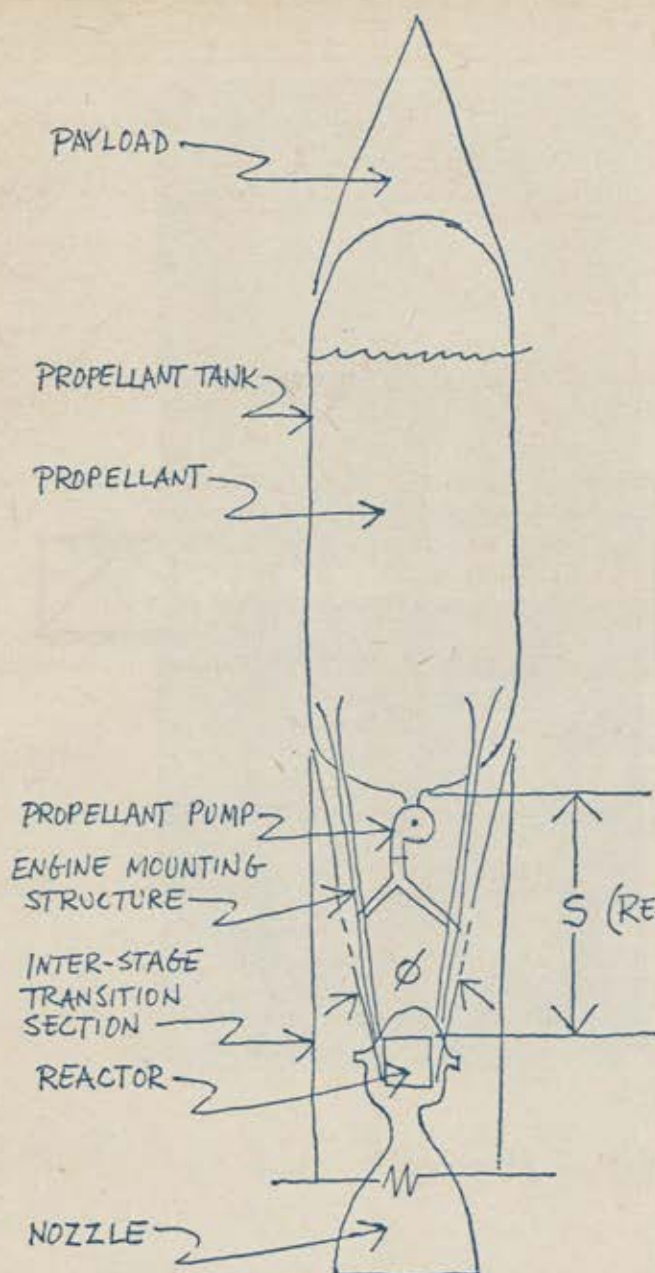
The Navy believes even more strongly than the Army that no single military service should be assigned the operational military space mission. In keeping with the present Department of Defense policy of leaving existing programs where they are, the Navy has its arms firmly around the Transit navigational satellite program, transferred from ARPA. It is also presently soliciting interest in moving the space-launch operation to sea where it naturally feels the process would be more flexible and economical.

Vice Adm. John T. Hayward, Deputy Chief of Naval Operations for Development, testified in this connection during this year's opening round of hearings before the House space committee.

"We in the Navy," he told the Committee, "feel that from a national point of view, the United States must have the capability of launching a satellite from the
(Continued on page 61)

MARTIN NUCLEAR ROCKET PROGRAM

- REACTOR DESIGN
- PROPULSION REACTOR START-UP
- NUCLEAR ROCKET SAFETY ANALYSIS
- RADIATION EFFECTS ON ROCKET SYSTEM
- FUEL ELEMENT DEVELOPMENT
- VEHICLE DESIGN
- CRYOGENICS



RADIATION INCIDENT ON TANK = ϕS

$\phi = fS$

TANK WEIGHT = $f(\text{PROPELLANT PRESSURE})$

PROPELLANT PRESSURE = $f(\text{PROPELLANT TEMPERATURE})$

PROPELLANT TEMPERATURE = $f(\text{RADIATION ON TANK})$

TANK WEIGHT = fS

ENGINE SUPPORT STRUCTURE WEIGHT = fS

INTER-STAGE TRANSITION SECTION WEIGHT = fS

INTEGRATION OF THESE FACTORS
WILL LEAD TO AN OPTIMUM S .

THE PROBLEM OF RADIATION HEATING IN NUCLEAR-POWERED ROCKETS

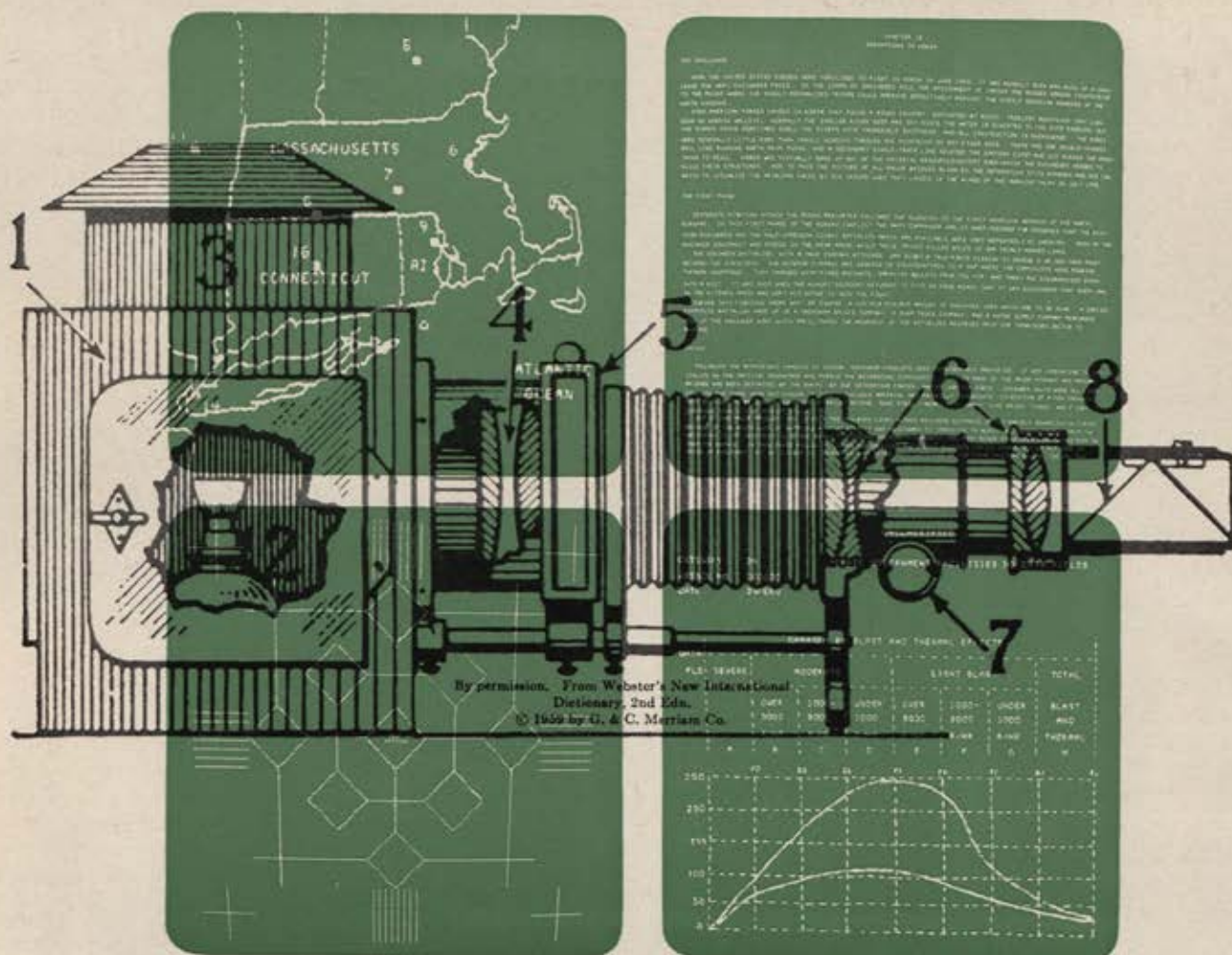


Martin liquid hydrogen test facility at Denver where heat transfer experiments are carried out.

The first flight of a U.S. nuclear rocket is targeted for the mid 1960's; but the achievement of this objective will depend upon the successful solution of many complex technical problems. At Martin, we are investigating all the areas listed above in a coordinated program designed to help solve these problems. An example of one approach to a problem area is illustrated. It concerns the propellant temperature elevation and excessive evaporation that might result from intense radiation created by the reactor.

Martin engineers at Baltimore and Denver are working on several approaches to the solution of this problem: 1) separation between the reactor and the propellant; 2) continuous cooling of certain components by the cryogenic propellant; and 3) shadow-shielding of propellant and components. Optimum solution appears to involve a combination of these alternatives, and can have a substantial influence on overall rocket system weight and performance.

MARTIN



“Change the Slide, Please”

The Magic Lantern was a major advance in visual communication. However, the slide itself remains extremely inefficient for mass information storage.

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Our SM-2 is but one of a complete line of display devices that translate from digital language, any dialect, to visual language at the rate of 20,000 characters per second. This soft copy may include alpha-numeric and abstract symbols, schematics, graphs, charts or maps.

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broad ocean areas. We feel that mobility is just as important [in space] as it is in the ballistic missile business. One does not have to be a great student of celestial mechanics or geography to realize the advantages gained by being able to launch a satellite from any latitude or longitude. It is with this in mind that we have gone forward to the Department of Defense with our ideas on mobility and the use of a solid-propellant booster that would permit us to do the above task. We feel that we have a requirement to enable us to do this at sea for many tasks."

Illustrative of the Navy's strong interest in space is the testimony of Rear Adm. Thomas F. Connolly, USN, also before the House space committee. Admiral Connolly is Assistant Chief of Naval Operations, Pacific Missile Range and Astronautics. He told the committee:

"... Everything the Navy plans to do in space has to be first a logical part of a national program; second, it must add strength to naval power, or, it must assist in preventing space and other systems in the hands of an enemy from reducing that power...."

Toward these ends, the Admiral reported to the committee that there are today "ten main astronautics endeavors that will provide direct and significant improvements in the nation's seapower."

These he listed as: "a satellite defense system, a tactical booster for naval operations suitable for sea launch, a space surveillance system, a reconnaissance satellite, a navigation satellite, a geodetic satellite, a meteorological satellite, several communications satellites, a global ground environment for space operations, a comprehensive research program that includes looking squarely at the day when manned space operations becomes vital to national defense."

In some of these areas, the Navy is already involved directly. It has responsibility for the Transit navigation satellite program, for example. In other areas, the Navy is feeding capability—into such efforts as NASA's Tiros and follow-on weather satellite systems and Echo passive balloon satellite program, and into the Army's Advent active communications satellite program. Also the Navy operates a space surveillance system called Spasur, which, along with the Air Force's Space Track system, was recently put under operational control of the North American Air Defense Command.

The politics of roles and missions are complicated. The strong opposition of the Army and Navy to any designation of the Air Force as the nation's space force has already been touched upon. If there is a single present source of potential conflict over space missions, it is the Navy's present campaign for sea-borne launching of space vehicles. But then again, the tightened decision-making on the DoD level is designed to obviate this problem.

As remarked above, the Air Force has been surprisingly conservative in laying its claims to the military space mission. But this is not to say that the Air Force is not very deep into the mission. Aside from its sizable ICBM program, which represents the first generation of offensive space weaponry, and its specific assignment as space research and development

agency, the Air Force is pushing ahead with the high-priority Midas satellite system for infrared sensing of ballistic missile attack and the Samos observation satellite system. Both of these are descended from pre-Sputnik studies which have gone by such names as Pied Piper and Sentry. In its program to develop what it calls a "blue-suit" capability for satellite systems—to include such qualities as attitude stabilization, payload recovery, and the like—the Air Force has run up an impressive record with its Discoverer series on the West Coast.

As noted before the House space committee by Lt. Gen. Bernard A. Schriever, Commander of the Air Force Air Research and Development Command, many firsts have been accomplished in the Discoverer program. Discoverer XXI, for example, marked the first restart of an engine and change of orbit after the first pass around the earth. The series, he said, has also demonstrated the ability to maintain a satellite in a stable condition throughout its flight around the earth, and increased the time for maintaining this stability.

"The system that we use for doing that, the ability to change the attitude of the satellite while it is in orbit, again through its stability system and by command from the ground," he told the congressmen, "these are just a few of the things that we ... looked at with a great deal of fear and trembling because they were quite significant technical problems."

"In addition to that," the general went on, "for military systems we demand reliability. The only way that you can get reliability is by continuing ... testing. You get reliability by repetitive shots. I think we have greatly increased reliability already in the Discoverer program, but one of our major objectives, of course, is reliability in our satellite systems. The Discoverer is really a test bed ... for every one of the systems that we now have under development, such as Samos, Midas, Advent, for example, which will require some very, very careful adjustments in orbit. I see the Discoverer program going on for a long time because of the tremendous contributions that it will make to the other programs we have."

The Air Force is pursuing manned military capability in space with the X-15 rocketcraft and its follow-on, the Dyna-Soar program, which will take a piloted craft into a near-orbital pattern piggyback on a Titan ICBM booster, after which the pilot will glide home to a landing on earth. Saint is another program indicative of the Air Force's interest in military uses of space. It is a study of systems which might be used to inspect spaceborne satellites to establish their intent. Also, the Air Force is involved with nuclear propulsion programs for airplanes and spacecraft, and with studies of solid-fuel and other propulsion systems which might cut the present large cost of space launchings, as well as recoverable booster approaches to obviate the present unavoidable waste of one-shot launchings. Another intriguing Air Force concept is Aerospace Plane, whereby a piloted craft would take off from earth in a comparatively conventional manner. It would reach sufficient altitude and speed to

(Continued on following page)

attain orbit and then freely maneuver in aerospace.

These are just some of the areas in which the Air Force is working presently. Its faith in the concept of manned spaceflight for military purposes is represented by such studies as SR (Study Requirement) 178, in which it is exploring the possibility of recoverable swooping, short-polar orbiting, manned, maneuverable vehicles to provide detailed reconnaissance using optical, video, and radar equipment. The Navy, incidentally, has similar ideas for satellites to obtain quick reconnaissance data for its fleets.

Perhaps one of the best recent summaries of Air Force views on military use of space was given by Maj. Gen. Osmond J. Ritland, then Commander of the Air Force Ballistic Missile Division, in an address to the 1960 Convention of the Air Force Association at San Francisco.

General Ritland's statement, quoted in part, follows:

"... While ballistic missile technologies have led us to the space age, they are not sufficient in themselves to sustain us over the long road ahead. We have progressed far enough to begin considering space in its own right. It is a medium of untold potential, a frontier of infinite challenge. Our ultimate obligations in aerospace extend far deeper than ICBM trajectories.

"For example, of the nineteen major programs currently assigned to the Air Force Ballistic Missile Division, all but five are—in fact—concerned with searching out the possible advantages suggested by space. The trend in research and development is clearly toward the vertical dimension. . . .

"Our immediate goals are early warning, observation, and communication. These are the requirements of the hour, dictated by the peril of the times and the raw facts of circumstances.

"Thanks largely to our foundations in ballistic missile technologies, we have made good progress toward realizing our initial objectives. . . .

"To date we have barely scratched the broad surface of aerospace. . . . But if we are to be coldly realistic in our appraisal of space, we must take into account other strategic advantages peculiar to the space environment—advantages there for the nation with the courage and foresight to put them to use. . . .

"We must recognize that our requirements must include capabilities for regular and frequent launchings, for flexibility in missions, for high reliability and adaptability to various purposes, for maximum simplicity, and for the employment of multiple payloads per launch.

"Now, further, if we are to put networks of productive military-purpose satellites into orbits, we must ensure the uninterrupted operations of their complex electronic and mechanical equipment. . . .

"In this connection, on the basis of investigative studies, we have evolved a concept we call Smart—for 'satellite maintenance and repair techniques.' Present indications point toward an actual economic advantage to be accrued from manned maintenance systems for orbital payloads—a truly military reason for putting man into space."

In any discussion of manned spaceflight, it is necessary to mention the medical aspect. The Air Force has by far the largest capability in the DoD in this area and is contributing heavily to the NASA Project Mercury program to orbit a man. DoD generally has helped greatly in this operation, since the Navy also has considerable experience and capability in the field too, which has been fed into NASA's Mercury program. The Army has helped, also, with its Redstone rockets, and with medical personnel.

It is worth noting that the space medical program, (or more properly programs) has recently come to the controversial fore. NASA's decision, last year, to set up its own Office of Life Science Programs touched off a set of hearings before the House space committee on the question of whether this move would be a duplication of existing biomedical facilities in the military services. One member of the House committee, Rep. Emilio Q. Daddario, Democrat of Connecticut, took an especially strong interest in the matter and went to the trouble of personally investigating the situation by visiting military facilities in the US and overseas. Last month, Representative Daddario issued a strongly worded forty-three-page report, in which he urged:

- That a study be undertaken of all space-oriented life science research.

- That an over-all, single military bioastronautical program be created, with the possible designation of one military service as executive agent.

- That one central authority should be set up to prepare a comprehensive national program.

- That NASA be "enjoined from further expansion of its life science research efforts" until a national program is established.

The congressman called on the President to direct that the Space Council, to be chaired by Vice President Johnson, give the life science organization question its immediate attention.

It is difficult to chart the future organization of the DoD's space effort. Although the Air Force, as noted by Dr. York, has up to ninety-one percent of DoD space money, there is no certainty that per se it will officially become the operational space force. The DoD's problem is the country's problem: how to manage the overwhelming problems of the present and think about the possibly greater problems of tomorrow. If a functional unification of DoD occurs under the Kennedy Administration, something like a joint space command may emerge. If today's separate-service organization continues, the Air Force will probably evolve by logic into the space force, with or without portfolio.—END



This article, prepared at the suggestion of The Bulletin of the Atomic Scientists, will also appear in the May 1961 issue of The Bulletin, which is devoted to some twenty articles concerned with the scientific, technologic, national, and international aspects and problems of space.

SPACE RENDEZVOUS RADAR

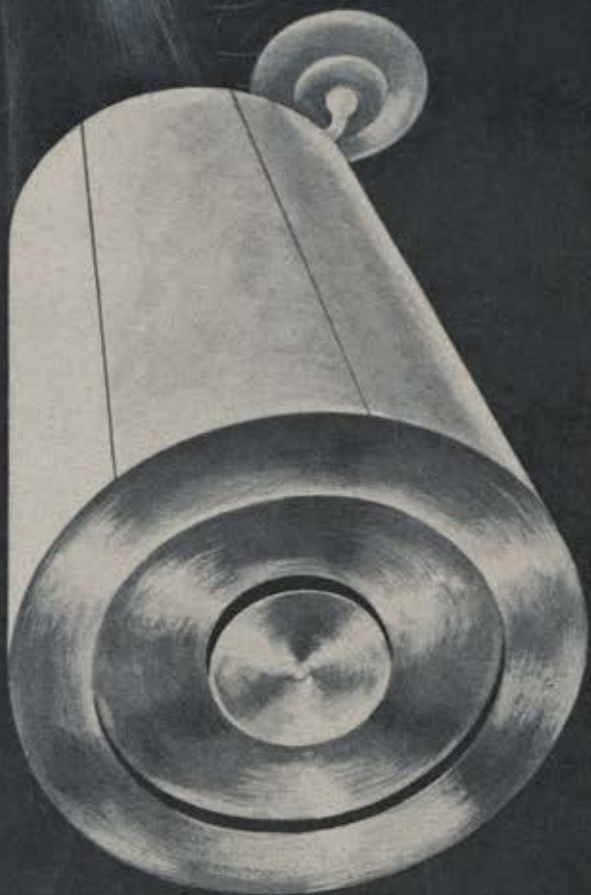
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tations leading up to the final decisions will be done automatically. In addition, 412L is a highly flexible system designed for use throughout the Free World. It will operate in mobile as well as fixed environments.

Currently going into prototype production, 412L has already anticipated technological advances. And, importantly, new equipment can be integrated into this versatile Air Weapons Control System in the future, assuring a complex which will remain combat-ready for many years.

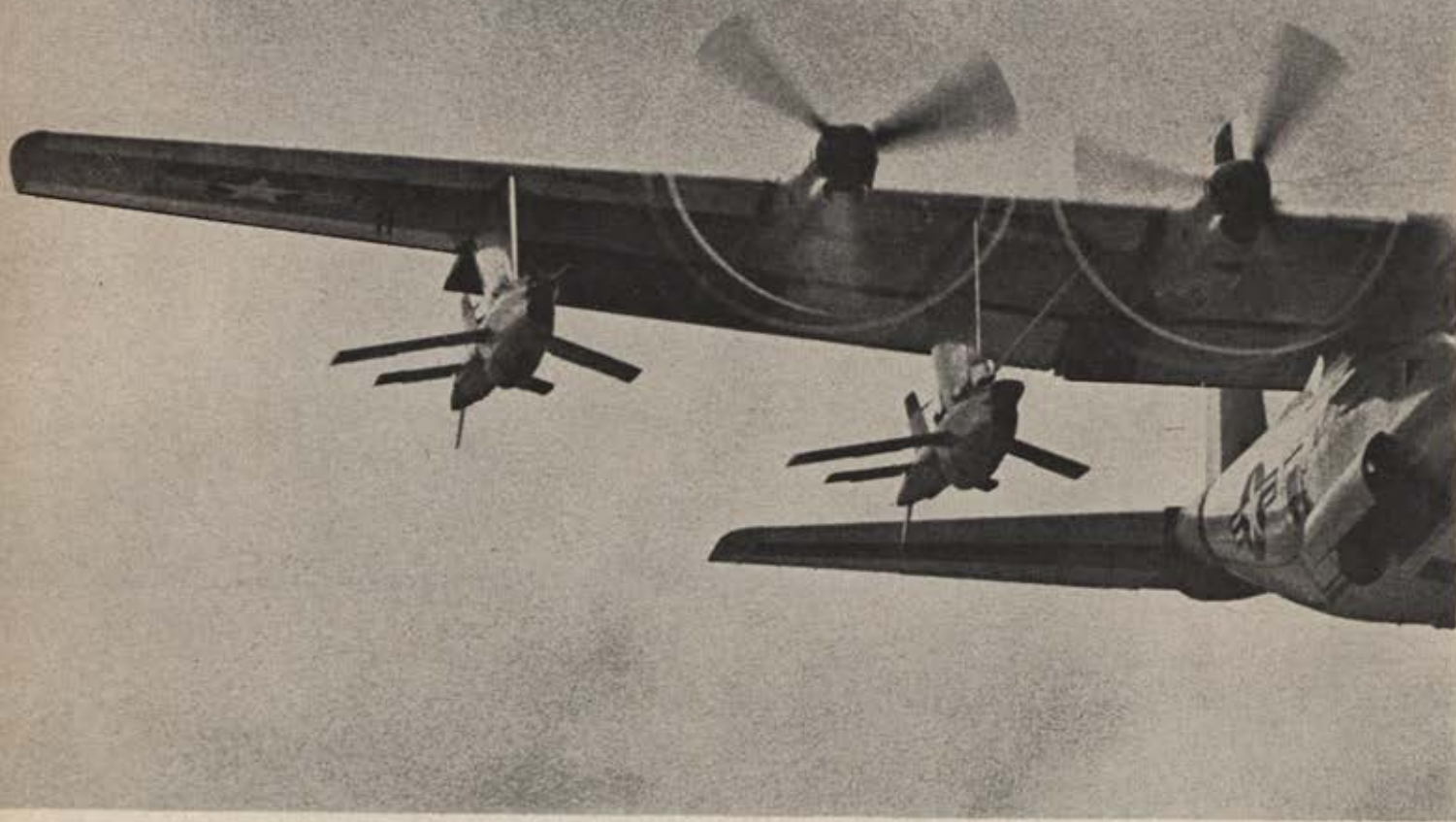
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LOCKHEED GEORGIA

The Human Intellect Is Wedded to the Machine



Intellectronics— Education's Newest Frontier

DR. SIMON RAMO

I WRITE not as an expert in education ready to tell what's wrong with our schools and how we stand compared with Russia. My field is technology. I have done teaching at the college level, and that has been enough to convince me that the task of education to meet the needs of the future is even harder than developing an ICBM.

It is an increasingly imposing assignment to start from an appreciation of our complex world and national goals to conceive and execute an educational program to prepare our young people for that world. This task is not going to get easier, because the world is heading toward a new, highly technological, fast-paced society. It is now clearly a responsibility of those of us in technology to interest ourselves more in education. We should seek to extract from our understanding of science those trends that we think might be of the greatest importance in educational planning and present them as part, but only part, of the larger over-all problem of that planning.

The New Importance of Technology

Three aspects of science and technology today seem to stand out in their potential influence on our civilization; one is the most important for its impact on



education. First is man's enhanced capability to release such quantities of energy as to be able drastically to alter the earth's population and resources in a few minutes. According to basic science, we have not yet reached the limit here. However, enough advance has been made to be terrifying if the scientific knowledge is used for destruction, but which, in contrast, suggests major future benefits if applied to peaceful ends.

The second area is space technology. We are preparing now to become a "three-dimensional-space" civilization rather than to remain limited to the surface of this earth. Today, what we are doing either is pure research in space to understand it better or involves extensions of our present surface civilization. But no one doubts that someday man will have the ability to colonize outer space.

Extending the Human Intellect

The third facet of science and technology, and the one that I submit will be for some decades to come the most important of all, is the extension of the human intellect by machine. We are beginning to understand that brain power will determine the nature of our society and the strength of nations. But brain power will soon emerge equally clear as the sum of trained human intelligence and man-made artificial intelligence.

The extending of the human intellect is of such consequence that it will give rise, I believe, to our largest new industries. It will become the greatest user of our technical and other creative talent. This area is thus worth discussing in some detail.

We could not exist in our present society if we had to rely entirely on man's muscles to produce the energy used in our daily operations. We have long recognized that man's force-producing capabilities are properly applied only when they are extended by machines—the machines doing the high-quantity energy functions, while man is elevated to the more subtle control functions. Similarly, in the mental domain of today's world

there is already a crying need for an extension of man's intellectual capabilities in order to keep our world operating in an orderly manner.

Every factory, bank, airline, railroad, and communications organization finds itself now with such detailed, rapidly changing, and complex interactions with all other operations, that the administrative control is considerably more troublesome than the substance of the operation. The red-tape control of the operation is reaching beyond the realistic possibilities of unaided human capabilities. It will not take much expansion before the average operation will be thrown into overriding confusion, unless, of course, the "nervous system" of the increasingly large, complex monster keeps pace. We must revolutionize the acquiring and communicating of all of the information, the comparison of actual against planned activities, the reaching of logical conclusions and decisions, and, all in all, the insurance that the intellectual "signals" that control the operation will override the confusing "noise."

In national defense, it is now some years since the highest priority was to create force exemplified by the bomb. We are already passing through the next phase: to develop the capability of delivering this force quickly on any part of the earth. The new urgent area is in the intellectual aspects—the command and control, observation, and communications segments. In a world in which one nation can inflict decisive damage on another in minutes even though they are separated by half of the earth, sound military action requires knowing what is going on everywhere and putting together a tremendous amount of continually shifting information into sound conclusions. A man-machine intellectual partnership is the only answer in sight to this problem.

In summary, on the intellectual front something new is urgently needed, and technology can provide the answer. Electronics, in particular, makes possible the extending of the human intellect. I am, therefore, going to use the word "intellectronics" as a convenient name for this field—a single word that conveys the idea of extending the "intellect" by "electronics."

Let us take a quick look at some key aspects of the world of the future to understand how deeply significant intellectronics is going to be. Then, we shall see how the most difficult and worthwhile intellectual activity of all, the education of the human brain, can benefit from the same key concept. This concept is of a man-machine partnership in the intellectual domain, with the machine partner doing the lower-grade, high-quantity task, while the educated human brain rises to the more difficult intellectual aspects.

Intellectronics in Engineering

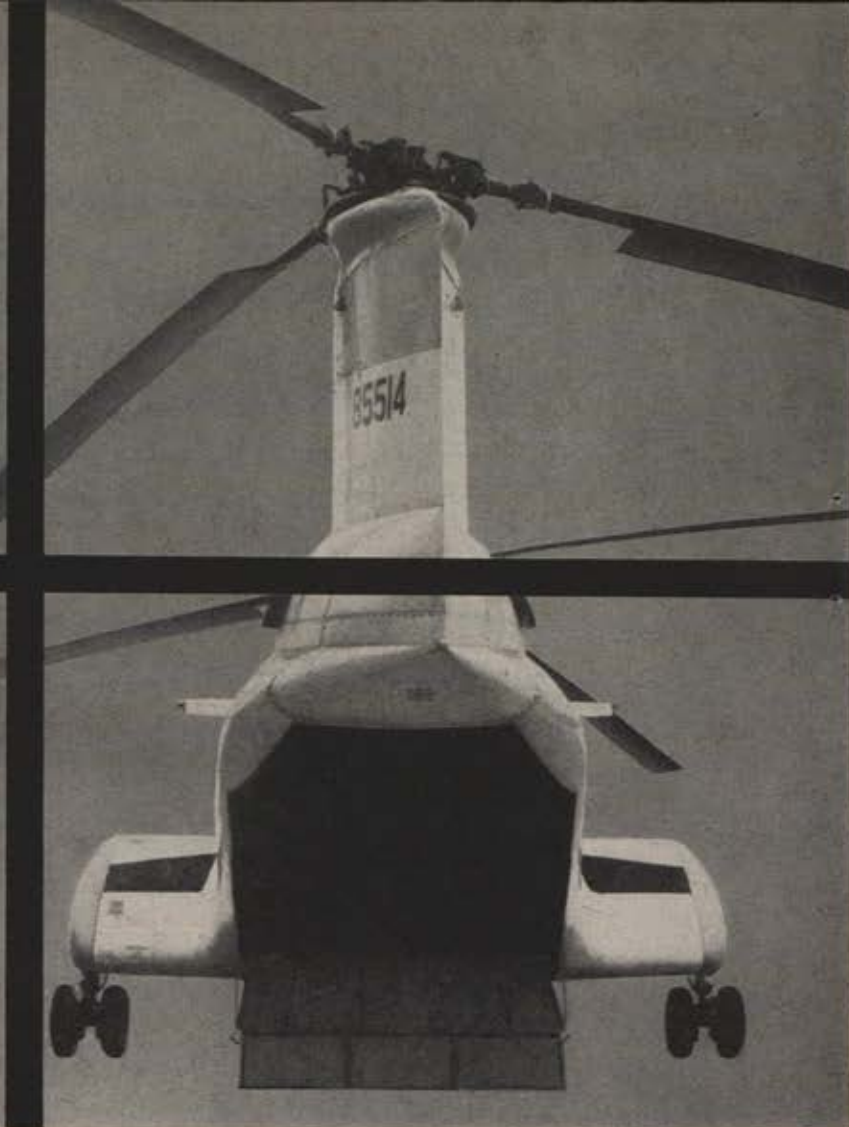
First, let us look at the professions. Engineering has already been revolutionized by intellectronics. We would not have an ICBM today if we had to fly tens of thousands of missiles in a clumsy trial-and-error approach. A few dozen flights have been sufficient to finalize design, because the tens of thousands of flights took place in the simulation laboratories. The choosing of the right combination of design parameters out of the myriad of possibilities, a task entirely unsuitable

(Continued on page 71)

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to the unaided human brain, was provided by an intellectronics system.

The Future Practice of Law

Technology already permits us to design a national intellectronics system to include a central repository of all the facts, rules, and precedents needed for most legal operations. The attorney of the future will step to his input device, file his routine records by instant electronic connection to the system, and will have automatically displayed to him any omissions, shortcomings, inconsistencies, violations of the rules, clashes with the claims of another—and this will be a far more thorough search than a few unaided human brains might have accomplished. It will cover the records of the whole nation for decades. The lawyer's intellect will be reserved for the more complex intellectual tasks.

Even on the nonroutine, more intellectual legal processes, the attorney will be able to consult with the equivalent of a host of informed fellow attorneys. His request to the system for similar cases will yield an immediate response, together with advice filed by other attorneys, even as he will later add his experience into the system for future use by all.

Without electronics, it is easy to imagine a future impossible condition of saturated legal processes and hopelessly jammed and confused procedural controls. The world is becoming ever more complicated, every action interacting with more other actions, our rules more detailed, and our red tape endlessly delaying. The intellectronics system may be imperative in the future, not just desirable. Its authoritative and broadly based statistical data will quickly disclose inadequacies in the nation's laws. For our law-making bodies, speculation will be replaced by hard facts.

Medicine in the Intellectronics Age

The physician will also routinely introduce his data on a patient's complete past history and his present complaints to the network of "consultative wisdom." The statistical amassed data will produce with electronic speed the probabilities of the relative effectiveness of various treatments, with numerous variations and warnings on corollary possibilities applying to this specific individual—all automatically triggered within the system by the specific data the physician introduced.

Notice that with diseases nationally monitored ailment-to-treatment relationships will be studied on a large, but rapid, scale. The intellectual effort of our physicians will be raised, new subprofessions in medicine and new areas of research will arise to improve the nation's health, because of the availability of such superior information.

Extending Human Brains by Machine

Intellectronics can create for every intellectual pursuit a library of information that is both mammoth and yet accessible with electronic speed. But the memory

extension is far from the total effect. Artificial intelligence works on the library's information. The higher intellect of the human brain can reduce a large fraction of the intellectual processes that make the world operate today to a set of logical thought processes, and these logical processes can be built into the machine partners. With this logic and with immediate access to information, the machine partners can handle the low intellectual tasks of the first sorting, categorizing, comparing, screening, selecting, and presenting. Thus, the human partners in all intellectual activities in the future can concentrate on the more subtle, less predictable, conclusion-drawing, decision-making, judgment aspects of the intellectual task.

We would not think any longer of having a thousand human beings pulling a big stone to build a pyramid. We insist on a better match of human force-producing capability to the task. Similarly, the future technological society will see a better match than now exists between man's intellectual capabilities and the intellectual tasks before him.

Language Reform

Clearly, most operations of the world—production, transportation, communication—are all candidates for passing under intellectronics systems control. But, also, many of the operations involve worldwide interconnection. Many millions of human minds and their extension in the forms of signals and data and machines will be connected together to control these operations, the network often crossing national and language barriers. No wonder one of the most interesting intellectronics areas today is in the translation of natural human language. Again the machine member of the team provides the crude first cut. It assists and sets up for the more brainy human partner.

But there is something even more significant about language in the technological age of the future. The machine partners in the universal electronics systems will create pressure for a common, purely informational, efficient, logical, and consistent kind of language. Natural language, originated in nontechnical times, falls far short in meeting these specifications. The technological intellectronics period of the future may force on the world a new kind of language reform.

The Crisis in Education

In the coming technological society, it will be common to accept the extension of the human mind by electronics, just as it is common to accept X-rays and cardiographs in a modern physician's technique, or a bulldozer to aid man's muscles in building a road. How is all this going to affect the crisis in education? The period ahead is one where education of the human brain is increasingly important for society and where education must cover a wider range than ever before. Yet we find it difficult to put the necessary fraction of our resources behind education. But intellectronics can greatly increase our intellectual resources. And I do

(Continued on following page)

not refer to the idea of a few more gadgets to assist in teaching, or to a classroom run by a robot.

Man-Machine Partnership in Education

In the intellectual process of education, human beings today are handling tasks where the intellectual level, or the quantity and rates of information to be stored, sorted, and presented, are not well suited to the human's brain. Surely, the routine material that is quite straightforward and mechanistic can be machine-presented. It is possible to imagine a presentation system in which: The students identify themselves to the system so that the material to be presented will be automatically chosen in accordance with the plan laid out by the higher-level human educators for students with their particular recorded background and rating. The material changes as to speed and complexity, even as it is being presented, and, moreover, this alteration is in direct relation to the student's apparent ability to understand. How is this done? Electronically, it is routine. The presentation includes frequent questions. The student's response with push buttons at his seat is automatically registered and interpreted, and this interpretation causes a slowing down, repetition, or a skipping of steps, or, perhaps, a complete substitution of different material.

An intellectronics system makes possible the virtually instantaneous analysis of results on millions of students. It makes possible comparisons of progress against the planned or the expected progress. It makes feasible mass statistical analysis on the relationship between what is happening and what it was thought ought to happen, and thus improves our ability to relate techniques, courses, content, methods, and details of presentation to the goals. It gives the scientists in the field of education new tools.

The same basic intellectronics approach which can handle statistical data on a huge number of students can at the same time cater to a specific individual student. Thus, a student identifying himself to the system can trigger an electronic scan of his entire past record and performance. Then, by automatically checking this record against judgments and rules introduced ahead of time by the higher-level human educator, the machine will suggest for this student a specific presentation, or a special examination to get further facts.

The Human Educator Is Elevated

We see that the human educators in such an intellectronics system will be able to concentrate on the most highly intellectual functions in the educational pattern, deciding on the programs, the division of effort between the machine and the human partner, how the human teacher should best use his time in direct dealings with the student, or to enter judgments on a particular individual student aided now by very good records on that individual and on the statistical average of the whole nation. New industries will give employment to specialists in the design of machines, experts in the subject, and individuals skilled in the

technique of teaching. Free enterprise can play a part in the educational process well beyond what happens today. (It may someday be that the experts in education will be the ones demanding the highest salaries in industry!)

Toward Greater Sociological Progress

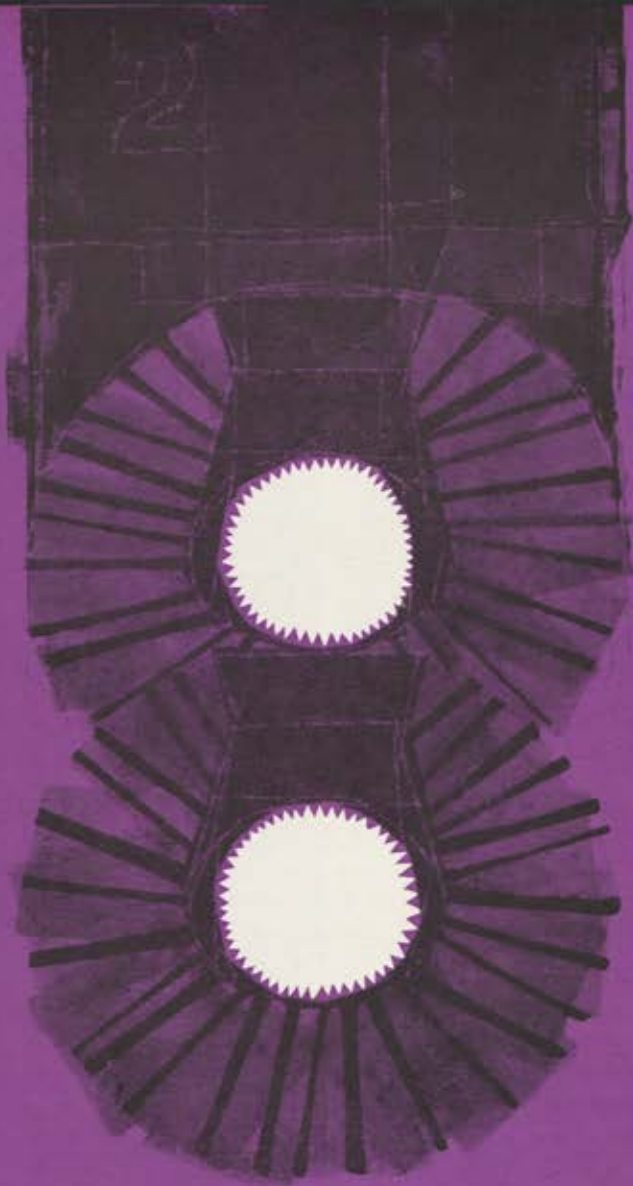
The real bottleneck to progress, to a safe, orderly, and happy transition to the coming technological age, lies in the severe disparity between scientific and sociological advance. But the preceding sketchy portrayals of the nature of the coming age could imply one grossly wrong conclusion: The future world will be an automatic robotlike regimented one, with every human only a constrained cog in a tight machine, freedom of spirit and expression and democracy dead. On the contrary, I believe that the extending of man's intellect by the mass-providing of synthetic intelligence can have just the opposite effect. If we want it that way, intellectronics can be used to make possible a degree of citizen participation in policy and goals unthinkable today. Consider only that our legislative bodies could have their deliberations open to millions in their homes. Further, the entire nation could vote by push button from their homes on any fraction we might choose of all issues. The result would be known to all instantly. A much greater proportion of all people could be up to date on, and interested in determining the aims and priorities of our lives.

If brain power will determine the course of the world and if a basic characteristic of the future technological society is that total brain power will be a sum of natural human intellectual activity and electronic intelligence, then it is important that we have a matched partnership. It is also important that each partner should be fully developed. Development of the human partner can lean on the development of the machine partner, to the benefit of the total intelligence.

But finally we are still left with the great imbalance between rapid, seemingly uncontrollable technological advance and sluggish, lagging sociological progress. Will intellectronics aid in the neutralizing of this inequality? Obviously, not directly. The challenging intellectual task of accelerating social progress is for man's mind, not his less intellectual partner. But perhaps there is a hope. If the machines do more of the routine, everyday intellectual tasks, man will be elevated to the higher mental domains. He will have the time, the intellectual stature, and, hence, the inclination to solve the world's social problems. We must believe he has the inherent capability.—END



The material in this article is based on an address by Dr. Ramo at the Educators' Luncheon at the AFA Convention in San Francisco last fall. A similar presentation was made at the National Conclave of the Arnold Air Society in Detroit on March 24, when Dr. Ramo was given the Paul T. Johns Trophy of the Society. Dr. Ramo is Executive Vice President of Thompson Ramo Wooldridge, Inc.



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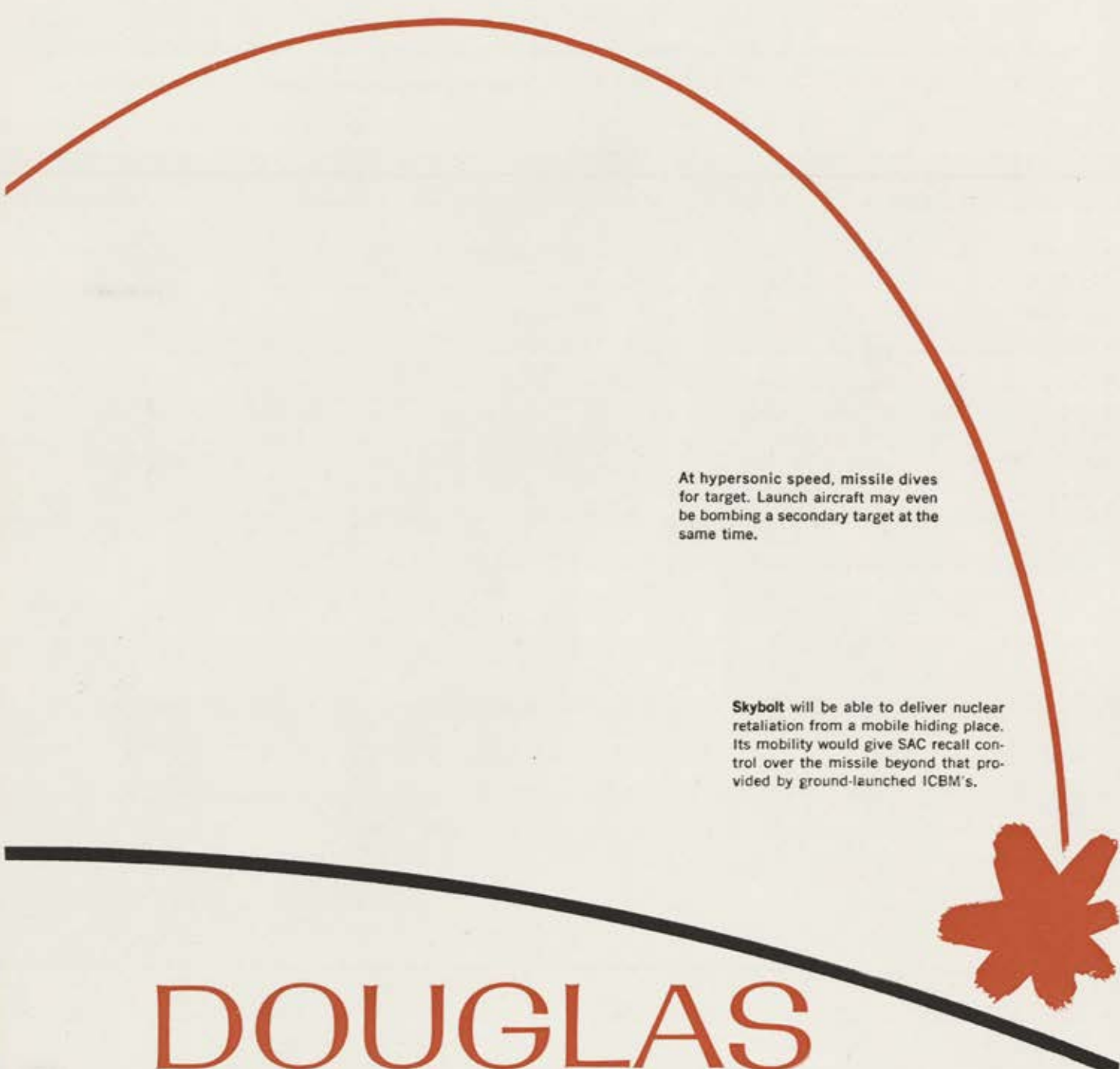


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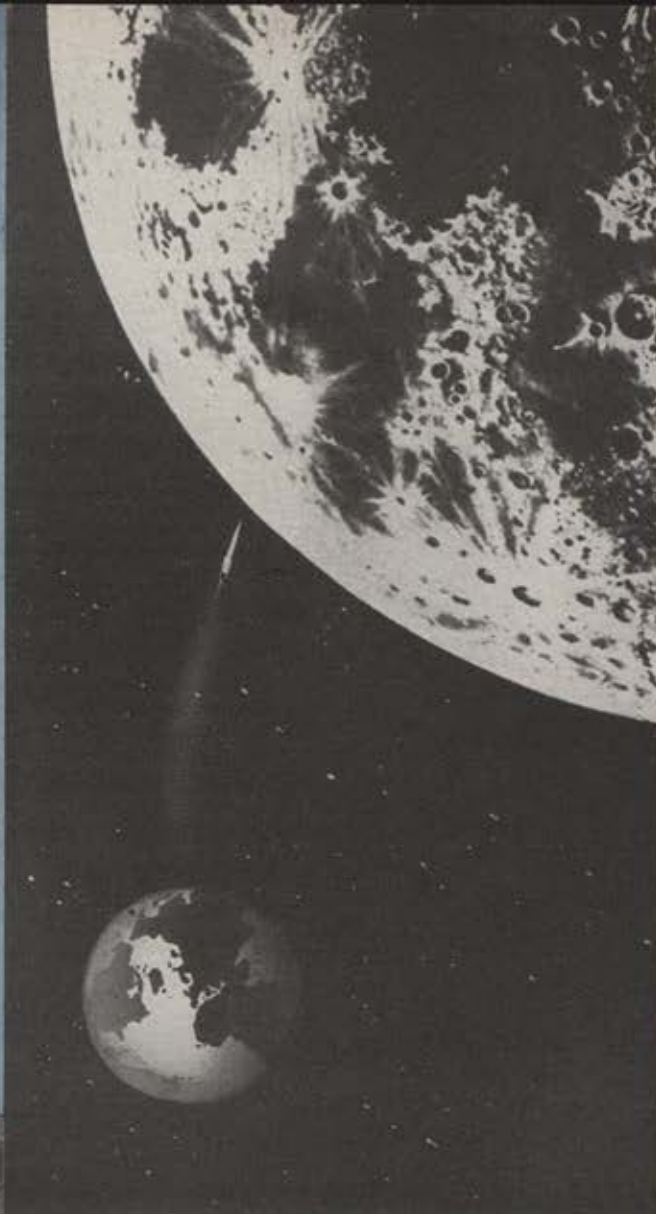
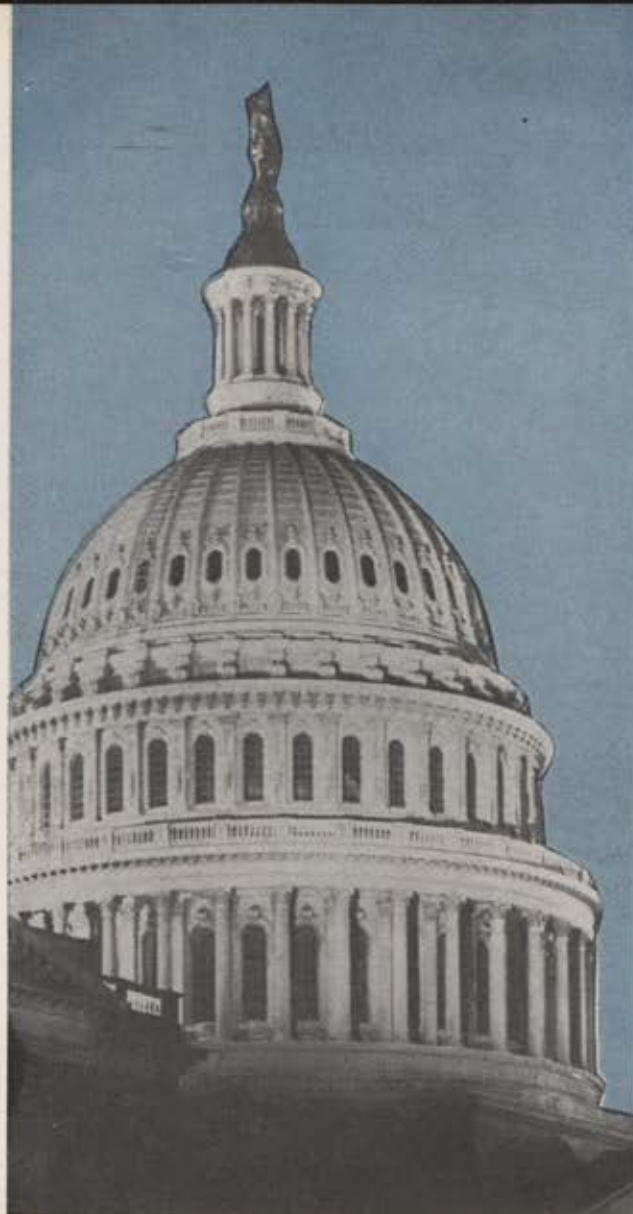
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Lawmaking for the Space Age

DIRECTION, PURPOSE, URGENCY

HON. EMILIO Q. DADDARIO

*Member, House Committee on
Science and Astronautics*

WHEN THE question of space was first brought forcefully home to the American people, we took the organizational steps necessary to develop a national program for the peaceful exploration and exploitation of this newly important medium.

Outer space wasn't just discovered, of course; it had been there all the time. But it was not until the mid-twentieth century that man first harnessed the power and the technological skill to penetrate beyond the atmosphere on a reasonably predictable basis.

During the Eighty-sixth Congress, the House Committee on Science and Astronautics, of which I am a charter member, conducted a comprehensive study of the peaceful uses of space, ranging from heat and power resources to the benefits to be derived from the exploration itself. It is an impressive catalogue.

When the Congress passed the National Aeronautics and Space Act of 1958, it included in the legis-

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lation a prologue emphasizing this nation's determination to key space exploration to peaceful purposes. This has tended to obscure and to downgrade, in some instances, our need to explore the uses of space for national security. But space *does* have national security potentials which are not so openly discussed. There is a military mission in space, and it is one that goes beyond the incidental projects—communications, reconnaissance, mapping, navigation—that have been disclosed.

When man himself can voyage in space, he must certainly be prepared to develop programs that affect our national security. How we will meet such challenges and turn them to our advantage may very well be an element of future national power. If we do not develop our talents to meet the space age, or if we are slow to stake our claims, we will inevitably risk falling behind in the growth of such power.

The National Aeronautics and Space Administration has grown to meet its responsibility by adding functional elements where it has believed the requirement existed. It has asserted claim to elements of the space



program that lay within the military jurisdiction where it could justify them, such as the transfer of the Von Braun team of the Army Ballistic Missile Agency because of its work on deep-space boosters.

Meanwhile, the military departments have continued working on those programs directly related to their own missions. In recent testimony before my committee, Herbert York, then Director of Defense Research and Engineering, appraised these programs and pointed out that almost ninety percent of the ones assigned to

a specific department had gone to the Air Force. These included such programs as reconnaissance and anti-missile studies. A further significant development in these directions occurred on March 6, when the Department of Defense issued a directive specifying that:

"Research, development, test, and engineering of Department of Defense space development programs or projects, which are approved hereafter, will be the responsibility of the Department of the Air Force."

This is a refreshing recognition of the importance of military space technology. And the qualification in the directive that the Secretary of Defense will make final assignment of operational space-weapon or support systems to the service he considers most suitable is a thoughtful projection of the needs of all three military services.

But despite this, because of the separation of our man-in-space program from any military requirement, the military departments are still somewhat limited in their approach to the possible uses of space in a security sense.

It is encouraging to note that this curb on imagination has begun to loosen, partly as the result of continued exploration of these possibilities by outstanding authorities.

For example, Dr. York conceded to our committee that:

"There are some things where we can see that the use of spaceflight is of direct advantage to solving the defense problem."

And, he added:

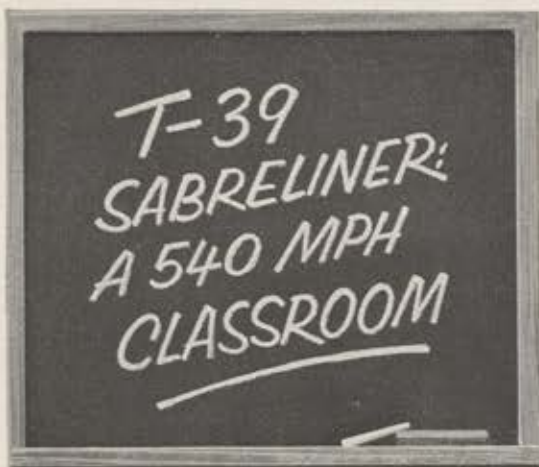
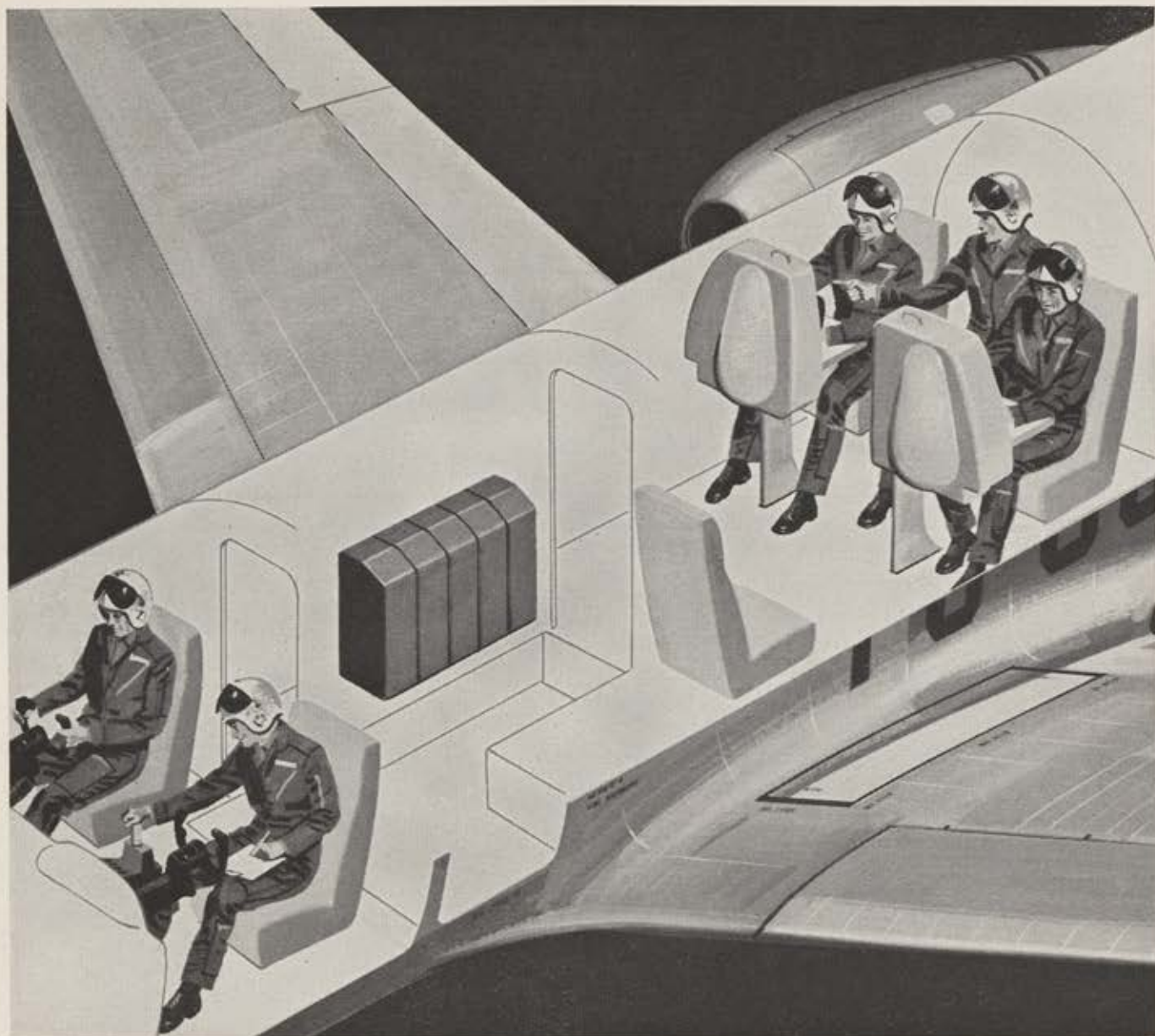
"The only problem we are directly concerned with solving is the problem of providing maximum defense. Where spaceflight is useful for that, we expect to exploit it."

Certainly the Defense Department will continue to be concerned primarily with the mission of military security. The exploration of space, by adding to the resources and national power of the country, may open new fields of view in the solution of military problems, just as the addition of aircraft to the fighting forces in this twentieth century revolutionized both tactics and strategy. It is to the vital interest of our defense establishment to play a part in developing the uses of space so that they may incorporate what is learned.

I have, on a number of occasions, expressed the view that we are not pursuing the exploitation of outer space with sufficient urgency. For, if the Space Act puts the responsibility for the development for peaceful purposes in the National Aeronautics and Space Administration, then it logically follows that the military responsibility to develop space technology for national security purposes rests with the Department of Defense.

Because such a parallel inquiry into space would be unjustifiable in terms of duplication of effort, the Congress spent a great deal of time in 1958 determining the best method to guarantee a unity of effort and avoid duplication. Its recommendation was that the unification be established at the level of the President, who would retain control over both civilian and military aspects. The Space Act thus gave the President a Space

(Continued on page 81)



Now the Air Force has a swift, swept-wing jet plane especially fitted for training several student pilots in NASARR radar operations during the same flight.

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Council to advise him; NASA was to develop space for peaceful uses; and the military departments were to exploit space for national security. First through direct liaison, then through decisions of the Space Council, duplication was to be curbed, and national goals were to be formulated for the approval of the President.

Under the previous Administration, this legislation expressing the intent of Congress in space matters was thwarted. The Space Council was seldom convened; its director and staff never appointed. The President delegated his functions to the Administrator of NASA who was essentially free to pick and choose as he saw fit in the administration of the civilian space program.

The military, not relieved of its responsibility for protecting the national security, went on its own way. Its activities on the fringes of space continued; occasionally it defended its plans as necessary to the national security, but mostly it carefully disavowed any claims to the space arena, deferring to the primacy of NASA, under the law. Thus, in effect, under a veneer of words and documents, the groundwork was laid for unnecessary conflict in what should have been regarded as a broad-spectrum program in search of national objectives.

The Russian space program shows little such semantic difficulty. I need not linger on the military implications of the recent Venus shot which shows a certain sophistication in the Soviet booster program that it is well to mark. It may be difficult to see any great advantage at the moment to launching a rocket and then separating a payload for a different target, and because of the characteristics of the ICBM, the launch from a parking orbit may appear to have the disadvantage of being a "local" when an "express" is required.

It is not impossible, however, to conceive of a satellite which would always be in position to launch a sudden attack—literally a sword of Damocles with tremendous psychological impact.

Whether the state of the art would permit or encourage such a development is not a matter for consideration at this point. What is imminent is the arrival of reconnaissance and early-warning satellites in the inventory, with the progress of the Samos and Midas projects. This poses a number of questions which are apparent in the news and will be difficult to solve, not the least of which being the issue of overflight already raised by the Soviet Union. We cannot allow these anxieties to slow down our efforts to obtain needed capabilities. Neither of these systems is aggressive; each bears on the maintenance of peace and a stable world. If successful, they could play a part in the control of arms which many have sought unsuccessfully for centuries.

Curiously, however, these projects also provide a perfect example of the inability to separate arbitrarily military and civilian uses of space. They are assigned to the Air Force for development, but the ramifications of such surveillance information also bear on our geographic knowledge of the world itself and must certainly call for study of the peaceful importance of these systems. The United Nations could, therefore, play a significant part in the development and use

of such information. If we are to have a truly national program in space we need to recognize the interlocking aspects of military and civilian space goals. As a congressman who has devoted a good deal of time to the study of these subjects, I do not believe it can be done through the magic word—*coordination*. The program needs direction, a sense of purpose and a sense of urgency.

When Congress wrote the National Aeronautics and Space Act of 1958, it looked into this question at some length. It determined that the President should have ultimate authority and responsibility in space matters, assisted by a National Aeronautics and Space Council. This mechanism was allowed to atrophy—it should now be invigorated to provide a basic assertion of national goals in space and the full use of all our facilities. I do not believe that we can continue to pretend that artificial compartments exist with civilian and military labels.

I have been convinced that the major fault of our space program is that it lacks a sense of urgency. Sound leadership can meet this need. I have been disturbed by the failure of the NASA plan to reflect a sense of urgency, and by the constant revisions of that plan, usually downward. It does little good to speak of the technological sophistication of our program compared with the Russian. We are launching highly effective small packages—but until we overcome the booster gap, we will be at a disadvantage. And we shouldn't answer this question by assuming that there are twenty-six-pound men available to overcome our payload limitations.

We need a new sense of dedication to the goal of being first in the effective use of space. It was no secret that January 13, 1961, would be a favorable time to try to reach the Venus vicinity, nor that the shot was feasible with only a slight penalty in speed demanded within a month either way. The Space Handbook issued by the House space committee in 1958 contained astronomical information, and it also pointed out that in 1969, the moon would be the most favorable position for a shot in space. Yet our plans do not even conceive of a manned lunar landing before the 1970s, although the Russians have announced their intention to be there in 1967, to celebrate the fiftieth anniversary of the Bolshevik Revolution.

Although we need bigger and stronger boosters as soon as possible, at least one target date to meet this need has been moved backwards—the qualifying tests of the Rocketdyne F-1, 1,500,000-pound-thrust liquid-fueled engine which has now slipped from 1963 to 1965. We have been painfully slow in decision-making on the national booster program. Almost two years have passed since my committee first held hearings on space propulsion yet many of the basic decisions needed to give this program impetus and direction have still not been made. While NASA and the Department of Defense both have booster development programs that could contribute to each other without being competitive in terms of industrial and scientific facilities, they individually lack the vigor that would

(Continued on following page)

come from a single comprehensive program incorporating both military and civilian goals.

How can we improve our space efforts? We must look, I think, at the way in which we have organized our space program—at whether we are making the fullest use of our technological skills and applying the full energy of our industrial capacity. Our nation has excelled over all other nations in this industrial age because we have been able, through our vast industrial resources, to produce results better and faster than any other people. The concentrated, vigorous application of our national talents and abilities could also overcome and surpass the Russian space lead. We have accomplished this fusion of effort readily in wartime. Industry has always, in time of emergency, marshaled its activities closely in the nation's interests. Today we face another time when we must make full use of the best of our talent.

I think we must inventory our abilities more adequately, cut through the red tape that has grown to surround the efforts of contractors seeking to put their abilities in the market, streamline administration, and forestall duplication that is still occurring. The large booster program, by its very nature, invites waste in expenditures unless it is carefully planned and programmed. Once again it is necessary to point out that this planning must be in accord with a single national set of goals. We cannot have separate national programs for specific goals without encouraging overlapping. The same applies to life science studies, the *sine qua non* of manned spaceflight.

I have pointed out the need to recognize the military mission in space as well as the civilian mission. We must bring them into harmony. The need to develop a forceful civilian program should not mean that we overlook military capabilities and accomplishments. Both the civilian and military programs have many similar goals, and the capabilities of both must be employed to the fullest if the nation is to benefit.

Over and beyond the national effort, the space program also offers a magnificent hope for new progress in the path of international cooperation and peace. The world scientific community is knit with bonds that go beyond national boundaries. This has been demonstrated through the accomplishments of many international programs in which scientists throughout the world have worked side by side.

Specific fields in which international cooperation is being sought include, of course, the approach to a law of space, the assignment of frequencies for satellite communication, the registration of satellite launchings, cooperation on liability provisions regarding damage or injury caused by space vehicles, and special arrangements for reentry and landing such vehicles. These are concrete areas in which progress has been sought and can be made. Another clear promise is in the field of arms control, as satellites increase their technical capabilities, but first we should encourage cooperation in the space effort, civilian and military, among the nations of the free world. Freedom of scientific exchange is a powerful binding force among nations as a recent study for NATO, reported in the publication *Increasing*

the Effectiveness of Western Science, Foundation Universitaire, Brussels, 1960, points out.

While Congress has the responsibility to plan for such activities and endow the Executive with the means to carry them out, it has long recognized the possibilities inherent in the development of ways to penetrate outer space. In more than one way, such efforts can transform our future. The Select House Space Committee, in 1958, discussed the impact of space technology on the future. The present committee, established as a standing committee since 1959, has surveyed a wide variety of possibilities in the space sciences, including elements of world cooperation which exist. The Senate Committee on Foreign Relations invited serious studies of the developing technologies as they affected our strategy and foreign policy. It would be useful to quote from them.

"Operational satellite and satellite space systems promise to become available in considerable numbers and sophistication during the next decade. Their military employment for reconnaissance mission, attack warning, and the facilitation of communication, navigation, and weather prediction will be of relative advantage to the United States in view of its existing needs for intelligence of the Soviet Union and the management of globally deployed forces. Their use for these missions will, however, sharpen existing tensions between the United States and the Soviet Union and provide fruitful sources of new ones. It appears highly unlikely that these problems can be avoided, or solved, by a distinction between 'military' and 'peaceful' uses of space."

Our own national effort has been psychologically impaired too long by the attempt to draw such a distinction. We had good intentions; we didn't want to appear militaristic in our public international image. True, the world is likely to judge us by the success of our scientific efforts; by our peaceful accomplishments in space. But the possibility of great accomplishments is bound to be lessened by failure to use our full capacities in all spheres. Thus we have suffered from a loss in international prestige because our accomplishments have not met world expectations.

Now is the time to renew our dedication to the goal of being first in space and to acknowledge that our space program has two purposes—one for peaceful development and one for national security.

Let us then move ahead to the position our nation deserves and the world expects.—END



Mr. Daddario is a Democrat, representing the First Congressional District of Connecticut. He was a star athlete at Wesleyan University, Middletown, Conn., being graduated in 1939. He then paid his way through law school at the University of Connecticut by playing professional football. During World War II he served brilliantly with the OSS in Italy, and was recalled to active duty with the Army during the Korean War, serving in Japan. He now lives in Hartford, is serving his second term in Congress. As part of his committee duties he recently authored a report on life sciences as related to space.



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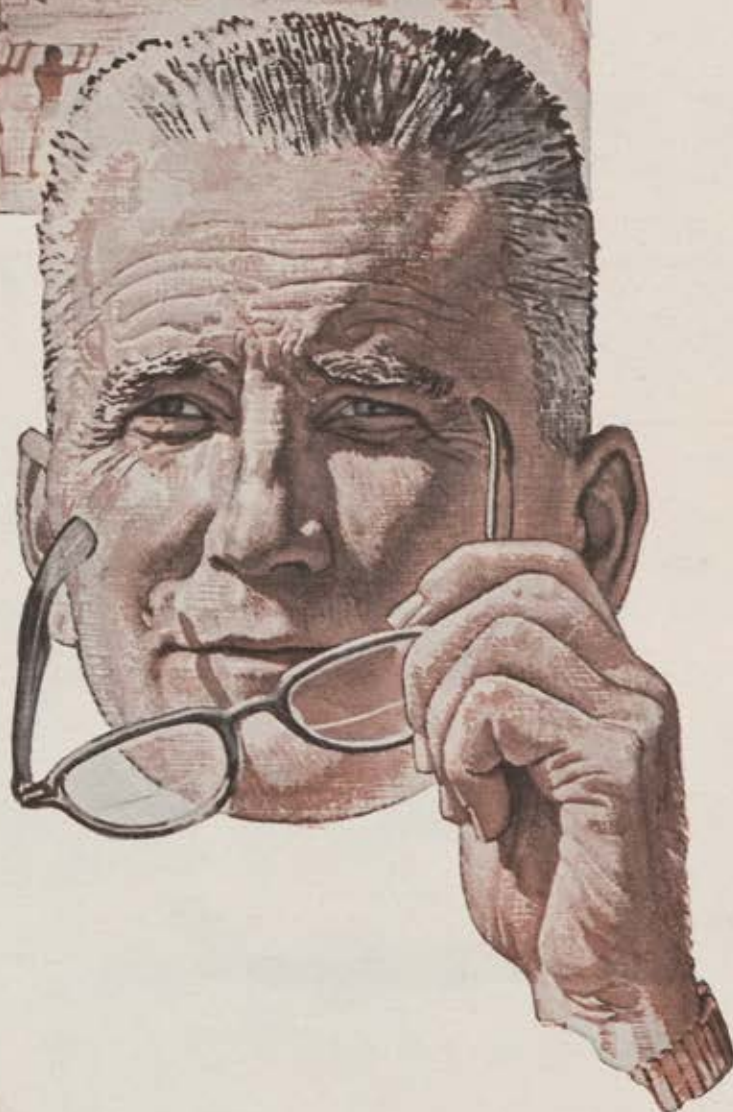
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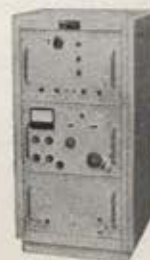
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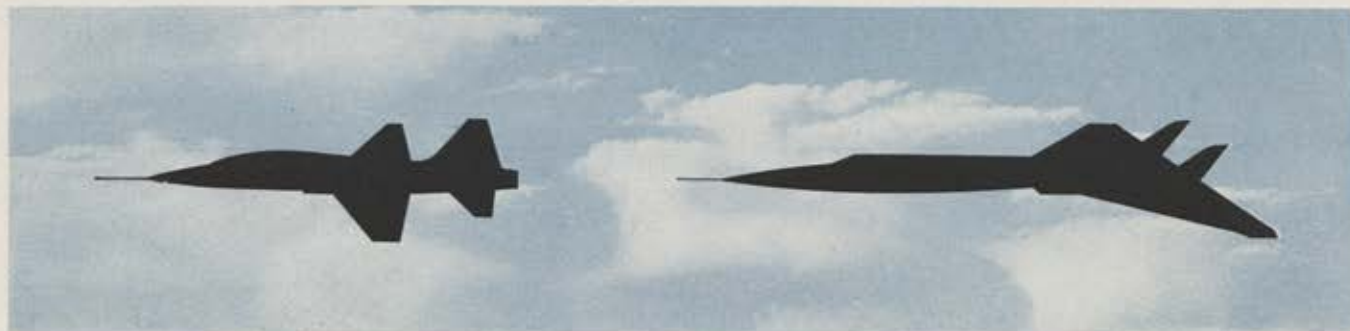
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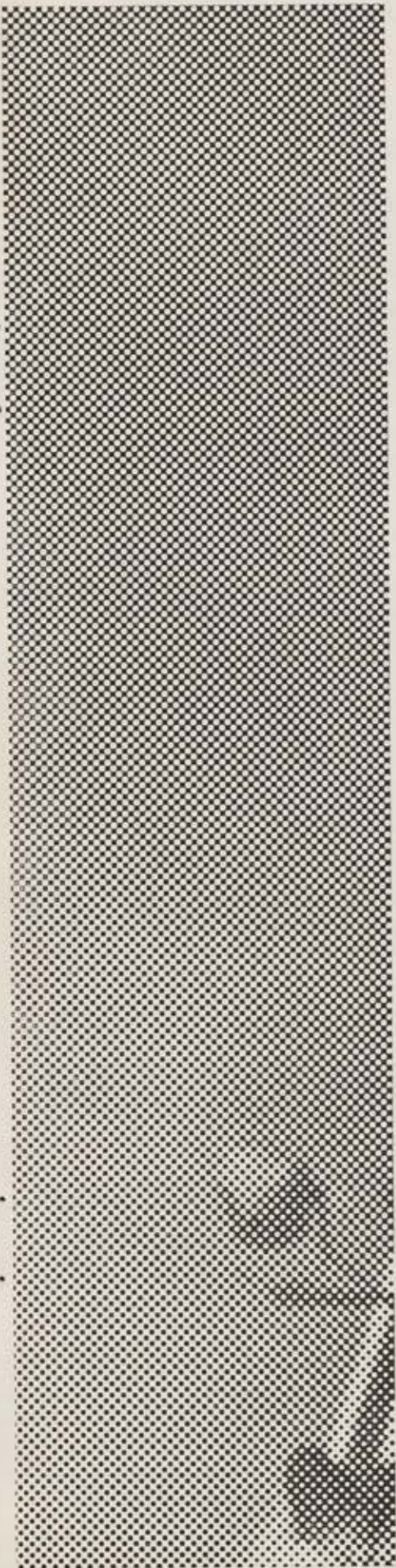
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Training, Retraining . . . and RETAINING

CLAUDE WITZE

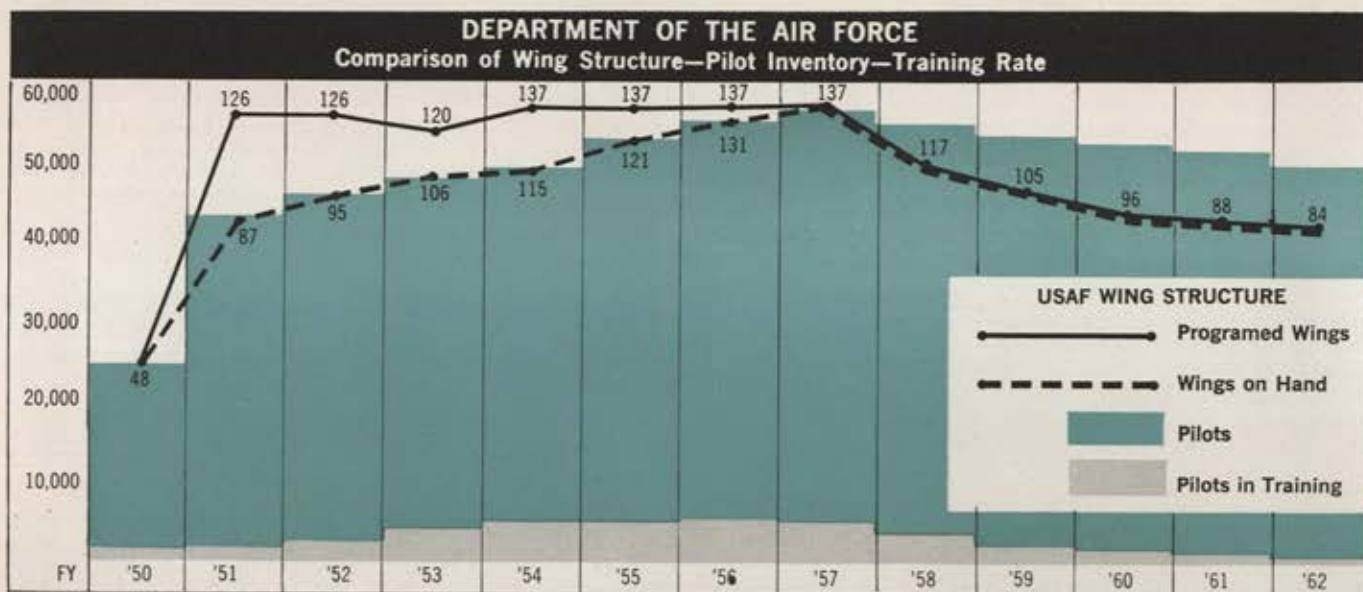
Senior Editor, AIR FORCE/SPACE DIGEST

IF THE US Air Force were a private corporation, operated for profit in a competitive business, today it would be well under way with the greatest personnel turnover in its history. It would be hiring and laying off every day. Wages would be going up as new talents and skills, all more rigorous than the ones needed in the past, were added. Many old-timers who wanted to stay with the company would have to learn new jobs or face technological unemployment.

Yet USAF is not a private corporation. It is a military service, with a high percentage of dedicated officers and airmen. It is subject to all the normal fluctuations that are forced on the military establish-

ment by the capriciousness of our potential enemies, our allies, our diplomats, and the diplomats of other nations. Politics, at home and abroad, are a factor. The whim, the prejudices, and the constructive efforts of Congress affect its welfare. Economics plays a role.

But here on the edge of the space age it is technology, rather than any of the more mundane facts of life, that is putting Air Force people through the wringer. USAF already has both feet in the missile business, and the impact on officers and airmen alike is felt at every installation in the world. This shift in weapons results in a change in manpower requirements and the assignment of new duties to thousands in the Air Force. It is changing the composition of the



USAF has had an excess of pilots ever since the middle of fiscal 1957, when the wing structure started its drop from a high of 137 down to the 84 wings programed for fiscal 1962. Training rates went up and down, but the surplus remained.

Air Force, and no amount of planning in the past ten years could have foreseen what will happen to the qualitative and quantitative personnel requirements that will be faced in the next ten years.

There are four basic reasons for this continuing problem. They are the activation of missile squadrons, the technical revolution in the business of designing weapons and support systems, the increasing complexity and higher unit cost of weapons and the slow reduction—but not elimination—of the requirement for manned aircraft. For an immediate headache, here in the spring of 1961, start at the bottom, with the pilot problem. Gen. Thomas D. White, Chief of Staff, is the first to declare, as he did last year before the Senate Appropriations Committee, that pilots face technological unemployment.

The general is not talking about *all* pilots. He is talking with an eye on his chart which compares USAF's wing structure with its pilot inventory and pilot training rate (see Chart 1). Here is a graphic representation of how the vagaries of the defense demand, with all its reliance on enemies, allies, diplomats, politics, economics, and congressmen, tightened the wringer even before the technological revolution gave a hearty turn to the screws.

Back in 1950, when officially there was no war, hot or cold, the Air Force had forty-eight wings and the pilots to man forty-eight wings. It is not necessary to go through the painful details of trying to make up for imposed deficiencies in the half-dozen years that followed the outbreak of hostilities in Korea. What happened was that the programmed forty-eight-wing Air Force was boosted to 137 wings. USAF recalled officers, increased the pilot training rate, and put every available man in a cockpit, but it was not until 1957 that it was able to meet the requirement for rated officers to man a 137-wing Air Force. And, having been met for the first time, the requirement started to go down. It has gone down steadily, to the programmed eighty-four-wing Air Force of fiscal 1962.

Reducing the number of rated officers is not as simple as the cutback methods used by private industry to close an assembly line. An Air Force officer, in thousands of cases, is far more than a pilot or navigator. Here is the way General White has explained it to the Senate:

"With the shift in weapon systems from manned aircraft to unmanned missiles, many of the pilots who are surplus to Air Force requirements have acquired skills and experience in such fields as atomic munitions, missile operations, electronic maintenance, research and development, as well as in logistics, procurement, operations, and administration. Many of these skills are in short supply not only in the military services, but in civilian industry as well. . . . Let us remember that we are dealing with highly motivated career officers who have dedicated themselves to the service of their country."

In recent years, since Korea and with greater enthusiasm since Sputnik, more and more officers have been putting a real effort into acquiring the skills to which General White refers. Probably more important, hundreds of them are using the skills, particularly in the technical and management areas. They may be project officers, working seven-day weeks to accelerate

R&D Skill Deserves Pay, Too

An Air Force major, about to retire from a position in the Ballistic Missile Division Headquarters in Los Angeles, tells why he is quitting: "The real reason I am leaving is that the good research and development officer is not getting recognition in the Air Force. For example, promotions are not comparable with those in operational commands.

"I have a master's degree in aeronautical engineering from MIT. On top of this I have ten years' experience in the missile and space field. Yet, today's system continues to use flying pay as a subterfuge instead of recognizing R&D skill as a skill in itself and as a skill that deserves the reward of professional pay.

"Another gripe is the traditional military rotation policy. I was one of the early 'space officers' at BMD. I was involved in developments here almost from the outset, and I want to stay. But I was scheduled for transfer to another activity in a different field.

"The traditional approach to research and development people is forcing some top men out of BMD and into industry and elsewhere.

"In short, the Air Force must certify people as scientists when that's the kind of work they do. The old system of military rank, flying pay, and transfer just won't work.

"General Schriever understands this problem but he is fighting alone for new approaches in USAF."

such weapons as Atlas, Titan, Thor, or some of the early space systems. With this kind of a job flight time goes by the board for the simple reason that the technically qualified men are so busy they don't have time to keep up their proficiency. If they lose flight pay as USAF tightens the rules to eliminate rated officers, they will be, in effect, penalized for equipping themselves to carry out a vital mission and sticking to the job.

It has been pointed out that physicians, commissioned in the Air Force but without ratings to qualify them for flight pay, still get an extra \$100 a month above the pay for their rank. This is a cash recognition of their professional competence and their invaluable service. So far, there is no provision for similar recognition of professional competence in the technological and management areas. The Air Research and Development Command is known to favor steps to improve this situation. There are proposals for accelerated temporary promotions, technical competence pay, a technical competence promotion system, and responsibility pay.

Among the critics it is common to assume that flying proficiency is not essential for officers who are not members of airplane crews. This is not necessarily true, because there are many assignments in the international area, in joint commands, and in staff and support jobs, where rated officers are considered essential. On the other hand, the Air Force recognizes that it has too many rated officers even after these slots are filled. There is a steady effort to cut down. In fiscal 1961, for example, about 3,000 were taken off flying

(Continued on page 91)

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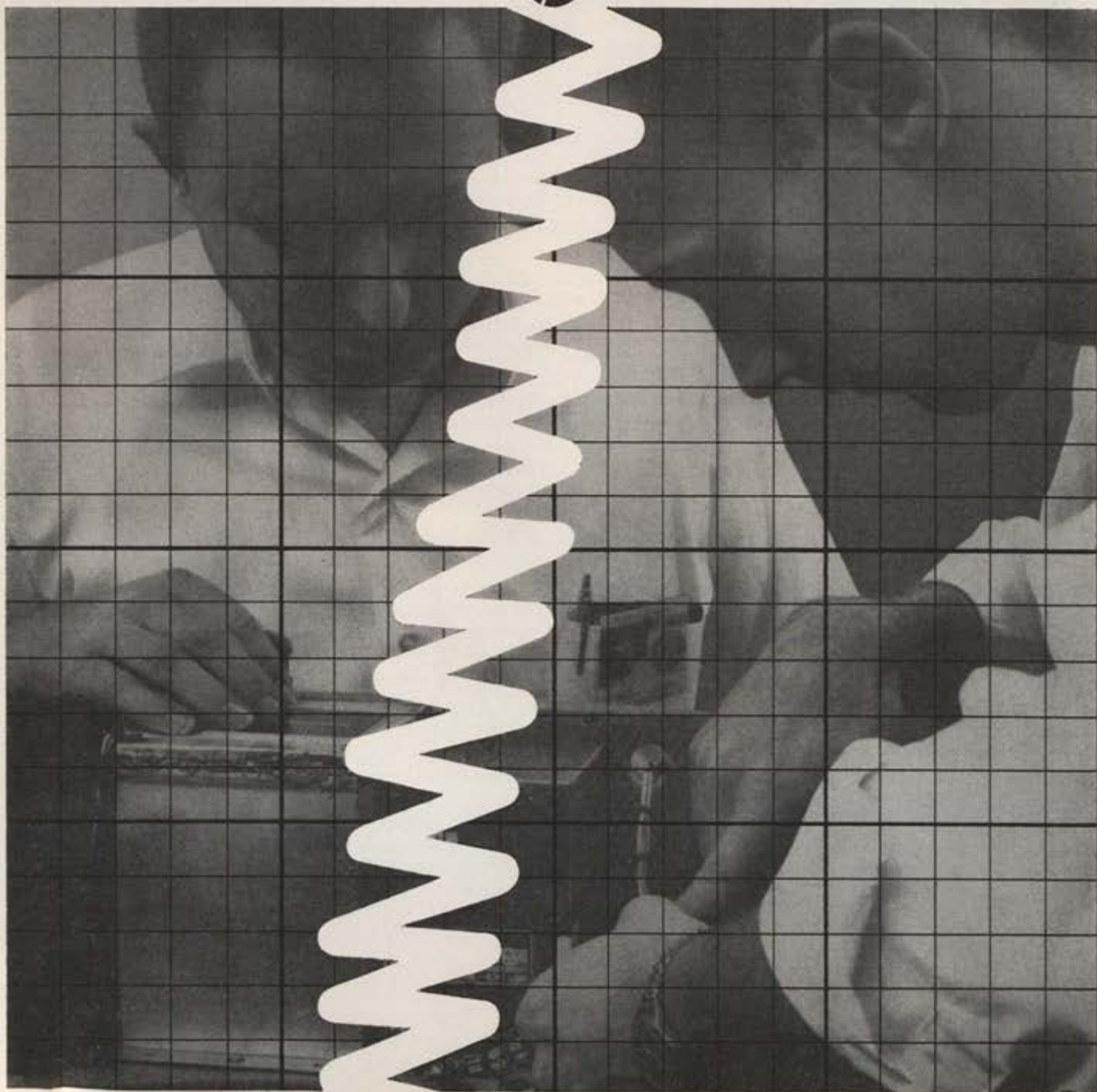
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status. In fiscal 1962 more than 2,000 more will be dropped.

The rub is the pay cut. The majority of these officers have planned their Air Force careers with the understanding that flight pay would be part of their income. There is a firm USAF viewpoint that morale will be smashed if these men are kept from their proficiency in nonflying jobs but take a cut in pay because there are too many rated officers. A colonel gets \$220 a month in flying pay. General White has made this observation:

"You cannot expect a highly skilled research and development officer who has come into the flying game and has specialized in research and development to suddenly take a \$220-a-month pay cut and resist an offer from civilian life of maybe \$25,000 to \$30,000 a year."

About a year ago the Air Force supported an accrual system under which the officer with more than five years of rated service would continue to receive a percentage of his flying pay if he was taken out of the cockpit "for the convenience of the government." It would take him twenty years to get the maximum of full flying pay, a point at which he almost certainly would be in a key position, one that would require flying status. The idea was not accepted at the White House, but President Eisenhower, in his 1962 budget message, recognized the need for legislation of some kind. The Administration, which means the Bureau of the Budget and the Defense Department, now is expected to support a new proposal defined as a "requit" plan. Starting with a peak granted at the time of suspension from cockpit duties—the first year it would be ninety-five percent of the flight pay—the requital would go down five percent each year until it sagged to \$100 a month, when it would be dropped entirely.

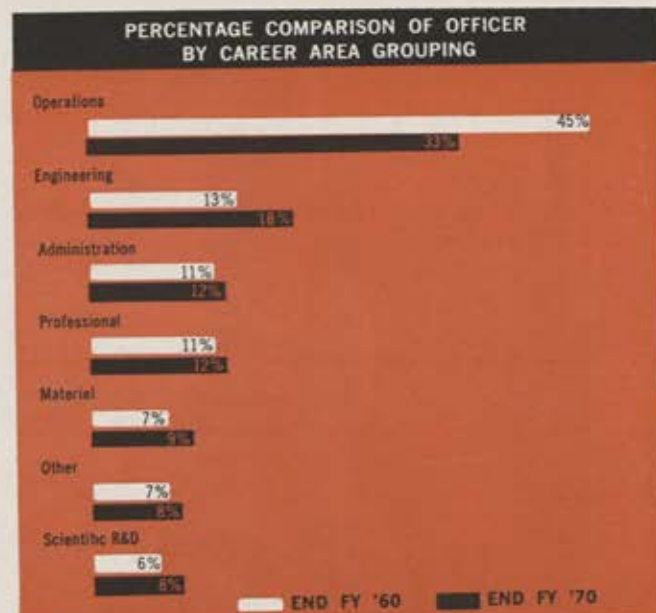
To Air Force personnel officers one of these proposals is an essential piece of legislation for the current Congress. If some relief is not provided, they are convinced, there will be an exodus of rated officers in critical positions who will not accept the loss of flying pay.

Paralleling the problem with rated personnel is the ceiling on the number of officers permitted in the Air Force under the Officer Grade Limitation Act of 1954. This is the bind on promotions, and if there is no change in the existing legislation USAF will find it almost impossible to have any kind of a promotion policy. The ceilings have been reached and, without relief, promotions will depend on the vacancies that are provided by retirements and other kinds of attrition.

In fiscal 1961 the Air Force picked out 6,000 captains now in their thirteenth or fourteenth year of service and tagged them for promotion to major. Only 2,500 vacancies opened up. The remaining 3,500 will not be promoted in fiscal 1962 unless the OGLA is altered by Congress. Revision of the law has been endorsed by an *ad hoc* committee set up by the DoD, and the relief sought by USAF is identical with new grade distribution tables, proposed by the committee.

Better promotion opportunities for captains, majors,

and lieutenant colonels are essential to encourage career officers. The men in these ranks are being encouraged to improve their qualifications for jobs in the new Air Force as it enters the missile era and marches on toward the even more complex period of development to meet the challenge of space. There is no doubt that the changing character of the Air Force has brought about a need for more officers in some areas and fewer in others. There will be vast retraining and requalification of officers to fill the new slots.



Charts show how USAF officer career groupings are expected to shift in decade. Operations requirement drops 12%.

Today forty-five percent of the career officers are in operations (see Chart 2). The second largest group is in engineering, which includes electronic, maintenance, and civil engineering. This is about thirteen percent of the officer corps. About six percent is in the scientific and research and development area. The professional personnel, doctors, lawyers, and chaplains account for eleven percent. Administration accounts for an equal part of the officer cadre.

If we look ahead ten years the operations group will drop to thirty-three percent but remain the largest single segment. The major gain will be in engineering, up five percent, and in the scientific area, up two percent. The other segments also show increases. It is important to note that the current operating program, which may be stimulated even further as USAF takes on new responsibilities as the Defense Department's single manager for space project development, calls for significant increases in the engineering and scientific fields between now and 1963. Even today, the Air Force is having difficulty in meeting its requirement for officers with these skills.

Plans have been made to double the number of scientific and engineering students at the Air Force Institute of Technology by 1964. Yet, from the standpoint of the Air Research and Development Command and its prospects for the long-time future, these efforts

(Continued on following page)

to retrain present officers may be entirely insufficient. ARDC's main source of R&D officers is the Air Force Reserve Officer Training Corps. These lieutenants—3,675 will join the Air Force in fiscal 1962 and those with the most critical skills will go to ARDC—find weak inducements to make a career of USAF engineering and scientific opportunities.

With the growing requirement in this area, it remains that only three to five percent of these men stay in uniform for longer than five years. Chart 3 shows the actual distribution of ARDC R&D officers and

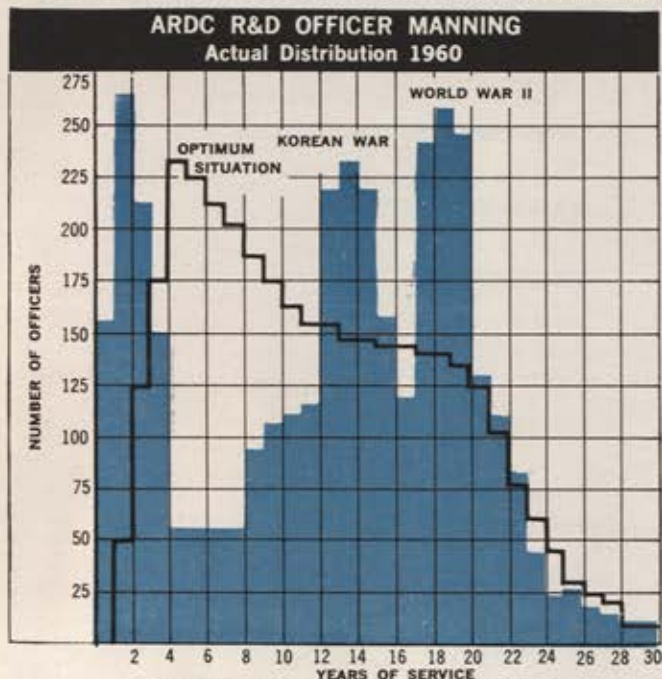


Chart shows that in the research and development fields, areas of critical importance to the future of USAF and national security, the load is carried by first-tour ROTC graduates, the Korean War influx, and World War II veterans.

reveals a nonretention "trough" starting in the fourth year of service and continuing until relief comes from the "humps" provided by officers who are veterans of Korea and World War II. The black line designates the optimum situation in this chart, and first-tour AFROTC graduates feel they carry more than their just share of the load. They have a long list of complaints.

They feel that they have paid for their own education, that USAF does not provide proper incentives for them to make a military career of the scientific and technical work for which they were trained, and that they do not get proper sympathy and understanding from their seniors. These young men feel strongly that the military life is full of frustration, that the pay is basically inadequate, and there is not enough job satisfaction. At their age, they show little interest in early retirement possibilities, fringe benefits, and other long-range inducements to pursue an Air Force career. Some of them contend there is too much emphasis on such things as leave policy and that first-tour assignments often misuse their talents. On top of this is the undeniable attraction of industry, which is competing

in the skills market for these men with the most attractive opportunities in history. Early this year most of these flaws were set down in strong language by a committee of six lieutenants working on an assignment for Lt. Gen. Bernard A. Schriever, ARDC Commander. Their job was to study the problem of low retention of AFROTC graduates with training in science and engineering. General Schriever, after studying their 115-page report, said he agreed with some of the conclusions. The general concurred that military R&D needs a pay structure that will make it more competitive, that it needs a promotion system designed to recognize ability, more careful assignment of junior officers, and an apprenticeship program to prepare lieutenants for managerial responsibility.

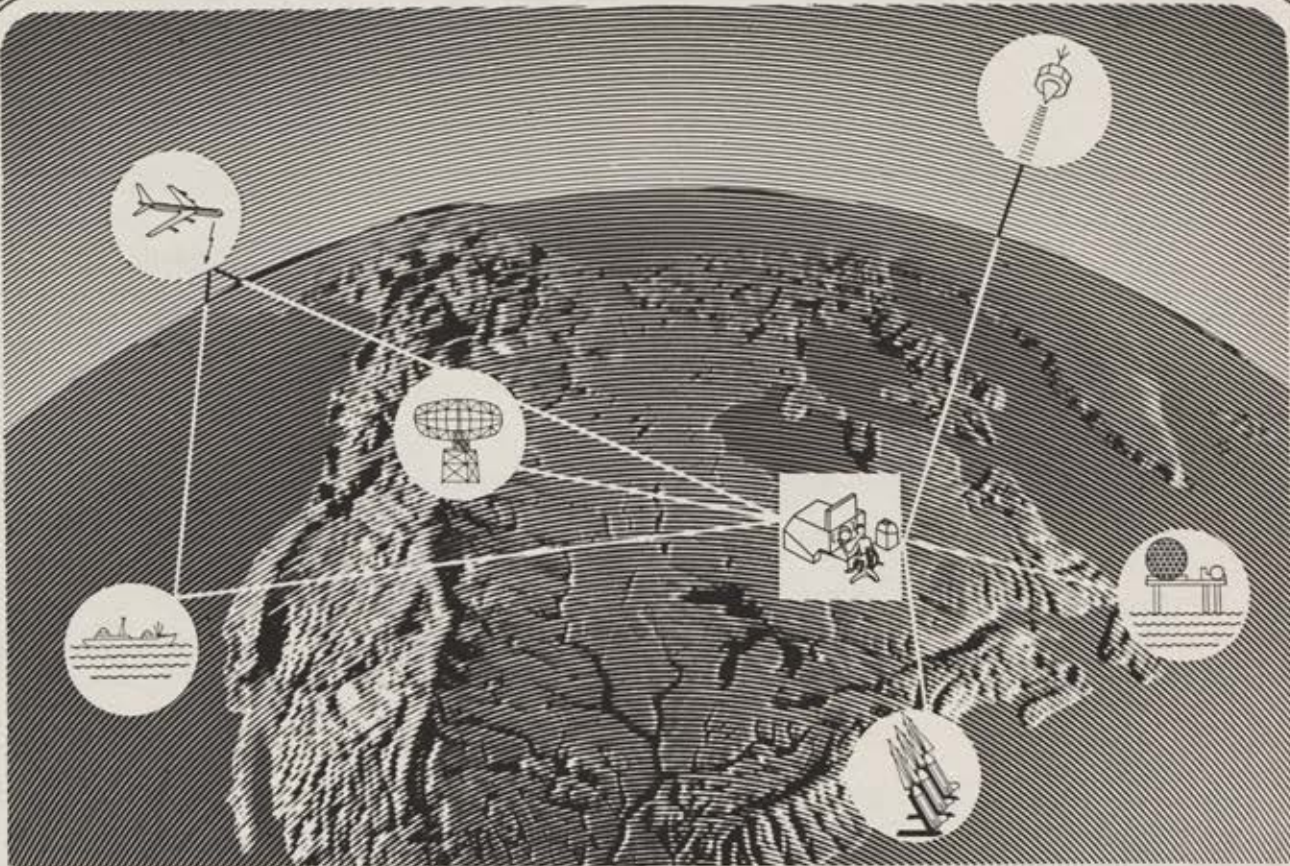
While only three percent of USAF's total officer strength is involved in research and development, this three percent is critical. As we have seen, the percentage will grow, and its role become more vital as the technological race presses on and USAF assumes its new role in the development of space systems for the entire Defense Department.

Many of the personnel problems of the officer corps are duplicated if the spotlight is turned on USAF's airmen. Again, the most significant thing is the low rate of reenlistment by men who have served a single hitch in uniform. In fiscal 1960 the rate declined sharply, but the total number of reenlistments is expected to increase in fiscal 1961 and 1962. The slump in first-term retention rates is attributed to the lack of promotion opportunities in 1959 and 1960. Without them, the bonus offered for reenlistment is reduced and the incentive weakened.

In fiscal 1959 a system of proficiency pay was instituted for airmen, initially as a five-year program. While the Air Force was literally forced to retrain many of its men in preparation for the missile and space era, the attractions of outside industry continued to mount. Men capable of assembling and maintaining missile and space systems, with all of their reliance on electronics and more-or-less esoteric propulsion systems, are in high demand. Proficiency pay was designed as an incentive for these highly trained technical people to stay in USAF. At the end of fiscal 1960 about 51,000 airmen were collecting this reward. Under the fiscal 1961 program about 7,500 airmen will be receiving \$60 a month in extra pay and 67,500 will be paid \$30 extra.

This system has improved the retention rate, in some cases as much as six percent. This gain was made in spite of poorer promotion and bonus incentives. USAF has plans to further improve the proficiency pay system.

Lt. Gen. Truman H. Landon, Deputy Chief of Staff, Personnel, says the missile and space era is forcing USAF to put new emphasis on quality and productivity in its evaluation of people—both officers and airmen. "Membership in the Air Force today," he says, "must be limited to those persons who are most capable and willing to contribute effectively. . . . The objective is to acquire, train, and retain only the most highly motivated and capable."—END



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As Technical Advisor to the United States Air Force, a primary concern of The MITRE Corporation is to help provide optimum command and control systems. Working closely with the Air Force Command and Control Development Division, MITRE is active in such programs as:

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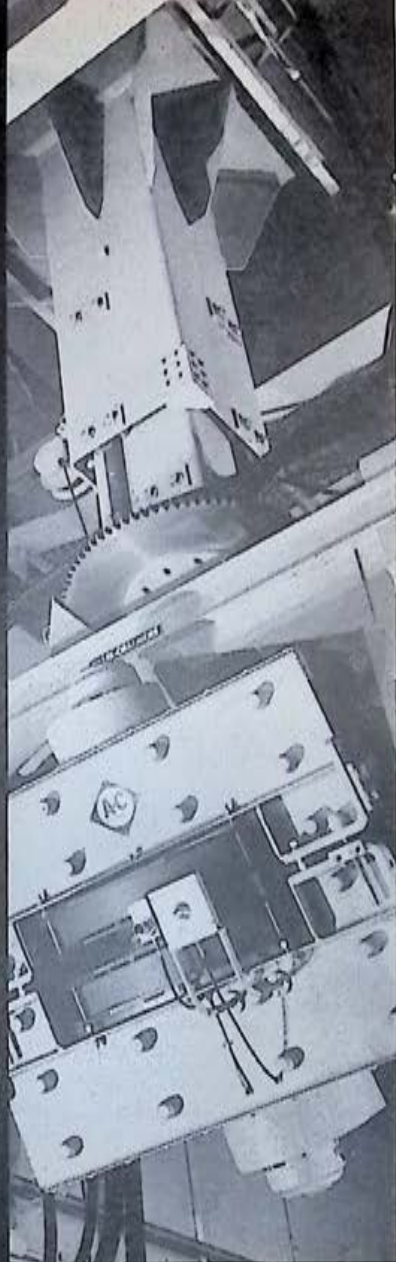
VICE PRESIDENT — TECHNICAL OPERATIONS

SPACE . . . IMAGINATION . . . ENERGY





Within these labyrinthed entrances, shielded from the world by six feet of reinforced concrete and full-height earth barricades, lurks the mighty Betatron. Its task: to search out any defect in production-line propellant grains exposed to its powerful X-ray eye.



This giant eye is only one part of our complete nondestructive test installation at Bacchus. Through such steps, the life history of each individual unit becomes an open book—its reliability can be computed, its readiness known before the need arises. Such exacting tests pave the way to space.

Here twenty-five million electron volts probe the inmost secrets of a missile

Vastly more powerful than any known industrial X-ray apparatus, the Betatron yields a clear picture through the full girth of the third-stage Minuteman engine in an eight-minute exposure, contrasted with more than a nine-hour exposure required with 1,000 curies of cobalt 60. Resolution is such that irregularities down to 0.01 inch can be examined. Power of the instrument, and dimensioning of the building which houses it, are more than equal to the task of scrutinizing interior topography of the cast composite double-base solid-propellant motors made at Bacchus: the third-stage Minuteman, advanced second-stage Polaris, Altair, and the others.

XP61-1



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Flight Propulsion

Convair Hustlers Smash Six World Speed Records



One of SAC's record-breaking B-58 flight crews checks final flight plan prior to takeoff. This J79-powered Hustler logged a top speed of 1430 mph during its run.

Log Top Speed of 1430 mph

EDWARDS AFB, Cal.—Six world speed records, five of them Russian-held, were nearly doubled here recently by two Convair B-58 Hustlers from SAC's 43rd Bomb Wing.

The Hustlers were powered by General Electric J79 turbojet engines, which have now helped set 18 world speed, altitude and payload records in little more than a year.

A B-58 piloted by Maj. H. J. Deutschendorf averaged 1061.8 mph while carrying a 2000 kg (kilogram) payload over a 2000 kilometer closed course. The record claim, which is over 450 mph faster than that previously held by a Russian Tu-104, was also entered for the no-payload and 1000 kg payload categories.

Two days later another B-58 swept over a 1000 km course at an average speed of 1248.7 mph. Records were claimed for the same three payloads. The Hustler, piloted by Maj. H. E. Confer, logged a top speed of 1430 mph during the run.

The previous 1000 km record was held by an Air Force F-101 Voodoo in the no-payload class, with 700.5 mph, and by Russia, (639 mph), in the 1000 and 2000 kg categories.

Nuclear Flight by '65 Is G-E Program Goal

CINCINNATI, Ohio—Nuclear-powered flight by 1965—or even sooner—is both possible and practical, according to David F. Shaw, general manager of General Electric's Aircraft Nuclear Propulsion Department.

"Since January, 1956, we have successfully operated modified J47 turbojets for hundreds of hours on nuclear power," Mr. Shaw said. "We have also successfully completed experimental tests on advanced reactors, and are now designing a high-performance nuclear-powered turbojet for flight testing in the mid-1960's.

"Full-scale turbojets specifically designed for nuclear power have also been operated hundreds of hours in test cells on chemical fuels. They have met or exceeded all performance estimates.

"It is no longer a question of can we build a nuclear-powered aircraft engine, but when we can place such an



Proposed Convair Nuclear Airplane

engine in an aircraft," Mr. Shaw said. "We have reached the point of saying that when an airframe is ready, we can have the direct-air-cycle nuclear turbojet ready for installation.

Use the coupon (check GEA-7105) if you would like further information on G.E.'s aircraft nuclear engine program.

B-58 AWARDED THOMPSON TROPHY...

WASHINGTON, D.C.—The Convair B-58 piloted by Maj. H. E. Confer was awarded the coveted Thompson Trophy in late February for its record-breaking closed course speed of 1430 mph.

It is the first time in aviation history that the trophy has been won by a heavy bomber. The award is presented annually by the Air Foundation of Cleveland.

The CJ-805 Aloft: 880 Nears First Anniversary; 990 and

CONVAIR 880—Fastest jetliner now in commercial service, the Convair 880 will enter its second year of operation on May 15. The CJ-805-3 powered transport is now flying with Delta, Northeast, and Trans World Airlines, and will "go international" in mid-year when Japan Air Lines inaugurates 880 jet service linking Tokyo with other major Far East cities.



CONVAIR 990—The 640-mph jet flew for the first time on January 24 and is being flight tested prior to scheduled service with AAL, REAL, Swissair, and SAS later this year. Four G-E CJ-805-23 aft-fan engines power the 990, whose maiden voyage was described by Convair Chief Test Pilot Don Germeraad as, "The cleanest I've had in six first flights."





SAC Hustlers Complete Six Months of Operation

CARSWELL AFB, Tex.—SAC's 43rd Bomb Wing—the Air Force's first operational group of Convair B-58 Hustlers—has completed its first six months of operational duty here.

During more than 4000 hours of engine flight time, reliability of the Hustlers' J79-5B turbojets was evidenced by a rate of approximately 400 hours between unscheduled engine removals for all causes.

Engine flight time for all phases of the Air Force's and Convair's B-58 program is currently over 25,000 hours. Four General Electric J79's power the Mach 2 bomber with a combined thrust of over 62,000 pounds.

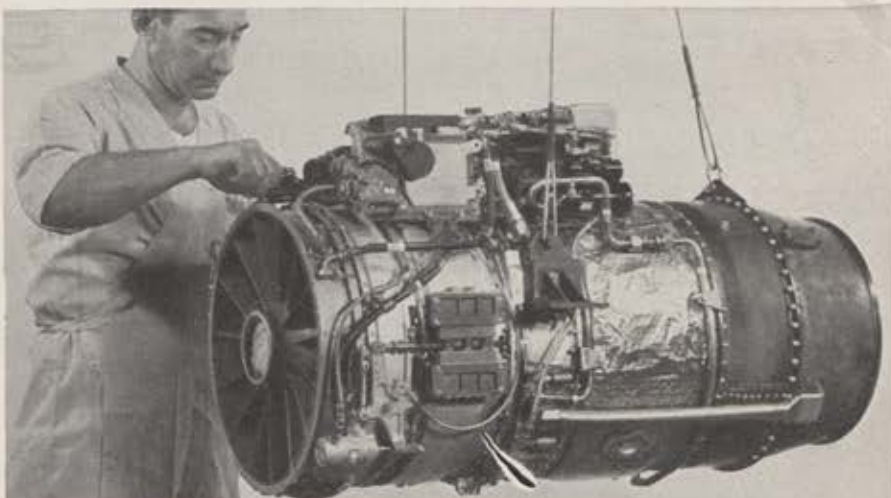
First Year of Flight Testing Confirms Aft-fan Principle

CINCINNATI, Ohio—"General Electric's first year of turbo-fan flight testing has proven beyond a doubt the soundness and practicability of the aft-fan principle," according to G-E Commercial Engine Operation Manager Neil Burgess.

His comment was occasioned on the first anniversary of American turbo-fan flight last February 19. On that day a year ago a G.E.-leased RB-66 flew aloft powered by two CJ-805-23s.

"The engines," reported Mr. Burgess, "have been operated over a complete range of altitudes and air speeds, under severe distorted inlet conditions, and with two entirely new nacelle designs. The fan has in no way compromised the good throttle response characteristics of the engine."

"In all cases," he said, "we have been completely satisfied with the engine



G.E.'s modified 10-to-1-ratio J85 will be ideal for VTOL, STOL, and copter boost power.

J85 Modified to Produce 10 to 1 Power Ratio

LYNN, Mass.—General Electric's J85 turbojet engine can now be modified to produce a thrust-to-weight ratio of more than 10 to 1.

Production J85 engines currently entering service with the Air Force deliver a specified 7.6 to 1 ratio, the highest of any military production jet powerplant.

The 10 to 1 power ratio makes the modified J85 an ideal engine to provide auxiliary power for VTOL and STOL aircraft. Here its primary use would be to provide boost power for takeoff and landing operations.

Adaptation of the modified engine to helicopters, where it could substantially augment cruise power and lift power, is also a possibility.

operating characteristics. In particular, the low noise levels of the engine are outstanding."

During this period, two other aircraft—the Convair 990 and G.E.'s Caravelle VII—also initiated flight test programs using G-E aft-fan engines.

A growth version of the commercial aft-fan engine, the MF239C-3, is being offered for the MATS SS467 cargo transport. It will develop up to 23,800 pounds of takeoff thrust, as compared with 16,100 for the CJ-805-23.

Boosting the J85's power ratio to 10 to 1 was accomplished by removing accessories—reducing engine weight from 325 pounds to less than 300—and by increasing engine speed and temperature. Over-all dimensions are similar to those of the J85-7.

A dry commercial version of the J85—the CJ610—develops 2850 pounds of thrust, weighs only 355 pounds.

Use the coupon (check GED-4095) if you would like further information on the G-E J85 turbojet engine.

Caravelle Flight Tests Progress Well

SUD/DOUGLAS CARAVELLE VII—Now entering its fourth month of intensive flight testing after conversion to General Electric CJ-805-23 aft-fan turbojet engines, G.E.'s Caravelle VII is currently in the midst of a heavily instrumented flight program marked for completion this spring. Tests have included in-flight noise measurements, duct inlet design confirmations, and thrust reverser trials. Performance to date, including noise level and short-runway prowess, has been highly favorable.



FOR MORE INFORMATION

If you would like free brochures on these or other G-E flight propulsion products, just clip and send this coupon.

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☐ Other.....

NAME.....

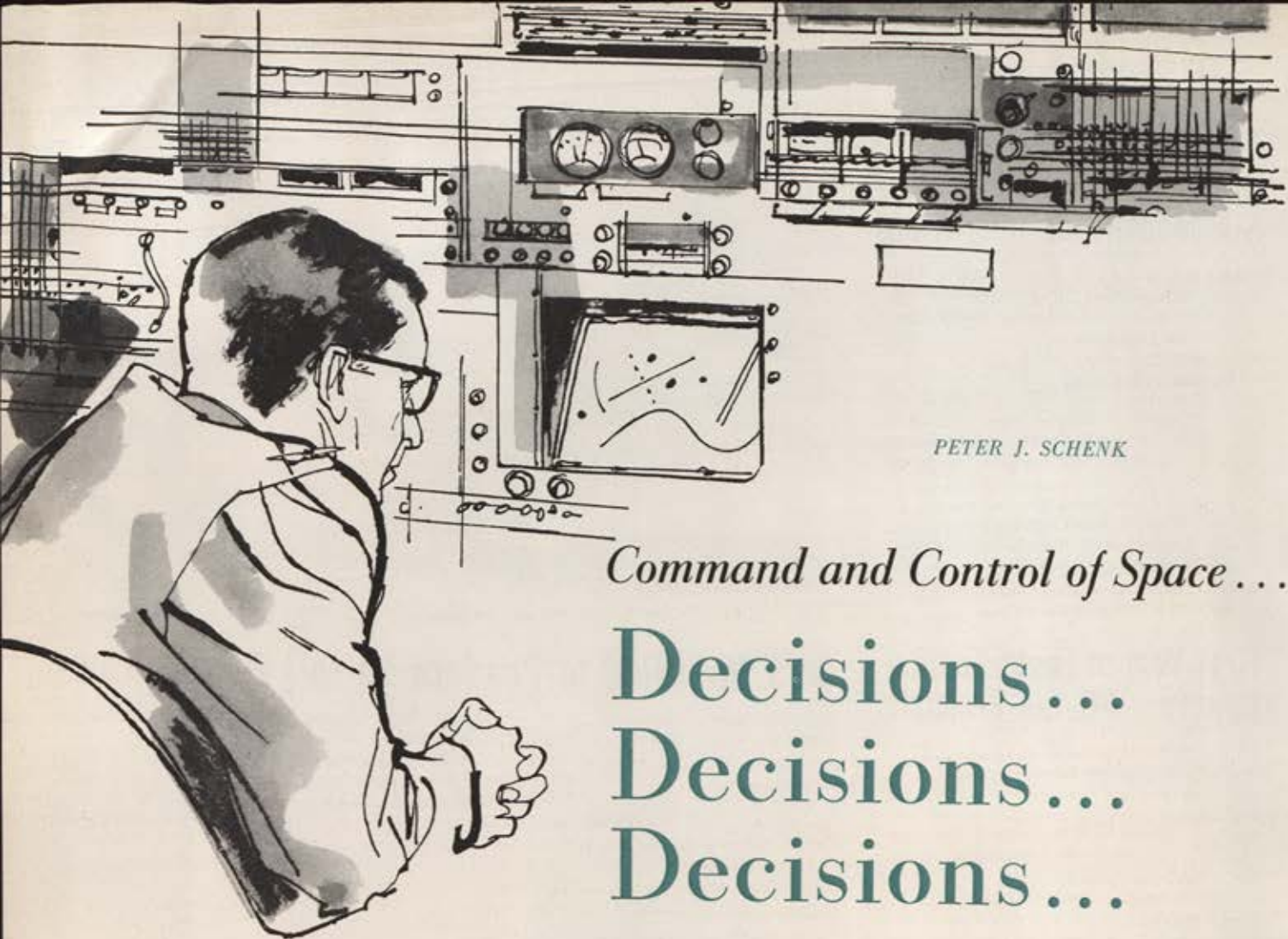
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PETER J. SCHENK

Command and Control of Space ...

Decisions... Decisions... Decisions...

THE LAST twenty years have produced two major milestones in military technology. The decade of the '40s might be described as the decade of nuclear-weapon development and the '50s as the decade of jet and rocket propulsion.

Anticipating history is difficult at best. However, it seems probable that the '60s may well go down in history as the era in which giant strides were made in the field of space and information systems.

The propulsion and weapons revolutions since 1940 have laid a foundation for space exploration and space-weapon systems. But relatively little public attention has been focused on the exploding technology of *information systems* currently being stimulated by urgent military and civilian needs.

In some respects, a modern missile or space-weapon system might be likened to a biological organism. In the years since the end of World War II we have witnessed several generations of new aircraft with vastly more range, speed, and altitude capability. More recently we have seen the introduction of operational missile systems. These weapons can be likened to the "muscles" in a biological organism. The "nervous system"—the radar "eyes," the communications "spinal cord," and the computer "brain" constitute, in military parlance, the "command and control system." Its function is to gather all available information on friendly and enemy forces, including the presence, movement,

and identity of objects in aerospace; to transmit this information to central collecting points where it is sorted, cross-checked, evaluated, and displayed, thus giving a commander the information needed to make decisions; and finally, to transmit orders based on these decisions to the appropriate weapons.

The magnitude of the revolution in warfare which has taken place in the twentieth century staggers the imagination. For hundreds of years commanders exercised control of their forces based mainly on hand-carried information as to the disposition and movement of friendly and enemy forces, supplemented by visual observation from the traditional "high ground." During the Civil War, command intelligence was extended by observation balloons, and in World War I substantial use was made of aircraft for observation over the enemy lines. However, the battlefield was still relatively limited geographically, and commanders of the past leaned heavily on substantial personal experience in deploying their weapons and troops.

Command and control systems as we know them today began with the air defense of Great Britain at the beginning of World War II. The newly developed radar of that era was able to see enemy airplanes through darkness, clouds, and fog at distances of fifty miles or so. The information from the radar net was fed into underground command posts where WAFs in stocking feet walked around on large-scale map-plotting boards and pushed about little plastic arrows

denoting the tracks of the aircraft. Status boards, written on in chalk and grease pencil, displayed information about available aircraft, weather, condition of runways, and whatever else the air commanders needed to fight the air battle of Britain.

While these systems met the needs of the day and the Battle of Britain was won, they would be pathetically slow and inaccurate against the requirements of today.

In modern warfare, the situation has been altered drastically. In the aerospace theater of operations, range, speed, and firepower of modern weapons have run right off the charts. Time for decision has been compressed almost intolerably; and today's commander has very little direct experience with actual combat operation of the new forces and weapons under his control. His lot is to sit in a command post watching electronic displays, which tell him about the disposition and status of his own forces and the actions of enemy forces. In a sense, the commanders of today and the future will engage in a complicated kind of chess game, using an electronic board that covers the globe and its space environs. Whether it's "checkmate" or *shakhmat*, the stakes are life and death of nations.

Modern technology has provided valuable new tools to assist in the command and control of modern forces. For example, although large digital computers existed only as laboratory curiosities ten years ago, they have been refined and polished into astonishingly reliable and well behaved servants of the commander. But despite the lightning speed of their individual computations, these machines can still not "think" in the sense that they can exercise judgment or make independent decisions. Whatever they do must be preset into them so that to any given set of conditions they react in a way which is foreordained by the computer program which resides in the machine's "memory."

The "data base," also stored in the computer, is analogous to the knowledge and experience stored in the memory of the experienced commander with the significant exception that the robot data base does not now have the flexibility of the human mind.

During the past few years widespread recognition of the need for a major effort toward the solution of the information-handling and decision-making problems of the missile/space age has given rise, in the Air Force, to a series of projects generally referred to as "L systems." The first, and perhaps best known, of these L systems is the SAGE System—a semiautomatic ground environment for continental air defense. This was begun at Lincoln Laboratory in 1950 and most of the country's air defense sectors are now equipped with SAGE. The SAGE System pioneered the application of large digital computers to the Air Force command and control problems. The lessons learned in SAGE will be invaluable in developing other L systems such as the Strategic Air Command Control System (465L) and the Air Weather System (433L).

The L systems make it possible to organize the development effort in the command and control area into discrete, manageable packages. The long-term trend should be in the direction of providing an "aerospace control environment" in which the L systems are considered as integrated parts of the total environment.

There is an important difference between L systems, particularly the command systems, and the more familiar weapon systems. A ballistic missile weapon system—say Atlas or Titan—goes through a well defined cycle of initial conceptual design, hardware development, quantity production, field installation, and eventually operational readiness. At some point along the way, new technology makes possible a better system—Minuteman, for example—which then goes through the same cycle, eventually replacing the ear-

The Hanscom Complex

United States Air Force organizations representing research and development, logistic, and operator-user commands have joined forces at L. G. Hanscom Field in Bedford (near Boston), Mass. to make possible a concurrent, coordinated approach to the task of providing electronic systems for command and control of aerospace forces. The so-called "Hanscom Complex" includes such electronic system management organizations as the Air Force Command and Control Development Division (AFCCDD) and the Electronic Systems Center (ESC) (now combined to form the Electronic Systems Division of the Air Force Systems Command), other Air Force operator-user command systems offices, and the System Program Offices (SPOs).

The Hanscom Complex also includes the Air Force Cambridge Research Laboratories which conducts and sponsors basic studies in electronics and geophysics. Massachusetts Institute of Technology's Lincoln Laboratory, with its specialized scientific competence, and The MITRE Corporation with its scientific advisory staff, are members of the complex. In addition, the Rome Air Development Center (RADC), although located at Rome, N. Y., outside the physical confines of the complex, is considered conceptually a part of it. RADC, with its extensive laboratories and test facilities for electronic research and development, supports the complex in system planning and development and is the primary development agency within the complex for subsystems and components.

These specialty organizations, working hand in hand with industrial talent spanning the country, form a team. Goal of the team is to develop, produce, and place in operation—in the shortest time possible—Air Force command and control systems that are conceptually sound, technically compatible, and properly time-phased.

lier-generation weapon system. In command systems, and to some extent in control systems, one cannot as a rule start with a "clean slate." It is usually necessary to supplement, or modify, an existing system.

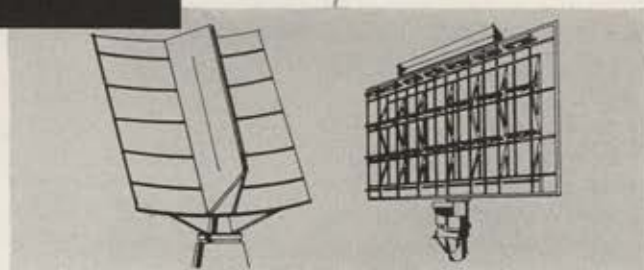
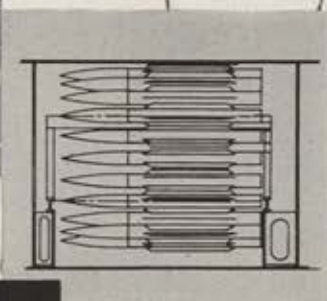
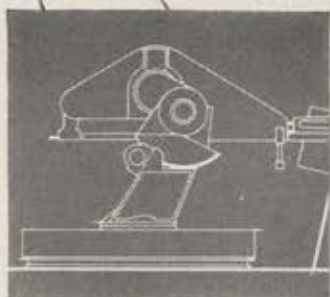
One might liken the problem to that of modifying the electrical circuits of a house. If the owner of an older house buys a new washing machine and a dryer whose electrical load exceeds the capacity of the present wiring, he usually does not completely rip out the existing wiring—instead he adds a new branch circuit or he puts in a bigger main distribution panel or changes the feed to the house from the power transformer on the street. Thus, the process of designing, developing, and finally producing the equipment which

(Continued on page 101)



IT'S THE MAN BEHIND THE SCENE WHO COUNTS

Vitro has performed the little-known but important role of systems engineering coordinator on more than 60 military systems. Take a careful look at this function — integrating components of complex range instrumentation and shipboard weapon systems. This backstage assignment has resulted in "on-time" performance to the military services.



Vitro



comprises one of the new L systems involves fitting it into existing command and control arrangements by selective addition or replacement of existing components. Actually, the development of the system is never really complete, for changing requirements demand a continuous process of modernization, change, and adaptation. L systems are fundamentally *evolutionary* in nature, gradually changing their character.

The success of command and control systems depends on a very tight relationship between equipment, facilities, and trained operating and maintenance personnel. When the hardware first arrives from the manufacturer and is installed, a system with operational capability does not yet exist. An extended period of exercising the system and training the personnel to establish an operational capability still lies ahead. One current fault is the failure to place sufficient emphasis on exercising the force in the way in which it would have to be used under combat conditions.

There have, of course, been many exercises which

assumed heavy damage due to enemy action, or interference with electronic systems by jamming. However, there is sometimes a tendency to avoid realism in such exercises, as illustrated by an apocryphal story about a post-exercise "critique" which two competing commanders held at the officers' club. They agreed, the story goes, that the next time around they would have to cut out the electronic jamming part of the exercise because it created such chaos that none of their people were receiving "adequate" training!

There are three broad areas of operational or environmental conditions in which electronic systems for missile and space control must be able to function. Unfortunately, the demands made upon the command and control system during these three conditions are very different and often mutually conflicting.

First, there is the prestrike phase in which the system contributes to the national deterrent posture. During this period the command and control system
(Continued on following page)

A CHECKLIST OF THE L SYSTEMS

(USAF assigns suffix letters L through Z to system numbers to connote support systems.)

412L—AIR WEAPONS CONTROL SYSTEM

An overseas theater tactical air weapons control and warning system.

413L—EXTENSION OF DEW LINE

A distant early-warning system for detecting hostile air-breathing threats approaching the North American Continent from the north.

416L—SAGE AIR DEFENSE SYSTEM

A semiautomatic area air weapons control and warning system for detecting, identifying, tracking, and providing interceptor-weapon direction against air-breathing threats to the United States and Canada.

425L—NORAD COMBAT OPERATIONS CENTER

A system which collects, processes, and displays data to assist the Commander in Chief, North American Air Defense Command (NORAD), in commanding and controlling his forces.

431L—TRAFFIC CONTROL AND LANDING SYSTEMS

A program to satisfy Air Force traffic control requirements by working with the Federal Aviation Agency (FAA) and development of equipment peculiar to Air Force needs.

433L—WEATHER OBSERVATION AND FORECASTING SYSTEM

A global semiautomatic electronic system for observing, forecasting, and handling weather information. It is being developed in conjunction with FAA and the US Weather Bureau.

438L—INTELLIGENCE DATA-HANDLING SYSTEM

A system for high-speed processing of worldwide intelligence data.

465L—STRATEGIC AIR COMMAND AND CONTROL SYSTEM

A system which collects, processes, and displays data to assist the Commander in Chief, Strategic Air Command (SAC), in commanding and controlling his forces.

466L—ELECTROMAGNETIC INTELLIGENCE SYSTEM

A worldwide system for collecting intelligence by electromagnetic means and processing for transmission to users.

473L—AIR FORCE CONTROL SYSTEM

A data-processing and display system to assist Headquarters USAF in making command decisions.

474L—BALLISTIC MISSILE EARLY WARNING SYSTEM

A system to provide early warning of a mass ICBM attack on the North American Continent from the north.

480L—AIR COMMUNICATIONS SYSTEM

A system to assure inter- and intrasystem communications services to support global Air Force operations.

496L—SPACE TRACK

A system for detecting, tracking, identifying, and cataloging orbiting objects.

In addition to the above L systems, all of which are Hanscom Complex systems, the following are under the management of the Air Force Ballistic Missile Division, Inglewood, Calif.:

117L—MIDAS, satellite system for detecting and giving an alarm on infrared emanations from the exhaust of launched missiles, and **SAMOS**, satellite system for gathering photographic and electromagnetic data.

470L—COMMUNICATION SATELLITE SYSTEM with requirement for twenty-four-hour global capability, not yet approved as to mission, system description, or operational concept.

must meet the requirements incident to the establishment and training of forces in peace time. A great deal of the capacity of the system is used in developing plans for the employment of the force, and in gathering and processing large amounts of information which is needed for functions such as making intelligence estimates of enemy forces. The emphasis during this phase is on the ability to handle a high volume of data under relatively good environmental conditions.

During the critical *attack phase*, the environmental situation may change drastically. Physical damage to the command and control facilities may knock out a good number of them. The side effects of nuclear explosions may seriously affect radio communications. During this period a relatively modest but absolutely reliable form of command and control is required for the critical functions such as the attack orders for various elements of the force.

It should be noted that what is needed for the attack phase is not necessarily a residual or degraded part of the prestrike system. It might well be a separate system with relatively limited capacity but as secure as possible against disruption by the enemy. The analogy here which seems most applicable is again to a house in which the normal nighttime illumination is furnished by electric lights; but in the basement the homeowner keeps some kerosene lamps, candles, flashlights, or what have you to use when a hurricane knocks out the power lines. Naturally these emergency means won't permit him to see as well, nor would he want to use them for any extended period of time, but they are acceptable as a substitute for a short period to permit essential operations to be carried out until normal service is restored.

Finally, we face the situation of post-attack recovery and reestablishment of the command structure. This calls for the assessment of damage suffered and initiation of "healing" action on the system as well as reestablishment of some command and control over the residual forces. To the greatest extent possible, arrangements should be made for the system to be "self-healing," on the basis, for example, of decentralized initiative taken by the surviving cells of the system.

More generally on the question of centralization versus decentralization, two things have happened since the end of World War II that have had an important effect on command and control design philosophy. They both have to do with nuclear weapons. The first is that under the law of the land only the President can authorize the employment of nuclear weapons. This, of course, calls for a very high degree of centralization of command reaching all the way back into the White House. The other related new factor is that a modern B-52, for example, can carry about as much explosive power as an entire Air Force could deliver in World War II in several years of sustained operations with large fleets of TNT-delivering aircraft. Thus, there is an understandable desire on the part of the commander of SAC, for example, to be able to talk with each individual aircraft. Especially if one assumes that if and when World War III might start we will

absorb the first blow and have to fight with the residual force, it becomes vitally important to make the most effective possible use of that portion of the force which has survived. Looked at in terms of each airplane's ability to wipe out a major city, for example, it is easy to understand the commander's desire to be able to communicate with—and therefore to direct—the force on an airplane-by-airplane (or missile-by-missile) basis. However, providing this feature along with the retargeting ability which it implies is both difficult and expensive.

We have discussed some of today's command and control problems. The next step, of course, is *space*. Physical scientists are just beginning to understand some of the new problems posed by this vastly different environment. Some things will be easier to do in space—for example, we will be less troubled by atmospheric absorption of conventional radio waves. In the vacuum of outer space it may be possible to communicate over great distances with extremely high-frequency radio signals, which have some attractive features impossible to exploit within the atmosphere. On the other hand, the problems raised by the high speed of objects in space may be extremely serious. Most people are familiar with the "Doppler effect"—the changing pitch of a locomotive whistle, for example, when it is approaching and when it is departing. Frequency changes in radio and radar systems due to this effect may be serious at the enormously greater speeds of satellites and space vehicles.

Indeed, with the vast distances encountered even in interplanetary space the speed of light itself becomes limiting. It will become increasingly difficult to carry out intelligent two-way conversations when a delay of several minutes is introduced between question and answer.

We cannot legislate against the laws of physics, of course. But we can take full advantage of the ways in which these laws can work for us in order to help solve some of the problems they create. The command and control problem is an ever-widening one and can be met only with consistent, coordinated, determined activity. This is the challenge that future command and control technology must meet.—END



Mr. Schenk is well known to our readers, having served two terms as President of the Air Force Association, 1957-1959. Assignments during twelve years of military service include Executive Officer to Lt. Gen. James H. Doolittle, Assistant Military Director of the Air Force Scientific Advisory Board, Executive Officer to the Chief Scientist of the Air Force, and Vice Commander of the Cambridge Research Center. He joined the General Electric Company in 1954, the Raytheon Manufacturing Company in 1958, and now is Executive Vice President of The MITRE Corporation, Bedford, Mass. MITRE is the nonprofit corporation providing technical support to the Air Force Command and Control Development Division at Hanscom Field, Mass. Mr. Schenk is a member of the Board of Directors of the Air Force Association and serves on the Policy Committee and Finance Committee.

IN AIR NAVIGATION... ITT ACTS WELL AHEAD OF PROBLEMS

ITT in 1907 developed the equi-signal radio range—basis of today's instrument landing systems.



DME • TACAN • VORTAC ITT'S ANSWER TO MANY OF TODAY'S TRAFFIC CONTROL PROBLEMS

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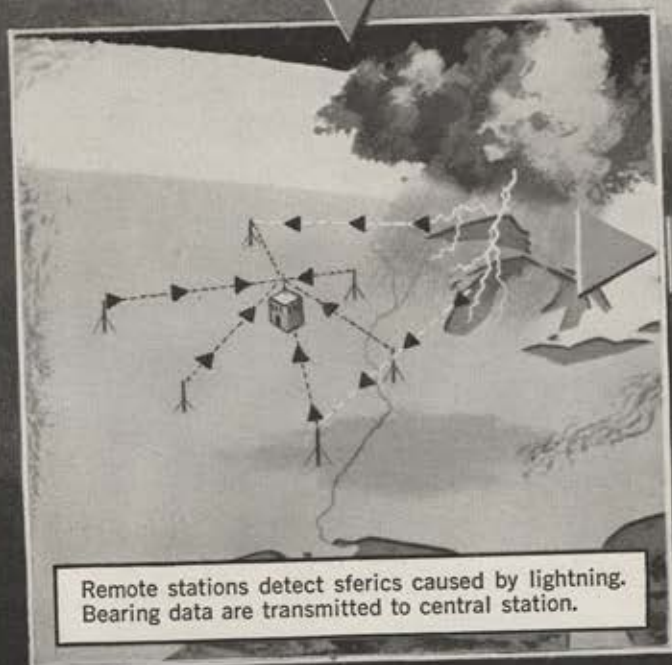
ITT's DME aboard today's aircraft tunes to any DME, VORTAC or TACAN ground station for continuous distance information. The development of VORTAC and TACAN, the civilian and military rho-theta systems, is an ITT achievement typical of its great capabilities in avionics. Now even greater resourcefulness is attainable through the fusing of two divisions to form ITT Federal Laboratories. In a single company are Research and Development **plus** Manufacture, Maintenance and Service... ready to serve the military and industry with the shortest possible cycle between initial concept and delivered system.



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Remote stations detect sferics caused by lightning. Bearing data are transmitted to central station.



At central station data from remote sites are triangulated and displayed.

Now... Forecasting by Lightning

**New Lockheed Electronics weather system
spots storms up to 2,000 miles away**

When a storm is brewing, lightning may send warnings hours before it is detected by weather radar. Lightning flashes (sferics) give valuable clues to weather conditions, but until recently, weathermen had no effective way of detecting and locating sferics at long range.

Now, Lockheed Electronics has produced, in conjunction with the Army Signal Corps and Air Force, a unique system that pinpoints all lightning flashes within a 4,000-mile area.

Remote antennas pick up radio signals generated by sferics. Processing equipment converts the signals into directional data and transmits the information to the Air Force's Severe Weather Warning Center in Kansas City, Missouri. There, after triangulation, the signals are traced on a display which gives the storm's location and path.

Continuing research is leading to use of sferics as an aid in forecasting tornados and for plotting severe storms in mid-ocean where present forecasting devices cannot be used.

LEC is contributing importantly in a variety of ways to development of equipment to advance meteorological knowledge. Among current projects are high performance radiosondes and wind data conversion systems.

MINDING THE FUTURE

LOCKHEED ELECTRONICS COMPANY

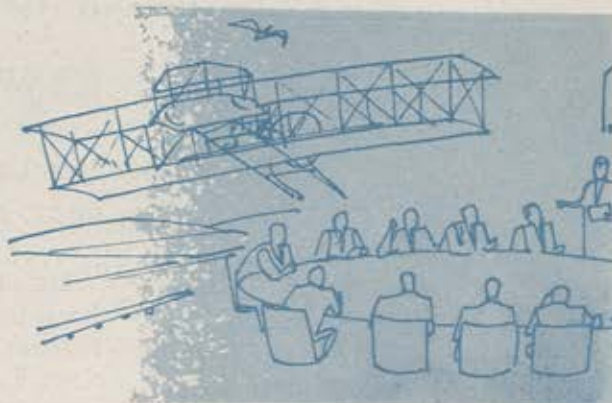
Plainfield, New Jersey



Flashes of light
on kinescope
indicate lightning's location.

Space Is A Place, Not A Thing . . .

What Do We Really Want to Do?



WALTER T. BONNEY

IN THE frustrating years since World War II, peace-loving peoples the world over have yearned for greater progress in translating international agreements into practical means of ensuring permanent peace.

Many Americans, as well as citizens of other countries, have sometimes argued that the West should discontinue nuclear testing—and hope that the Soviet Union might follow suit. All of us have wished that we had a *choice* between improving ourselves and dealing with the obvious threats to our security. We have, unfortunately, been confronted with the paradox of having to be dedicated both to building our military strength and to seeking effective arms control, to our own national security as well as to international negotiation.

As Henry A. Kissinger has pointed out in his book on the prospects of American foreign policy, *The Necessity for Choice*: "Our ability to master the seeming paradoxes will test even more than our ability to survive: It will be the measure of our worthiness to survive."

Before we agree to a ban on nuclear testing or limit the military use of space, we might profitably study the lessons of history.

Even before the invention of the airplane, the Hague Peace Conference of 1899 solemnly promulgated a declaration that prohibited aircraft, present or projected, from combatant use in war. The discharge of projectiles or explosives from the air was proscribed, and by agreement the role of air vehicles was limited to reconnaissance or equally passive employment.

Eight years later, in 1907, the second Hague Conference convened. In almost direct, but inverse, pro-

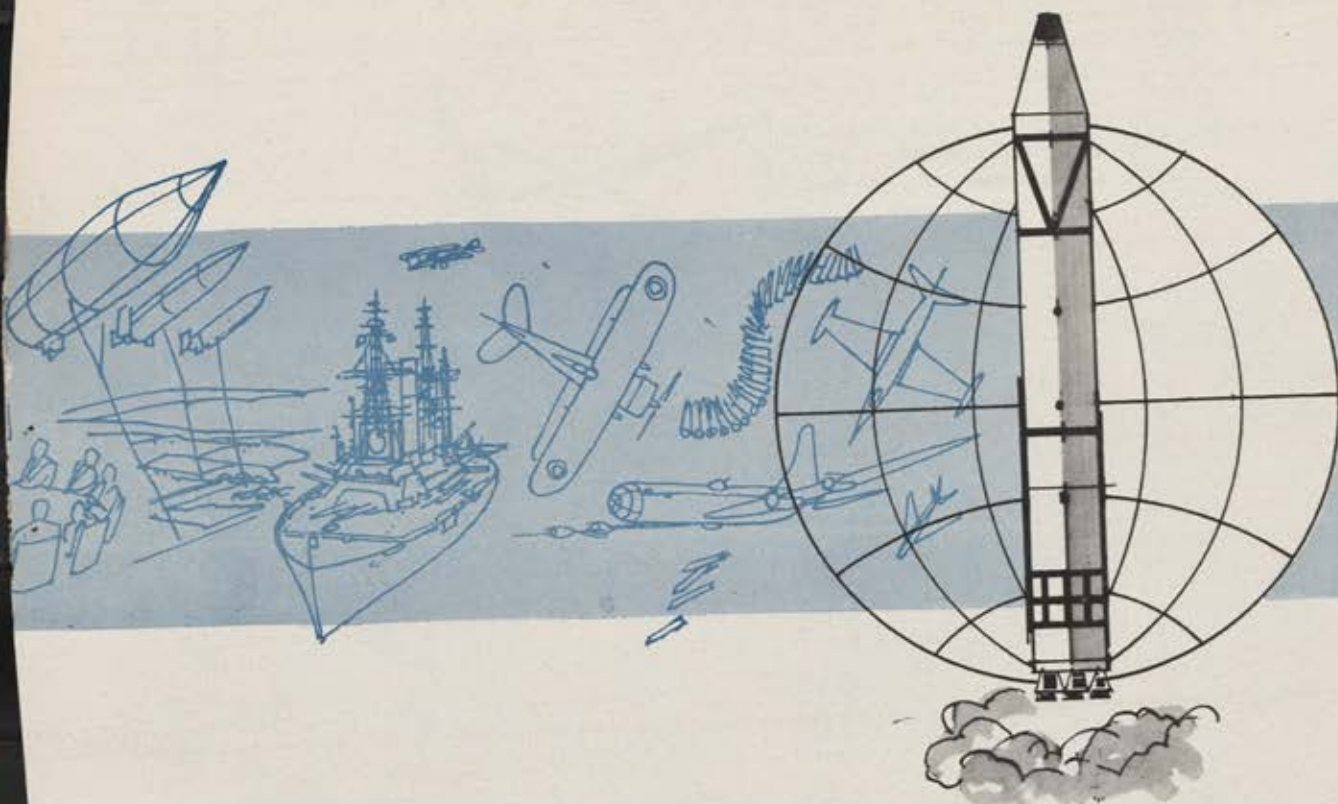
portion to the plausibility of the intervening demonstrations of the military potential of the airship and the airplane, the zeal of the Powers, great and small, diminished as they gave further consideration to continuance of this prohibition. Of the forty-four Powers represented at the second conference, only twenty-seven signed for renewal of the Declaration; and of the World War I belligerents, it was ratified only by Great Britain, Belgium, Portugal, and the US.

Further, even this Declaration was virtually devoid of meaning because of a provision that the prohibition ceased to be binding when, in a war between the contracting Powers, one of the belligerents was joined by a noncontracting Power. With the beginning of war in August 1914, in which contracting and noncontracting Powers were at once involved, the limiting Declaration automatically lapsed.

With commendable foresight, the British government appointed a committee in 1908 to examine the dangers to which that nation might be exposed by the development of air vehicles. A significant sentence in the committee's report read: "The evidence . . . tends to show that the full potentialities of airships and the dangers to which we might be exposed by their use can only be ascertained definitely by building them ourselves."

Now, as just demonstrated, it is relatively easy to dig into the history books to prove once again that "there's nothing new under the sun." And yet, because of the human proclivity always to view each day's developments as entirely novel, it can be profitable, occasionally, to look to the past for the wisdom that will be useful in attacking our current problems.

At the turn of the century, many men who should have known better persisted in thinking of the sky



as a *thing* rather than as a *place* to do things with the airplane. And in the past two or three years, we have seen other men who persisted in considering space as a *thing*—a revolutionary new development—rather than as a *place* where, for the first time, we could do things with our satellites.

Similarly, a misconception that has persisted from generation to generation is that technological advances can be categorized as good or evil—peaceful or warlike. To the contrary, as Hugh L. Dryden, Deputy Administrator of NASA, has said, the fruits of science are amoral—it is man's use of them which is the determinant.

One might note, in this connection, that sometimes the inventor can become disillusioned when his brain child turns out to be militarily useful. Three ready examples might be Nobel's dynamite, the Wright brothers' airplane, and the concept of atomic fission.

Within the past decade, our yeasting technology has produced a new invention—the means to go into space. And we and the Soviet Union have quickly learned how to exploit this new capability for both military and peaceful purposes. We have learned how to hurl warheads into space on journeys halfway around the world at speeds which only yesterday were in the realm of the fantastic. Perhaps of far more ultimate importance—if in the meantime we can avoid a global holocaust—we have learned how to send instrument-laden satellites into space, searching out scientific information that may prove to be of incalculable value.

Looking to the future, and limiting our considerations to possible military applications, we need to ask ourselves: What do we want to do in space? Can we do it? And we need to ask also: Are there better ways

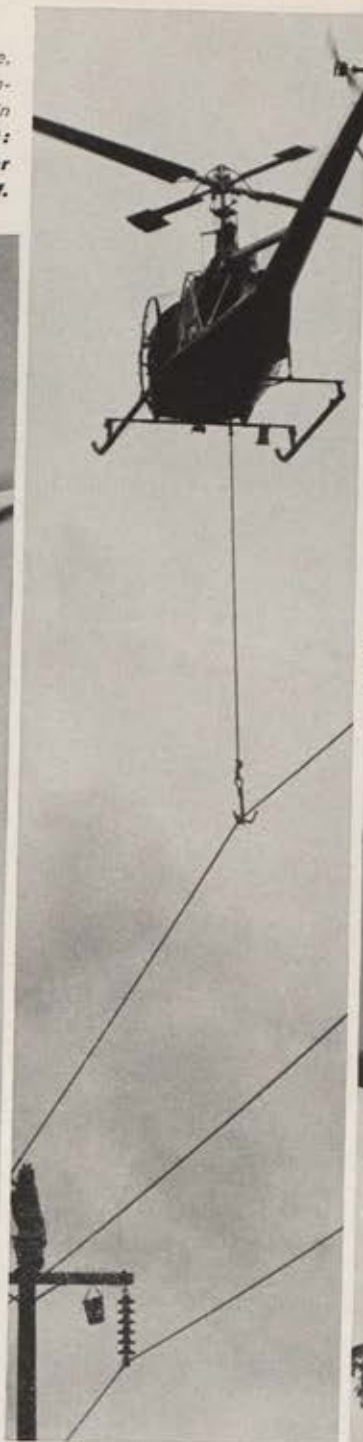
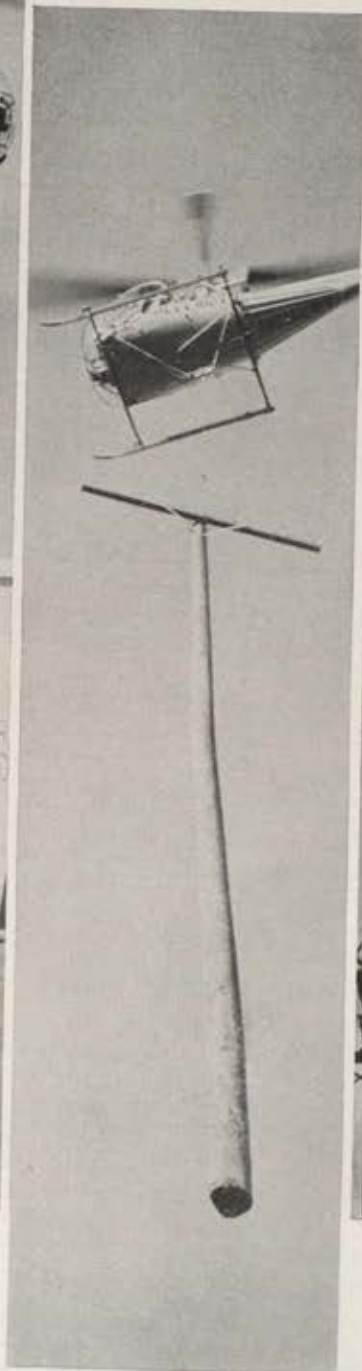
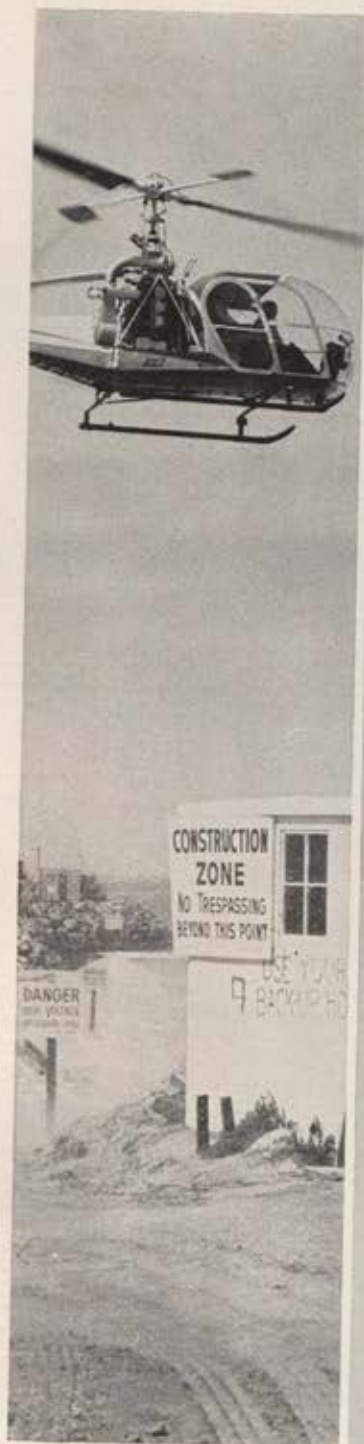
to accomplish the same mission in some other medium—in the atmosphere, or under the sea, or even underground? Do any of these alternatives promise such advantages as being easier, more reliable, faster to achieve, or cheaper?

Recently, the Senior Vice President-Technical at Aerospace Corporation, Allen F. Donovan, made this down-to-earth comment: "When we try and look at what we can do in space, we find that this is an area about which there has been a lot of talk but relatively little real analysis. Many people have made such statements as, 'Space is the important area of the future; it is really going to be essential for military and scientific reasons; we have got to get into it; we have got to accomplish things in space.' But if you ask why, you get sort of blank response; nobody seems to know why. I think, fundamentally, and psychologically, this intuition of the people may be right; but if it is right, then it ought to be our job to determine why it is right and see what it is that will make it worthwhile. And if it is not right, then we ought to be able to determine that it is not and proceed to figure out what we should do instead."

Now, of course, Mr. Donovan was exaggerating somewhat, because we in the United States (doubtless the same could be said for the USSR) have done a lot of thinking about what makes spaceflight capability genuinely unique: extremely high speed, extremely high altitude (providing a long-ranging line of sight to large areas), and near-infinite flight duration. It wasn't much of a trick to figure out numerous military applications for devices with such attractive performance specifications: global communications, worldwide weather observation, reconnaissance, early-

(Continued on page 111)

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warning systems, etc., etc. And it was relatively easy to focus on some of the obstacles that make difficult the military exploitation of space technology in all the ways we desire. Two of the most craggy and most obvious of these, of course, are that our space-launching costs are too high, by at least one order of magnitude, and the life of our space payloads is too short, by about the same degree.

I am not at all sure that we're going to be able to cut our launching costs by all that today seems to be mandatory, or that we will learn how to prolong the life of our payloads to the ripe old age we want. Note, please, that I said, "That today seems mandatory."

Sometimes, I wonder how much optimism about the future utility of the airplane Calbraith Rodgers had on November 4, 1911, when he landed in Pasadena, Calif.—still twenty-five miles and several days from the end of the first American transcontinental flight. The statistics of his journey from New York to Pasadena included: mileage, 3,350; elapsed time, 49 days; longest hop, 265 miles; average speed while in the air, 40 mph; number of crashes, 15. Rodgers' Wright Flyer, at the finish, had been repaired and rebuilt so many times that only a single strut and the rudder of the original aircraft remained.

And yet, quite properly, the feat of Calbraith Rodgers was hailed as a portent of things to come. One journal of the day, after acknowledging that the elapsed time of the Rodgers flight was not so spectacular, especially when compared with the 1904 transcontinental record of fifteen days, set by an air-cooled Franklin automobile, was so bold as to predict that the day would surely shine when a cross-continent air journey, *inside a month*, would become commonplace!

But the predictions, a half century ago, respecting the airplane were not always so daring. To quote from the respected *Scientific American*:

"[We have] no wish to depreciate the skill shown by Curtiss in successfully dropping imitation bombs within an area which represented the deck of a battleship; but in the interests of truth and cold logic, we feel compelled to give it as our opinion that, so far as the future of naval warfare is concerned, this dexterous feat of the aviator has but little significance. . . .

"To hit a battleship with airplane bombs, even if they be let go from the perfected flyer of the future, is a problem most complicated. We do not hesitate to say that to take accurate aim from a safe height, clear of shrapnel fire, would involve such very accurate data and such complicated calculations of height, speed of airplane, speed of ship, speed of falling shell, wind velocity, direction of airplane flight, etc., and the shell if it did strike home would do such insignificant damage, that to affirm that the airplane is going to 'revolutionize' the naval warfare of the future is to be guilty of the wildest exaggeration."

To be entirely fair, one must admit that this editorializing wasn't too far from the truth—in terms of the 1910-11 technology. What was missing was a crystal ball which would show what new developments would come along in later years to make conservative

prophets out of the science-fiction writers of that day.

The story of the development of the airplane is, essentially, a two-theme book. In the first theme, there are numerous examples where we have expected too much too soon. The second theme is the thrilling account of what spectacular advances were made over the decades, the demonstration that we had underestimated greatly the progress we could make. Sometimes, the short-term failures threatened to result in consequences most serious to the long-term march of aeronautical progress, but just like in the cliff-hangers, at the crucial moment, a new advance was successfully attained, and the march continued!

Our problem—perhaps the most serious we face—is learning more perfectly than has been managed to date in other technologies, how to eliminate the faulty analysis of what we really want to accomplish, how we propose to reach our goals, and how soon—applying our best possible effort—we can expect to reach those goals. Then, of course, we must continue to improve our management techniques to translate soundly based confidence in what we can do into the vehicles that will permit us to accomplish what we desire, out in space.

The final words of a current best seller, *The Economics of Defense in the Nuclear Age*, are these:

"A generally useful way of concluding a grim argument of this kind would be to affirm that we have the resources, intelligence, and courage to make the correct decisions. That is, of course, the case. And there is a good chance that we will do so. But perhaps, as a small aid toward making such decisions more likely, we should contemplate the possibility that they may *not* be made. They *are* hard, *do* involve sacrifice, *are* affected by great uncertainties, and concern matters in which much is altogether unknown and much else must be hedged by secrecy; and above all, they entail a new image of ourselves in a world of persistent danger. It is by no means certain that we shall meet the test."

What we do in the future, respecting military applications in space, is bound in a very large way to affect "The Economics of Defense in the Nuclear Age" that Messrs. Charles J. Hitch and Roland N. McKean discuss—and to be affected by those economics.

We can do what we must. And that we shall.—END



Mr. Bonney has been a member of the Board of Directors of the Air Force Association for a number of years and has served several times on its Policy Committee. He is a long-time student and historian of the aviation, and now the space, scene. An AAF veteran of World War II, his professional career includes eight years as Director of Public Relations for the Bell Aircraft Corporation and eleven years with the National Aeronautics and Space Administration and its predecessor, NACA. Currently, he is Director of Public Information for the Aerospace Corporation, the non-profit corporation which provides technical support for the Air Force's Ballistic Missile Division.



Wright Air Development Division researcher tries out a hand-held rocket to propel himself through the air during a zero-G flight aboard specially modified KC-135.

ALL IN A WEIGHTLESS



Ordinary tools are ineffective in zero-G. Screwdriver (above) must be replaced by squeeze-type device.

NASA moon-probe hardware gets a ride aboard C-131 also used for zero-G studies.





Head-down, a weightless researcher propels himself, using adaptation of an Army infantry rocket back pack.

Hand gun must be used with precision or it gives operator a push — right into a bad spin.

Experimenter tries out hand-held gyroscope to improve his stability.



DAY'S WORK

A VARIETY of experimental hardware to aid human performance in subgravity is being designed and evaluated in the Air Force's expanding research into problems of weightlessness. Zero-gravity research during the past year or so in a modified C-131 aircraft at Wright Air Development Division, Wright-Patterson AFB, Ohio, has resulted in the construction and testing of more than five separate stability and propulsion systems for men floating freely in space.

Propulsion devices evaluated have used compressed air as a propellant. Higher-performance chemical propellants can be substituted in any system that allows a man to move with certainty and without strain. The propellant tanks have been located in back packs in all of the promising designs, and the thrust nozzles have been hand-held or fitted to back braces. Thrust level has been varied from two to twenty pounds.

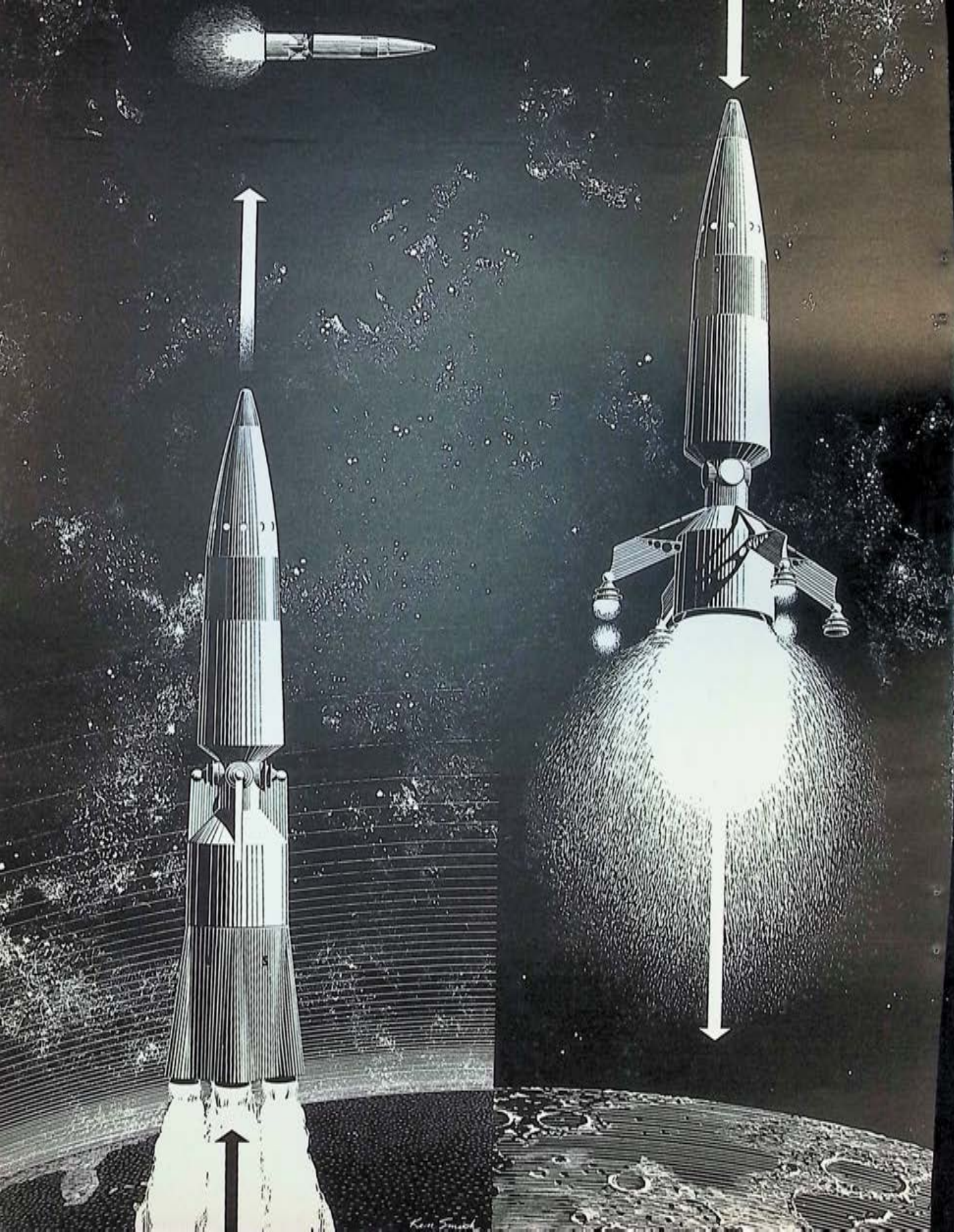
One interesting approach uses a hand-held, encased gyroscope spinning at 3,000 rpm. This has led to the preliminary design of a small, back-pack stabilization and propulsion unit using two gyroscopes. One gyro will be fixed and the other can be controlled by the crewman to propel himself in a completely controlled manner. Electric power to turn the gyros will come

from the space vehicle through a cord. The crewman would control the unit through a lever on his chest.

Experiments performed during the approximately fifteen seconds of weightlessness which can be achieved aboard the C-131 also have shown that: Men need special squeeze tools with "closed force circuits" to perform simple mechanical assembly tasks when tethered by loose lines to the outside of an orbiting space vehicle; pilots strapped into their seats during zero-G prefer highly damped control systems; man's ability to judge the weight of objects and perform maintenance tasks is reduced under zero-gravity.

Experimental capability has recently increased through the assignment of a KC-135 to Wright Air Development Division for subgravity research. The KC-135 provides a maximum of thirty-four seconds of zero-G and a much larger working space than was available on the C-131. The increased volume makes it possible to observe complete fluid systems in operation during zero-G.

Detailed observations may be repeated many times, offering an advantage that cannot be duplicated by zero-G tests aboard rocket vehicles. Cryogenic propellant feed systems for rockets and hydraulic power units are scheduled for test.—J. S. BUTZ, JR.



MARQUARDT ROCKET ENGINES SPAN THE POWER SPECTRUM

Recently developed throttleable engine capable of 250,000 pounds of thrust

A large rocket engine burning high-energy boron fuel and a storable oxidizer has demonstrated the highest performance ever attained with storable liquid propellants. In a static test firing the engine operated at 98% efficiency using a combustor design developed from high-energy fueled ramjets. The tests — part of a program sponsored by the Air Force — although limited to 100,000 pounds of thrust, proved an operational capability exceeding any ever attained with storable liquid propellants in large scale firings.

The concept of Energy Management¹ as applied to a variety of space systems requires rocket engines with throttling and restart capabilities. Marquardt liquid rocket engines share the following distinct advantages: throttleable rocket performance; ability to be restarted at altitude; near theoretical maximum performance; scaling by multiplicity; no regenerative cooling.

Marquardt has also achieved significant performance results in the development and testing of liquid rockets in the low and intermediate thrust range — from one pound to 15,000 pounds. These rockets are throttleable over a wide thrust range with no efficiency drop-off (see C* efficiency graph shown at right).

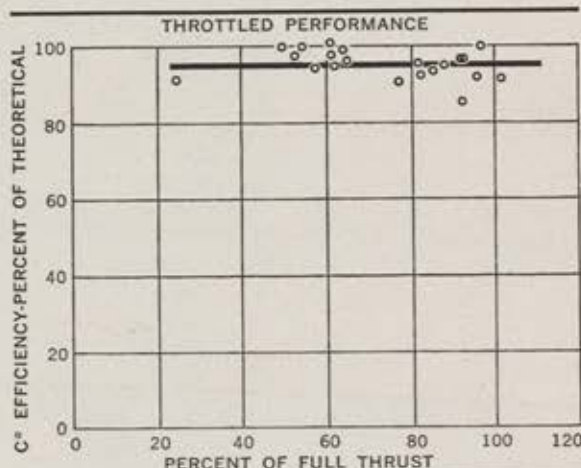
Radiation cooled rockets can be controlled accurately down to a few milliseconds in duration — as low as 0.003 pound-seconds impulse bits. A radiation cooled rocket motor has operated for over 23 minutes at a thrust efficiency of 90%. This design has demonstrated reliable ignition at 10^{-5} mm of mercury.

The development of rocket power plants of advanced design and near theoretical maximum performance is based upon sixteen years of experience and leadership in the propulsion field. Successful participation in and direction of more than 100 major high-altitude research rocket programs including the Explorer VIII and Vanguard satellite launching programs lend further support to Marquardt's leadership in the propulsion field. Capabilities in the research rocket area range from solid propellant rocket motor design and fabrication through final data reduction and information presentation.

For information concerning Marquardt propulsion systems contact Don L. Walter, Vice President, Power Systems Group.

Scientists and engineers experienced in the fields of advanced propulsion devices are invited to investigate exceptional career opportunities with The Marquardt Corporation.

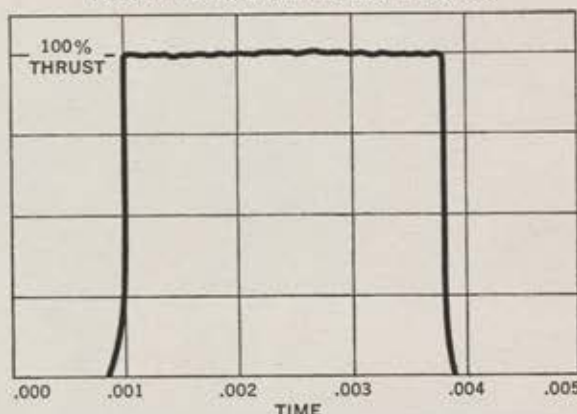
¹Energy Management—The technique of programming the use of stored chemical energy in a space system for maximum performance.



VARIABLE THRUST ROCKET ENGINE

A typical group of rocket test firings using storable liquid propellants prove an average C* efficiency of 95% over a wide throttling range.

THRUST LEVEL: FROM ONE TO 15,000 POUNDS
PULSE WIDTH: DOWN TO .003 SECONDS



DOCUMENTED IMPULSE CAPABILITY

The above trace represents one impulse bit — demonstrating controllability of pulse width down to .003 seconds.

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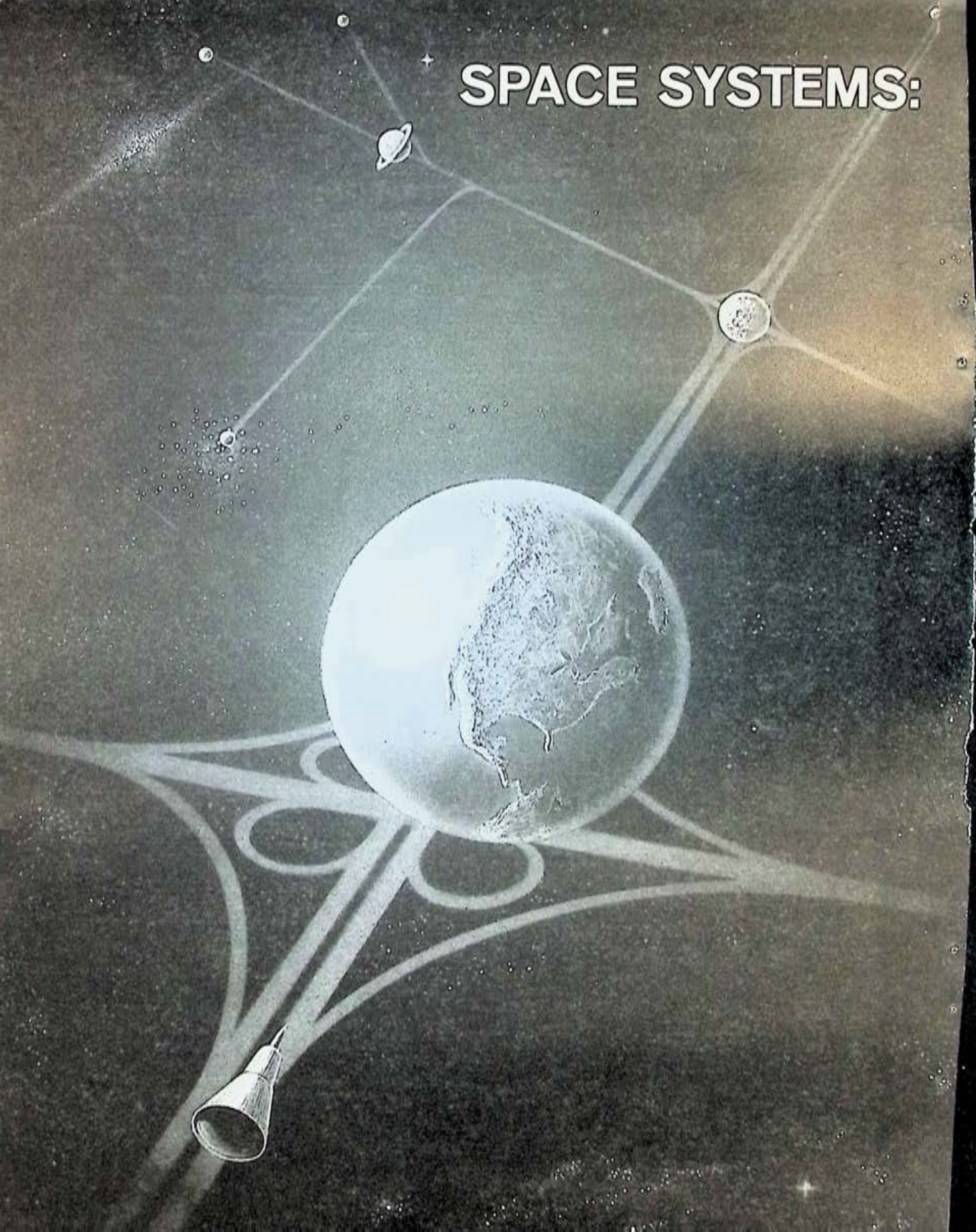
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SPACE SYSTEMS:



FROM TALENTS TO HARDWARE

LOOK TO GENERAL PRECISION FOR DEVELOPMENT, PRODUCTION AND SYSTEMS MANAGEMENT

The talents and capabilities of the four divisions of General Precision, Inc., are heavily represented in the latest space systems, as well as in space-age hardware and weapons of all categories. The divisions are responsible for some system, subsystem or component on virtually every space vehicle, satellite, missile, rocket and aircraft now in operation or development.

To make these broad capabilities available to the fullest of their combined potential, General Precision, Inc., has consolidated its four divisions for the systems management of major new space and weapons projects.

A major space program can now draw upon more than 2½ million square feet of combined General Precision floor space and over 16,000 General Precision employees, including 4,500 scientists, engineers and technicians.

This combination of talents and facilities, backed by the corporate financial resources of General Precision, Inc., makes it possible to develop, produce and manage a space system as an integrated package.

GENERAL PRECISION'S DEMONSTRATED CAPABILITIES:

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B-70
B-52

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ACQUISITION
AND
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VENUS STUDY
TALOS
NAVY ASW
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BOMARC-B
ASROC
SUBROC
B-58
F-106A
A3J-1
F8U-1 & 2
F11F-1
DC-8
707
880



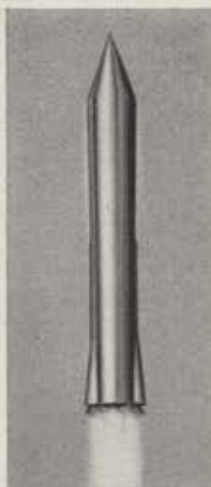
MIDAS



BOMARC-B



B-70



CENTAUR



ATLAS



POLARIS

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SPACEPOWER for a Soaring Decade

Manned Aerospace Flight Projects and Study Programs

● MERCURY

NASA top-priority program to place US Astronaut in low (some 120 miles) orbit, for an expected three passes around the earth, followed by parachuted capsule reentry and recovery at sea. Choice for first orbital mission has narrowed down to three of original seven Astronauts assigned to program in 1959. Three include one Air Force, one Navy, and one Marine veteran test pilot. Project headquarters at NASA Langley Research Center, Langley AFB, Va. Ballistic trajectory flight by primate in McDonnell-built capsule mounted aboard Army Redstone missile already successfully achieved; manned ballistic trajectory flights in capsule expected in 1961, and actual manned orbital flight hoped for in 1961. Mercury capsule by McDonnell Aircraft Corp.; orbital boost by USAF Convair Atlas ICBM. Human factors support by Air Force, Navy, Army.

● APOLLO

NASA follow-on program to Mercury, to develop manned spacecraft with capability of useful earth-orbiting missions and manned circumlunar flight. Apollo craft would probably use "module" concept, i.e., separate self-contained elements, including a command center to house the crew during launch and reentry stages of flight, serving also as the flight-con-

trol center during the mission; the propulsion module, to serve primary function of providing safe return to earth in case of an aborted mission (for circumlunar flights, propulsion module would have capability of making midcourse corrections to attain and leave lunar orbit—for earth-orbit flights, propulsion module would probably have maneuverability capability for orbital change or rendezvous with other vehicles); the mission module would provide living quarters and scientific equipment for orbital and circumlunar mission. Saturn 1.5 million-pound-thrust engine would probably be used as booster. Apollo program is still in study stage at NASA, pending actual Mercury mission.

● X-15

Air Force-NASA program, with naval funding and pilot support—first conceived in 1952. Air launch of North American Aviation-built rocket-powered craft from under wing of Boeing B-52; to attain altitudes of fifty to 100 miles at speeds which some estimates have placed as high as 4,500 mph. From maximum altitude, X-15 will glide home to a dead-stick landing, obtaining data on aerodynamic heating at hypersonic speeds, pilot capabilities under high-accelerative stresses and during several minutes of weightlessness anticipated during the flight. Some 136,500 feet (August 1960) and 2,905 mph (March 1961) speed already attained in powered flights from air launch. All three vehicles accepted in 1960 by USAF and turned over to NASA for executive management of program. Propulsion: 50,000-pound-plus-thrust liquid-fueled engine by Reaction Motors Division of Thiokol. Actual mission hoped for in 1961.

● DYNA-SOAR

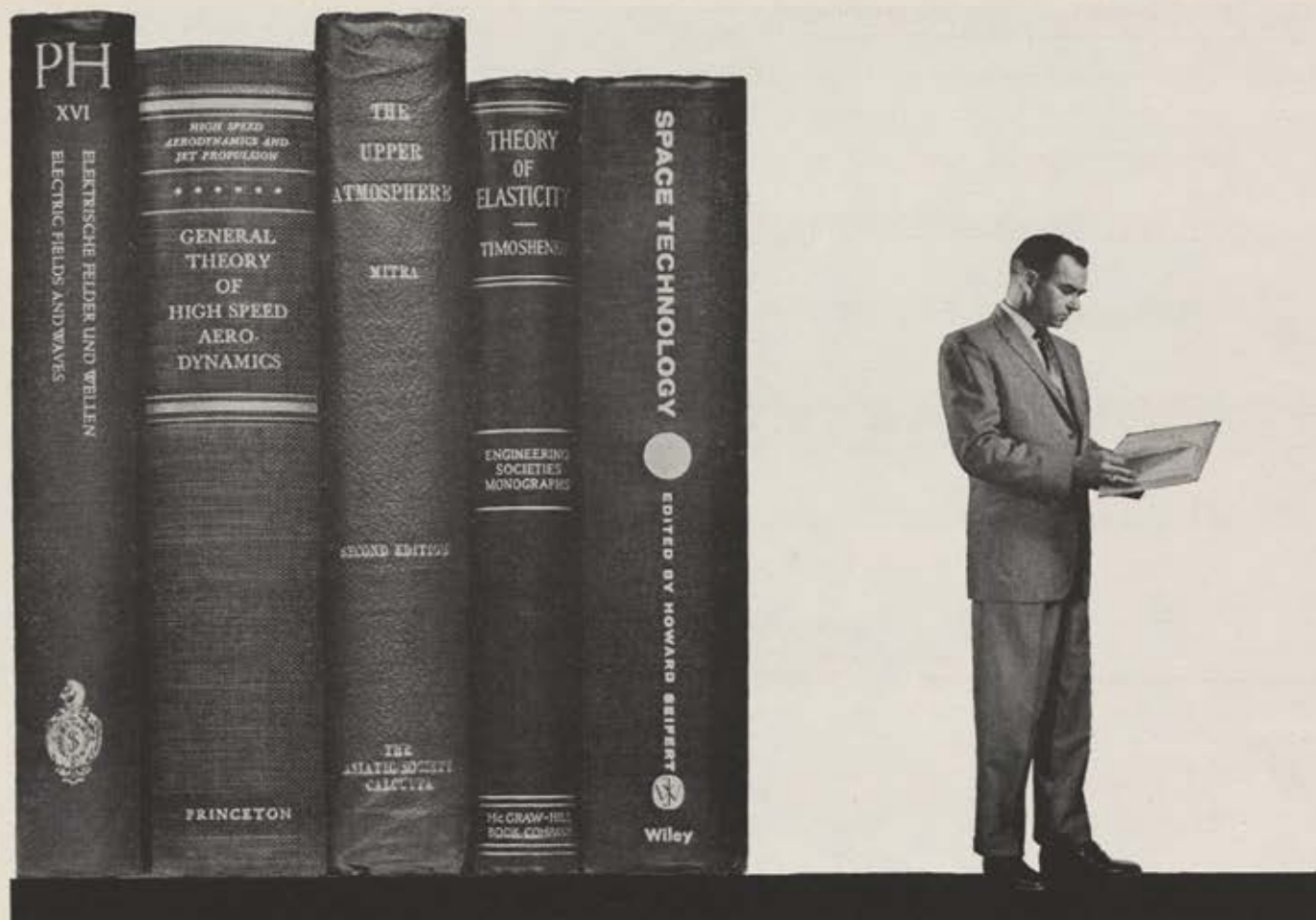
Air Force follow-on program to X-15, manned hypersonic glider, to be launched by modified USAF Martin Titan II ICBM, to orbital speed and altitude, to be followed by glide reentry at low angle through upper atmosphere and landing at preselected point. Mission: to test feasibility of manned orbital glider system. Boeing and Martin Companies head industrial teams, with Boeing handling glider vehicle and Martin propulsion. Minneapolis-Honeywell provides guidance; RCA handles communications link. USAF Wright Air Development Division is prime contractor. USAF glider training program under study. Actual mission hoped for in mid- or late 1960s.

● AEROSPACE PLANE

USAF feasibility studies of a manned aerospace craft
(Continued on page 121)

Mercury capsule got an Atlas-boosted ride to 107-mile peak altitude during test February 21. Manned ballistic flights are expected soon.





scientists and engineers in a unique leadership role

Able minds are at work within Aerospace Corporation. The scientists and engineers of this leadership organization are the critical civilian link uniting government and the scientific-industrial team developing space systems and advanced ballistic missiles. In providing broad scientific and technical leadership to every element of this team, they are engaged in a balanced program of activities spanning the spectrum from basic research and forward planning through general systems engineering to technical review, monitoring, and steering of hardware development by industry. Their singular role installs the men of Aerospace Corporation in a position to make real progress. They are privileged to view both the state of the art and system development in their totality. They are thus able to implement objectively, decisively, and with all due timeliness and economy, major advances in the national interest. Now more men of their caliber are needed: highly motivated scientists and engineers with demonstrated achievement, maturity, judgment, and discretion beyond the norm. Such men are urged to contact Aerospace Corporation, Room 107, P.O. Box 95081, Los Angeles 45, California.

*Organized in the public interest and dedicated to providing objective leadership
in the advancement and application of space science and
technology for the United States Government.*



AEROSPACE CORPORATION

**From the largest
to the fastest
of pilotless aircraft**



Sperry "flies" them all

The highest levels of performance and reliability in pilotless flight are currently being attained at Sperry Phoenix. Working with the Department of Defense and in cooperation with other leading American defense contractors, Sperry has played a major role in "droning" virtually every type of airborne vehicle.

Soon the Lockheed F-104 — with a special Sperry drone stabilization and control system — will fly precision, unmanned missions for the U.S. Air Force at double-sonic speed and altitudes of 60,000 feet and above. It is the

fastest of pilotless aircraft, just as the Sperry-equipped QB-47 is the largest. To meet the Army's difficult battlefield surveillance mission, Aerojet-General's SD-2 reconnaissance drone also employs Sperry stabilization and control.

No organization has had more experience in drone control than Sperry. Beginning with the first aerial torpedo in 1915, this experience covers a wide spectrum, including QB-17, QF-80, SD-2, QB-47 and QF-104. Sperry Phoenix now is delivering to USAF a revolutionary Microwave Command Guidance System

permitting precision remote control of many types of pilotless craft over hundreds of miles.

Sperry's pilotless flight capability encompasses both components and complete systems . . . points to a host of new applications, including the newest and most challenging—spacecraft and rocket-booster recovery.

SPERRY

SPERRY PHOENIX COMPANY, DIVISION OF SPERRY RAND CORPORATION, PHOENIX, ARIZONA

which would have capability of taking off from a conventional airfield in a conventional aerodynamic manner, then accelerating itself into orbit, where it would have rocket-powered maneuverability, and capability of reentering atmosphere and landing on conventional airfield. Various technical approaches, including absorption of ambient oxygen to use in an oxygen-hydrogen rocket system, and nuclear engines, are under study.

- SLOMAR

USAF studies of manned logistics spacecraft to serve operational space systems. Various industrial study contracts. Wright Air Development Division prime contractor.

- SMART

USAF study, in-house, at Ballistic Missile Division of feasibility of manned satellite maintenance and repair techniques. Smart and SLOMAR concepts may be merged into a single project.

Vehicles, Vehicle Programs, Vehicle Studies

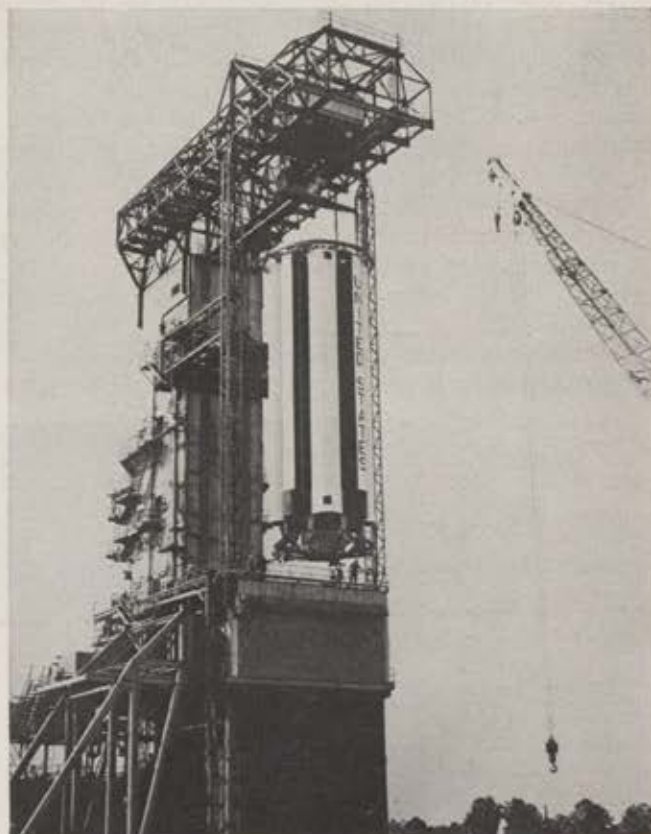
The family of space vehicle combinations contemplated for scientific and military uses during the '60s includes those combinations already being phased out, their incoming replacements, and study programs for superthrust systems, as well as nonchemical systems.

In the first category are such items as the Army-developed REDSTONE missile, which will be phased out by NASA after service as a booster for the upcoming manned ballistic trajectory flights associated with Project Mercury; the JUNO II Army-developed vehicle which has been used for space-probe missions by NASA, and will soon be phased out after final use in a radiation probe program; the Air Force-developed ATLAS-ABLE and THOR-ABLE combinations which have been used by NASA in moon-probe attempts and to boost various satellites into orbit, and which are phasing out. These first-generation combinations are being replaced by newer combinations such as the ATLAS-AGENA-B, and THOR-AGENA-B (*see below*), which essentially are improved versions of upper stages, specifically designed for space-boosting jobs, mounted on modified Air Force Atlas ICBMs and Thor IRBMs. Also in the replacement category is the ATLAS-CENTAUR combination (*see below*), which is in a much earlier stage of development than the early Agena combinations, which have already performed successfully.

Also, there are "interim" vehicles such as THOR-DELTA and THOR-ABLE-STAR (*see below*). It should be pointed out that Atlases and Thors will eventually be phased out as SATURN and other superthrust vehicles become available as first-stage boosters.

To keep the listing of vehicles current, we have omitted those above described which are almost or already phased out, since they will have only historical significance as the space decade proceeds.

The other categories—new superthrust programs and nonchemical propulsion systems—are represented by



NASA's Saturn booster, in its giant gantry, is readied for test firing at the civilian space agency's Marshall Spaceflight Center at Huntsville, Ala., during summer, 1960.

such items as the NASA SATURN (*see below*) project to create a million-pound-plus first-stage liquid-fueled engine cluster, and the follow-on NASA Nova program (still not firm) to build a six-million-pound-plus-thrust first-stage liquid-fueled cluster. Also significant are Air Force and NASA programs in million-pound-plus solid-fueled rocket systems, based on experience gained with NASA's SCOUT and USAF's BLUE SCOUT.

In addition, there are the important AEC-NASA studies in nuclear rocket propulsion (*see below*) and Air Force and NASA studies in some far-out propulsion systems based on magnetohydrodynamics and ionic and photon methods.

For purposes of clarification, it is noted that the Atlas designation in the following listing refers to the USAF Convair-built Atlas-D model ICBM, powered by three North American Rocketdyne liquid-fueled engines (two boosters and one sustainer) developing some 360,000 pounds of thrust. The Thor designation refers to the USAF Douglas-built IRBM, powered by a single Rocketdyne liquid-fueled engine developing more than 150,000 pounds of thrust.

- SATURN

NASA program, under way at Marshall Spaceflight Center, Huntsville, Ala., under direction of Dr. Werner von Braun, to develop superthrust multistage vehicle with a first-stage thrust of 1,500,000 pounds. First stage, a cluster of eight H-1 North American Rocket-

(Continued on following page)

dyne liquid-fueled engines (modifications of those used in Thor and Jupiter IRBMs). Possibly four upper stages contemplated, fueled by liquid oxygen and liquid hydrogen. Marshall Center, prime and booster. Douglas and Convair, upper stages. Pratt & Whitney, top-stage engines. Early configuration expected to have capability of orbiting 20,000-pound payload. Flight test expected in 1961. Test flight with upper stages scheduled for 1963. Saturn would provide US with thrust power surpassing *present* USSR capability.

● F-1

NASA program to develop single-chamber liquid-oxygen liquid-hydrogen engine, which might be used



Air Force Agena-A, used in Discoverer, Midas, Samos launches, gets a checkout at Lockheed static test stand, Santa Cruz, Calif.

with NASA Nova program (*see below*), succeeding Saturn. North American Rocketdyne, prime contractor. Flight test hoped for in 1963.

● ATLAS-AGENA-B

USAF-NASA two-stage vehicle adaptable for both military and scientific missions, including Air Force Midas and Samos polar-orbiting early-warning and observation satellite systems (*see below*). Combines first-stage Atlas, with second-stage Agena-B, powered by Bell Aerospace liquid-fueled engine, with restart capability. Agena-B is 15,000-pound-thrust version of Agena-A, which had been used in earlier stages of USAF Discoverer polar-orbiting test program from Vandenberg AFB, Calif. First-stage airframe by Convair, second by Lockheed. Prime contractor, Lockheed.

● THOR-AGENA-B

USAF two-stage vehicle currently used in Discoverer program, consisting of first-stage Thor IRBM, and second-stage Agena-B described above. NASA is planning to use Thor-Agena-B for a variety of scientific missions, as successor to previously used IRBM-based configurations such as Thor-Able, Thor-Delta, and Juno II. Expected by NASA to be capable of placing 1,600 pounds in a 300-nautical-mile orbit. For meteorological, geophysical satellite programs.

● THOR-DELTA

NASA configuration of now-phased-out Thor-Able four-stage vehicle, including first-stage Thor, with upper-stage guidance. NASA Goddard Spaceflight Center, prime contractor. Douglas, booster. Bell, guidance. North American Rocketdyne, Aerojet-General, Allegany Ballistics Laboratory, propulsion. Being used as launch vehicle for NASA Tiros meteorological and Echo communications satellite programs, pending succession of Thor-Agena-B, after 1962.

● ATLAS-CENTAUR

USAF-NASA program to develop two-stage, high-thrust general-purpose space vehicle. Combines first-stage Atlas with projected Centaur second stage to be powered by two Pratt & Whitney liquid-oxygen liquid-hydrogen engines with some 30,000 pounds of thrust. Guidance by Minneapolis-Honeywell. Convair, prime contractor. Expected capability of placing 8,500 pounds into a 300-nautical-mile orbit or some 1,450 pounds into planetary probe missions. First test flight scheduled in 1961.

● NOVA

NASA concept (not a firm program) for superthrust multistage vehicle with possibly five stages. First-stage thrust would exceed 6,000,000 pounds (some estimates suggest figures as high as 12,000,000 pounds). First stage, a cluster of North American Rocketdyne F-1 liquid-fueled engines. Second stage, a single F-1 engine. Third, fourth stages fueled by liquid oxygen and liquid hydrogen, and fifth stage by a storable liquid propellant. Nova is described by NASA as but one of several possible approaches to such missions as manned landings on the moon.

● SCOUT

NASA four-stage "economy" all-solid-fueled vehicle with basic mission of placing 150-pound payloads in 300-nautical-mile orbit. Also usable for high-altitude soundings. Chance Vought, prime contractor. Aerojet-General, Hercules, Thiokol, Allegany Ballistics Laboratory, propulsion. Minneapolis-Honeywell, guidance. First-stage thrust, some 100,000 pounds. Research and development hoped to be completed in 1961. Was used for launch of Explorer IX in February 1961.

● BLUE SCOUT

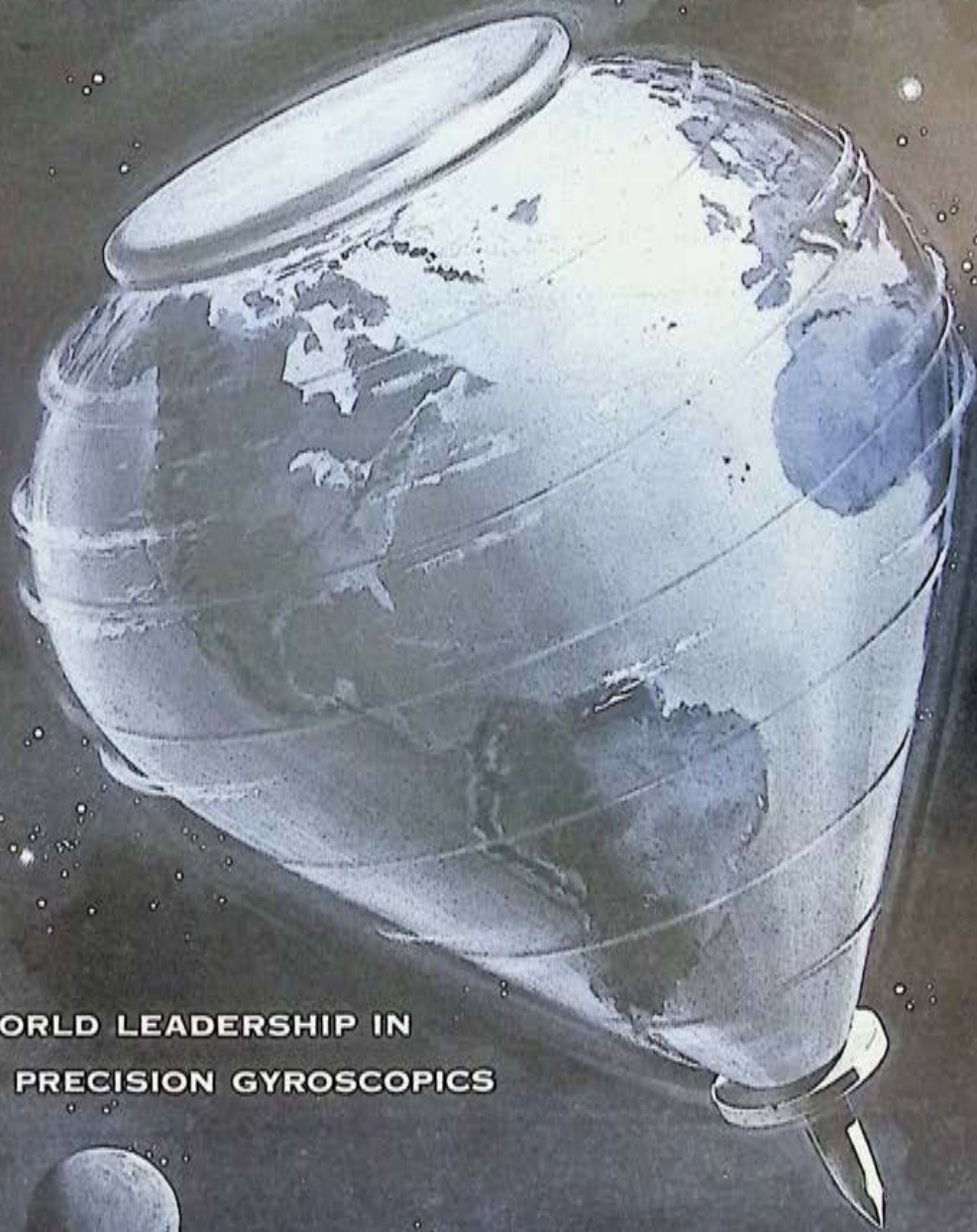
USAF solid-fueled multistaged vehicle designed for military sounding and orbital projects. Based on modification of NASA Scout vehicle. Aeronutronic Division of Ford Motor Co., prime contractor. USAF Ballistic Missile Division, program management. Procurement through NASA. Aerojet-General, Hercules, Thiokol, propulsion. Minneapolis-Honeywell, guidance. First-stage thrust, more than 100,000 pounds.

● LITTLE JOE

NASA solid-fueled vehicle, using eight solid-fueled modified Army-developed Sergeant rockets, fired sequentially. Used for testing Mercury capsule. Air-
(Continued on page 125)

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frame by North American. Propulsion by Thiokol. Combined thrust, some 370,000 pounds.

● THOR-ABLE-STAR

USAF-NASA three-stage vehicle, with orbital capability of some 800 pounds, and with restart capability in top stage. Used to launch Navy's Transit navigation satellite, and Army's Courier signal test satellite. Space Technology Laboratories, prime contractor. First stage, Thor, liquid fueled by North American Rocketdyne. Second stage, liquid fueled by Aerojet-General. Third stage, solid fueled by Allegany Ballistics Laboratory.

● PROJECT 3059

USAF studies into feasibility and demonstration of million-pound-plus-thrust solid-fueled vehicle. Aerojet-General has a demonstration program contract with USAF for segmented-solid vehicle. Grand Central has

space-oriented projects beyond the feasibility study phase has been assigned to the Air Force, except when "unusual circumstances" justify assignment of research and development to the other military services. Existing assignments, such as the ADVENT and COURIER communications satellite programs in the Army, and the TRANSIT navigation satellite program in the Navy, stay where they are (*see below*).

The Secretary of Defense, under the new directive, reserves the right to assign operational space systems to any of the services, after research and development are completed.

Nonmilitary space projects are the responsibility of the National Aeronautics and Space Administration, with large-scale launchings (beyond the research rocket category) usually handled by the Air Force.

Scientific Projects

● PIONEER

Over-all project name for series of space-probe missions under NASA direction, including lunar and deep-space probes, latest of which was PIONEER V, launched March 11, 1960, into a solar orbit between earth and Venus, and carrying a 94.8-pound "paddle-wheel" satellite. Pioneer is to be differentiated from the EXPLORER designation, which applies to NASA's earth satellite series (*see below*).

Most recent—unsuccessful—PIONEER effort was the December 15, 1960, attempt to launch a probe to the lunar vicinity. Pioneer series began in 1958. Launchings have been by the Army and Air Force for NASA, have employed Army-developed JUPITER-C and follow-on JUNO II vehicles in Army firings, and THOR-ABLE and ATLAS-ABLE in Air Force firings. Launches from Air Force Missile Test Center, Cape Canaveral.

● TIROS

First-generation NASA meteorological satellite program using television cameras to photograph cloud cover of the earth from orbits inclined to the equator by some fifty degrees, some 400 miles out. Tiros I launched successfully in 1960. Tiros II, similar orbit, with improved instrumentation, launched in November 1960. At least one more Tiros expected to be launched. Payload development managed by Army Signal Corps, with Radio Corporation of America.

● NIMBUS

Follow-on to NASA Tiros program. Second-generation meteorological satellite, to be launched into polar orbit, with earth-oriented stabilization system. GE prime contractor. Project director, Goddard Spaceflight Center. To be boosted into orbit by Thor-Agena-B. Launchings expected 1962 through 1964.

● AEROS

Third-generation follow-on NASA program (not firmly scheduled) to Nimbus meteorological satellite, to be placed in stationary orbit, some 22,000 miles out. In planning stage, with possible launches in 1964 or

(Continued on page 127)

Pioneer I,
launched by Air
Force in October
1958, scored
impressive first
by traveling some
70,000 miles
into space.



USAF contract to study best cost-effective approaches to million-pound-plus-thrust solid-fueled systems and is expected to build scale models.

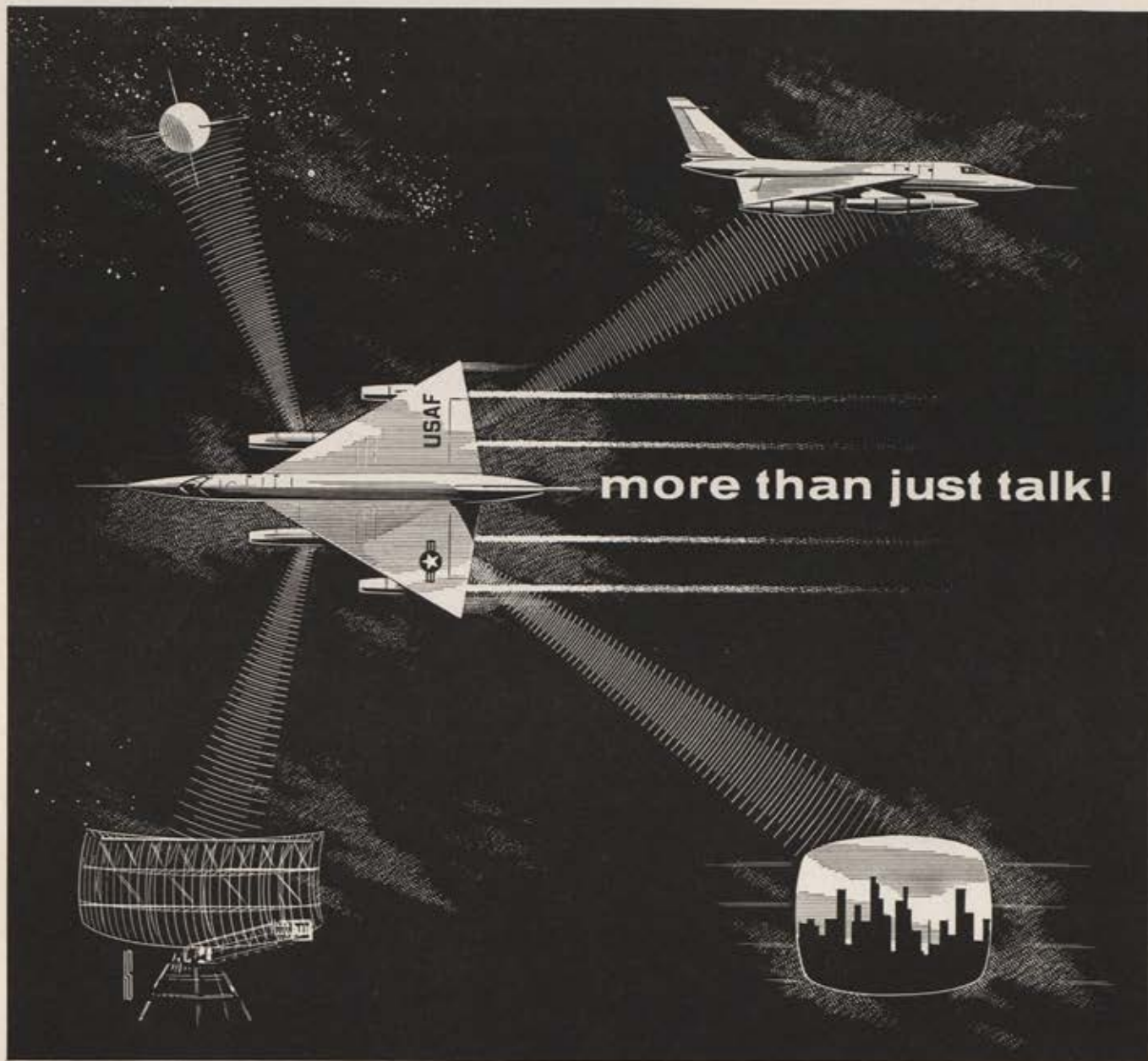
In addition, Aerojet-General, Grand Central, Thiokol, and United Technology have NASA contracts in this area. USAF and NASA programs are described as complementary.

● ROVER

Atomic Energy Commission-NASA project to develop nuclear rocket system, with AEC providing nuclear reactor and NASA the nonnuclear components and liquid-hydrogen propellant. Industrial contracts to be let soon, according to reports at this writing.

Specific-Mission Space Projects and Feasibility Studies

Following is a listing of current civilian and military projects geared to specific missions or in feasibility study stages. On the military side, under the March 1961 directive of the Secretary of Defense (*see page 40*), responsibility for research and development of

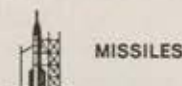


Magnavox continues to maintain a position of leadership in the airborne communications field.

Magnavox engineering, in conjunction with the Air Force, has developed an advanced airborne communication system that is designed to meet the requirements of the future. Utilizing wide band techniques, such functions as television relay for bomb damage assessment, data link for control and identification, and many other forms of air-to-air and air-to-ground communications can all be realized over the same equipment as used for voice.

Magnavox

AN/ARC-50 SYSTEM



1965. Contractors unannounced at this writing. Boost would be by Saturn or Centaur vehicles, if available.

● ECHO

NASA passive communications satellite program to place 100-foot inflatable plastic spheres in orbit for relay of signals from earth. Echo I successfully placed in orbit and demonstrated feasibility of system August 1960. Langley Research Center directs program. Additional launches expected in 1961 and 1962. Communications relay experiments conducted by NASA's Jet Propulsion Laboratory personnel at Goldstone, Calif., and the Bell Telephone Laboratories at Holmdel, N. J.

● REBOUND

NASA follow-on program to Echo (not firm) which would utilize a number, at least twelve, of passive communications satellites spaced around the globe. Possible launchings in 1963-65 period; some reports say 1962.

● RELAY

NASA studies in active-repeater communications satellite system, utilizing a large number of lightweight, some eighty-five-pound, satellites, for commercial applications. Contracts unannounced at this time.

● ORBITING ASTRONOMICAL OBSERVATORY

NASA program to orbit a 3,500-pound astronomical observatory carrying telescopic equipment. Project direction by Goddard Spaceflight Center. Grumman, prime contractor. Westinghouse, electronic components. First launch reportedly scheduled for 1963. Atlas-Agena-B to be used as booster.

● ORBITING GEOPHYSICAL OBSERVATORY

NASA program to launch 1,000-pound satellites to take geophysical measurements. Project direction by Goddard Spaceflight Center. Space Technology Laboratories, prime contractor. First launch reportedly scheduled for 1963, using Atlas-Agena-B booster.

● ORBITING SOLAR OBSERVATORY

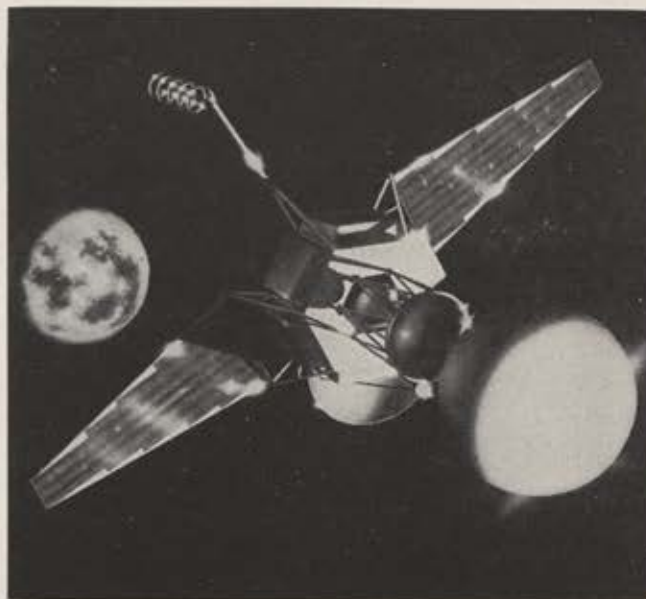
NASA program to launch 350-pound observational payload to obtain solar data, with constant instrumentation orientation toward the sun. Project direction by Goddard Spaceflight Center. Ball Brothers, prime contractor. First launch reportedly scheduled for 1961, using Thor-Delta booster.

● RANGER

NASA program to rough-land 300-pound instrument package on the moon. Jet Propulsion Laboratory, prime contractor. Aeronutronic Division of Ford Motor Co., capsule development. Hercules, retrorocket. Expected launch, using Atlas-Agena-B, 1962.

● SURVEYOR

NASA program to soft-land 100-300 pounds of instrument payload on the moon. Under direction of Jet Propulsion Laboratory. Hughes, prime contractor. Atlas-Centaur to be booster. First launch planned for 1963.



Artist's conception of NASA's Ranger vehicle which will rough-land a 300-pound instrumented capsule on the surface of the moon and relay scientific data back to earth.

● PROSPECTOR

NASA follow-on program to Surveyor, under study at Jet Propulsion Laboratory, to soft-land mobile instrument package on moon, capable of exploring lunar surface within radius of some fifty miles. Contracts unannounced at this writing. First launches, using Saturn booster, hoped for by 1965.

● MARINER

NASA program to send instrumented probes to vicinities of Mars and Venus. Payload weights of 600-1,200 pounds planned. Atlas-Agena-B to be used as booster. Jet Propulsion Laboratory, prime contractor. Some seven launches planned, with an initial launch toward Venus scheduled for 1962.

● VOYAGER

NASA follow-on program to Mariner, to send instrumented probes to orbit Mars and Venus, using Saturn as booster, with possibility of ejecting instrument capsules for landing on planetary surfaces. In study stages at Jet Propulsion Laboratory. First launches hoped for by 1965.

● NASA INTERNATIONAL PROGRAMS

NASA has a number of agreements with foreign nations for cooperation in tracking networks, for launching of foreign scientific payloads, for fellowships and exchange programs, and for assistance to European efforts in the planning of cooperative space research programs. These include planned launch of a Canadian upper atmosphere sounding payload, use of a Scout vehicle to launch a British scientific payload into orbit, plans with Australia for mapping Southern Hemisphere atmospheric ultraviolet radiation, sodium-vapor sounding rocket programs with Italy, and possible atmospherical sounding programs with Japan.

(Continued on following page)

The NASA Office of International Programs handles such negotiation and planning.

- NERV

NASA recoverable radiation-probe program. General Electric payload. Launch in 1960.

- SUNFLOWER

NASA program to develop spaceborne solar power system, suitable to generate three kilowatts continuously for a year's orbit. Lewis Research Center directs project. Thompson Ramo Wooldridge Inc., to deliver two flight prototypes in 1963, for demonstration in 1964.

Military Projects

- DISCOVERER

USAF series of polar-orbiting launchings by Ballistic Missile Division from Vandenberg AFB, Calif., to gather data on vehicle attitude stabilization, environmental information for biomedical studies, payload recoverability. Eventual test with simian aboard. Vehicles currently used: first stage, Thor; second stage, Agena-B which in entirety goes into orbit; developed by Lockheed, powered by Bell liquid-fueled engine. Twenty-one successful launches at this writing. Midair recovery of capsules has been achieved. Data fed into Air Force Midas and Samos programs (*see below*). Lockheed, prime contractor.

- MIDAS

Missile Defense Alarm System—USAF program in research and development stage to place a series of satellites in polar orbit to detect aggressive missile launches by infrared. Upcoming vehicle: first stage, Atlas; second stage, Agena-B, which goes into orbit in entirety carrying payload. Successful launch of test vehicle May 1960, but transmitting devices failed after brief interval. Lockheed, prime contractor.

- SAMOS

USAF R&D program to place series of observation satellites in polar orbit. Upcoming vehicle: first stage, Atlas. Second stage, Agena-B which orbits in entirety, carrying payload. Successful launch of test vehicle January 1961. Lockheed, prime contractor.

- SAINT

USAF research and development program to develop satellite inspection system. USAF Ballistic Missile Division directing project. RCA, prime contractor.

- TRANSIT

Navy navigational satellite program, utilizing Doppler principle. Johns Hopkins Applied Physics Laboratory provides payload. Feasibility demonstrated. Three successful launches, two in 1960, one in 1961. Operational use, utilizing system of four satellites, scheduled for 1962.

- ADVENT

Army twenty-four-hour instantaneous repeater com-

munications satellite research and development program. Army Signal Corps directs project, with Bendix development instrumentation. Advent satellite would utilize a number of satellites at approximately 22,000-mile altitude. Launching, using Atlas-Centaur booster, hoped for by 1962. Advent is one phase of communications satellite study program formerly under aegis of ARPA, as is Courier (*see below*).

- COURIER

Army delayed-repeater communications satellite payload research and development program. Army Signal Corps directs project. Philco, payload development. Radiation, Inc., antenna systems. International Telephone & Telegraph Corp., ground stations. Successful launching of test vehicle in October 1960, with successful transmission of messages and pictures. Courier is being phased into Advent program (*see above*).

- ARENTS

ARPA study involving launch, possibly in 1962, using Atlas-Centaur booster, of payloads to approximate 22,000-mile orbits to obtain data on exposure of materials, radiation detection information. Convair, prime contractor.

- BAMBI

ARPA study of ballistic missile booster intercept systems.

- ORION

Formerly ARPA study, now in USAF, of space station maneuverable by controlled nuclear explosions. General Dynamics, prime contractor. In study stage.

- ANNA

Department of Defense study, with triservice participation, of small, 50-100-pound geodetic satellite system. Launches possible in 1961.

- SR-178

USAF studies of short-term manned reconnaissance system which would have capability of obtaining quick observational data.

- YO-YO

Navy studies of sateloid vehicles, sea-launched, to make single orbital passes for quick reconnaissance.

- PONTUS

ARPA advanced materials studies.

- DEFENDER

ARPA antimissile studies.

- PRINCIPIA

ARPA solid-fuel studies.

- SEA SCOUT

Navy-proposed system to launch space vehicles from seaborne pads, using solid-fueled vehicles.

—WILLIAM LEAVITT

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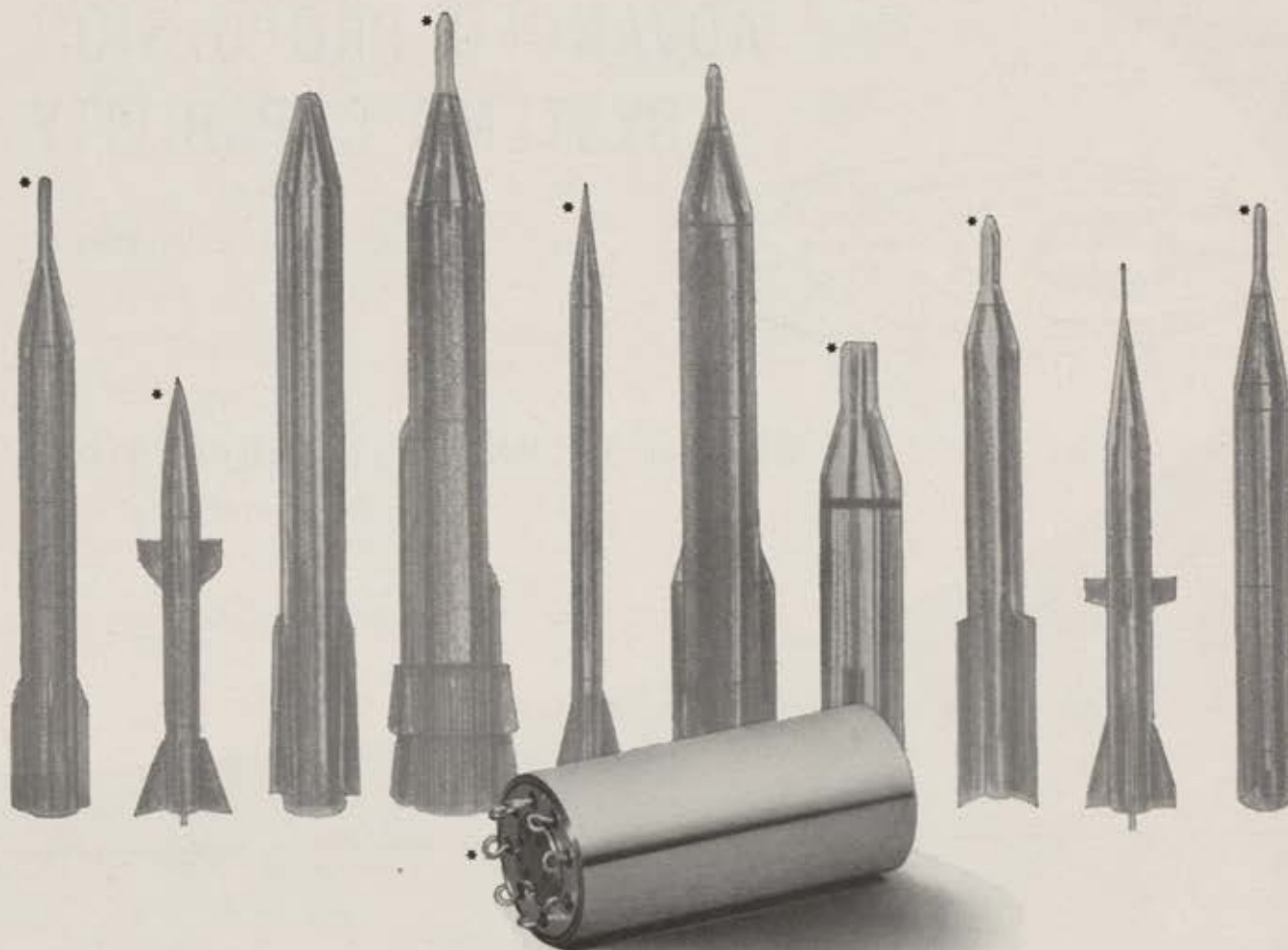
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What Went Up, When It Went, Is It Still Up There?

Satellite Scoreboard . . . US and USSR

DISCOVERER: Systems evaluation of launch techniques, orbital performance, recovery techniques, and advanced engineering tests.

No.	Launch Date	Place	Launch Vehicle	Project Direction	Program Result
I	2/28/59	Vandenberg	Thor-Agena-A	ARPA-USAF	Achieved orbit; down 3/5/59.
II	4/13/59	Vandenberg	Thor-Agena-A	ARPA-USAF	Achieved orbit; timer malfunction prevented capsule recovery; down 4/26/59.
III	6/3/59	Vandenberg	Thor-Agena-A	ARPA-USAF	Orbit not achieved.
IV	6/25/59	Vandenberg	Thor-Agena-A	ARPA-USAF	Orbit not achieved.
V	8/13/59	Vandenberg	Thor-Agena-A	ARPA-USAF	Achieved orbit; rocket carrier down 9/28/59; capsule down 2/11/61.
VI	8/19/59	Vandenberg	Thor-Agena-A	ARPA-USAF	Achieved orbit; capsule ejected but not recovered; rocket carrier down 10/20/59.
VII	11/7/59	Vandenberg	Thor-Agena-A	ARPA-USAF	Achieved orbit; capsule could not be separated; down 11/26/59.
VIII	11/20/59	Vandenberg	Thor-Agena-A	USAF	Achieved orbit; capsule ejected but could not be located; carrier rocket down 3/7/60.
IX	2/4/60	Vandenberg	Thor-Agena-A	USAF	Orbit not achieved.
X	2/19/60	Vandenberg	Thor-Agena-A	USAF	Orbit not achieved.
XI	4/15/60	Vandenberg	Thor-Agena-A	USAF	Achieved orbit; capsule ejected but not observed; down 4/26/60.
XII	6/29/60	Vandenberg	Thor-Agena-A	USAF	Orbit not achieved.
XIII	8/10/60	Vandenberg	Thor-Agena-A	USAF	Achieved orbit; capsule successfully recovered from ocean 8/11/60; carrier rocket down 11/14/60.
XIV	8/18/60	Vandenberg	Thor-Agena-A	USAF	Achieved orbit; capsule recovered from midair by C-119; carrier rocket down 9/16/60.
XV	9/13/60	Vandenberg	Thor-Agena-A	USAF	Achieved orbit; capsule ejected and sighted but not recovered; carrier rocket down 10/18/60.
XVI	10/26/60	Vandenberg	Thor-Agena-A	USAF	Orbit not achieved.
XVII	11/12/60	Vandenberg	Thor-Agena-B	USAF	Achieved orbit; capsule recovered from midair by C-119 11/14/60; carrier rocket down 12/29/60.
XVIII	12/7/60	Vandenberg	Thor-Agena-B	USAF	Achieved orbit; capsule recovered after 48 orbits by C-119; carrier rocket still in orbit in mid-March.
XIX	12/20/60	Vandenberg	Thor-Agena-B	USAF	Achieved orbit; no recovery capsule; mission to collect infrared data in support of programs such as Midas; down 1/23/61.
XX	2/17/61	Vandenberg	Thor-Agena-B	USAF	Achieved orbit; malfunction prevented release of capsule; no recovery attempt; still in orbit.
XXI	2/18/61	Vandenberg	Thor-Agena-B	USAF	Achieved orbit; no recovery capsule; Agena engine successfully restarted in space; carried instruments to measure and radio back earth's temperature; still in orbit.

EXPLORER: Early US satellite program, still going on, to conduct various studies.

No.	Launch Date	Place	Launch Vehicle	Project Direction	Program Result
I	1/31/58	Canaveral	Jupiter-C	Army	Achieved orbit; first US satellite; discovered Van Allen radiation belt; estimated lifetime 7-10 years.
II	3/5/58	Canaveral	Jupiter-C	Army	Orbit not achieved.
III	3/26/58	Canaveral	Jupiter-C	Army	Achieved orbit; yielded data on radiation belts and micrometeor impacts; down 6/27/58.
IV	7/26/58	Canaveral	Jupiter-C	ARPA-Army	Achieved orbit; provided data on radiation and analysis of earth's magnetic field; down 10/23/59.
V	8/24/58	Canaveral	Jupiter-C	ARPA-Army	Orbit not achieved.
(none)	7/16/59	Canaveral	Juno II	NASA	Orbit not achieved.
VI	8/7/59	Canaveral	Thor-Able	NASA	Achieved orbit; obtained television pictures of cloud cover; mapped Van Allen radiation belt; estimated lifetime 2 years; still in orbit.
VII	10/13/59	Canaveral	Juno II	NASA	Achieved orbit; provided data on radiation and magnetic storms; first micrometeorite penetration of a sensor in flight; estimated lifetime 20-30 years; still in orbit.
(none)	3/23/60	Canaveral	Juno II	NASA	Orbit not achieved.
VIII	11/3/60	Canaveral	Juno II	NASA	Achieved orbit; provided data on the ionosphere and micrometeorites; estimated lifetime of 10 years; still in orbit.
(none)	12/4/60	Wallops	Scout	NASA	Orbit not achieved.
IX	2/16/61	Wallops	Scout	NASA	Achieved orbit; successful orbit launch with solid-fuel rocket; 12-foot polka-dot sphere was to determine atmospheric density; short lifetime expected; still in orbit mid-March.
X	3/25/61	Canaveral	Thor-Delta	NASA	Achieved highly elliptical, short-lifetime orbit designed to explore magnetic fields and solar winds out 120,000 miles from earth.

SATELLITE SCOREBOARD . . . US AND USSR

CONTINUED

VANGUARD: Test of launch vehicle for US-International Geophysical Year earth-satellite program.

No.	Launch Date	Place	Launch Vehicle	Project Direction	Program Result
(none)	12/6/57	Canaveral	Vanguard	Navy	Orbit not achieved.
(none)	2/5/58	Canaveral	Vanguard	Navy	Orbit not achieved.
I	3/17/58	Canaveral	Vanguard	Navy	Achieved orbit; revealed earth to be pear-shaped; one transmitter still operating; estimated lifetime of 200-1,000 years.
(none)	4/28/58	Canaveral	Vanguard	Navy	Orbit not achieved.
(none)	5/27/58	Canaveral	Vanguard	Navy	Orbit not achieved.
(none)	6/26/58	Canaveral	Vanguard	Navy	Orbit not achieved.
(none)	9/26/58	Canaveral	Vanguard	Navy	Orbit not achieved.
II	2/17/59	Canaveral	Vanguard	NASA	Achieved orbit; wobble prevented interpretation of cloud-cover data; estimated lifetime of 10-100 years.
(none)	4/13/59	Canaveral	Vanguard	NASA	Orbit not achieved.
(none)	6/22/59	Canaveral	Vanguard	NASA	Orbit not achieved.
III	9/18/59	Canaveral	Vanguard	NASA	Achieved orbit; surveyed earth's magnetic field; located lower edge of Van Allen radiation belt; estimated lifetime of 30-40 years.

SCORE: Test of reliability of Atlas as space vehicle and feasibility of voice and teletype relay via satellite.

No.	Launch Date	Place	Launch Vehicle	Project Direction	Program Result
(none)	12/18/58	Canaveral	Atlas ICBM	ARPA-USAF	Achieved orbit; first satellite known to have been guided into orbit by radio-inertial system; first time a human voice beamed from outer space; remained in orbit 34 days; down 1/21/59.

MIDAS: Systems test to detect missile launchings with infrared sensors.

No.	Launch Date	Place	Launch Vehicle	Project Direction	Program Result
I	2/26/60	Canaveral	Atlas-Agena-A	USAF	Orbit not achieved.
II	5/24/60	Canaveral	Atlas-Agena-A	USAF	Achieved orbit; transmissions ceased two days after launch; lifetime estimated 40 months.

SAMOS: Observation satellites in polar orbits.

No.	Launch Date	Place	Launch Vehicle	Project Direction	Program Result
I	10/11/60	Pt. Arguello	Atlas-Agena-A	USAF	Orbit not achieved.
II	1/31/61	Pt. Arguello	Atlas-Agena-A	USAF	Achieved near-circular polar orbit; lifetime unknown.

BEACON: Place inflatable sphere in orbit to study atmospheric density.

No.	Launch Date	Place	Launch Vehicle	Project Direction	Program Result
(none)	10/23/58	Canaveral	Jupiter-C	NASA	Orbit not achieved.
(none)	8/14/59	Canaveral	Juno II	NASA	Orbit not achieved.

ECHO: Place 100-foot inflatable sphere in orbit as reflector in communications experiments.

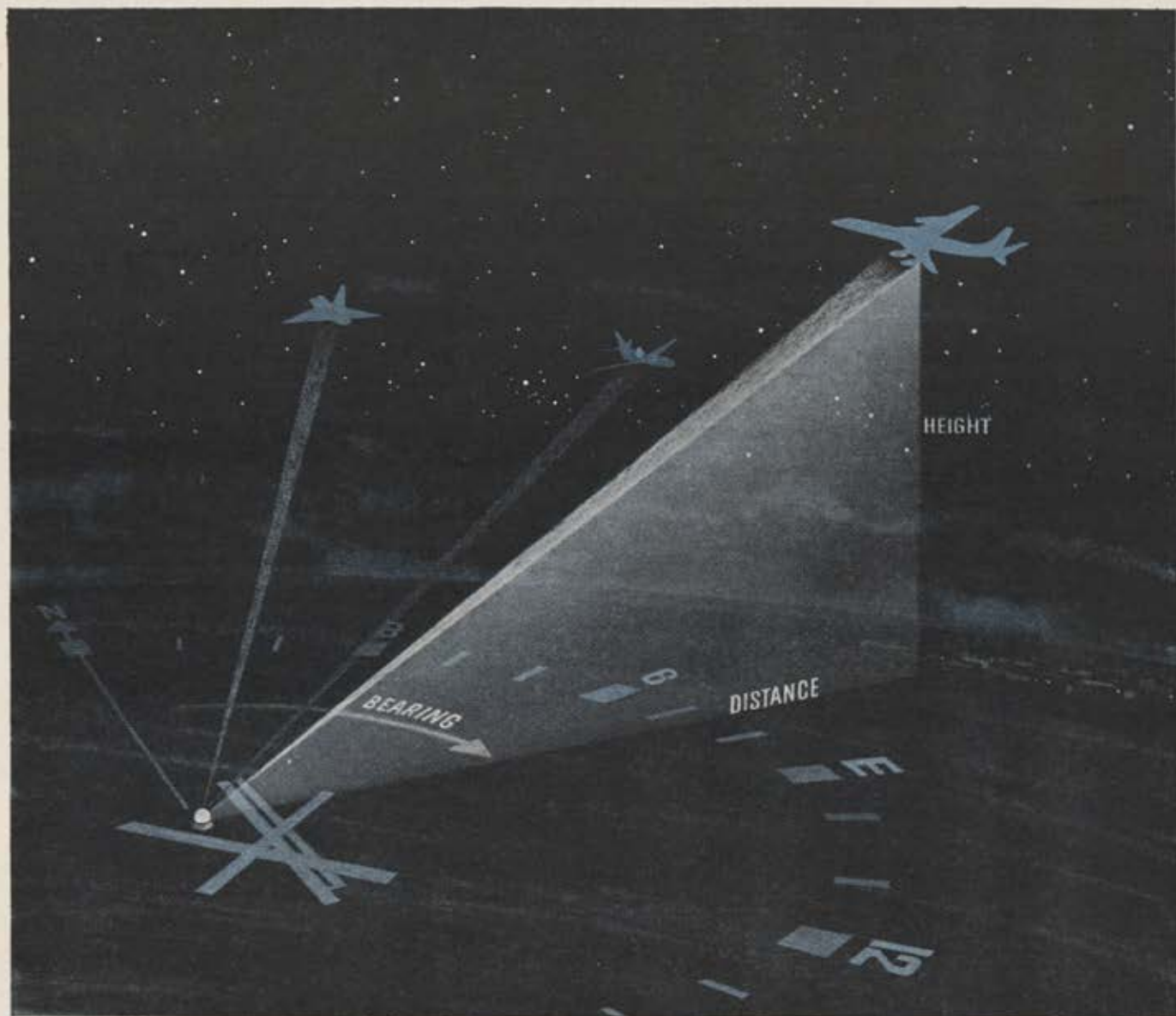
No.	Launch Date	Place	Launch Vehicle	Project Direction	Program Result
(none)	5/13/60	Canaveral	Thor-Delta	NASA	Orbit not achieved.
I	8/12/60	Canaveral	Thor-Delta	NASA	Achieved orbit; successful voice transmission from Goldstone, Calif., to Holmdel, N. J.; indefinite lifetime.

TIROS: Meteorological satellites using television and infrared equipment.

No.	Launch Date	Place	Launch Vehicle	Project Direction	Program Result
I	4/1/60	Canaveral	Thor-Able	NASA	Achieved near-circular orbit; video system relayed some 22,000 pictures of cloud cover during 78-day useful lifetime; expected to remain in orbit 50-100 years.
II	11/23/60	Canaveral	Thor-Delta	NASA	Achieved orbit; good data from narrow-angle camera and infrared instrumentation; still transmitting March 1961; expected to remain in orbit 50-100 years.

TRANSIT: Provide basis for global all-weather navigation for ships and aircraft.

No.	Launch Date	Place	Launch Vehicle	Project Direction	Program Result
I-A	9/17/59	Canaveral	Thor-Able	Navy	Orbit not achieved.
I-B	4/13/60	Canaveral	Thor-Able-Star	Navy	Achieved orbit, indicating feasibility of such a navigational system; expected lifetime of 16 months.
II-A	6/22/60	Canaveral	Thor-Able-Star	Navy	Achieved orbit, also placing in orbit Naval Research Lab solar-radiation satellite, marking first time two satellites were launched with a single vehicle; both still transmitting; expected lifetime of each about 50 years.
III-A	11/30/60	Canaveral	Thor-Able-Star	Navy	Orbit not achieved; second payload was NRL solar-radiation satellite.
III-B	2/21/61	Canaveral	Thor-Able-Star	Navy	Achieved highly elliptical, short-lifetime orbit; also placed in orbit Lofti satellite, for Low Frequency Trans-Ionospheric, designed to measure very-low-frequency signal intensities.



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EAST HARTFORD, CONNECTICUT



COURIER: Feasibility study for global military communications.

No.	Launch Date	Place	Launch Vehicle	Project Direction	Program Result
I-A	8/18/60	Canaveral	Thor-Able-Star	ARPA-Army	Orbit not achieved.
I-B	10/4/60	Canaveral	Thor-Able-Star	Army	Achieved orbit; estimated lifetime of several years.

PIONEER: Various deep-space probes.

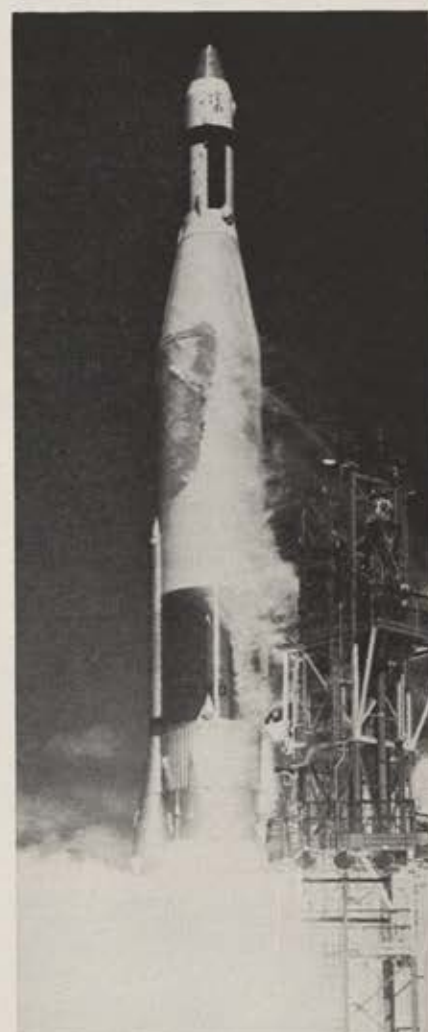
No.	Launch Date	Place	Launch Vehicle	Project Direction	Program Result
(none)	8/17/58	Canaveral	Thor-Able	ARPA-USAF	Lunar probe; first-stage engine failure after 77 seconds of flight caused explosion between 40,000 and 70,000 feet altitude.
I	10/11/58	Canaveral	Thor-Able	NASA-USAF	Lunar probe; unable to escape earth's magnetic field after reaching 70,700 miles; reentered 10/12/58; provided first measurements of interplanetary magnetic field.
II	11/8/58	Canaveral	Thor-Able	NASA-USAF	Lunar probe; third stage failed to ignite; reached peak altitude of 963 miles before reentry and destruction.
III	12/6/58	Canaveral	Juno II	NASA-Army	Deep-space probe; failed to reach escape velocity; peak altitude of 63,580 miles; discovered second radiation belt around earth; down 12/7/58.
IV	3/3/59	Canaveral	Juno II	NASA-Army	Achieved earth-moon trajectory and yielded radiation data; in 406.95-day solar orbit; expected lifetime of millions of years.
(none)	11/26/59	Canaveral	Atlas-Able	NASA-USAF	Lunar probe; payload shroud fairing broke away after 45 seconds of flight.
V	3/11/60	Canaveral	Thor-Able IV	NASA-USAF	"Paddlewheel" satellite; set long-distance transmission record from 22.5 million miles 6/26/60; in 311.64-day solar orbit; expected lifetime of millions of years.
(none)	9/25/60	Canaveral	Atlas-Able	NASA-USAF	Lunar probe; failed to achieve necessary velocity; vehicle destroyed on reentry.
(none)	12/15/60	Canaveral	Atlas-Able	NASA-USAF	Lunar probe; explosion destroyed vehicle at about 40,000 feet after 70 seconds of flight.

SPUTNIK: General name for Soviet Union earth-satellite program.

No.	Launch Date	Program Result
I	10/4/57	First earth satellite; payload weight of 184 lb.; provided new information on density and temperature of upper atmosphere; rocket case down 12/1/57; satellite down 1/4/58.
II	11/3/57	Payload weight of 1,120 lb. included dog "Laika"; provided ionospheric, cosmic-ray, and biomedical data; down 4/14/58.
III	5/15/58	Total weight in orbit, including 2,925-lb. payload, estimated at 3½ tons; rocket case down 12/3/58; payload down 4/6/60.
IV	5/15/60	Placed spacecabin and "dummy spaceman" in orbit in test of life-support systems; payload weight of 10,008 lb.; recovery failed when craft went into lopsided orbit instead of reentering; payload still in orbit; expected lifetime "relatively brief."
V	8/19/60	Test of capsule and recovery system for ultimate manned spaceflight; payload weight of 10,120 lb.; capsule reported to contain two dogs, rats, mice, flies, plants, fungi, seeds; reported to have been recovered on 18th orbit, 8/20/60, after traveling 437,500 miles.
VI	12/1/60	Test of equipment for ultimate manned spaceflight; 10,060-lb. payload reported to include 2 dogs, other animal and plant life; vehicle descended on uncalculable trajectory when signaled to return to earth and was destroyed on reentry, 12/2/60.
VII	2/4/61	Achieved orbit for 7.1-ton vehicle, heaviest satellite to date; no recovery attempt; down 2/26/61.
VIII	2/12/61	First satellite to launch another vehicle from orbit; also on 2/12/61, a 1,419-lb. "automatic interplanetary station" was launched from the Sputnik toward vicinity of Venus (see below).
IX	3/9/61	Five-ton vehicle; contained dog named Chernushka (Blackie); successfully brought back on command to preselected area.
X	3/25/61	Five-ton vehicle; contained dog named Zvesdochka (Little Star); successfully brought back on command to preselected area.

SOVIET DEEP-SPACE PROBES: Includes Luniks and Venus space probe.

No.	Launch Date	Program Result
Lunik I	1/2/59	Known as "Mechta" or "dream"; total weight reported to be 3,245 lb.; went into 443-day solar orbit; expected lifetime millions of years.
Lunik II	9/12/59	Payload weight estimated at 858.4 lb.; impacted moon 9/13/59 after traveling 236,865 miles in 35 hours.
Lunik III	10/4/59	Payload weight of 4,037 lb. including 614-lb. scientific satellite and last-stage rocket casing of 3,423 lb. carrying 345 lb. of scientific equipment; photographed 70 percent of moon's far side from 40,000 miles distance; pictures transmitted to earth; satellite went into translunar orbit; down 4/20/60.
Venus Probe	2/12/61	"Automatic interplanetary station" launched from Sputnik VIII in earth orbit; planned to reach vicinity of Venus late in May 1961; radio contact with earth lost shortly after launch.



Atlas booster with Agena vehicle at Cape Canaveral for first Midas try.



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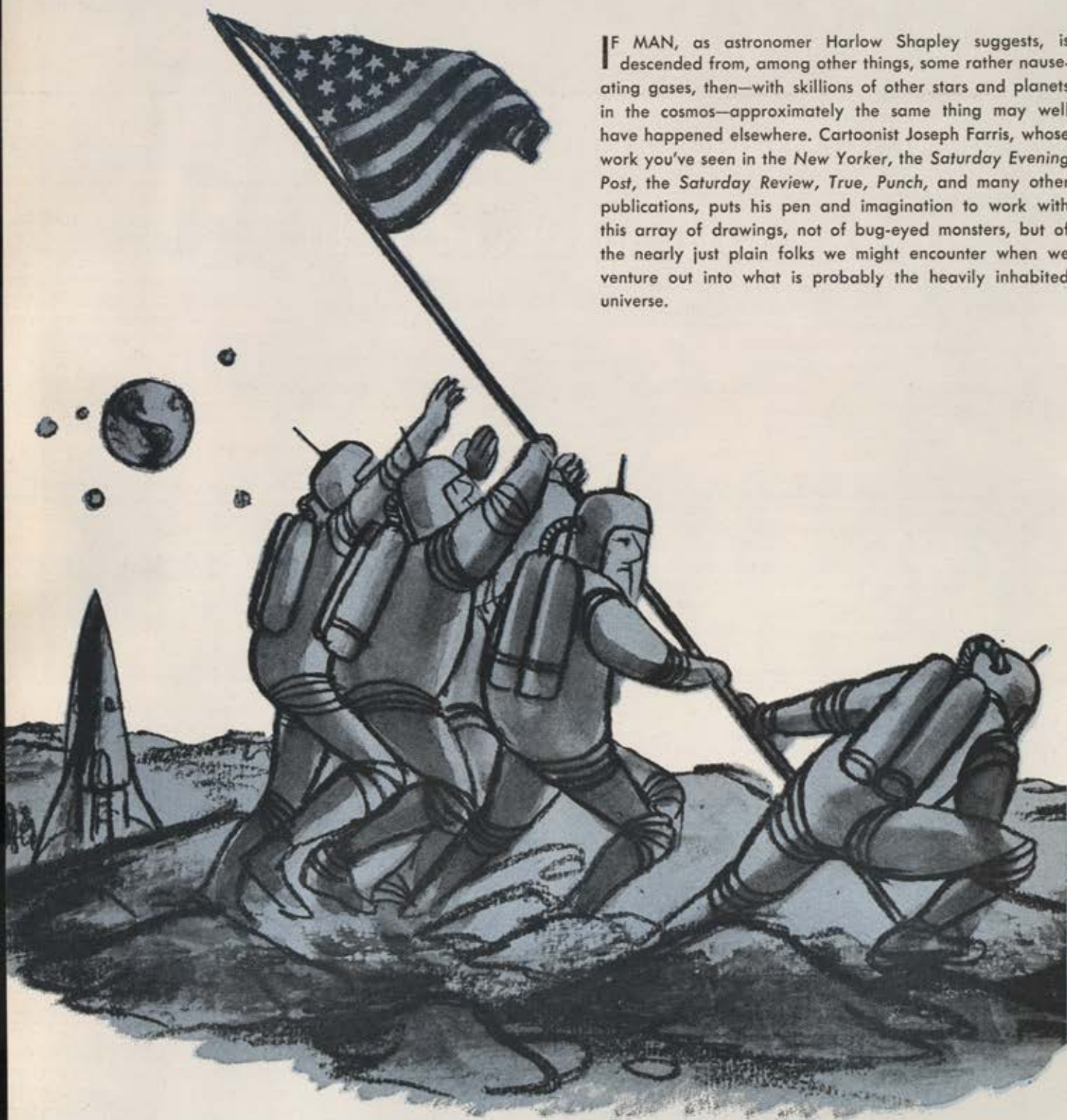
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IS ANYONE OUT THERE?

IF MAN, as astronomer Harlow Shapley suggests, is descended from, among other things, some rather nauseating gases, then—with skillions of other stars and planets in the cosmos—approximately the same thing may well have happened elsewhere. Cartoonist Joseph Farris, whose work you've seen in the *New Yorker*, the *Saturday Evening Post*, the *Saturday Review*, *True*, *Punch*, and many other publications, puts his pen and imagination to work with this array of drawings, not of bug-eyed monsters, but of the nearly just plain folks we might encounter when we venture out into what is probably the heavily inhabited universe.







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Creative technical intellects constitute a very substantial percentage of our nearly 5,000 employees. Our 15 or so really great scientists — national authorities on electronics, computers, propulsion, optics, magnetic phenomena, solid-state physics, applied mathematics and other phases of aerospace science — are only a small fraction of the full range of Kollsman brain power.

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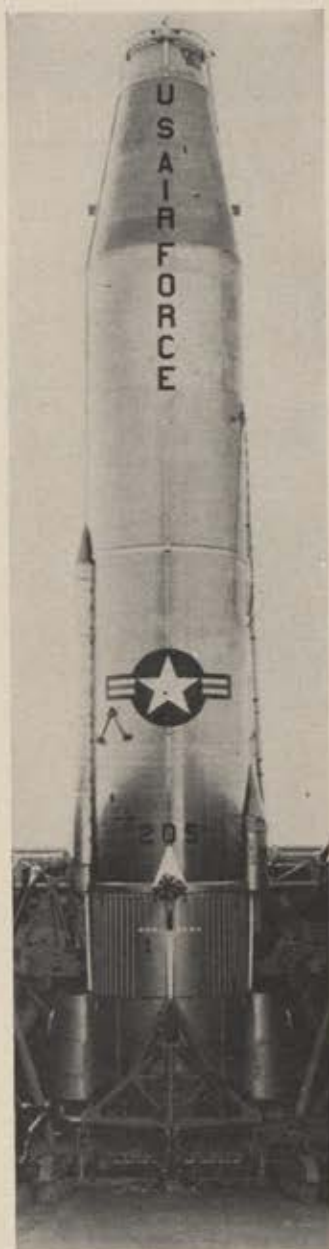
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Missiles and Space Weapons

AIR FORCE

ATLAS SM-65

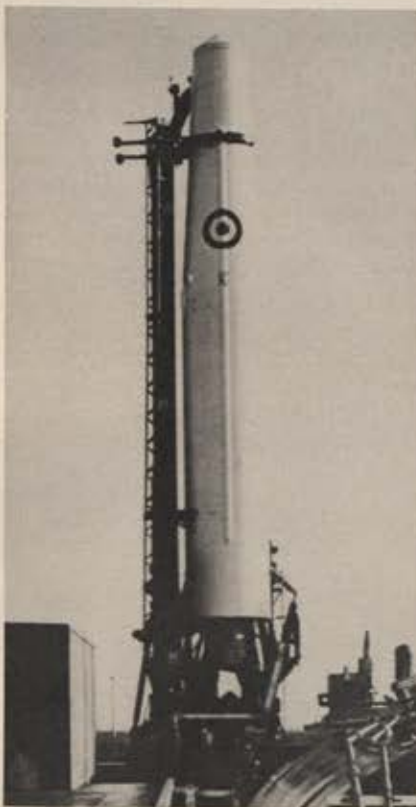
Type—SAC intercontinental ballistic missile (ICBM); prime contractor—Convair; maximum speed—over 15,000 mph; range—over 6,000 mi.; length—over 82 ft.; diameter—10 ft. for tank section, 16 ft. at base; weight—over 260,000 lb.; power system—liquid propellant, two boosters of 150,000-lb. thrust, one liquid-propellant sustainer of 60,000-lb. thrust and two verniers on the "D" model, large engine thrust on the advanced "E" and "F" models about 10 percent higher; guidance—radio-inertial on "D" model, all-inertial on "E" and "F"; warhead—nuclear; status—operational at Vandenberg AFB, Calif., total of 13 squadrons with 129 missiles and 13 spares scheduled; two "D" squadrons of 6 plus 1 spare in nondispersed, soft sites with one firing blockhouse; two "D" squadrons of 9 plus 1 spare in soft sites with 3 firing blockhouses; 3 "E" squadrons of 9 plus 1 spare in dispersed semihard, 25 psi coffin sites, with firing blockhouse for each site; six "F" squadrons of 12 plus 1 spare in dispersed, hard, 100 psi plus silo sites with firing blockhouse for each site; launch record by March 1961—51 successful out of 79 launchings, 12 partially successful, and 16 failures; other contractors—airframe, Convair; powerplant, North American Rocketdyne; guidance (radio-inertial), General Electric and Burroughs (all-inertial) Arma; nose cone, General Electric; systems engineering, Space Technology Laboratories.

TITAN SM-68

Type—SAC two-stage ICBM; prime contractor—Martin Co.; speed—over 15,000 mph; range—over 6,000 miles; weight—222,000 lb.; length—about 90 ft., first stage 53 ft.; diameter—first stage 10 ft., second stage 8 ft.; power system—liquid-propellant rockets in both stages, two 150,000-lb.-thrust engines in first stage and one 80,000-lb.-thrust engine in second stage; guidance—radio-inertial; status—developmental; advanced Titan II, under development, has approximately 10 percent more thrust from all engines, weighs more, has an all-inertial guidance system, will use storable propellants, and can be fired from silo-type "hard" emplacement in a few seconds after fire order is given; 14 operational squadrons of 10 missiles each are planned, 8 of

(Continued on following page)

which will be equipped with Titan II; Titan I missiles must be raised above their silo emplacements before launching. Modified Titan II will be used as booster for suborbital flights of the Dyna-Soar boost-glide vehicle, modification will consist of strengthening of the missile structure and the addition of four large fins on the aft end; **launch record** by March 1961—19 successful firings, 4 partially successful, and 6 unsuccessful; **other contractors**—airframe, Martin; powerplants, Aerojet-General; nose cone, Avco; guidance, Bell Telephone Laboratories, Arma, Sperry Rand; systems engineering, Space Technology Laboratories.



► **THOR**



► **JUPITER**

THOR SM-75

Type—Intermediate-range ballistic missile (IRBM); **prime contractor**—Douglas Aircraft Co.; **maximum speed**—more than 11,000 mph; **ceiling**—several hundred miles; **range**—over 1,650 mi.; **length**—65 ft.; **diameter**—8 ft.; **weight**—110,000 lb.; **power system**—single-stage liquid-propellant rocket engine, 150,000-lb. thrust, and two verniers; **guidance**—all-inertial; **warhead**—nuclear; **status**—operational, deployed to United Kingdom, with 4 British Royal Air Force squadrons of 15 missiles each, plans also called for deployment in Turkey; **launch record**—total IRBM launchings by March 1961, 65: successful, 44; partially successful, 11; unsuccessful, 10; total space firings by March 1961, 44: successful, 36; partially successful, 2; unsuccessful, 6; **other contractors**—airframe, Douglas; powerplant, North American Rocketdyne; guidance, AC Spark Plug; nose cone, General Electric; systems engineering, Space Technology Laboratories.



► **SNARK**

SNARK SM-62

Type—SAC air-breathing intercontinental cruise missile; **prime contractor**—North Division of Northrop Corp.; **cruise speed**—600 mph; **ceiling**—60,000 ft.; **range**—at best altitude, 7,300 mi.; at sea level 2,000 mi.; **length**—69 ft.; **span**—42 ft.; **diameter**—about 5 ft.; **takeoff weight**—50,000 lb. without boosters including 26,000 lb. of internal and external fuel; **power system**—J57-P-17 turbojet developing 10,500-lb. thrust at takeoff and 9,000-lb. thrust at cruise; two solid-propellant booster rockets for zero-length takeoff totaling 230,000-lb. thrust; **guidance**—self-contained, stellar-monitored inertial; **warhead**—nuclear; **deployment**—Presque Isle AFB, Me.; **launch record** (test series

complete)—over 60 successful flights; **other contractors**—airframe, Northrop; powerplant, Pratt & Whitney, Allegany Ballistics; guidance, Northrop.

JUPITER SM-78

Type—IRBM; **prime contractor**—Chrysler Corp., designed by the Army Ballistic Missile Agency; now under operational control of the USAF; **maximum speed**—over 11,000 mph; **range**—over 1,700 mi.; **maximum height of trajectory**—over 300 mi.; **length**—60 ft. 4 in.; **diameter**—9 ft.; **weight**—110,000 lb.; **power system**—single-stage, one liquid-propellant rocket, 150,000-lb. thrust; **guidance**—all-inertial; **warhead**—nuclear; **status**—operational, to be deployed in Italy and Turkey, 15 missiles per squadron; **other contractors**—airframe, Chrysler; powerplant, North American Rocketdyne; nose cone, Goodyear; guidance, Ford Instrument.

MINUTEMAN SM-80

Type—SAC solid-propellant ICBM; **prime contractor**—Boeing Airplane Co.; **speed**—over 15,000 mph; **range**—over 6,500 mi.; **length**—55 ft.; **diameter**—5.5 ft.; **weight**—65,000 lb.; **power system**—solid-propellant rockets, first stage, 170,000-lb. thrust, second stage, 65,000-lb. thrust, third stage, 35,000-lb. thrust; **guidance**—all-inertial; **warhead**—nuclear; **status**—developmental, expected to be operational in 1962; **launch record** and **program**—tethered silo launch phase complete, first launching was completely successful February 1960, long-range test launchings from train and from silo expected early in 1962; four Minuteman squadrons
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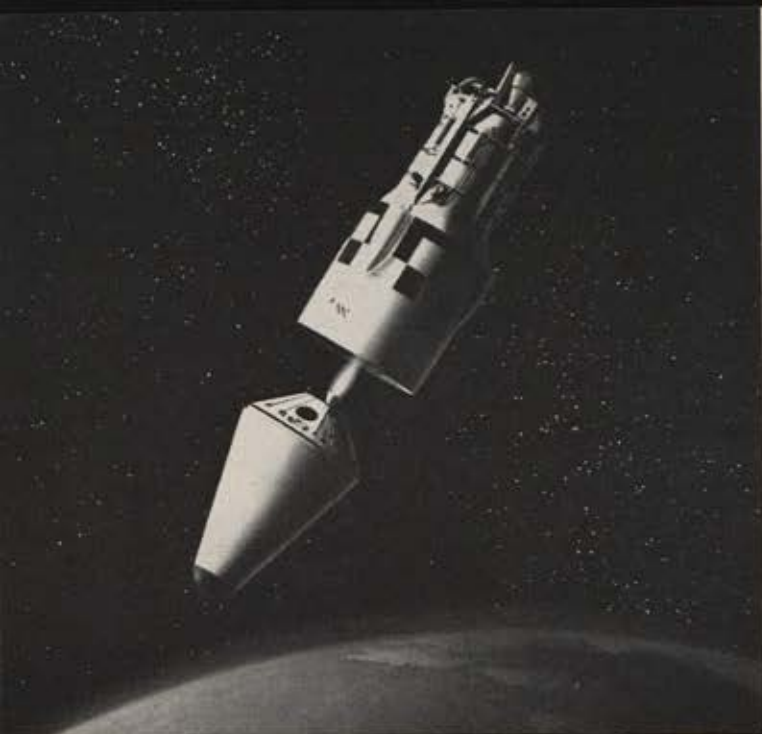


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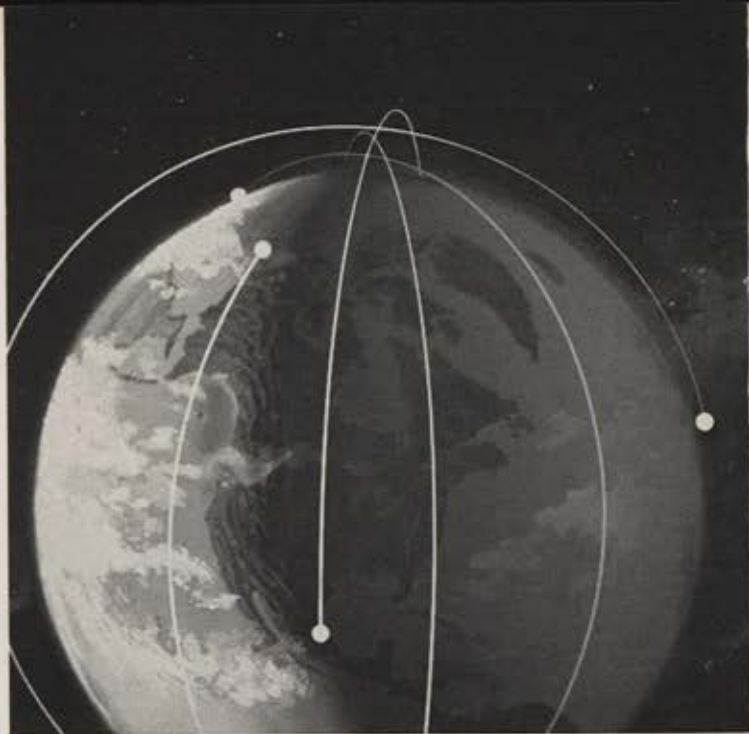
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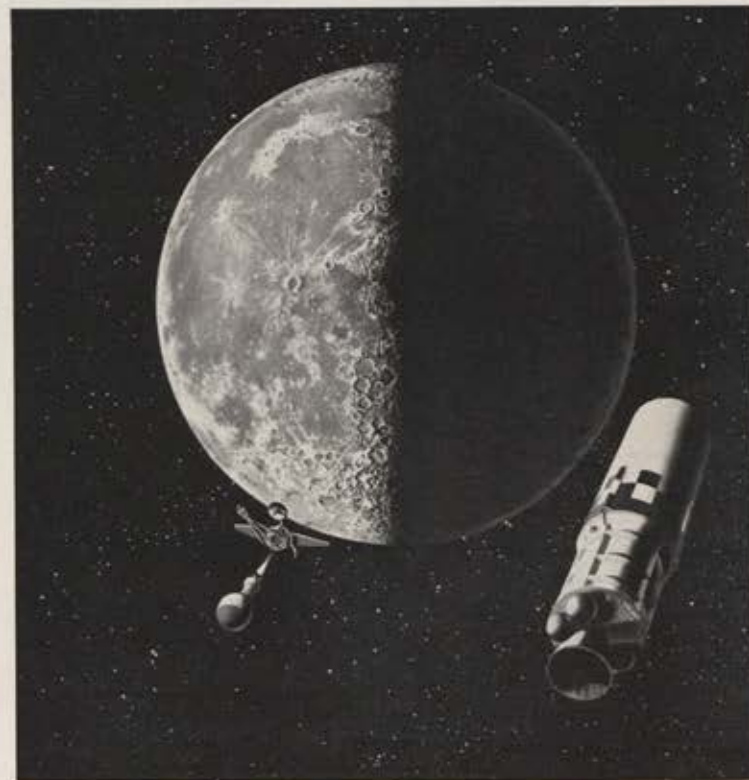
Midas

Its infrared eye instantly "sees" a missile's white-hot exhaust. Only a few Midas satellites on orbit will be enough to warn us of a missile attack.



Nimbus

The National Aeronautics and Space Administration plans to survey the earth's cloud cover with this second-generation weather satellite.



Ranger

A 300-lb. instrumented capsule that includes a seismometer is to be rough-landed on the moon sometime in 1962 by this NASA Agena B satellite.

More and more of America's military and scientific space programs are using the same basic satellite: the versatile Lockheed-built Agena B.

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GALLERY / continued

in hardened, silo-type, underground installations have been announced with up to 55 missiles per squadron; one squadron is at Malmstrom AFB, and the other three are at Ellsworth AFB, S. D.; two mobile squadrons carried in railroad cars have also been announced and two squadrons of undisclosed deployment are planned; when all three stages were ignited, the warhead traveled 4,600 miles, and the operational guidance system was used for control; this unprecedented test procedure is vital part of accelerated Minuteman development program; all major missile systems are exhaustively tested on the ground and are ready for flight test at the same time; **other contractors**—guidance, North American Autonetics; first-stage propulsion, Thiokol; second-stage propulsion, Aerojet-General; third-stage propulsion, Hercules Powder Co.; nose cone, Avco; systems engineering, Space Technology Laboratories.



► MINUTEMAN

MIDGETMAN

Type—third-generation, small, highly accurate, and mobile ICBM in the study phase; current thinking foresees a need for range of 9,000 mi. and over; **maximum weight**—30,000 lb.; **power system**—solid propellants or storable liquids; **guidance**—inertial with terminal guidance and glide feature to attack targets from the "side" at relatively low altitudes; transportable and fireable from trucks and railroad cars with very low reaction time; **systems engineering**—Aerospace Corp.



► SKYBOLT

SKYBOLT GAM-87A

Type—SAC air-launched ballistic missile (ALBM); **prime contractor**—Douglas Aircraft Co.; **speed**—about 9,500 mph; **range**—about 1,150 mi. after launching from bombers; **length**—33 ft. without tail fairing; **diameter**—about 3 ft.; **weight**—about 11,000 lb.; **power system**—solid-propellant rockets, first-stage 35,000-lb. thrust, second-stage 19,000-lb. thrust, **warhead**—nuclear; **status**—development; B-52H will be constructed to carry four Skybolts on external pylons and older B-52s can be modified to carry them also; Great Britain plans to purchase them; **other contractors**—airframe, Douglas; propulsion, Aerojet-General; nose cone, General Electric; guidance, Nortronics Division of Northrop, General Electric, Boeing.

HOUND DOG GAM-77

Type—SAC air-breathing air-to-ground guided standoff missile; **prime contractor**—North American Aviation; **speed**—Mach 1.6 to 2.2; **range**—over 500 mi.; **maximum altitude**—over 50,000 ft.; **length**—42.5 ft.; **diameter**—28 in.; **span**—12 ft. 2 in.; **power system**—J52 turbojet, 7,500-lb. thrust; **guidance**—all-inertial; **warhead**—nuclear; **status**—operational, launched from B-52G aircraft, ground-handling facilities available at 11 SAC bases in US and 1 in Puerto Rico; one of few US missiles ever designed around state-of-the-art knowledge available when design work began; consequently, its lead time was relatively short and it entered operational service about 2½ years after project was initiated; **other contractors**—airframe, North American; powerplant, Pratt & Whitney; guidance, North American Autonetics.

MATADOR TM-61

Type—TAC air-breathing surface-to-surface guided missile; **prime contractor**—Martin Co.; **speed**—about 650 mph; **ceiling**—over 35,000 ft.; **range**—latest version over 500 mi.; **length**—39.6 ft.; **span**—28.7 ft.; **diameter**—4.5 ft.; **weight**—about 10,000 lb.; **power system**—J33-A-37 turbojet with 100,000-lb.-thrust booster for launch-

ing; **guidance**—radar line-of-sight command and "Shanicle" hyperbolic beacon systems; **warhead**—nuclear or conventional; **status**—operational, deployed throughout the world and being turned over to the West German forces; **other contractors**—airframe, Martin; powerplant, Allison, Aerojet-General; guidance, Martin.

(Continued on following page)



► HOUND DOG



► MATADOR

MACE TM-76

Type—TAC air-breathing surface-to-surface guided missile (improved version of the Matador); **prime contractor**—Martin Co.; **speed**—650 mph plus; **operating altitude**—1,000 to 40,000 ft.; **range**—"A" model over 650 mi., "B" model, 1,000 mi.; **length**—44 ft.; **span**—22.9 ft.; **diameter**—4.5 ft.; **weight**—about 14,000 lb.; **power system**—J33-A-41 turbojet with



► **BOMARC B**

5,200-lb. thrust, booster of approximately 100,000-lb. thrust for launching; **guidance**—ATRAN map-matching system in "A" model, inertial in "B"; **warhead**—conventional or nuclear; **status**—"A" model operational, replacing Matador, "B" model is developmental; **other contractors**—airframe, Martin; powerplant, Allison; Thiokol; guidance, Goodyear, AC Spark Plug; transport vehicles, Goodyear, Ford Motor Co.



► **MACE**

BOMARC IM-99A

Type—ADC surface-to-air area defense missile; **prime contractor**—Boeing Airplane Co.; **speed**—Mach 2.5 plus; **ceiling**—68,000 ft.; **range**—200 to 250 mi.; **length**—46 ft. 9 in.; **span**—18 ft. 2 in.; **diameter**—35 in.; **weight**—15,000 lb.; **power system**—launched by nonjettisonable liquid-propellant rocket with two Marquardt RJ43-MA-3 ramjets for cruise; **guidance**—radar-command, linked to SAGE air-defense system during midcourse; homing system in missile as terminal guidance; **warhead**—nuclear or conventional; **status**—operational at five bases in northeast US; **launch record**—tactical tests, 17 successful intercepts out of 23 launches with 3 partially successful and 3 failures; **other contractors**—airframe, Boeing; powerplant, Marquardt, Aerojet-General; guidance, Westinghouse.

SUPER BOMARC IM-99B

Type—ADC surface-to-air area defense missile; **prime contractor**—Boeing Airplane Co.; **speed**—Mach 4; **ceiling**—100,000 ft.; **range**—over 400 mi.; **length**—45 ft.; **span**—18 ft. 2 in.; **diameter**—35 in.; **weight**—about 16,000 lb.; **power system**—launched by nonjettisonable solid-propellant rocket with two Marquardt RJ43-MA-9 for cruise; **guidance**—radar-command, linked to SAGE air defense system during midcourse; terminal guidance provided by advanced target-seeker system which can search a corridor from sea level to almost maximum altitude; **warhead**—nuclear or conventional; **status**—development; first squadrons to become operational at McGuire AFB, N. J., Langley Field, Va., and Otis, Mass., Bomarc A bases; Bomarc B bases under construction at Kincheloe AFB, Mich., Duluth AFB, Minn., Niagara Falls, N. Y. and in Canada at North Bay, Ontario, and LaMacaza, Quebec; RCAF-operated Bomarc Bs will be constructed at Canadair Ltd., Montreal; **launch record**—R&D testing (block

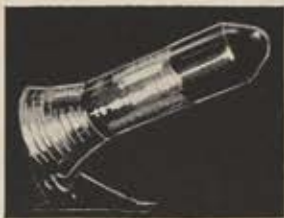
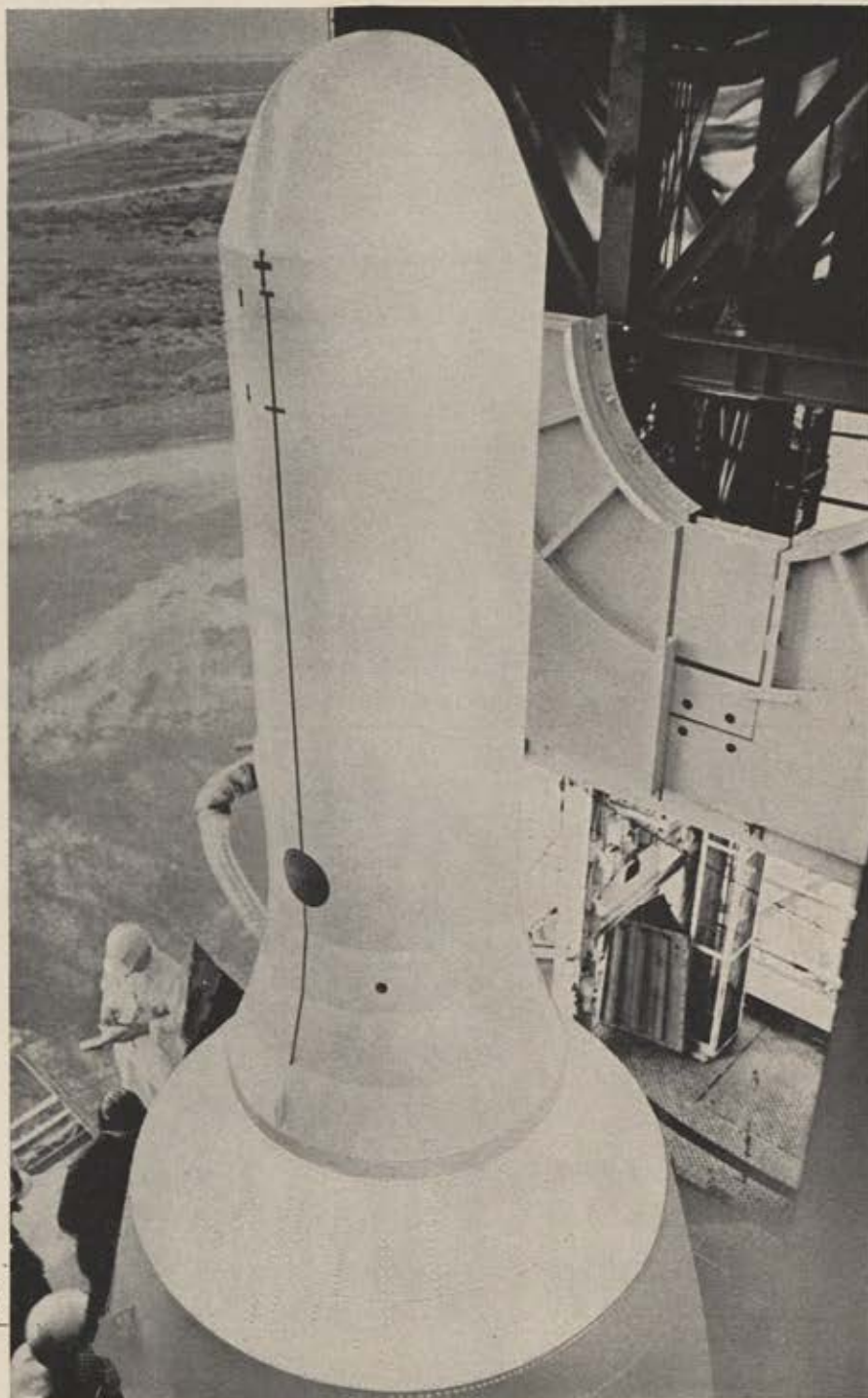
1) no complete successes out of 7 flights; (block 2) 6 complete successes out of first 7 flights; **other contractors**—airframe, Boeing; powerplant, Marquardt, Thiokol; guidance, Westinghouse.

(Continued on page 149)



► **BOMARC**

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RELIABILITY



FROM
LEFT:
GAR-11,
-2A, -1D,
-4A, -3A

FALCON GAR-1, 1D, -2, 2A

Type—ADC, TAC air-to-air guided missile; prime contractor—Hughes Aircraft Co.; speed—above Mach 2; range—above 5 mi.; length—6.5 ft.; span—20 in.; diameter—6.4 in.; weight—over 100 lb.; power system—solid-propellant rocket; guidance—GAR-1 and -1D, radar-homing, GAR-2 and -2A, infrared homing; warhead—conventional; status—operational, carried by F-89, F-101, F-102, F-106, and other aircraft; other contractors—airframe, Hughes; powerplant, Thiokol; guidance, Hughes.

SUPER FALCON GAR 3, -4, -9, -11

Type—developments of Falcon air-to-air guided missiles; prime contractor—Hughes Aircraft Co.; physical characteristics—GAR-3, and -4 are slightly larger in every respect than early Falcons and have a higher-thrust solid-propellant engine which burns longer and provides greater range; GAR-11 is much larger than early Falcons with a length of over 7 ft., a diameter of 11 in., and a weight of more than 200 lb.; guidance—GAR-3, and -11, radar-homing; GAR-4, infrared; warhead—GAR-3, and -4 conventional, GAR-11 nuclear; status—GAR-3, -4, and -11 operational; GAR-9, highly advanced missile originally intended for use on the F-108, Mach 3 interceptor is still under development to advance state-of-the-art and for possible use on high-speed aircraft; other contractors—airframe, Hughes; propulsion, Thiokol; guidance, Hughes.

SLAM

General designation for a broad group of proposed supersonic low-altitude missiles, all of which use nuclear ramjet powerplants. Design and development of reactors for the nuclear ramjet engines is being conducted under the AEC-Air Force Project Pluto. Development work on variable geometry air intakes, nozzles, and other equipment is being conducted for the Air Force by Marquardt. Chance Vought is studying wingless airframes and guidance systems for Mach 3 plus low-altitude missiles. Rate of progress with this state-of-the-art work has been so rapid in the last year that a wide variety of nuclear ramjet weapon systems is now possible.



► QUAIL

GENIE MB-1

Type—ADC air-to-air unguided interceptor rocket; prime contractor—Douglas Aircraft Co.; speed—supersonic; range—6 mi.; length—8 ft.; diameter—1 ft. 3 in.; powerplant—solid-propellant rocket; guidance—none; warhead—nuclear, 1.5 kilotons; status—operational, carried by F-89J, F-101, F-102, F-106; advanced version with built-in guidance system and greater range under development; other contractors—airframe, Douglas; powerplant, Aerojet-General; fire control, Hughes.

QUAIL GAM-72

Type—SAC air-launched diversionary (ECM-equipped decoy) bomber-defense missile; prime contractor—McDonnell Aircraft Corp.; speed—high subsonic; range—200 mi.; length—12 ft. 10 in.; diameter—2 ft.; span—5 ft. 4 in.; power system—J85-7 turbojet with 2,450-lb. thrust; weight—1,100 lb.; warhead—none; status—operational with SAC, may be used in B-47 and B-52 bombers, B-52 can carry several of the missiles; advanced Quail with approximately double range has been successfully flight tested; other contractors—airframe, McDonnell; powerplant, General Electric; guidance, McDonnell, Summers Gyroscope; countermeasures gear, Thompson Ramo Wooldridge Inc. (Continued on following page)



► GENIE

Missiles and Space Weapons

ARMY



PERSHING

Type—two-stage, surface-to-surface, selective-range ballistic missile; **prime contractor**—Martin Co.; **speed**—about 7,000 mph; **range**—about 600 mi.; **length**—about 80 ft.; **diameter**—about 3 ft.; **power system**—two-stage solid-propellant rocket; **guidance**—all-inertial, with range selectivity feature; **warhead**—nuclear; **status**—in development, both stages have been fired and operational guidance system used during flight testing, scheduled to become operational early in 1962; **other contractors**—airframe, Martin; powerplant, Thiokol; guidance, Bendix; warhead fuzing and arming, Bulova.

REDSTONE SSM-A-14

Type—surface-to-surface ballistic missile; **prime contractor**—Chrysler Corp.; **maximum speed**—well over 4,400 mph; **range**—well over 250 mi. depending upon warhead weight; **length**—about 70 ft.; **diameter**—6 ft.; **fin span**—12 ft. 9 in.; **weight**—about 61,000 lb.; **power system**—single-stage, liquid-propellant rocket, 78,000-lb. thrust; **guidance**—self-contained, all-inertial; **warhead**—nuclear or conventional; **status**—operational, deployed in Europe; **other contractors**—airframe, Chrysler; powerplant, North American Rocketdyne; guidance, Ford Instrument.



CORPORAL SSM-A-17

Type—surface-to-surface, short-range ballistic missile; **prime contractor**—Firestone Tire & Rubber Co., Gilfillan Bros.; **speed**—2,800 mph; **range**—100 mi.; **length**—46 ft.; **diameter**—30 in.; **weight**—12,000 lb.; **guidance**—preset and radio-command; **warhead**—nuclear and conventional; **status**—operational, deployed abroad with US Army; used by British Army; **other contractors**—airframe, Firestone; powerplant, Ryan; guidance, Gilfillan; warhead arming and fuzing, General Electric.



SERGEANT SSM-A-27

Type—medium-range, surface-to-surface ballistic missile with terminal guidance; **prime contractor**—Sperry Utah Engineering Laboratory and Jet Propulsion Laboratory; **speed**—about 2,800 mph; **range**—about 85 mi.; **length**—34 ft.; **diameter**—31 in.; **span**—7 ft. 8 in.; **weight**—11,000 lb.; **power system**—solid-propellant rocket, about 50,000-lb. thrust; **guidance**—all-inertial, range control during terminal portion of trajectory provided by controllable drag brakes; **warhead**—nuclear or conventional; **status**—in production, replacement for Corporal, going to West German forces also; **other contractors**—airframe, Sperry; powerplant, Thiokol; guidance, Sperry, Minneapolis-Honeywell.



LITTLE JOHN M-51

Type—surface-to-surface unguided tactical rocket; **prime contractor**—Emerson Electric Co.; **speed**—about 1,000 mph; **range**—10 mi.; **length**—14.5 ft.; **diameter**—about 1 ft.; **weight**—800 lb.; **power system**—solid-propellant rocket; **guidance**—none; **warhead**—nuclear or conventional; **status**—first two battalions activated early in 1961, each battalion equipped with four launchers; **other contractors**—airframe, Emerson Electric; powerplant, Hercules; warhead arming and fuzing, General Electric, Consolidated Western Steel, Minneapolis-Honeywell.

(Continued on page 153)

AiResearch pressure suit cooling unit

*provides maximum pilot
comfort on the ground*



This portable, lightweight package keeps the pilot cool and comfortable on the ground in his flight pressure suit from one to two hours. Utilizing cryogenic liquid oxygen as the coolant, it requires no electric power or other connecting supplies which might hinder the pilot's mobility.

Easily carried by hand or slung from the shoulder, the AiResearch unit can cool a pilot wearing either full or partial pressure suit during travel to and from his aircraft, preflight checkout and while seated in the cockpit. Pure oxygen for prebreathing can also be provided as a simultaneous function.

This extremely simple and reliable cooling unit has no moving parts. In operation, ambient air vaporizes a supply of liquid oxygen to pressurize the system. Cooling air, made up of stored oxygen and ambient air, is then circulated through the suit.

AiResearch is also in production on self-contained life support systems inside fully enclosed protective suits. These suits allow the wearer to work safely in hostile environments such as toxic missile fuel handling and fire fighting. Research for modification of these systems is now being conducted for space use.

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The Magnetic Surfacing Pilot Production Area; Mr. H. B. Dickinson, Vice President (left), and Mr. B. Diener (center) and Dr. M. B. Melillo (right) of the Component Development Division.

A Report from American Systems Incorporated...

A New Development in Magnetic Surfacing

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Developed by Dr. Manlio Melillo of American Systems Component Development Division, the new process typifies the systems approach to component problems. In addition to magnetic surfacing, the activities of this division encompass component development for computer and communications systems technology.

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Electromagnetic physics; electronic and mechanical scanning antenna systems; development and manufacturing of special microwave components and complete sensor systems.

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HONEST JOHN M-31

Type—surface-to-surface unguided tactical rocket; **prime contractor**—Douglas Aircraft Co.; **speed**—about 1,200 mph.; **range**—about 15 mi.; **length**—27 ft.; **diameter**—30 in.; **weight**—5,800 lb. with payload of about 1,500 lb.; **power system**—solid-propellant rocket; **guidance**—none; **warhead**—nuclear or conventional; **status**—initial version operational, deployed in Europe and Japan and supplied to NATO forces; XM-50, Slim John, in production; is shorter and lighter than the Honest John and has about 20-mi. range; **other contractors**—airframe, Douglas, Emerson Electric; powerplant, Hercules.

LACROSSE SSM-A-12

Type—surface-to-surface, close-support guided missile; **prime contractor**—Martin Co.; **speed**—about 800 mph; **range**—20 mi.; **length**—19.2 ft.; **span**—9 ft.; **diameter**—20.5 in.; **weight**—about 3,500 lb.; **power system**—solid propellant; **guidance system**—radar-command, exact target location does not have to be known at launch point, forward observer provides guidance during terminal phase of flight to

provide accuracy; **warhead**—nuclear or conventional; **status**—operational on mobile launchers, deployed in Europe; **other contractors**—development, Cornell Aeronautical Laboratories; airframe, Martin; powerplant, Stewart Warner, Thiokol; guidance, Federal Telecommunications Labs, Martin; warhead, Minneapolis-Honeywell; fuzing, General Electric.

NIKE AJAX SAM-A-7

Type—surface-to-air guided missile; **prime contractor**—Western Electric Co.; **maximum speed**—Mach 2.5; **range**—30 mi.; **ceiling**—60,000 ft.; **length**—34 ft. 10 in.; without booster 21 ft.; **span**—52 in.; **diameter**—12 in.; **weight**—2,300 lb.; **power system**—liquid-propellant rocket sustainer, solid-propellant booster; **guidance**—radar-command; **warhead**—conventional; **status**—operational, first US surface-to-air missile deployed in US and overseas; **other contractors**—airframe, Douglas; powerplant, Bell, Hercules, Goodyear; guidance, Bell; warhead fuzing, Elgin.

MISSILE A

Type—short-range third-generation Army surface-to-surface missile, first of a series of lightweight, simplified, highly accurate missiles intended to eventually replace most existing bombardment missiles, heaviest members of this series will have range of more than 500 mi., exact composition of this missile family has not been established; **prime contractor**—General Electric Co.; **speed**—about 1,400 mph; **range**—about 20 mi.; **power system**—solid propellant; **warhead**—nuclear and conventional; **status**—developmental, component production has begun.

NIKE HERCULES SAM-A-25

Type—surface-to-air guided missile;

prime contractor—Western Electric Co.; **speed**—Mach 3.3; **range**—75 to 100 mi.; **altitude**—above 150,000 ft.; **length**—with booster 41 ft., without 27 ft.; **span**—74 in.; **diameter**—31 in.; **weight**—missile and booster 10,000 lb.; **power system**—solid-propellant rocket booster and sustainer; **guidance**—radar-command; **warhead**—nuclear or conventional; **status**—optional, superseding Nike-Ajax in production, deployed overseas as well as US; **other contractors**—airframe, Douglas; powerplant, Thiokol, Hercules; guidance, Bell; warhead, General Electric, W. C. Maxson.

NIKE ZEUS

Type—automated antimissile missile system; **prime contractor**—Western Electric Co.; **maximum speed**—about 5,000 mph; **range**—about 200 mi.; **power system**—solid-propellant booster thrust more than 400,000 lb.; **guidance**—radar-command; **warhead**—nuclear; **status**—developmental flight testing, flight test of the complete system is scheduled for early 1962; **other contractors**—airframe, Douglas; guidance, Bell; propulsion, Thiokol, Grand Central.

(Continued on following page)



► LACROSSE

► HONEST JOHN



► NIKE AJAX

► NIKE ZEUS





▶ HAWK

HAWK SAM-A-18

Type—surface-to-air for use against low-flying aircraft; **prime contractor**—Raytheon Co.; **speed**—Mach 2.8; **range**—22 mi.; **effective altitude**—100 ft. to over 38,000 ft.; **length**—16.8 ft.; **span**—4 ft.; **diameter**—14 in.; **weight**—1,275 lb.; **power system**—single solid-propellant rocket engine which lowers its thrust level after high-acceleration boost to cruise speed; **guidance**—radar-homing; **warhead**—conventional; **status**—operational, has shown capability to serve as battlefield antimissile defense against cruise and ballistic missiles, deployed with US forces abroad, will be supplied to Allies; **other contractors**—airframe, Northrop, Raytheon; powerplant, Aerojet-General, Thiokol; guidance, Raytheon.



◀ LOBBER

LOBBER

Type—ballistic missile primarily intended for the delivery of supplies to isolated front-line troops, can be adapted to carry napalm, nuclear, or conventional warheads; **prime contractor**—Convair; **speed**—about 1,500 mph; **range**—15 to 20 mi.; **length**—9 ft.; **power system**—solid-propellant rocket; **payload**—over 50 lb.; **guidance**—none; **recovery**—effected by parachute and shock-absorbing nose cone; **status**—in development. This missile is the forerunner of several elaborate ballistic missile resupply projects in the advanced study phase.

SS-10, SS-11

Type—antitank guided missiles for firing from ground launcher, vehicle, helicopter, or airplane; **prime contractor**—Nord Aviation, Paris, France; **speed**—SS-10, about 300 mph, SS-11, about 400 mph; **range**—SS-10, 1,600 yd., SS-11, 3,800 yd.; **weight**—SS-10, 33 lb., SS-11, 62 lb.; **length**—SS-10, 34 in., SS-11, 46 in.; **diameter**—SS-10, 6 in., SS-11, 6.45 in.; **span**—SS-10, 30 in., SS-11, 19.7 in.; **warhead**—conventional; **power system**—solid-propellant rocket; **guidance**—wire guided; **status**—SS-10, operational with US troops and NATO, SS-11, under operational evaluation by US.

▶ BELOW: SS-11, RIGHT: SS-10





SHILLELAGH

Type—lightweight surface-to-surface, close-support missile for vehicle-mounted use against armor, troops, fortifications; **prime contractor**—Ford Aeronutronics Co.; **weight**—about 40 lb.; **caliber**—90 mm.; **guidance**—fired from guide tube to target by microwave beam; **status**—in development; **other contractors**—Raytheon.

REDEYE

Type—surface-to-air, shoulder-fired, bazooka-type rocket weapon for use by combat troops against low-flying aircraft; **prime contractor**—Convair; **length**—4 ft. 3 in.; **diameter**—4 in.; **weight**—20 lb.; **power system**—solid-propellant rocket; **guidance**—infrared homing; **warhead**—conventional; **status**—final stages of development, completely self-contained unit with firing tube serving as carrying case about to enter quantity production; **other contractors**—propulsion, Atlantic Research; guidance, Philco, Convair.

DAVY CROCKETT

Type—light surface-to-surface nuclear infantry weapon to be produced in two sizes; developed by US Army Ordnance Corps at Rock Island Arsenal; **range**—5,500 to 8,800 yd.; **power system**—development of solid-propellant rocket-boosted artillery fired from light recoilless field piece; **warhead**—low-yield nuclear or conventional housed in fat bomb-shaped fairing with four fins, 200- and 400-lb. units; **status**—late development stages, ready to enter quantity production, normally a crew-served weapon but can be handled by one or two men.



REDEYE

DAVY CROCKETT

MAULER

Type—surface-to-air guided missile for close-in protection of troops; **prime contractor**—Convair; **speed**—supersonic; **guidance**—ground radar with homing devices in missile. Highly simplified and rugged

vehicle-mounted radar for target acquisition and missile launching can be operated by one man; missiles are sealed in their launch tubes after manufacture and transported in the tubes; **status**—in development.

(Continued on following page)

Another reason...
the world becomes smaller



Troposcatter network, providing multi-channel Telephone, Teleprinter, and Data Transmission, linking England, Spain and North Africa is being designed and built for the Air Force

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Page



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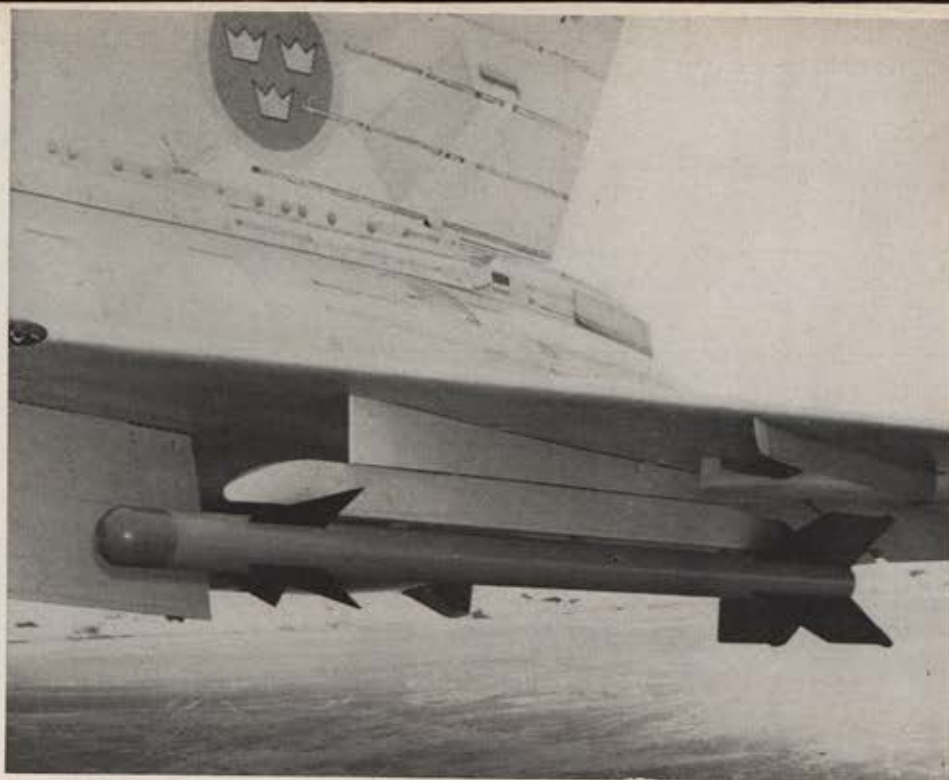
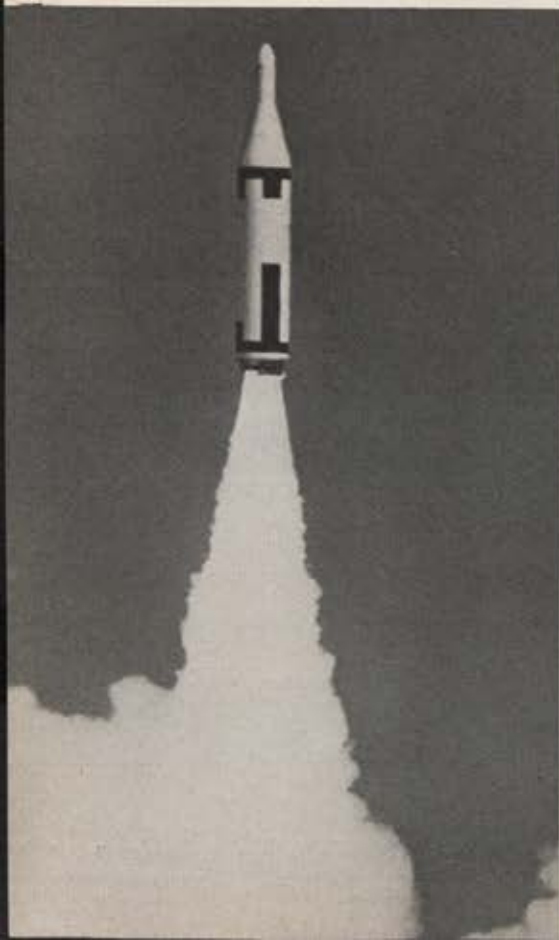
Missiles and Space Weapons

NAVY

POLARIS A-1 FBMS

Type—underwater-to-surface or surface-to-surface Fleet Ballistic Missile System (FBMS); prime contractor—Lockheed Aircraft Corp.; maximum speed—about 10,000 mph; range—1,350 mi.; length—28 ft.; diameter—4.5 ft.; weight—28,000 lb.; power system—two-stage solid-propellant rocket; guidance—inertial; warhead—nuclear; status—operational aboard nuclear-powered submarines, scheduled to be carried aboard the cruiser USS *Long Beach*; advanced versions, the A-2 with 1,500-mi. range, and the A-3 with 2,500-mi. range in development; launch record of A-1 by March 1961: 65 of 80 flight-test vehicle flights were considered to be completely successful; other contractors—nose cone and airframe, Lockheed; powerplant, Aerojet-General; guidance, General Electric.

► POLARIS



► SIDEWINDER

SIDEWINDER

Navy: AAM-N-7; Air Force: GAR-8

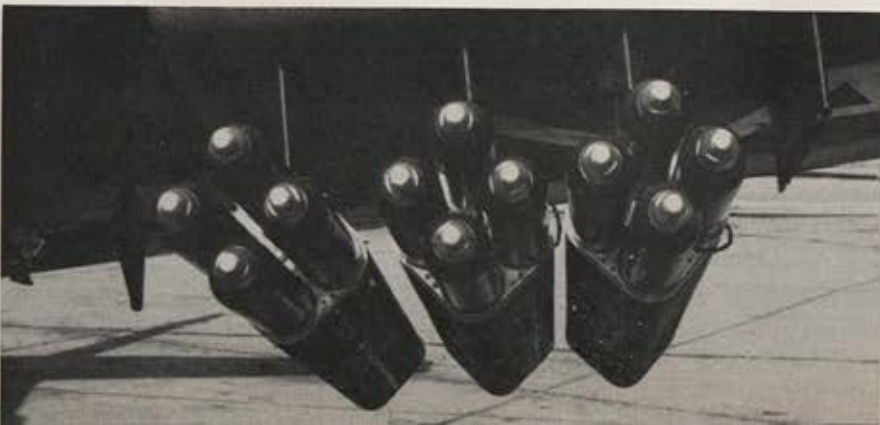
Type—air-to-air guided missile; prime contractor—Philco Corp.; maximum speed—Mach 2.5; range—at sea level, 3,500 ft., at 50,000 ft., 11,000 ft.; effective ceiling—over 50,000 ft.; length—9 ft. 5 in.; diameter—5 in.; finspan—1 ft. 7 in.; weight—155 lb.; power system—solid-propellant rocket; guidance system—infrared homing;

warhead—conventional; status—operational, supplied to several Allied air forces, advanced all-weather models with both radar and infrared homing under development; other contractors—guidance, Philco, General Electric; propulsion, Naval Powder Plant, Allegany Ballistics; warhead, Eastman Kodak, Minneapolis-Honeywell, Baldwin Piano; development, Naval Ordnance Test Station, China Lake, Calif.

► SPARROW



► ZUNI



SPARROW III AAM-N-6

Type—air-to-air guided missile; prime contractor—Raytheon Co.; speed—Mach 3; range—8 mi.; effective ceiling—over 50,000 ft.; length—12 ft.; diameter—9 in.; span—3 ft. 3 in.; weight—380 lb.; power system—solid-propellant rocket; guidance—semiactive radar-homing; warhead—conventional; status—operational, superseded the obsolete Sparrow I; other contractors—airframe, Raytheon; powerplant, Aerojet-General; guidance, Raytheon. Sparrow II was dropped after being considered by the Royal Canadian Air Force and the USAF as well as the Navy.

ZUNI

Type—air-to-surface or air-to-air rocket; developed by Naval Ordnance Test Station, produced by Bridgeport Brass Co.; speed—Mach 3; range—5 mi.; length—9 ft.; diameter—5 in.; weight—107 lb.; power system—solid-propellant rocket; guidance—none; warhead—conventional in a wide variety of types, armor piercing, high explosive, etc.; status—operational.

TALOS



TERRIER



EAGLE XAAM-N-10

Type—long-range, air-to-air guided missile; prime contractor—Bendix Aviation Corp.; speed—over Mach 3; range—about 75 mi.; power system—two-stage solid-propellant; guidance—active radar homing; warhead—nuclear; status—in development with extensive flight testing scheduled during 1962. Eagle will be launched from subsonic aircraft with long endurance in accordance with new Navy interceptor philosophy calling for the high performance to be built into the guided missile rather than the aircraft that launches it; other contractors—airframe, Grumman; propulsion, Aerojet-General; target-seeking equipment, Sanders Associates; tactical computer, Litton; airborne intercept radar, Westinghouse; guidance, Bendix.

TERRIER SAM-N-7

Type—surface-to-air guided missile for firing from shipboard and US Marine mobile launchers ashore; prime contractor—Convair; speed—Mach 2.5; ceiling—over 50,000 ft.; range—over 10 mi.; length—15 ft., 27 ft. with booster; diameter—14 in.; span—4 ft.; power system—two-stage solid-propellant rocket; guidance—radar beam rider; warhead—conventional; status—operational, advanced Terrier with more

powerful rockets and over 20-mi. range will become operational this year; advanced Terrier can be handled by same launchers and handling equipment as Terrier; other contractors—airframe, Convair; propulsion, Allegany Ballistics; guidance, Sperry, Convair, Motorola.

TALOS SAM-N-6

Type—shipboard surface-to-air and surface-to-surface guided missile; prime contractor—Bendix Aviation Corp.; speed—Mach 2.5; ceiling—above 100,000 ft.; range—over 65 mi.; length—21 ft., 31 ft. with booster; diameter—30 in.; span—9.5 ft.; weight—3,000 lb., 7,000 lb. including booster; power system—solid-propellant booster for a few seconds then cruise on ramjet engine delivering maximum of about 9,000-lb. thrust; guidance—beam riding with semiactive radar homing; warhead—nuclear or conventional; status—operational, advanced version known as Typhoon Long Range or Super Talos; Talos also used to bombard surface ships at extreme ranges; other contractors—airframe, McDonnell; powerplant, McDonnell, Allegany Ballistics, Bendix; guidance, Farnsworth Electric; "homing" radar, Sperry; development, Applied Physics Laboratory, John Hopkins University.

(Continued on page 159)

Another reason... the world becomes smaller



Turkey trot... tropospheric scatter network employing fixed and mobile stations... linking eight strategic areas through Turkey with more than 99% reliability... is being designed and built for the U. S. Air Force

by

Page



COMMUNICATIONS ENGINEERS, INC.

Subsidiary of Northrop Corporation

2001 WISCONSIN AVENUE, N.W., WASHINGTON 7, D.C.

To recall a bullet 12,000 miles away



requires Motorola systems reliability

THE B-70 M&TC major system management contract places in the hands of a single contractor, Motorola, an unprecedented responsibility: positive recall of a Mach 3, nuclear deterrent force. At speeds over 2,000 mph—faster than a rifle bullet—crew and aircraft safety, as well as mission success, demand integration of myriad electronic functions with simplified controls and displays. ☆ The integrated M&TC system includes the functions of world-wide command communications (LRR) linked to the SAC Command Network; line-of-sight, short-range communications (SRR); improved tactical air navigational aids (TACAN); air-by-air IFF; air-by-ground IFF; aerospace ground support equipment (AGE); air-to-air rendezvous equipment; instrument landing system (ILS); and crew intercommunications. ☆ Motorola's role as a major electronic system contractor for the B-70 Valkyrie's Mission and Traffic Control typifies its systems management capabilities. Detailed information is available on request.

Military Electronics Division



MOTOROLA

*Qualified technical personnel
are invited to apply*

CHICAGO 51, Illinois, 1450 North Cicero Avenue
SCOTTSDALE, Arizona, 8201 East McDowell Road
RIVERSIDE, California, 8330 Indiana Avenue

TARTAR

Type—shipboard surface-to-air guided missile which represents a significant improvement over original Terrier; the Tartar is approximately the same size and has the same range and speed capability yet requires no booster; Tartar has virtually the same external aerodynamic configuration as the advanced Terrier; **prime contractor**—Convair; **speed**—above Mach 2; **range**—about 10 mi.; **length**—15 ft.; **diameter**—over 1 ft.; **power system**—one dual-thrust solid-propellant rocket which lowers its thrust for sustained flight after a short high-acceleration boost to cruise speed; **status**—operational, advanced version known as Typhoon Medium Range in development; **other contractors**—airframe, Convair; powerplant, Aerojet-General, Allegany Ballistics; guidance, Raytheon.

▶ TARTAR



◀ BULLPUP

BULLPUP

Navy: ASM-N-7A; **Air Force:** GAM-83A (also called White Lance)

Type—air-to-surface guided missile; **prime contractor**—Martin Co; **speed**—Mach 1.8; **range**—over 3 mi.; **length**—11 ft.; **diameter**—1 ft.; **span**—3 ft. 1 in.; **weight**—540 lb. including 250-lb. warhead; **power system**—solid or storable liquid-propellant rocket; **guidance**—command (radio signals from launch-plane pilot); **warhead**—conventional; **status**—operational, used in fleet on aircraft and helicopters, in TAC on attack aircraft; advanced versions, one known as Bulldog, in development, one Air Force version is larger, will have nuclear warhead; **other contractors**—airframe, Martin; powerplant, Allegany Ballistics, Aerojet-General, Thiokol; guidance, Martin.

▶ WEAPON ABLE



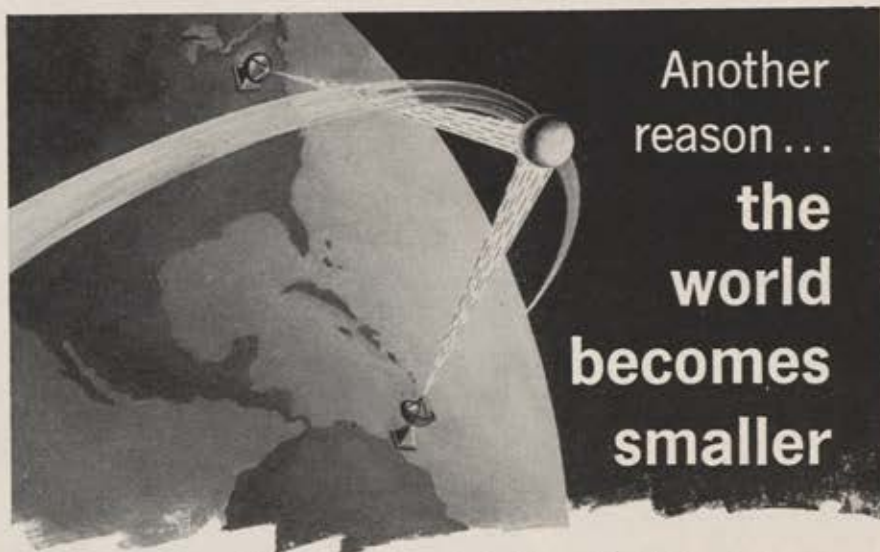
WEAPON ABLE

Type—antisubmarine surface-to-underwater rocket; **prime contractor**—Avco; **length**—8.5 ft.; **diameter**—12.75 in.; **weight**—500 lb.; **power system**—solid-propellant rocket; **guidance**—fired from launchers adapted to destroyer guns by advanced fire-control system; **warhead**—conventional; **status**—operational.

SUBROC

Type—surface or underwater-to-air-to-underwater for firing primarily from submerged submarines against other subs or surface craft; **prime contractor**—Goodyear Aircraft Corp.; **range**—over 25 mi.; **power system**—solid propellant; **warhead**—nuclear or conventional; **status**—soon scheduled for operational use; final system will include advanced sonar equipment to compute target, course, speed, and fire weapon; **other contractors**—propulsion, Thiokol; guidance, Librascope, Kearfott.

(Continued on following page)



An experimental satellite communication relay being designed and engineered under cognizance of Rome Air Development Center will transmit voice and teletype 2000 miles through space via a passive orbiting satellite. Stations will be at Floyd, N.Y. and Trinidad.

Page  **COMMUNICATIONS ENGINEERS, INC.**

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► ASROC

► REGULUS



► ASTOR

► COBRA



WET SPACEMAN ■ The Null-Gravity Simulator—developed by Lockheed/Georgia—rotates submerged spacemen up to 80 r.p.m. to create the effects of weightlessness. This device in the Human Factors Laboratory is just one of the diverse aerospace research and manufacturing capabilities at the Georgia Division.

LOCKHEED/GEORGIA
MARIETTA, GEORGIA



GALLERY / continued

ASROC (Antisubmarine Rocket)

Type—surface-to-underwater antisubmarine rocket; prime contractor—Minneapolis-Honeywell; range—over 2 mi. in the air; power system—solid-propellant rocket; guidance—unguided booster rocket fires warhead to target area ballistically from launch ship, then homing system in torpedo locates target after entering water; warhead—variety of unguided depth charges and acoustical homing torpedos, nuclear and conventional; status—entering operational service on more than 150 cruisers and destroyers.

ASTOR (Antisubmarine Torpedo Ordnance Rocket)

Type—antisubmarine torpedo to be launched from submerged submarines; prime contractor—Westinghouse Electric Corp.; length—20 ft.; underwater speed—20 kt.; power system—electric with propeller drive; range—20,000 yd.; guidance—wire guided; warhead—nuclear; status—final development.

REGULUS I SSM-N-8

Type—air-breathing surface-to-surface cruise missile (KDU-1 is drone version); prime contractor—Chance Vought Corp.; cruise speed—650 mph; range—575 mi.; length—33 ft.; span—21 ft.; diameter—4.5 ft.; weight—14,522 lb.; power system—J33-A-18 turbojet with 2 solid-propellant boosters; guidance—command; warhead—nuclear; status—operational; production halted after 514th missile delivered in January 1959; installed on carriers, cruisers, and submarines; supersonic Regulus II project terminated in December 1958; other contractors—airframe, Chance Vought; powerplant, Allison, Aerojet-General; guidance, Motorola, Vance Industries.

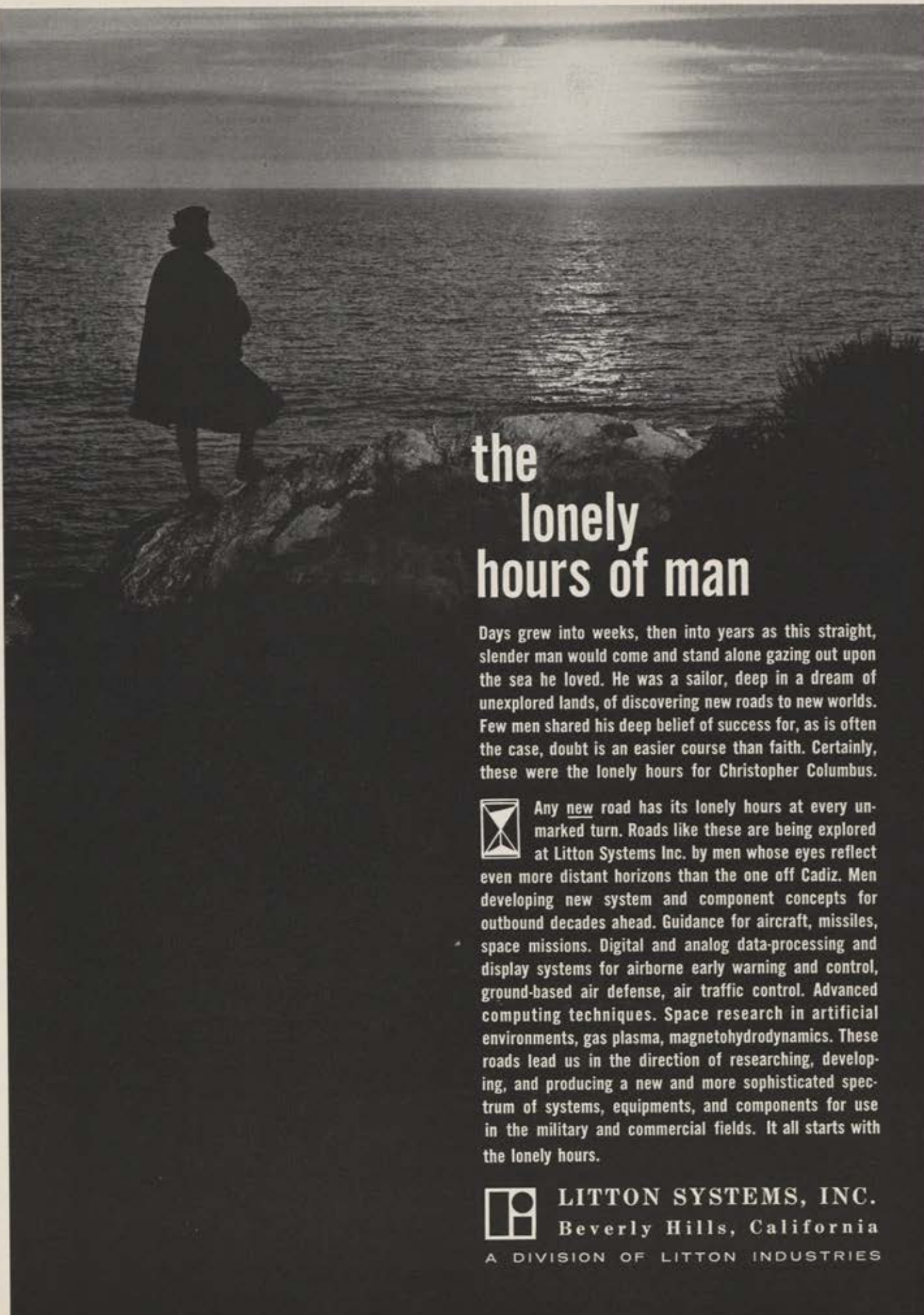
COBRA

Type—antitank missile for US Marine Corps; prime contractor—developed by Boelkow Entwicklungen of West Germany; Daystrom, US distributor; speed—about 200 mph; range—500 to 1,760 yd.; length—30 in.; diameter—4 in.; weight—30 lb. over-all with 5.5-lb. warhead; power system—solid-propellant rocket; guidance—wire guided; warhead—conventional; status—recommended for purchase by Marine Corps, under US Army evaluation, operational with West Germans.

GIMLET

Type—air-launched rocket with high accuracy; speed—above Mach 3; guidance—none; status—in development.

—J. S. BUTZ, JR.



the lonely hours of man

Days grew into weeks, then into years as this straight, slender man would come and stand alone gazing out upon the sea he loved. He was a sailor, deep in a dream of unexplored lands, of discovering new roads to new worlds. Few men shared his deep belief of success for, as is often the case, doubt is an easier course than faith. Certainly, these were the lonely hours for Christopher Columbus.



Any new road has its lonely hours at every unmarked turn. Roads like these are being explored at Litton Systems Inc. by men whose eyes reflect even more distant horizons than the one off Cadiz. Men developing new system and component concepts for outbound decades ahead. Guidance for aircraft, missiles, space missions. Digital and analog data-processing and display systems for airborne early warning and control, ground-based air defense, air traffic control. Advanced computing techniques. Space research in artificial environments, gas plasma, magnetohydrodynamics. These roads lead us in the direction of researching, developing, and producing a new and more sophisticated spectrum of systems, equipments, and components for use in the military and commercial fields. It all starts with the lonely hours.



LITTON SYSTEMS, INC.
Beverly Hills, California

A DIVISION OF LITTON INDUSTRIES

U.S. AIR FORCE

BLUE SCOUT





U. S. AIR FORCE PHOTOS

LEFT: USAF technicians of 6555th Test Wing under technical supervision of Aeronutronic engineers erect Blue Scout on simplified launch pad prior to successful flight. The development of Blue Scout effectively bridges gap between larger, more expensive ICBM's and smaller sounding rockets in our advanced space research and test programs. The Blue Scout is the largest solid fuel missile ever fired at Cape Canaveral.

OPPOSITE: U. S. Air Force Blue Scout Jr., lifts off launch pad as spin rockets ignite. This unguided 4-stage missile was successfully launched on the first attempt.

The United States Air Force Blue Scout Program provides the Nation with a new and versatile low-cost family of test vehicles to support our military weapons and space systems development programs. It can be used in a variety of deep space probes, orbit missions, boost glide trajectories, and as a rocket and satellite command and control communications system. Blue Scout has already fired a 32-pound scientific payload 16,000 miles into space ...and a 392-pound payload in a controlled trajectory 1400 miles down the Atlantic Missile Range. Aeronutronic is systems engineer, payload and test contractor on this important Air Force program.

AERONUTRONIC DIVISION *Ford Motor Company*, DEFENSE PRODUCTS GROUP
FORD ROAD, NEWPORT BEACH, CALIFORNIA



Write for information about Aeronutronic's capabilities and the career opportunities open for engineers and scientists.

The Blue Scout program, based on modifications of the NASA Scout, is under the executive direction of the U.S. Air Force Ballistic Missile Division, Air Research and Development Command. Above **LEFT:** Blue Scout is raised to a firing position on simplified launch pad. Because missile requires minimum ground support equipment, it is operable in a number of various field environments at minimum cost. **RIGHT:** Instrument package of Blue Scout is checked by Aeronutronic personnel and Air Force technicians. Accurate guidance system, data recovery system and final stage attitude control make Blue Scout adaptable to a wide variety of applications.

A Missile and Space GLOSSARY

Ablation. Melting of nose-cone materials during reentry of spacecraft or other vehicles into the earth's atmosphere at hypersonic speeds to dissipate kinetic energy and prevent excessive heating of the main structure.

Abort. In research and development: an uncompleted missile flight or an uncompleted hold-down test resulting from a failure of equipment or of a system other than the one undergoing test. In a tactical operation simulated or real, a missile failure either on the ground or in flight; a missile that fails to complete a programmed flight.

Absolute zero. Theoretical temperature at which all thermal motion or heat action ceases, approximately -273.16 degrees C, -459.69 degrees F, zero degrees K, and zero degrees R.

Acceleration. Velocity increase or the rate of velocity increase. In physics, any velocity change—increase or decrease.

Accelerometer. An instrument that measures one or more components of the accelerations of a vehicle.

Acid trailer. A trailer used to transport acid fuels or oxidizers.

Actuating system. A system in a guided or ballistic missile supplying and transmitting energy for operation of devices within the missile.

Adapter skirt. Flange or extension of a missile stage or section providing a means of fitting another stage or section to it.

Additive. A substance added to a propellant to achieve some purpose such as a more even rate of combustion.

Advanced Research Projects Agency (ARPA). Agency of Department of Defense sponsoring research in ballistic missile defense, nuclear test detection, advanced propellant chemistry, and materials research.

Aeroballistics. Term derived from aerodynamics and ballistics, dealing primarily with the motion of bodies whose flight path is determined by applying the principles of both sciences to different portions of the path.

Aerodynamic heating. The heating of an aerospace vehicle due to friction of air, significant at high speeds as during reentry.

Aerodynamic missile. Missile using aerodynamic forces to maintain its flight path, generally winged and guided; Snark, Matador, and Bomarc are aerodynamic missiles.

Aerodynamics. Science of motion of bodies relative to the air and the forces acting on the bodies, especially in flight through the air.

Aeroembolism. Formation of gas bubbles (principally nitrogen) in body tissues after exposure to low atmospheric pressure, as in high-altitude flying without benefit of a pressure suit or pressurized cabin. Danger to unprotected travelers in vacuum of space.

Aeromedicine. See aerospace medicine. Alternate term for aviation medicine or aerospace medicine.

Aeronautics. Art, science, or business of designing, manufacturing, and operating vehicles that move through the air.

Aeronomy. Science of the atmosphere of the earth or other spatial bodies, especially in respect to properties, motions, reactions, and changes in reaction to radiation bombardments from space, or its relations to its primary body.

Aeropause. Upper region of the atmosphere in which the atmosphere ceases to support manned or unmanned flight.

Aeros. NASA program for a stationary meteorological satellite system, now in study stage.

Aerospace. The earth's envelope of air and the space above it, the two considered as a single realm for activity in the flight of air vehicles and the launchings, guidance, and control of ballistic missiles, earth satellites, space vehicles, and the like.

Aerospace craft. An aerospace vehicle.

Aerospace power. The entire aeronautical and astronautical capacity of a nation.

Aerothermodynamic border. Area above an altitude of about 100 miles, where the atmosphere becomes so rarefied that there

is no longer any significant heat-generating air friction on the skin of vehicles.

Aerothermodynamics. Branch of thermodynamics that treats of mechanical actions or relations of heat generated by friction between air particles and a moving body.

Afterbody. A companion body that trails a satellite, or an unprotected section, or piece of a ballistic missile that reenters the atmosphere behind the nose cone or other body protected for reentry.

Afterburning. Characteristic of some rocket engines to burn irregularly after main burning and thrust have stopped.

Agna. Second stage of Air Force Discoverer vehicle, containing payload, all of which is designed to attain orbit.

Agravic. Unaffected by gravitation. Weightless.

Aimed missile. Missile aimed on its launcher so as to attain a desired trajectory, but not guided during flight. Unguided missile.

Air. The mixture of gases in the earth's atmosphere. The element that gives lift to aircraft.

Air breakup. Destruction of a vehicle by aerodynamic forces on its reentry into the atmosphere, sometimes deliberately done to retard fall of certain pieces and aid in recovery of records and instruments.

Air-breathing missile. Missile with an engine requiring air intake for fuel combustion, contrasted with a rocket-propelled missile carrying its own oxygen and operable beyond the atmosphere.

Aircraft rocket. Rocket-powered missile carried by, and launched from, an aircraft, guided or unguided.

Air drag. Drag exerted by air particles on a moving object, as an aircraft or rocket moving through the air, or on an artificial satellite that comes within the upper reaches of the atmosphere during orbit.

Air Force Ballistic Missile Division (AFBMD). Division of Hq. ARDC located at Inglewood, Calif. Responsible for research, development, and initial operational capability of Air Force intercontinental- and intermediate-range ballistic missiles.

Airframe. Assembled structural and aerodynamic components of an aircraft or missile.

Airglow. Nighttime luminescence of the sky caused by the upper atmospheric release of energy absorbed from the sun during the daylight hours.

Air-launched ballistic missile (ALBM). A ballistic missile, generally utilizing a solid propellant, carried aloft and launched from an aircraft.

Air Research and Development Command (ARDC). A United States Air Force major air command at Andrews AFB, Md., conducting research and development on Air Force aerospace weapon systems and equipment.

Air-to-air missile (AAM). Missile launched from an aircraft at an air target.

Air-to-surface missile (ASM). Missile launched from an aircraft at a surface target.

Air-to-underwater missile (AUM). Missile launched from an aircraft toward an underwater target.

Albedo. The ratio of light reflecting from an unpolished surface to the light falling upon it. Term is used in reference to light reflected from the moon or planets.

ALBM. Air-launched ballistic missile.

Alcohol. Ethyl alcohol (C_2H_5OH) or methyl alcohol (CH_3OH), used with liquid oxygen as a bipropellant.

Alga (usually plural, algae). Unicellular and multicellular plants considered as a potential source of food and oxygen in a closed ecological system for space vehicles.

Alpha Centauri. Star in the constellation Centaurus, seen in the Southern Hemisphere, about as near to our sun as Proxima Centauri, some 4.3 light-years distant. Alpha Centauri is the third brightest star in the heavens.

Alpha particle. The nucleus of a helium atom.

Ambient conditions. Environmental conditions such as pressure or temperature.

Anacoustic zone. Zone of silence in space. The region of altitude where distances between rarefied air molecules are so great that sound waves are not propagated.

Angstrom unit. Unit for measuring the wave length of light, equal to one hundred-millionth of a centimeter.

Anhydrous. Free of water.

Aniline. Liquid compound $C_6H_5NH_2$, used as a rocket fuel.

Anoxia. An absence of oxygen in the blood cells or tissues of the body; hazard of high-altitude flight without protective oxygen equipment.

Antiatom. Postulated elemental particle consisting of a negative nucleus with positive electrons in orbit. The atom of the known world consists of a positive nucleus with negative electrons in orbit.

Antigravity or antigravitation. A still-to-be-discovered energy field or technique to cancel or reduce gravitational effects.

Anti-G suit. A tight flying suit that covers parts of body below the heart, designed to retard the flow of blood to the lower body in reaction to acceleration or deceleration. An antiblackout suit. Bladders or other devices may be used to inflate and increase body constriction as G force increases.

Antimatter. Matter theoretically considered to exist, consisting of antiatoms.

Antimissile missile. Now-hypothetical defensive missile launched to intercept and destroy other missiles in flight.

Aphelion. Point on an elliptical orbit around the sun which is farthest from the sun.

Apogee. Point on an elliptical orbit (of the moon or artificial satellite) around the earth which is farthest from the earth.

Apollo. NASA designation for follow-on manned spaceflight program to Project Mercury manned orbital mission. Apollo spacecraft is hoped to be usable for manned earth-orbiting laboratory and manned circumlunar flight.

APU. Auxiliary power unit.

Aral'sk. Russian town some seventy miles southwest of a space-probe launch site, located in Kazakh Republic.

Area defense. Defense against air or missile attack designed to protect a large area surrounding the specific target such as a city or base rather than the target point alone.

Argon. A colorless, odorless, and inert gaseous element, comprising nearly one percent of air.

Argus theory. Theory that a shield of radiation placed above the earth's atmosphere would burn up incoming nuclear warheads or make infrared targets of them.

Arming. Process of changing a fuze or warhead from a safe condition to a state of readiness for initiation.

Arming signal. Radio signal for arming a warhead.

Army Ballistic Missile Agency (ABMA). An agency of the US Army with missile research and development facilities at Huntsville, Ala.

Army Rocket and Guided Missile Agency (ARGMA). Army research agency for development of rockets and guided missiles at Huntsville, Ala.

ARPA. Advanced Research Projects Agency.

Artificial gravity. Proposed system to simulate gravity by rotating a cabin about the longitudinal axis of a spacecraft.

Asteroid, or minor planet. One of many thousands of small bodies revolving around the sun, mainly between the orbits of Mars and Jupiter. Ceres, the largest known, is some 489 miles in diameter.

Astrionics. Electronics as applied to astronautics.

Astro. Prefix meaning "star" used as combining form, as in astrobiology.

Astrobiology. Branch of biology concerned with the discovery or study of life on other planets.

Astrogation. Navigating in space. Astronavigation.

Astronaut. One who flies or navigates through space.

Astronautics. The art or science of designing, building, and operating space vehicles.

Astronauticate. To guide and direct a spacecraft from within the vehicle, by means of observations on celestial bodies.

Astronomical unit. Mean distance of the earth from the sun, equal to 92,907,000 miles.

Astronomy. Oldest of the sciences. Treats of the celestial bodies, their magnitudes, motions, constituents, location, etc.

Astrophysics. The study of the physical and chemical nature of celestial bodies and their environs.

Astrotracker. A star tracker.

Atlantic Missile Range (AMR). A 5,000- to 6,000-mile instrumented range for testing ballistic and guided missiles located between Cape Canaveral, Fla., and a point beyond Ascension Auxiliary AFB, near the middle of the South Atlantic.

Atmosphere. The body of air surrounding the earth; also, the body of gases surrounding or comprising any planet or other celestial body.

Atmospheric braking. Action of atmospheric drag in decelerating a body approaching a planet; can be deliberately used where sufficient atmosphere exists, to reduce velocity before landing.

Atmospheric flare. Projection beyond the upper limits of the normal atmosphere. Comparable to a solar flare.

Atmospheric refraction. Refraction of light from a distant point by the atmosphere, caused by its passing obliquely through varying air densities.

Atomic rocket. Projected rocket engine in which energy for the jet stream would be generated by atomic fission or fusion.

Attenuation. Diminution of effectiveness of an emission of radiant energy, such as a radio signal, caused by distance or passage of the emitted wave through the exhaust flame of the rocket engine, etc.

Attitude. Orientation of an air vehicle as determined by the inclination of its axis to a frame of reference, usually the earth.

Attitude control system. System within the flight-control system to maintain the desired attitude of a vehicle.

Attitude jets. Sometimes called steering jets, attitude-control jets, or roll, pitch, and yaw jets; fixed or movable gas nozzles on a rocket, missile, or satellite operated continuously or intermittently to change its attitude or position.

Auntie. Slang for antimissile missile.

Aurora. Commonly known as northern and southern lights; high-altitude airglow caused by solar particles, predominantly protons, moving as charged particles in the earth's magnetic field and interacting with the earth's atmosphere.

Auto-igniting propellant. Any propellant that ignites at room temperature with a small time delay.

Auto-ignition temperature. The temperature at which combustible materials ignite spontaneously in air.

Avionics. Contraction of aviation electronics.

Azusa system. Launch-site tracking system developed by Convair for measuring missile velocity and position during early flight of the missile.

Backout. Reversing the countdown sequence because of the failure of a component in a missile or a hold of unacceptable duration.

Backup. Designed to come along closely behind an earlier missile system or project to complement the latter or take advantage of techniques and processes learned on the earlier development.

Ballistic missile. Any projectile, guided during powered flight in the upward part of its trajectory that becomes, usually after a successive loss of fallaway sections, a free-falling or ballistic body after fuel cutoff.

Ballistic Missile Division. Air Force Ballistic Missile Division.

Ballistic Missile Early Warning System (BMEWS). Electronic system to provide detection and early warning of attack by enemy intercontinental ballistic missiles, supplementing the present Distant Early Warning (DEW) Line built across the top of the continent to warn against bomber attack.

Ballistic Missiles Center. An office of Hq. Air Materiel Command at Inglewood, Calif., providing logistics support for specified missiles.

Ballistics. Science of the motion, behavior, appearance, or modification of missiles or other vehicles as they are acted upon by propellants, wind, gravity, temperature, or any other modifying substance, condition, or force.

Ballistic trajectory. The curved portion of a missile trajectory traced after the propulsive force is cut off and the body is acted upon only by gravity, aerodynamic drag, and wind.

Balloon-type missile. A missile that requires the pressure of its propellants (or substitute gases) within it to give it structure integrity. Atlas is an example.

(Continued on following page)

Barber chair. An adjustable type of seat that can position the occupant from an upright seated position to a supine or semi-supine position to increase tolerance to high acceleration.

Beam-rider guidance. A scheme of guidance in which the missile follows a radar beam to the target by means of onboard computers and controls sensitive to radar beams.

Beast. Familiar term for a large rocket.

Bends. Acute pain and discomfort in the arms, legs, and joints resulting from the formation of nitrogen and other gas bubbles in body tissues and fluids, caused by exposure to reduced barometric pressure.

Beta rays. Electrons given off by radioactive atoms.

Binary star. Two stars revolving around a common center of gravity.

Bioastronautics. Study of the effects of astronautics upon animal or plant life. Space medicine.

Biodynamics. Study of forces acting upon bodies in motion or in the process of changing motion, as they affect living beings.

Biomedicine. Combined discipline of biology and medicine for analysis of human tolerances to and protection against environmental variances.

Biopak. Container for housing a living organism in a habitable environment and to record biological functions during spaceflight.

Biosatellite. Satellite designed to carry an animal (as man) or plant.

Biosphere. That part of the earth and its atmosphere in which animals and plants live.

Bipropellant. A rocket propellant consisting of two unmixed or uncombined chemicals (fuel and oxidant) fed to the combustion chamber separately.

Bird. Figurative name for a missile or earth satellite.

Black box. Electronic unit, as a robot pilot, that may be mounted in, or removed from, a missile or the like as a single package. Module.

Blastoff. Missile launch. Slang.

Blockhouse. Heavily reinforced building, to withstand blast and heat, housing electronic controls and equipment for preparing and launching a missile.

Blowoff. Separation of a section from the remainder of the rocket vehicle by application of explosive force for purposes of retrieving instruments after they have collected data.

Blue Scout. AF solid-fueled rocket development program.

Boattail. Rear section of a ballistic body, sometimes tapered but squared off at the end, and serving as the base of the missile during launch.

Boiloff. Vaporization of a cold propellant such as liquid oxygen or hydrogen as the propellant mass rises to higher temperatures because of exposure to ambient conditions through walls of the missile tank or other uninsulated containers.

Boost. Rocket propulsion, either by solid or liquid propellants, during the initial climb, the liftoff, and the first phase of propelled flight of a missile.

Booster. Propulsion unit used in initial stage of flight.

Booster engine. An engine, especially a booster rocket, that adds thrust to the thrust of the sustainer engine, or provides propulsion for a special phase of flight.

Boost-glide vehicle. A rocket-booster winged vehicle capable of leaving the atmosphere and reentering under aerodynamic control in low-angled unpowered gliding maneuvers.

Boron or boron hydride. High-energy fuel with a high specific impulse.

Braking ellipses. A series of orbital approaches to the earth's or any other planet's atmosphere for the purpose of slowing a rocket preparatory to landing.

Breakoff phenomenon. Feeling during high-altitude flight of being totally detached from earth and human society.

Bremsstrahlung (German: brake radiation). Radiation of energy from charged particles after they have been decelerated or retarded, as in the case of atomic particles entering the earth's atmosphere, slowed down by collision with air particles.

Brennschluss (German: combustion termination). Cessation of fuel burning in a rocket, resulting from consumption of the propellants, from deliberate shutoff or other cause.

Bubble colony. Colony of persons placed on the moon or other spatial body provided with individual or group environmental capsules.

Burnout. Point in time or in the missile trajectory when propellant is exhausted or its flow cut off.

Burnout velocity. The velocity attained at the time the propellant is exhausted or fuel cutoff occurs.

Can. A shield or container for a missile, by which environment can be controlled.

Canopus. The second brightest star in the heavens, a star in the constellation Argo.

Cape Canaveral. Cape on the east coast of Florida, used as laboratory for launching missiles and/or space vehicles. The Air Force Missile Test Center operates launching site.

Capsule. Sealed, pressurized cabin with an acceptable environment, usually for containing a man or animal for extremely high-altitude flights, orbital spaceflight, or emergency escape.

Captive firing. Test firing of a complete missile where all or any part of the propulsion system is operated at full or partial thrust while the missile is restrained in the test stand.

Capture. Of a central force field, as of a planet; to overcome by gravitational force the velocity or centrifugal force of a passing body and bring the body under the central force field's control, in some cases absorbing its mass.

Cardiovascular reactivity. The response and function of heart and blood vessels to various types of stress, such as exercise, acceleration, heat, and cold.

Carrier rocket. A rocket vehicle used to carry something, as in the "carrier rocket" of the first artificial earth satellite.

Cavitation. Rapid formation and collapse of vapor pockets in a flowing liquid under very low pressures, a frequent cause of structural damage to rocket components.

Celestial. Pertaining to the sky or universe.

Celestial guidance. Onboard guidance of a missile or vehicle by reference to celestial bodies.

Celestial mechanics. Branch of astronomy concerned with the laws governing the motions of heavenly bodies, natural and now man-made also.

Celestial navigation. Onboard navigation using the celestial bodies for reference; celestial guidance.

Celestial sphere. Imaginary sphere of infinite radius, assumed for navigational purposes, the center of which coincides with the center of the earth.

Centaur. NASA rocket vehicle project, consisting of modified Atlas ICBM as first-stage, with a liquid-oxygen and hydrogen second stage.

Center of mass. Commonly called center of gravity, the point at which all the given mass of a body or bodies may be regarded as being concentrated as far as motion is concerned. (The center of mass in the earth about which the moon revolves is not at the same point as the center of mass of the two bodies as they revolve about the sun.)

Central force field. Gravitational or electromagnetic field that attracts and limits behavior of surrounding objects or particles.

Centrifugal force. Force away from the center of rotation.

Centrifuge. A large motor-driven apparatus with a long rotating arm at the end of which human and animal subjects or equipment can be revolved at various speeds to simulate accelerations encountered in high-performance vehicles.

Centripetal force. A force which is directed toward the center of rotation.

Chamber pressure. The pressure of gases within a firing chamber.

Characteristic length. In propulsion, the ratio of the chamber volume to its nozzle throat area. A measure of the length of travel available for the combustion of propellants.

Charge spectrum. The range and magnitude of electric charges with reference to cosmic particles at a certain altitude.

Checkout. A sequence of operational and calibrational tests needed to determine the condition and status of a weapon system.

(Continued on page 169)

*A Step
Ahead of
the State of
the Art in
Space
Electronics*



Goe, and catche a falling starre

(John Donne, 1572-1631)

By replacing erratic, expensive magnetrons with a *pulsed triode output stage**, the General Dynamics/Electronics Model 702 C-Band Transponder makes a major contribution to the art of target enhancement ... increases the reliability of tracking systems. Output—a solid 1 Kw, answering precision C-Band tracking radars such as the AN/FPS-16 and AN/MPS-26. The 702 is a tough little ten-pounder that measures 7½ x 8¼ x 3½ overall, including its own power converter. It draws a skimpy, weight-saving 30 watts from an external 28-volt DC power source. It is completely transistorized, except for the transmitter and



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**FASTER
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FASTER!**

Chemical fuel. A fuel depending upon an oxidizer for combustion or for development of thrust, such as liquid or solid rocket fuel, jet fuel, or internal-combustion engine fuel. Distinguished from nuclear fuel.

Chemosphere. A stratum of the atmosphere marked for its photochemical activity. By some meteorologists the chemosphere is considered to be an extension of the stratosphere.

Chlorate candles. Usually, a mixture of solid chemical compounds which, when ignited, liberates free oxygen into the air.

Chromosphere. One of the atmospheric shells of the sun, lying above the photosphere and best visible at time of total eclipse; can be observed spectroscopically at other times.

Chuffing. The characteristic of some rockets to burn intermittently with an irregular puffing noise.

Circular error probable (CEP). An indicator of the accuracy of a missile; used also as a factor in determining the probable damage to a target.

Circular velocity. Critical velocity at which a satellite will move in a circular orbit around its primary, a special case of orbital velocity.

Circumplanetary space. Space relatively close by a planet, especially the space close by the earth, including the outer reaches of the atmosphere.

Cislunar space. Space around the earth beyond the outermost reaches of the terrestrial atmosphere and within the orbit of the moon.

Closed ecological system. A system providing for the body's metabolism in a spacecraft cabin by means of a cycle wherein expired gases and body wastes are reconstituted into oxygen, water, and food.

Closest approach. The place or time at which two planets are nearest each other as they orbit about the sun.

Cluster. Two or more rocket engines bound together so as to function as one propulsive unit.

Coasting flight. The flight of a rocket missile or other vehicle between burnout or thrust cutoff of one stage and ignition of another, or between final burnout and summit altitude or maximum range. Also the unpowered portion of an interplanetary flight.

Cold-flow test. Test of a liquid rocket without firing to check efficiency of a propulsion subsystem that provides for the conditioning and flow of propellants, including tank pressurization, propellant loading, and propellant feeding.

Combustible. Any material or structure which can burn. A relative term; many materials will not burn in one state but will in another. For example, steel wool will burn, structural steel will not.

Comet. One of many loose bodies of gases and solid matter revolving around the sun.

Command destruct. Remote control system which destroys a flightborne missile, actuated on command of the range safety officer whenever performance degrades enough to be a safety hazard.

Command guidance. The guidance of a missile or vehicle by radio command or by wire.

Companion body. A nose cone, last-stage rocket, or other body that orbits along with an earth satellite. Afterbody; fallaway section.

Conic section. A curve formed by the intersection of a plane and a right circular cone. The conic sections are circular, elliptic, parabolic, or hyperbolic; curves that are used to describe the paths of bodies moving in space.

Conjunction. The passing of two or more celestial bodies in the same degrees of the zodiac. Inferior conjunction is when the planet is between the earth and the sun; superior conjunction is when the sun is between the earth and the planet.

Console. Master instrument panel from which rocket and missile launchings and tests are controlled.

Constellation. Any one of the arbitrary groups of fixed stars, some ninety of which are now recognized. A division of the heavens in terms of any one of these groups.

Contraorbit missile. Missile sent backward along the calculated orbit of a space vehicle.

Controlled environment. Environment in which matters such as humidity, pressure, temperatures, etc., are under control.

Controlled leakage system. A system that provides for the body's metabolism in an aircraft or spacecraft cabin by a controlled escape of carbon dioxide and other waste from the cabin, with replenishment provided by stored oxygen and food.

Control rocket. A vernier rocket, retrorocket, or other such rocket, used to guide, accelerate, or decelerate a ballistic missile, spacecraft, or the like.

Control system. A system in a missile that serves to maintain attitude stability during powered flight and to correct deflections caused by gusts or other disturbances.

Coriolis effect. Deflection of a body in motion due to the earth's rotation, diverting horizontal motions to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

Cosmic rays. Extremely fast particles continually entering the upper atmosphere from space which have very great energies because of enormous velocities; potentially dangerous to humans experiencing extended exposure.

Cosmos. Totality of the observed and postulated physical universe.

Countdown. Series of numbered events and checks that take place from the start of rocket-launching operations until the rocket lifts off the launch stand.

Courier. Army project to develop capability for a delayed repeater communication satellite payload.

Creep. Property of a metal which allows it to be permanently deformed when subjected to a stress. Accelerated at elevated temperatures.

Cryogenic fuel. A rocket fuel that either in itself is kept at very low temperatures or combines with an oxidizer kept at very low temperatures.

Cryogenics. The science of low-temperature conditions.

Cutoff. The shutting off of a liquid or solid-propellant combustion process of a rocket engine, causing a rapid drop toward zero thrust.

Cycle checkout. The periodic action of giving a complete physical checkout on missiles held in alert status.

Deceleration. Negative acceleration (slowing down).

Declination. In astronomy and celestial navigation, the angular distance of a celestial equator measured through ninety degrees and named "north" or "south" as the body is north or south of its celestial equator measured on an hour circle.

Decompression sickness. A disorder in deep-sea divers and aviators caused by reduced barometric pressure and evolved gas bubbles in the body, marked by pain in the extremities, occasionally leading to severe central nervous system and neurocirculatory collapse.

Deimos. The outer of the two moons of Mars.

Delta. NASA configuration of Air Force Thor-Able four-stage rocket vehicle, expected to be phased out after 1962.

Deluge collection pond. Facility at launch site into which water used especially to cool the flame deflector is flushed as the rocket begins its ascent. Also called a "skinner basin."

Destruct. Deliberate destruction for safety reasons of a rocket missile after it has been launched, but before it has completed its course.

Destruct line. Graphic representation drawn on a geographical map to show the boundary which a missile must not cross during flight. A missile which starts beyond the destruct lines on either side is immediately destroyed.

Detonation. Extremely rapid reaction in which an oxidizer and fuel combine with large evolution of heat. A high-order detonation, or "true detonation," proceeds with very high speed, generally several thousand feet per second.

Discoverer. Air Force Ballistic Missile Division series of launchings from Vandenberg AFB, Calif., of payloads into polar orbits to obtain data on maneuverability, attitude control, recovery, etc.

Diversionary missile. A missile decoy.

Doppler drift. The drift of a missile as determined through use of Doppler principle by means of radar.

Doppler principle. A principle of physics that, as the distance between a source of constant vibrations and an observer

(Continued on following page)

diminishes or increases, the frequencies appear to be greater or less.

Doppler radar. Radar that measures the velocity of a moving object by measuring the shift in carrier frequency of the return signal, the shift being proportional to the velocity with which the object approaches or recedes from the radar station.

Doppler shift. A shift of a luminous body's lines in a spectrum toward the red indicating an increase in distance.

Downrange. In a direction away from the launch site and along the line of a missile test range.

Down the slot. Vernacular expression for successful flight of a missile down the test range and within the limits established by range safety personnel.

Drag. Aerodynamic force in a direction opposite to that of flight and due to the resistance of the body to motion in air.

Dry-fuel rocket. A solid-fuel rocket that uses a mixture of fast-burning powder. Used especially as a booster rocket.

Dry weight. Weight of a rocket vehicle without its fuel.

Dual thrust. Thrust derived from two propellant grains using the same propulsion section of a missile.

Dyna-Soar. USAF research and development program to develop capability for manned, maneuverable, hypersonic reentry from orbital altitudes and velocities with normal landing at conventional fields. Consists of detaching glider boosted to near-orbital speeds by modified Titan ICBM.

Dyne. Unit of force that will accelerate a particle having a mass of one gram one centimeter per second per second.

Dysbarism. A general term which includes a complex variety of symptoms within the body caused by changes in ambient barometric pressure, exclusive of hypoxia. Characteristic symptoms (other than hypoxia) are bends and abdominal gas pains at altitudes above 25,000 to 30,000 feet. Increased barometric pressure, as in descent from high altitude, is characterized by painful distention of the ear drums and sinuses.

Earth fixed reference. An oriented system using some earth phenomena for positioning.

Ebullism. Formation of bubbles, with particular reference to water vapor bubbles and the boiling effect in body fluids caused by reduced barometric pressure.

Eccentricity. The degree of deviation from a circular orbit.

Echo. NASA passive communication satellite test program, using large plastic balloons inflated in space against which signals from earth are bounced and relayed back to earth.

Ecliptic. Plane of the earth's orbit around the sun, used as a reference plane for other interplanetary orbits. Also the name for the apparent part of the sun through the celestial sphere.

Ecosphere. Spherical extent inhabited by living organisms or suitable for life of such organisms. Also, layer of space about the sun extending from and including Venus through Mars.

EDP center. Electronic data-processing center.

Effective atmosphere. That part of the atmosphere which effectively influences a particular process of motion, such as aerodynamic support, or air friction, its outer limits varying according to the terms of the process of the motion considered.

Effective exhaust velocity. The velocity of an exhaust stream after the effects of friction, heat transfer, nonaxially directed flow, and other conditions have reduced it.

Effector. The mechanical means of maneuvering a missile during flight, an aerodynamic surface, a gimbaled motor, or an auxiliary jet.

Egads button. Button used by range safety officer to destroy a missile in flight if its plotted course is predicted to go beyond destruct line.

Electric engine. Projected ion or plasma engines, so named because of the separation of charged particles.

Electrojet. Current sheet or stream moving in an ionized layer in the upper atmosphere. Electrojets move around the equator following the subsolar point and also in polar regions where they give rise to auroral phenomena; generally caused by solar activity.

Electromagnetic wave. Form in which radiant energy travels, produced by oscillation of an electric charge, and including waves of radio, infrared, visible light, ultraviolet light, X-rays, gamma rays, cosmic rays, when considered as quanta of energy.

Electrons. High-speed, negatively charged particles forming outer "shell" of atom.

Ellipse. A curve described about two fixed points (the foci) so that the sum of the distances between any point on the curve and foci is equal to the sum of the distance between any other point on the curve and foci. Paths of planets in solar system are elliptical.

Emissivity. The term for relative power (of a surface or a material composing a surface) to emit heat by radiation.

Engine. The powerplant of a vehicle.

Ephemeris. Book of tables giving daily positions of celestial bodies.

Erector launcher. A mobile equipment that erects a missile onto launching position, then serves as a launcher.

Escape. To achieve a sufficient velocity outward from a primary body, as earth, so as neither to fall back to the body nor to orbit it.

Exhaust stream. The stream of gaseous, atomic, or radiant particles that emit from the nozzle of a rocket or other reaction engine.

Exhaust velocity. The velocity of gases that exhaust through the nozzle of a rocket engine or motor relative to the nozzle.

Exosphere. The outermost fringe or layer of the atmosphere, where collisions between molecular particles are so rare that only the force of gravity will return escaping molecules to the upper atmosphere.

Exotic fuel. New fuel combinations under study and development for aircraft and rocket use with the purpose of attaining far greater thrusts than now possible.

Explorer. Any of the earth satellites launched under the research and development program of the Army Ballistic Missile Agency or under programs of the National Aeronautics and Space Administration.

Exterior ballistics. That branch of ballistics concerned with the behavior of a missile during flight, influenced by conditions of air density, temperatures, velocity, and the like. Sometimes called "external ballistics."

Extragalactic nebulae. Star systems outside our own galaxy.

Fallaway section. Any section of a rocket vehicle that is cast off and falls away from the vehicle during flight, especially such a section that falls back to earth.

Final trim. Action in the flight of a ballistic missile that adjusts it to the exact direction programmed for its flight, normally accomplished by use of vernier engines.

Fin-stabilized. Directional stability of a projectile obtained by placement of fixed or adjustable airfoils on the airframe.

Firing chamber. Chamber in rocket engine in which the fuel and oxidizer are ignited, and in which pressure of gases is built up to provide an exhaust velocity sufficient to attain thrust.

First motion. First indication of motion of the missile or test vehicle from its launcher. Synonymous with "takeoff" for vertically launched missiles.

Fission. The release of nuclear energy through splitting of atoms.

Flame bucket. Opening built into the pads of some rockets into which the hot gases of the rocket pour as thrust is built up.

Flight readiness firings (FRF). Missile system tests of short duration conducted with the propulsion system operating while the missile is secured to the launcher.

FPS. Feet per second.

Free fall. The motion of any unpowered body traveling in a gravitational field.

Free-flight trajectory. That part of a ballistic missile's trajectory that begins with thrust cutoff and ends at reentry.

Freeze-out method. A method for controlling the composition of gases or liquids by freezing and separating frozen matter from the remaining liquids or fluids.

Fuming nitric acid. A highly concentrated solution of nitric pentoxide (N_2O_5) in water, red, brown, or white in color, and more active than the clear nitric acid, sometimes used as an oxidizer in a rocket engine.

Fusion. The combining (fusing) of atoms to release energy.

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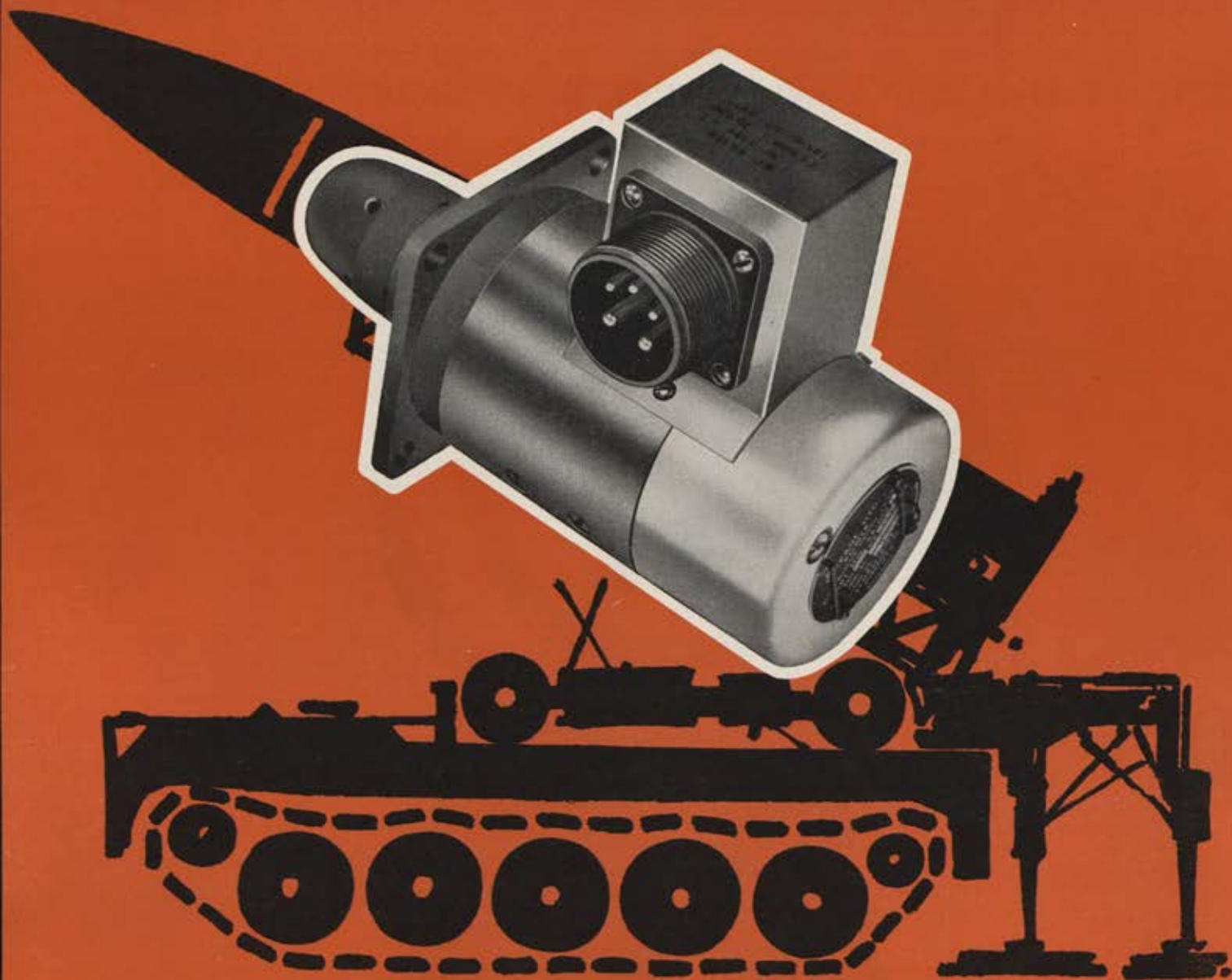
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G or G-force. The measure or value of the gravitational pull of the earth as modified by the earth's rotation, equal to the acceleration of a freely moving body at the rate of 32.16 feet per second per second.

Galaxy. Spiral system of stars; our galaxy, a disc-shaped aggregation of stars called the Milky Way, includes the solar system, far out on one of its spiral arms.

Gamma radiation. Electromagnetic radiation similar to X-rays originating from the nucleus, having a high degree of penetration.

Gantry. Crane-type structure, with platforms on different levels, used to erect, assemble, and service large rockets or missiles; may be placed directly over the launching site and rolled away just before firing.

Gegenschein. Faint light area of the sky always opposite the position of the sun on the celestial sphere. Believed to be the reflection of sunlight from particles moving beyond the earth's orbit.

Geocentric. Relating to or measured from the center of the earth; having, or relating, to the earth as a center.

Geodesy. The science which treats mathematically of the figure and size of the earth.

Gimbaled motor. A rocket motor mounted on a gimbal, i.e., on a contrivance having two mutually perpendicular axes of rotation so as to correct pitching and yawing.

Goddard, Robert H. American rocket pioneer.

Goddard Space Flight Center (GSFC). NASA research center at Greenbelt, Md.

Goldstone tracking facility. Radio telescope located at Army's Camp Irwin, Barstow, Calif., operated for NASA by JPL.

Go-no-go. A missile launch controlled at the end of the countdown as to permit an instantaneous change in decision on whether to launch or not to launch.

GOX. Gaseous oxygen.

Grain. Body of a solid propellant used in a rocket fashioned to a size and shape to burn smoothly without severe surges.

Gravireceptors. Specialized nerve endings and organs in skeletal muscles, tendons, joints, and in the inner ear, furnishing information to the brain on body position, equilibrium, the direction of gravitational forces, and sensation of "up" and "down."

Gravisphere. Spherical extent in which the force of a given celestial body's gravity is predominant in relation to that of other celestial bodies.

Gravitation. Force of mutual attraction between all matter in the universe. Varies directly as the product of the bodies' masses, and inversely as the square of the distance between them.

Gravity. Force of gravitation which tends to pull bodies toward the center of mass of the earth, giving them weight.

Gravity well. Analogy in which the gravitational field is considered as a deep pit out of which a space vehicle has to climb to escape from a planetary body.

Gross error. A missile strike at such distance from the target as to do no useful damage.

Ground start. A propulsion starting sequence through ignition to main stage which is initiated and cycled through to completion on the ground. In large rocket vehicles this ground start is commonly effected from pressurized propellant tanks external to the missile.

Ground-support equipment. All ground equipment that is part of the complete weapon system and that must be furnished to ensure complete support of the weapon system.

Ground-to-ground. Of a missile: launched from the surface to strike at a target on the surface.

G-tolerance. A tolerance in a person or other animal, or of a piece of equipment, to G-force of a particular value.

Guidance. The effect on a missile or vehicle that moves it in a desired direction, in response to controls exercised by a person inside the vehicle or by a preset or self-reacting automatic device within it, or by an onboard device reacting to outside signals.

Guided aircraft missile. A type of self-propelled missile, normally carried by a parent aircraft, which after launching can be guided to surface targets.

Guided aircraft rocket. A type of self-propelled armament carried by aircraft for attack on airborne targets, and which after launching can be guided to the target.

Guided missile. An unmanned vehicle moving above the earth's surface whose trajectory or flight path is capable of being altered subsequent to launch, or substantially throughout flight, as distinguished from a ballistic missile.

Gyroscope. Device consisting of a wheel so mounted that its spinning axis is free to rotate about either of two other axes perpendicular to itself and to each other; once set in rotation, its axle will maintain a constant direction, even when the earth is turning under it; when its axle is pointed due north, it may be used as a gyrocompass.

Half stage. A booster unit in a stage-and-a-half rocket.

Hard base. Missile launching base that is protected against nuclear bomb attack.

Heat exchanger. A device for transferring heat from one substance to another, as by regenerative cooling.

Heat sink. A contrivance for the absorption or transfer of heat away from a critical part or parts, as in a nose cone where friction-induced heat may be conducted to a special metal for absorption.

Heat transfer. In missilery, spread of heat across the combustion chamber of walls of a rocket engine.

Heaviside layer. Region of the ionosphere that reflects radio waves back to earth; also called Kennelly-Heaviside layer.

Heavy cosmic ray primaries. Positively charged nuclei of elements heavier than hydrogen and helium up to, but not including, atomic nuclei of iron, comprising about one percent of the total cosmic ray particles.

Heliocentric. Measured from the center of the sun; related to, or having the sun as a center.

Heterosphere. That part of the upper atmosphere wherein the relative proportions of oxygen, nitrogen, and other gases are unfixed and wherein radiation particles and micrometeoroids are mixed with air particles.

Hohmann orbit. Proposed paths of flight from earth's orbit to orbits of other planets, using minimum energy.

Hold. Scheduled or unscheduled delay or pause in the launching sequence or countdown of a missile or space vehicle.

Hold-down test. Testing of some system or subsystem in a missile or other vehicle while the vehicle is restrained in a stand.

Homing guidance. The guidance of a missile or other vehicle by means of an internal receiver that is sensitive to emissions at the objective, such as infrared or electronic radiations.

Homosphere. That part of the atmosphere made up, for the most part, of atoms and molecules found near the earth's surface, and retaining through the entire extent the same relative proportions of oxygen, nitrogen, and other gases.

Hot configuration. Test missile equipped and ready for firing, either static or live.

Hot test. Conducted by actually firing the propellants. A hot test may be live or static, or conducted in a confined place.

Hydrazine. Liquid base, NH_2NH_2 rocket fuel.

Hydrazone. An exotic fuel formed by the action of hydrazine or one of its derivatives on a compound containing the carbonyl group CO.

Hydrocarbon fuel. Gasoline or kerosene.

Hydrogen (H). Lightest chemical element, flammable, colorless, tasteless, odorless gas in its uncombined state. Used in liquid state as a rocket fuel.

Hydrosphere. The water envelope of a planet.

Hydrostatic effects. The pressures exerted by a column of liquid under normal gravitational conditions on the surface of the earth or in a gravitational field during an acceleration.

Hydyne. Also Hidyne. Hydrazine-based liquid rocket fuel.

Hyperacoustic zone. The region in the upper atmosphere above sixty miles where the distance between the rarefied air molecules roughly equals the wave length of sound, so that sound is transmitted with less volume than at lower levels. Above this zone, sound waves cannot be propagated.

Hyperbola. A conic section made by a plane intersecting a

(Continued on following page)

cone of revolution at an angle smaller than that of a parabola. The value of its eccentricity is greater than one.

Hypergol. A rocket fuel or propellant that ignites spontaneously upon contact with the oxidizer. A propulsion system that utilizes such a fuel.

Hypersonic. Velocities of five or more times the speed of sound in the surrounding medium.

Hypoxia. Oxygen deficiency in the blood, cells, or tissues of the body in such degree as to cause psychological and physiological disturbances. May result from scarcity of oxygen in the air being breathed, or from inability of the body tissues to absorb oxygen under conditions of low barometric pressure.

ICBM. Intercontinental ballistic missile.

Ice frost. A thickness of ice that gathers on the outside of a rocket vehicle over surfaces supercooled by liquid oxygen.

IGY. International Geophysical Year.

Inertial force. The force produced by the reaction of a body to an accelerating force, equal in magnitude and opposite in direction to the accelerating force. Inertial force endures only as long as the accelerating force endures.

Inertial guidance. An onboard guidance system for missiles and satellite vehicles where gyros, accelerometers, and possibly a gyro-stabilized platform satisfy guidance requirements without use of any ground-located components; entirely automatic, following predetermined trajectory.

Infrared light. Light in which the rays lie just below the red end of the visible spectrum.

Inhibitor. A substance bonded, taped, or dip-dried onto a solid propellant to restrict the burning surface and to give direction to the burning process.

Initial mass. Takeoff mass of a rocket.

Integral tank. A fuel or oxidizer tank built within the normal contours of an aircraft or missile and using the skin of the vehicle as part of the walls of the tank.

Intercontinental ballistic missile (ICBM). A ballistic missile with sufficient range to strike at strategic targets from one continent to another. ICBM minimum range is approximately 5,000 miles.

Interface. In a rocket vehicle or other system, a common boundary between one component and another.

Interior ballistics. That branch of ballistics concerned with the behavior, motion, appearance, or modification of a missile when acted upon by the ignition and burning of a propellant. Sometimes called "internal ballistics."

Intermediate-range ballistic missile (IRBM). A ballistic missile with a range of 200 to 1,500 miles.

Interplanetary. Between planets.

Interstellar. Between stars.

IOC. Initial operational capability.

Ion. An electrically charged atom or group of atoms. A positively charged ion is an atom or group of atoms with a deficiency of electrons; a negatively charged ion is an atom or group of atoms with an added electron.

Ion engine. Projected type of engine in which the thrust to propel the missile or spacecraft is obtained from a stream of ionized atomic particles, generated by atomic fusion, fission, or solar energy.

Ionized layers. Layers of increased ionization within the ionosphere. Responsible for absorption and reflection of radio waves and important in connection with communication and the tracking of satellites and other space vehicles.

Ionosphere. An outer belt of the earth's atmosphere in which radiations from the sun ionize, or excite electrically, the atoms and molecules of the atmospheric gases. The height of the ionosphere varies with the time of day and the season.

IRBM. Intermediate-range ballistic missile.

Isostatic. Under equal pressure from every side.

Isothermal region. The stratosphere considered as a region of uniform temperature.

Ivory tower. Vernacular for vertical test stand.

Jetavator. A control surface that may be moved into or against a rocket's jet stream, used to change the direction of the jet flow for thrust vector control.

Jet steering. The use of fixed or movable gas jets on a space weapon, ballistic missile, or sounding rocket to steer it along a desired trajectory, during both propelled flight (main engines) and after thrust cutoff.

Jet stream. The stream of gas or fluid expelled by any reaction device, especially the stream of combustion products expelled from a jet engine or rocket engine. Also, a narrow band of high-velocity wind, especially near the base of the stratosphere.

Jodrell Bank. Site of a large radio telescope, located near Manchester, England, with a paraboloidal receiver 250 feet in length, sixty feet deep, used to track space probes.

Jovian planet. Any one of the giant planets, i.e., Jupiter, Saturn, Uranus, or Neptune. Usually in plural "Jovian planets."

JPL. Jet Propulsion Laboratory of California Institute of Technology at Pasadena, Calif., operated for NASA under contract.

Kapustin Yar. A town some sixty miles east southeast of Stalingrad on the Akhtuba River, near which the Russians developed launch sites for short-range missiles and later for their Sputniks.

Kelvin scale. A temperature scale that uses centigrade degrees but makes the zero degree signify absolute zero.

Keplerian trajectory. Elliptical orbits described by celestial bodies (and satellites) according to Kepler's first law of celestial motion.

Kepler's laws. The three laws of planetary motion discovered by Kepler (1571-1630) that explain the movements of planets in terms of Copernican concept.

Kick rocket. A small rocket engine attached to the base of a satellite or other object capable of giving additional speed of fifty to 100 mph if desired.

Kiwi. Series of developmental studies by Atomic Energy Commission with goal of developing nuclear reactors useful in high-thrust rocket engines.

Knot. A nautical mile per hour, i.e., 1.1516 statute miles per hour.

Laika. Female dog carried as a passenger in Sputnik II.

Laminar flow. A nonturbulent airflow over and about a nose cone or other surface, made up of thin parallel layers.

Launch. Initial motion in transition from static repose to dynamic flight. The moment when the missile is no longer supported by the launcher. Takeoff. See **liftoff**.

Leveled thrust. A rocket powerplant equipped with a programmer or engine-control unit that maintains the output at a relatively constant thrust.

Liftoff. Initial motion along the trajectory of a space weapon or ballistic missile as it rises from the stand under rocket propulsion; the takeoff.

Light-year. Distance traveled in one year by light, which covers 186,284 miles in one second; equal to some 5,880,000,000,000 miles.

Limb. The outer edge of a celestial body, as of the sun.

Limb of the earth. The edge of the earth at the horizon.

Liquid hydrogen. Liquid rocket fuel that develops a specific impulse, when oxidized by liquid oxygen, ranging between 317 and 364 seconds depending upon the mixture ratio.

Liquid oxygen. Oxygen supercooled and kept under pressure so that its physical state is liquid. Used as an oxidizer in a liquid-fuel rocket.

Liquid propellant. Any liquid ingredient fed to the combustion chamber of a rocket engine.

Little Joe. A solid-rocket test vehicle developed by NASA, used especially to test the Mercury capsule.

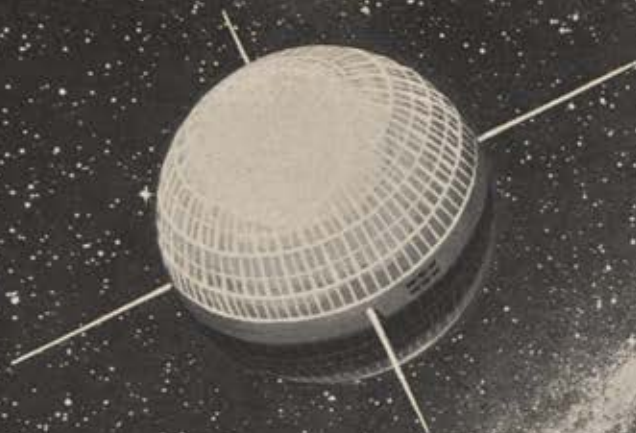
Logbalnet. Air Materiel Command network for the exclusive use of transmitting ballistic missiles logistical data via electrical media. This includes both ICBM and IRBM.

Lox. Liquid oxygen.

Luminous bands. Faint bands of luminosity appearing in the night airglow.

Lunik. Russian term for space probe launched to moon's vicinity or to impact on moon.

(Continued on page 177)



COURIER



DISCOVERER



MIDAS



ECHO

Philco Achievements in Space Technology

Philco has made many major contributions to the nation's vital space programs. COURIER, the world's first advanced communications satellite, was designed and built by Philco. Philco played a major role in the development and installation of the complex communications, command, tracking and data systems for the DISCOVERER program. Space-borne and ground communications systems for MIDAS and other satellites have been Philco designed. Philco developed and installed the tracking and receiving systems for the Air Force Passive Satellite Relay Link, which utilizes

the ECHO satellite. In the field of human factors engineering, Philco has developed personnel subsystems for several major space projects. Philco also produces the world's largest 3-axis satellite tracking antennas.

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DEFENSE SYSTEMS DIVISION, GENERAL MOTORS CORPORATION, WARREN, MICHIGAN AND SANTA BARBARA, CALIFORNIA

Magnetohydrodynamics. New science dealing with employment of ionized gases in propulsion systems.

Magnitude. Brightness of a star; first magnitude is the brightness of a candle flame at a distance of 1,300 feet. Order of magnitude decreases from first to twentieth at a ratio of intensity of 2.5; first magnitude is 100 times brighter than sixth; stars of the first six magnitudes are visible to the naked eye. Negative value used for objects brighter than first magnitude.

Main stage. In a single-stage rocket vehicle powered by one or more engines, the period when full thrust (at or above ninety percent) is attained. Also, in a multistage rocket, the stage that develops the greatest amount of thrust. Also, a sustainer engine, considered as a stage after booster engines have fallen away.

Map-matching guidance. Guidance of a flightborne vehicle by means of a radarscope film previously obtained by a reconnaissance flight over the terrain of the route.

Mariner. NASA program to send instrumented probes to vicinity of Mars and Venus.

Mars. The sun's fourth planet, its orbit outside the orbit of the earth.

Mass. The quantity of matter in an object.

Mass ratio. Ratio of a rocket's mass at launch to its mass at burnout.

Mechanical border. That layer in the atmosphere where air resistance and friction become negligible.

Mechanoreceptor. A nerve ending that reacts to mechanical stimuli, as touch, tension, and acceleration.

Mechta. (Russian "Dream.") A Russian space probe or asteroid launched on January 2, 1959, now in orbit around the sun.

Mercury. The planet nearest the sun. Also, the man-in-space program of NASA.

Mesosphere. In the nomenclature of Chapman, a stratum of atmosphere that lies between the stratosphere and the ionosphere, sometimes called the chemosphere. In the nomenclature of Wares, a stratum that extends approximately from 250 to 600 miles, lying between the ionosphere and the exosphere.

Metagalaxy. The entire system of galaxies including the Milky Way.

Meteor. Body originating in space but entering the earth's atmosphere with such velocity as to become incandescent and to appear as a falling star. Such a body encountered outside the atmosphere is normally called a "meteorite" or "meteoroid."

Meteor safe wall. Refers to the protective blanket of atmosphere through which meteors only rarely can penetrate instead of being burned up and vaporized by friction with air molecules.

Midas. Air Force project aimed at developing a system of satellites for detecting ballistic missile launching by infrared and other techniques.

Milky Way. The galaxy to which the earth's sun belongs.

Millstone Hill. Lincoln Laboratory site near Lexington, Mass., location of an eighty-four-foot dish radar antenna.

Minitrack. System for tracking artificial satellite by means of radio waves transmitted from the vehicle itself; several ground stations are required.

Missilry. The art or science of designing, developing, building, launching, directing, and sometimes guiding a missile.

Module. A combination of components, contained in one package or so arranged that together they are common to one mounting, which provides a complete function. Sometimes called black box vernacularly.

Momentum. Product of mass times velocity.

Monopropellant. A rocket propellant in which the fuel and oxidizer are premixed ready for immediate use.

MOR. Missile operationally ready.

M storm. Magnetic storm, produced by disturbances on the sun.

Multipropellant. A propellant that consists of two or more liquid ingredients each separated from the others until introduced into the combustion chamber.

National Aeronautics and Space Administration (NASA). Civilian agency with research and development jurisdiction in "aeronautical and space activities" sponsored by the US, except

those activities peculiar to or primarily associated with the development of weapon systems, military operations, or the defense of the US.

National Aeronautics and Space Council. Statutory advisory council to the President, consisting of Secretary of Defense, Administrator of NASA, Chairman of Atomic Energy Commission, Secretary of State, other members selected by President. President Kennedy has named Vice President Johnson to serve as Chairman.

Nautical mile (NM). A measure of distance equal to 6,076.103 feet or approximately 1.15 mile.

Nebula. Any celestial structure outside the solar system that occupies a perceptible extent in the sky and is not resolvable into stars by large telescope.

Negative G. Opposite of "positive G." In a gravitational field or during an acceleration, when the human body is so positioned that the force of inertia acts on it in a foot-to-head direction, i.e., the headward inertial force produced by a footward acceleration.

Neptune. The sun's eighth planet.

Nerv. NASA sounding rocket program to obtain data on radiation environment at high altitude.

Nimbus. Advanced NASA meteorological satellite program, follow-on to Tiros, planned to include television cameras and radar for observing precipitation.

Nitrogen tetroxide. A toxic liquid oxidizer, N_2O_4 , insensitive to shock and stable at room temperatures.

Nitromethane. An oily, colorless liquid compound (CH_3NO_2) used as a propellant.

Noctilucent cloud. High-altitude cloud lying at an altitude of fifty miles, appearing only after sunset or before sunrise when contrasted against a dark sky; may consist of volcanic dust or interplanetary matter trapped by temperature inversion.

Node. Either of two points where the orbit of an orbiting body intersects the plane of the orbit of its primary.

Nose cone. Assembly at the upper end of a ballistic missile from which it is separated after the end of propelled flight. The nose cone may contain a warhead or scientific payload.

Nova. Star which undergoes a sudden and enormous increase in brightness; about twenty-five appear every year in our galaxy. (Supernova is a star which explodes with a liberation of most of its energy into space.) Also, a projected satellite vehicle of NASA, powered by liquid multistage rockets.

Nozzle. The exhaust duct of a rocket thrust chamber in which gases are accelerated to high velocities.

Nuclear rocket. Projected rocket in which the energy for the exhaust stream would derive from nuclear fission or fusion.

Null circle. Theoretical point in space where the gravitational attraction of one planet balances that of another planet; there is no actual null point or region because of the constant movement of celestial bodies in relation to each other.

Oberth, Hermann. German pioneer in rocketry theory.

Oculo-gravimic illusion (perceptual illusion). During subgravity states, luminous targets seen in the dark appear to move and to be displaced in an upward direction.

Optical star tracker. A star tracker that locks onto the light of a particular celestial body. Distinguished from a radiometric star tracker. See star tracker.

Orb. A spherical body, especially a celestial sphere, as the moon, a planet, or a man-made satellite of that shape.

Orbit. The path described by a celestial body in its revolutions around another body.

Orbital bomber. A vehicle with the capability of orbiting speeds to allow circling the earth one or more times at very high altitudes and then gliding home to earth.

Orbital period. The period of time taken by an orbiting body to make a complete orbit.

Orbital velocity. Velocity needed to keep a body moving in a closed orbit around a sun, planet, or satellite. Orbital velocity of the earth is some 18,000 mph.

Orbit nodes. Points in an orbit where the orbit crosses a reference plane, such as the ecliptic or the equatorial plane.

Orbiting astronomical observatory (OAO). NASA development
(Continued on following page)

ment program leading toward earth-orbiting vehicle to make astronomical observations from vantage point above thickest portion of earth's atmosphere.

Orbiting Geophysical Observatory (OGO). NASA development program leading toward earth-orbiting vehicle to make geophysical observations of earth.

Orion. USAF study of a space platform maneuverable by controlled nuclear explosions.

Oxidizer. A rocket propellant component, such as liquid oxygen, nitric acid, fluorine, and others, which supports combustion when in combination with a fuel.

Oxygen-hydrocarbon engine. A rocket engine that operates on propellant of liquid oxygen as oxidizer and a hydrocarbon fuel, such as the petroleum derivatives.

Ozonosphere. A stratum in the upper atmosphere having a relatively high concentration of ozone, important for absorption of ultraviolet solar radiation.

Pacific Missile Range. National missile range located on the West Coast. The Navy is executive agent, with headquarters at Point Mugu, Calif.

Pad. A permanent or semipermanent load-bearing surface constructed or designed as a base upon which a launcher can be placed. Short for launch pad.

Parabola. A conic section made by an intersecting plane parallel to the side of the cone.

Parallax. The apparent displacement of an object, or the apparent difference in its direction of motion, if viewed from two different points.

Parsec. Astronomical unit of distance equal to 19,150,000,000 miles, indicating the distance at which the mean radius of earth's orbit would subtend an angle of one second of arc.

Payload. Useful cargo.

Perigee. Point in an elliptical orbit around the earth which is closest to the earth.

Perihelion. That point on an elliptical orbit around the sun which is nearest to the sun.

Period. Time required for an orbiting body to make a single revolution around its primary.

Perturbation. Effect of the gravitational attraction of one body on the orbit of another.

Phobos. Inner of the two moons of Mars.

Photon rocket. Hypothetical reaction-type powerplant based on directional emission of photons, a continuous quantum of radiant energy moving with the velocity of light.

Photosphere. The outermost luminous layer of the sun's gaseous body.

Picket ship. One of the ocean-going ships used on a missile range to provide added instrumentation for tracking or recovering the missiles.

Pioneer. Any of the space probes launched by the Army and Air Force under the aegis of NASA.

Pitch. The movement about an axis that is at once perpendicular to the missile's longitudinal axis and horizontal with respect to the earth.

Pitchover. Turning of a vertically rising vehicle into a course leading to a particular target.

Planet. A body that revolves about the sun or other star.

Planetoid. One of the numerous small planets nearly all of whose orbits lie between Mars and Jupiter. Also called asteroid and minor planet.

Planetology. The study of planets and satellites.

Plasma. An electrically charged gas or body of gas, formed when the gas is subjected to very high temperatures.

Plasma jet. High-temperature jet of electrons and positive ions that has been heated and ionized by the magnetohydrodynamic effect of a strong electrical discharge.

Pluto. The sun's ninth planet, discovered in 1930.

Point defense. Point defense has as its purpose the air defense of specified geographical areas, cities, and vital installations.

Point Mugu. A point on the Pacific coast near Oxnard, Calif., the site of the US Naval Air Missile Test Center, and of the headquarters of the Pacific Missile Range.

Polaris. Navy IRBM. Solid-propellant rocket designed to be launched from nuclear-powered submarines.

Polar orbit. The orbit of an earth satellite that passes over or near the earth's poles.

Polyurethane. A polymeric compound of urethane, used as a fuel in a solid propellant. With its oxidizer, polyurethane has a relatively high specific impulse.

Pontus. Code name for an ARPA project aimed at improvement of structural and power conversion materials.

Positive G. In a gravitational field or during an acceleration, when the human body is normally so positioned that the force of inertia acts on it in a head-to-foot direction, i.e., the footward inertial produced by a headward acceleration.

Pound of thrust. A measurement unit of the reaction force generated in a jet or rocket engine and available for propulsion.

Power landing. The landing of a spacecraft on a body in space in which the thrust of its motors is used as a brake.

Pressurized cabin. A cabin in an aircraft or spacecraft kept at, or designed to be kept at, an adequate internal air pressure to permit normal respiratory and circulatory functions of persons within it.

Pressurized suit. A garment designed to provide pressure upon the body so that respiratory and circulatory functions may continue normally, or nearly so, under low-pressure conditions, such as occur at high altitudes or in space without benefit of a pressurized cabin.

Prestage. Sequential phase in the starting of a large liquid-propellant rocket engine where initial partial flow of propellants into the thrust chamber is ignited, and this combustion is satisfactorily established before main stage is ignited.

Primary. The body around which a satellite orbits. Sun is primary of earth, earth of moon, etc.

Principia. Code name for an ARPA project in advanced solid propellants.

POC. Production operational capability.

Programed roll. An automatically controlled roll of a ballistic missile or satellite vehicle, usually executed during its vertical ascent before pitchover.

Programed turn. The turn of a ballistic missile from vertical motion, after liftoff, to a curved path approximating the desired powered flight trajectory prior to the initiation of guidance.

Propagation. In missile terminology, to describe the manner in which an electromagnetic wave such as a radar signal, timing signal, or ray of light, travels from one point to another.

Propellant. A liquid or solid substance burned in a rocket for the purpose of developing thrust.

Prospector. NASA program to land mobile instrumented exploratory vehicle on the moon.

Proxima Centauri. One of the two nearest known stars to the earth, about 4.3 light-years distant.

PSI or psi. Pounds per square inch. Used especially as a measure of overpressure.

Pyrophoric fuel. A fuel that ignites spontaneously in air.

Radial velocity. Speed of approach or recession of a body from the point of observation with respect to the earth; can be determined by measuring the Doppler shift between lines of the same elements in the spectra of the star and of a laboratory on the earth.

Radiant energy. Energy that travels as a wave motion, as with radio waves, infrared rays, visible light, etc.

Radiation. The emission and propagation of energy or matter. Energy traveling as a wave motion; the energy of electromagnetic waves. Radiant particles, such as alpha rays or beta rays.

Radio astronomy. Branch of astronomy that utilizes radio waves emitted by certain celestial bodies as a means of obtaining data.

Radio guidance system. A guidance system that uses radio signals to guide a flightborne vehicle.

Radio-inertial guidance. Missile or space weapon guidance system divided into two major groups: the onboard guidance system and flight-control system and the ground-located guidance station.

Radiometer. An instrument that detects and measures the intensity of thermal radiation, especially infrared radiation.

Ranger. NASA program leading to orbiting of moon and

(Continued on page 181)

He's got Minutemen "working on the railroad"

Hard basing is one way to protect America's force of retaliatory ICBM's. The problem was to find an alternate means of accomplishing the same mission. The Air Force solution was a new ICBM mobility concept—railroad car-mounted Minutemen, utilizing the nation's vast track mileage for numerical and geographical dispersion, creating a difficult target for enemy attack.

To put the Minuteman, its support systems and associated equipment on rails was a completely new problem in missile handling. The first requirement assigned by Boeing to American Machine & Foundry Company and ACF Industries, Inc., was a feasibility study of the existing limitations of roadbeds, rails, railroad operations and right-of-way. Unique tactical cars are being designed within these limitations to carry the Minuteman—cars that can handle the missile and its operating equipment, safely isolated from roadbed shock and ready for immediate retaliatory launching.

Single Command Concept

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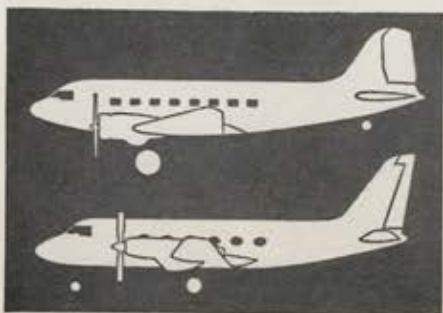
- for air evacuation
- for facilities inspection
- for high-priority personnel and cargo transport

Military transports of World War II and Korea vintage performed admirably. But today they deserve to be retired as befits any battle-weary veteran.

Typical of such transports is the DC-3—one of the finest, most reliable airplanes of its day. Its size, and ability to land and take off from virtually any military field, made it an extremely flexible transport. It has served faithfully in many roles over the past 20 years and has proved to be an excellent military investment. The Grumman Gulfstream is ready to serve as the optimum in military transport for the next 20 years, and as a comparable investment.

In the illustration, right, you see two airplane silhouettes: the first, a DC-3; the second, a Grumman Gulf-

stream. Note how closely they coincide in size. The Gulfstream is the modern pressurized, high performance replacement for the DC-3 and other older transports; equivalent to the DC-3 as a work horse transport—and costing even less to operate—the Grumman Gulfstream is a new airplane proved in service by over 60 world-wide corporations and the Federal Aviation Agency. Modernization of our country's airlift capacity for limited or brush fire warfare can be accelerated by the Grumman Gulfstream. And it's available now.



Gulfstream compared to DC-3



Facilities inspection

Here are the Gulfstream's capabilities: For military application, it will carry up to 24 passengers and has a transcontinental range against 50-knot head winds. It needs only 3,000 feet of runway, enabling personnel to use fields close to their destinations. It is completely independent of ground



Air evacuation

handling facilities. With its pressurization system (up to 30,000 feet), it flies above weather and traffic at a cruising speed of 350 mph and is powered by proven turboprop Rolls-Royce engines. An active develop-



Multipurpose Gulfstream cabin

ment program is in progress at Grumman for the installation of the General Electric T64 turboprop engine as an alternate source of power.

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eventual hard landing on the moon by an unmanned, instrumented space vehicle.

Rate receiver. A guidance antenna that receives a signal from a launched missile as to its rate of speed.

Reaction engine. An engine or motor that derives thrust by expelling a stream of moving particles to the rear.

Readout. A radio transmitter transmitting data either instantaneously with computation of the data or by play of a magnetic tape on which the data has been recorded.

Rebound. NASA code name for advanced system of passive balloon reflector communications satellites, all launched by a single vehicle.

Reconnaissance satellite. Earth satellite designed to obtain strategic information, through photography, television, etc.

Recovery. The act of retrieving a portion of a launched missile or satellite which has survived reentry.

Redstone Arsenal. Army facility at Huntsville, Ala., headquarters of the Army Ordnance Missile Command.

Reentry. Return of a part of a ballistic missile or other vehicle to the atmosphere after flight above the sensible atmosphere.

Regenerative cooling. Cooling of a rocket engine by circulating the fuel or oxidizer fluid in coils about the engine prior to use in the combustion chamber.

Reliability. Dependability.

Remaining body. That part of a missile or other vehicle that remains after the separation of a fallaway section or companion body.

Remaining mass. Mass of a rocket missile or vehicle after separation of fallaway section and afterbodies and after the expenditure of fuel; the payload remaining.

Restricted propellant. A solid propellant with restricted surfaces exposed for burning, the other surfaces being covered by an inhibitor.

Retrograde motion. Orbital motion opposite in direction to that normal to spatial bodies within a given system.

Retrorocket. Relatively small rocket unit, usually solid propellant, installed on a rocket-propelled vehicle and fired in a direction opposite to the main motion to decelerate main unit.

Revolution. The motion or the apparent motion of a body in orbit.

Right ascension. Arc of the celestial equator, or the angle at the celestial pole measured eastward from the hour circle of the vernal equinox to the hour circle of a given celestial body, either through hours or 360 degrees.

RJ-1. A liquid fuel somewhat denser than the kerosene-based fuel RP-1, and with greater energy yield.

Rocket. Self-contained, thrust-producing system that moves by ejecting a stream of hot gas from its rear; powered by either solid or liquid propellant, containing its own means of oxidation, making it independent of the atmosphere.

Rocket airplane. An airplane using rocket propulsion for its main or only propulsive power. Also, an airplane fitted out to carry and fire rocket ammunition.

Rocket sled. A sled that runs on a rail or rails and is accelerated to high velocities by a rocket engine. This sled is used by the Air Force in determining G tolerances and for developing crash survival techniques.

Rockoon. A rocket research vehicle designed to be carried up to very high altitudes by a balloon before being fired.

Roll. The movement of a missile body about its longitudinal axis.

Rotation. The turning of a body about its axis.

Rover. Joint AEC-NASA program to develop a nuclear rocket engine.

RP-1. A rocket liquid propellant consisting essentially of kerosene.

Rubber-base propellant. A solid-propellant mixture in which the oxygen supply is obtained from a perchlorate and the fuel is provided by a synthetic rubber latex.

SAC-Mike. Strategic Air Command ballistic missile staff at BMD, Inglewood, Calif.

Saint. Air Force study of feasibility of system of inspecting satellites to determine their missions.

Satellite. An attendant body that revolves about another body.

Satelloid. An artificial body or vehicle like an artificial satellite except that it uses engine thrust to remain in orbit.

Saturn. The sun's sixth planet. Also, a NASA rocket engine cluster in research and development expected to develop some 1,500,000 pounds of first-stage thrust.

Scintillating counter. An instrument that measures radiation indirectly by counting the light flashes emitted when radiation particles are absorbed.

Scout. NASA four-stage solid-fueled rocket under development for vertical probe and low-orbit missions.

Scrub. Vernacular for canceling out a scheduled test firing, either before or during countdown.

Sea Scout. Navy proposal for four-stage solid-fueled rocket to place satellites into orbit, with launching from seaborne pads.

Sealed cabin. Cabin, especially a spacecraft cabin, sealed against exfiltration or infiltration of any gas, liquid, or solid.

Secondary cosmic radiation. The energetic nuclear debris and ionization caused by the impact of primary cosmic ray particles on atoms and molecules of the upper atmosphere.

Second-of-arc. A measure of an angle 1/60th of a minute.

Seeker. A guidance system which homes on energy emanating or reflected from a target or station.

Selenoid. A lunar satellite.

Sensible atmosphere. That part of the atmosphere that may be felt, i.e., that offers resistance.

Separation. Moment when a full stage, half stage, a warhead, or a nose cone is separated from the remainder of the rocket vehicle; the moment when staging is accomplished.

Shake-table test. A laboratory test in which an instrument component is placed in a vibrator that simulates one of the conditions during the launch of a missile or other vehicle.

Shot. A missile launching.

Shutdown. Synonymous with cutoff. See cutoff.

Sidereal. A measurement of time. A sidereal day, for example, is the time it takes the earth to make a complete revolution measured from the stars. A sidereal day is four minutes shorter than our solar day.

Sidereal period. Time taken by a planet or satellite to complete one revolution about its primary as seen from the primary and as referred to a star.

Silo. A missile shelter that consists of a hardened vertical hole in the ground with facilities either for lifting the missile to a launch position, or for direct launch from the shelter.

Sirius. Brightest star in the heavens, a star of the constellation Canis Major.

Skin tracking. The tracking of an object by means of radar.

Skip-glide bomber. Winged vehicle that is boosted above the atmosphere by rocket power and turned into a somewhat circular orbit before thrust is cut off. From this point, follows an undulating trajectory, glancing or skipping off the upper regions of the atmosphere to slow its speed prior to reentry.

Skirt fog. Cloud of steam and water that surrounds the engines of a missile being launched from a wet emplacement.

Sky screen. An element of equipment used by range safety officer. The sky screen, electronic or optical, provides indication to the range safety officer whenever the missile deviates from planned trajectory.

Slenderness ratio. A configuration factor expressing the ratio of a rocket vehicle's length to its diameter.

Sloshing. Back-and-forth splashing of a liquid fuel in its tank, creating problems of stability and control in the vehicle.

Smart. Air Force studies of techniques by which manned maintenance of orbiting vehicles could be performed.

Smithsonian Astrophysical Observatory. An observatory of the Smithsonian Institution established in 1890 in Washington, D. C., but with its headquarters moved to Cambridge, Mass., in 1956.

Snap. AEC-NASA development program for nuclear auxiliary power systems for space vehicles.

Soft base. Launching base not protected against atomic attack.

(Continued on following page)

Soft landing. Landing on the moon or other spatial body at such slow speed as to avoid destruction of landing vehicle. Soft landings on moon are anticipated by use of retrorockets.

Solar constant. Amount of energy arriving per unit area exposed to unobstructed solar rays at the mean radius of the earth's orbit around the sun.

Solar corona. Outer atmospheric shell of the sun.

Solar corpuscular rays. Cosmic radiation originating from the sun.

Solar flare. Solar phenomenon which gives rise to intense ultraviolet and corpuscular emission from the associated region of the sun, affecting the structure of the ionosphere, interfering with communications.

Solar noise. Electromagnetic radiation which radiates from the atmosphere of the sun at radio frequencies.

Solar time. Time measured by reference to the apparent motion of the sun about the earth.

Solid propellant. Rocket propellant in solid state consisting of all the ingredients necessary for sustained chemical combustion, consisting of a compound of fuel and oxidizer, usually in plasticlike caked form. They burn on their exposed surface, generating hot exhaust gases to produce a reaction force.

Sounding rocket. Rocket used for carrying instruments to high altitudes for "sounding" upper atmosphere.

Space. That part of the universe between celestial bodies.

Space equivalence. A state of being in which a condition or conditions within the atmosphere are virtually identical with a condition or conditions beyond the atmosphere.

Space-fixed reference. An oriented reference system in space independent of earth phenomena for positioning.

Space law. A projected code of international law that would govern the use or control of space.

Space medicine. Medical factors involved in spaceflight.

Space platform. A habitable orbiting installation (normally geocentric) used as a platform for the launch of other space vehicles or for space research.

Space station. Space platform.

Spacesuit. Pressure suit designed for wear in space or at very low-pressure altitudes within the atmosphere, designed to permit the wearer to leave the protection of a pressurized cabin.

Space-time dilemma. According to Einstein's theory of relativity, time would slow down increasingly for occupants of systems moving at velocities approaching the speed of light, relative to the earth. This slowdown would not be apparent to inhabitants of the spacecraft until they return to earth.

Spatiography. System proposed by Dr. Hubertus Strughold for charting a "geography" of space.

Specific gravity. The ratio of the weight of any volume of a substance to the weight of an equal volume of another substance taken as standard at a constant or stated temperature. Solids and liquids are usually compared with water at four degrees centigrade.

Specific impulse. The thrust produced by a jet-reaction engine per unit weight of propellant burned per unit time, or per mass of working fluid passing through the engine in unit time. Equal to thrust in pounds divided by weight flow rate in pounds per second.

Speed of light. The speed at which light travels, 186,284 miles per second.

Speed of sound. The speed at which sound waves travel through a medium. In air at standard sea-level conditions, some 750 mph.

Sphere of gravitational influence. Gravisphere.

Spin rocket. A small rocket that imparts spin to a missile's airframe.

Spin-stabilized. Directional stability of a projectile obtained by the action of gyroscopic forces.

Spin table. A flat, round platform on which human and animal subjects can be placed in various positions and rapidly rotated, much as on a phonograph record in order to simulate and study the effects of prolonged tumbling at high rates.

Splash. Proving-ground vernacular for the intentional destruction or impact of a missile that is deviating from the preselected safe range limits or is malfunctioning.

Sputnik. The Russian name for its man-made moons or satel-

lites. The full Russian designation is *Iskustvenyi Sputnik Zewli* "artificial companion of the earth."

Squib. A small pyrotechnic device which may be used to fire the igniter in a rocket or for some similar purpose.

Stage. In a rocket vehicle powered by successive units, one or other of the separate propulsion units.

Stand talker. A person on a static test stand responsible for coordinating and timing preparations.

Star. A self-luminous celestial body exclusive of nebulae, comets, and meteors; any one of the suns seen in the heavens. Distinguished from planets or planet satellites which shine by reflected light.

Star-grain propellant. A solid propellant, its cross-section shaped like a star.

Star tracker. A telescopic instrument on a missile or other flightborne object that locks onto a celestial body and gives guidance to the missile or other object during flight.

Static testing. Testing of a missile or other device in a stationary or hold-down position, to verify structural integrity, the effects of limit loads, or to measure thrust.

Stationary orbit. Also, in reference to earth, known as a twenty-four-hour orbit; a circular orbit around a planet in the equatorial plane, having a rotation period equal to that of the planet.

Step rocket. A rocket with two or more stages.

Strain gauge. A device for measuring thrust on a test stand. See rocket thrust.

Stratopause. The upper limit or limits of the stratosphere.

Stratosphere. A calm region of the upper atmosphere characterized by little or no temperature change in altitude, separated from the lower atmosphere, or troposphere, by the tropopause. Stratosphere is free from clouds and convective currents of the troposphere.

Subgravity. A gravitational effect that is less than one G, i.e., less than the normal measure of the earth's gravity.

Subsatellite. An object designed to be carried into orbit inside an artificial earth satellite, but later ejected to serve a particular purpose. For example, an inflatable subsatellite has been designed to measure air density and satellite drag.

Sun. The star about which the earth revolves.

Sunflower. NASA program to develop spaceborne system based on solar radiation to supply power for at least one year to orbiting vehicle.

Sunseeker. Two-axis device actuated by servos and controlled by photocells to keep instruments pointed toward the sun despite rolling and tumbling of the rocket vehicle carrier.

Superior planet. A planet that is farther from the sun than the earth, i.e., Mars, Jupiter, Saturn, Uranus, Neptune, or Pluto.

Supersonic. Beyond the speed of sound.

Surface-to-air missile (SAM). A missile, especially a guided missile, launched from the surface to intercept a target in the air.

Surveyor. NASA program for soft-landing an unmanned instrumented vehicle on the moon.

Sustainer engine. An engine that sustains or increases the velocity of a missile or other aerospace vehicle once it has achieved its programmed velocity by use of the booster.

Sweat cooling. Method of controlling the excessive heating of a reentering body. Surfaces subjected to excessive heating are made of porous material through which liquid of high-heat capacity is forced. The evaporation of this coolant completes the sweat-cooling process.

Synergic curve. A curve plotted for the ascent of an aerospace vehicle determined to give the missile or other vehicle an optimum economy in fuel with an optimum velocity.

Synodic period. The time between two successive inferior conjunctions or between two successive oppositions, as seen from the earth.

Systems engineering. Process of applying science and technology to the study and planning of an over-all missile or aerospace vehicle system, whereby relationships of various parts of the system and the utilization of various subsystems are fully planned and comprehended prior to time hardware designs are committed.

(Continued on page 185)

Skybolt launching pad.

Any piece of sky can be the launching pad for Skybolt air launched ballistic missile. This radically new deterrent weapon is designed to have global mobility. It will be carried, and launched in flight, by the USAF B-52, or RAF Vulcan. When it becomes operational, four Skybolts may be launched from the same B-52 to strike multiple targets up to 1000 miles away. The very existence of such a flexible retaliatory force will be a formidable deterrent. The stellar-monitored inertial guidance system for the USAF-Douglas Skybolt is being developed and built by Nortronics.

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Takeoff mass. The mass of a rocket vehicle and its payload at the time of takeoff.

Takeoff weight. Weight of a rocket vehicle ready for takeoff, including the vehicle, fuel, and payload.

Tangential ellipse. Also known as a Hohmann orbit. The transfer ellipse from earth orbit to orbits of other planets, designed to use a minimum of fuel.

Telemetering. The technique of recording space data by radioing an instrument reading from a rocket to a recording machine on the ground.

Terminal velocity. Hypothetical maximum speed a body could attain along a specified straight flight path under given conditions of weight and thrust if diving through an unlimited distance in air of specified uniform density.

Terrella. Self-contained manned spaceship in which crew life is maintained during spaceflight by a closed-cycle breathing system.

Terrestrial reference guidance. Technique of missile control wherein predetermined path set into the control system of a missile can be followed by a device in the missile which reacts to some property of the earth, such as magnetic or gravitational effects.

Theodolite. A sighting and measuring telescopic instrument that gives a reading on horizontal or vertical angles.

Thermal barrier. Speed at which friction heat generated by rapid passage of an object through the atmosphere exceeds endurance compatible with the function of the object.

Thermal load. Stresses imposed upon a missile structure because of expansion or contraction (or both) of certain structural elements by aerodynamic heating during flight and reentry, by exposure to the heat of a rocket flame, or by cooling effects of liquid oxygen in the oxidizer system.

Thermosphere. The ionosphere considered as a region of temperature variation from minus twenty-eight degrees F to several thousand degrees F.

Thindown. The process by which cosmic rays, atomic particles, meteoroids, or the like lose their identity or their force as they penetrate into the atmosphere.

Throat. In rocket and jet engines, the most constricted section of an exhaust nozzle.

Throatable. Of a nozzle: Designed so as to allow a change in the velocity of the exhaust stream through changing the size and shape of the throat of the nozzle.

Thrust. The amount of "push" developed by a rocket; measured in pounds.

Thrust decay. When a rocket motor burns out or is cut off, propulsive thrust does not fall to zero instantaneously, but progressively declines over some fraction of a second.

Thrust-weight ratio. A quantity used to evaluate engine performance and obtained from dividing the thrust output by the engine weight less fuel. If the pound is used as the unit of measure for thrust and weight, the result is pounds of thrust per pound of engine.

Time dilation. Space-time dilemma. See above.

Tiros. Current NASA meteorological satellite program.

Topping the tank. Ground propellant supply system adjacent to the launch stand that replaces the boiloff or vapor loss of propellant as it is consumed during the thrust buildup.

Total impulse. The thrust of a jet engine, rocket motor, or rocket engine for the entire time that fuel is burning. Units are expressed in pound sections.

Touchdown. Landing of a manned or unmanned space vehicle on the surface of a planet by any method except gliding. Reverse jets would be the probable method of touchdown.

Trajectory. The path described by a missile or a space vehicle.

Tranquilizer. An instrument that adds stability to a missile's guidance system. Slang.

Transcontinental ballistic missile (TCBM). A ballistic missile with a range capability of 11,000 miles or more.

Transfer ellipse. Path followed by a body moving from one elliptical orbit to another.

Transit. Current Navy navigational satellite program.

Translunar. Beyond the moon.

Transverse acceleration; transverse G. The inertial force

produced by an acceleration acting across the body, perpendicular to the long axis of the body, as in a chest-to-back direction.

Tropopause. The upper limit or limits of the troposphere.

Troposphere. The lower layer of the earth's atmosphere, extending to about 60,000 feet at the equator and 30,000 feet at the poles.

Tsiolkovsky, K. E. A Russian engineer and scientist (1857-1935) whose paper "Rockets into Cosmic Space" (1903) was one of the pioneer works in the achievement of rocket flight.

T-time. The moment at the end of a countdown when action is taken to fire a rocket propulsion unit that launches a rocket vehicle or missile.

Tumble. Of an oblong earth satellite: to rotate about its horizontal axis, end over end.

Two-stage rocket. A rocket that has two propulsion systems, each housed in a separate section with its own fuel source, the upper one ignited after separation from the first.

Ultrasonic. Speeds between sonic and hypersonic.

Umbilical cord. Any one of the servicing electrical or fluid lines between the ground and an upright rocket missile or vehicle before the launch.

Universe. The entire spatial cosmos.

UOC. Ultimate operational capability.

Upper air. The atmosphere region embracing the ionosphere and the exosphere. See aerospace.

Uranus. The sun's seventh planet.

Van Allen radiation belts. Two doughnut-shaped belts of high-energy particles, trapped in the earth's magnetic field, which surround the earth. These belts, which form an obstacle to interplanetary explorations, were first discovered by Dr. James A. Van Allen of Iowa State University.

Vanguard. Experimental satellite project developed by US Naval Research Laboratory, later taken over by NASA. The first Vanguard, launched in 1958, is expected to remain in orbit some 200 years.

Vector steering. Vernacular for a steering method where one or more thrust chambers are gimbal-mounted so that the direction of the thrust force (thrust vector) may be tilted in relation to the center of gravity of the missile to produce turning.

Velocity. A vector quantity that includes both magnitude (speed) and direction relation to a given frame of reference. Rate of motion in a given direction, employed in its higher magnitudes as a means of overcoming the force of gravity.

Velocity vector. Combination of two ballistic missile trajectory values; the speed of the missile's center of gravity at a designated point on the trajectory and the angle between the local vertical and the direction of the speed.

Venus. The sun's second planet.

Vernier. Small rocket engines or gas nozzles mounted on missiles which can be fired by commands from the flight-control system to control the roll, pitch, and yaw attitudes during propelled flight. Second function is to make final adjustment of missile velocity as it approaches the thrust-cutoff point.

Voyager. NASA program to send unmanned, instrumented vehicles to orbit Mars and Venus, possibly land instrumented capsules on planetary surfaces.

Warhead. That part of a missile that constitutes the explosive, chemical, or other charge.

Weight. Gravitational force on a mass.

Weight flow rate. The flow rate of a liquid propellant expressed in pounds per second.

Weightlessness. The absence of any apparent gravitational pull on an object. Any object deprived of support and freely falling in a vacuum is weightless. An orbiting satellite above the earth's atmosphere is a special case of "free fall" as is an aircraft when flying a parabolic curve. Weightlessness is experienced in each case.

Wet emplacement. A launch emplacement that provides a deluge of water for cooling the flame bucket, missile engines, and other equipment during the launch of a missile.

Wet-fuel rocket. A liquid rocket.

(Continued on following page)



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GLOSSARY

CONTINUED

White Sands Missile Range (WSMR). A proving ground in New Mexico under the control of the Army Ordnance Missile Command as executive agency.

Wind tunnel. A tunnel through which a stream of air is drawn at controlled speeds for aerodynamic tests.

Wire-guided. Of a missile: Guided by electrical impulses through a wire over a closed circuit between the guidance operator and the missile.

Woomera Rocket Range. A rocket range located in inland South Australia, at which British missile flight tests are made.

Wright Air Development Division (WADD). An ARDC center at Wright-Patterson AFB, Ohio, conducting research, development, tests, and evaluation in aerodynamics, human factors, materials, electronics equipment, and aerospace sciences.

X. Symbol for experimental.

X-15. Manned research vehicle being built for USAF, NASA, Navy by North American; to make exploratory flight studies of aerodynamic heating, stability, control, and reentry problems of hypersonic flight and spaceflight, probably at altitudes of 50-100 miles.

X-time. Time remaining before launching of a missile, according to a schedule established by launch control personnel.

Y. Symbol for prototype.

Zero. To zero in. To bring a missile exactly into a position where it can be directed toward target.

Zero gravity. Weightlessness.

Zodiac. Belt on the celestial sphere on which the moon, sun, and planets appear to move about the earth, the middle line of the belt being the ecliptic or the sun's path.

Zodiacal band. Faintly luminous band of light appearing on the celestial sphere, connecting the zodiacal light with the Gegenschein.—END

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A Missile and Space BIBLIOGRAPHY

Rockets and Missiles

Alperin, Morton & Sutton, George P.: *Advanced Propulsion Systems* (Pergamon, N. Y., 1960).

Barrere, M.; Jawmotte, A.; De Vuerbeke, B. F.; Vandenkerckhove, J.: *Rocket Propulsion* (Van Nostrand, Princeton, 1959).

Bencke, T. H. & Quick, A. W.: *History of German Guided Missiles Development* (Verlag E. Appelhaus, Germany, 1960).

Bergaust, Erik: *Rockets and Missiles* (Putnam's, N. Y., 1957).

Bergaust, Erik: *Rockets of the Air Force* (Putnam's, N. Y., 1960).

Bergaust, Erik: *Rockets of the Army* (Putnam's, N. Y., 1960).

Bergaust, Erik: *Rockets of the Navy* (Putnam's, N. Y., 1960).

Bowman, Norman J.: *The Handbook of Rockets and Guided Missiles* (Perastation Press, Chicago, 1957).

Buchheim, Robert W.: *Space Handbook: Astronautics and Its Applications*, hard-back and paper edition (Random House, N. Y., 1959).

Burchard, John E., editor: *Rockets, Guns and Targets* (Little, Brown, Boston, 1948).

Burgess, Eric: *Frontier to Space* (Macmillan, N. Y., 1956).

Burgess, Eric: *Guided Weapons* (Macmillan, N. Y., 1957).

Burgess, Eric: *Rocket Propulsion, with an Introduction to the Idea of Interplanetary Travel*, second revised edition (Macmillan, N. Y., 1954).

Bussard, W. R. & De Lauer, R. D.: *Nuclear Rocket Propulsion* (McGraw-Hill, N. Y., 1958).

Caidin, Martin: *Countdown for Tomorrow* (Dutton, N. Y., 1958).

Caidin, Martin: *War for the Moon* (Dutton, N. Y., 1959).

Chapman, John: *Atlas: The Story of a Missile* (Harper, N. Y., 1960).

Cleator, Phil E.: *Rockets Through Space* (Simon and Schuster, N. Y., 1936).

Cox, Donald & Stoiko, Michael: *Spacepower: What It Means to You* (Winston, Philadelphia, 1958).

Davis, Clive E.: *The Book of Missiles* (Dodd, Mead, N. Y., 1959).

Davis, L. et al: *Exterior of Ballistics of Rockets* (Van Nostrand, Princeton, 1958).

Desoutter, D. M.: *Aircraft and Missiles: What They Are, What They Do, How They Work* (John de Graff, N. Y., 1959).

Dornberger, Walter: V-2 (Viking, N. Y., 1954).

Dow, Dr. R. W.: *Fundamentals of Advanced Missiles* (Wiley, N. Y., 1959).

Feodosiev, V. I. & Siniarev, G. B.: *Introduction to Rocket Technology*, translated from Russian by S. N. Samburoff (Academic Press, N. Y., 1959).

Gantz, Lt. Col. Kenneth F., USAF, editor: *The United States Air Force Report on the Ballistic Missile: Its Technology, Logistics and Strategy* (Doubleday, Garden City, 1958).

Gasland, Kenneth W.: *Development of the Guided Missile* (Philosophical Library, N. Y., 1958).

Goddard, Dr. Robert H.: *Rocket Development: Liquid-Fuel Rocket Research, 1929-1941*, edited by Esther C. Goddard and G. Edward Pendray (Prentice-Hall, N. Y., 1948).

Goddard, Dr. Robert H.: *Rockets* (American Rocket Society, N. Y., 1946).

Haley, Andrew G.: *Rocketry and Space Exploration* (Van Nostrand, Princeton, 1958).

Hartt, Julian: *Mighty Thor: Missile in Readiness* (Duell, Sloan & Pearce, N. Y., 1961).

Hobbs, Marvin: *Basics of Missile Guidance and Space Techniques*, 2 Vols. (Rider, N. Y., 1959).

Humphries, John: *Rockets and Guided Missiles* (Macmillan, N. Y., 1956).

Joubert de la Ferte, Air Chief Marshal Sir Philip Bennet: *Rocket* (Philosophical Library, N. Y., 1957).

Kooy, J. M. J. & Uytendogaart, J. W. H.: *Ballistics of the Future* (McGraw-Hill, N. Y., 1948).

Lawrence, Mortimer W.: *The Rockets*

Red Glare: The Challenge of Outer Space (Coward-McCann, N. Y., 1960).

Lent, Constantin P.: *Rocketry, Jets and Rockets: The Science of the Reaction Motor and Its Practical Application for Aircraft and Space Travel* (Pen-Ink, N. Y., 1947).

Ley, Willy: *Rockets, Missiles and Space Travel* (Viking, N. Y., 1957).

Medaris, Maj. Gen. John B., USA (Ret.): *Countdown for Decision* (Putnam's, N. Y., 1960).

Merrill, Capt. Grayson, USN, editor: *Principles of Guided Missiles Design* (Van Nostrand, Princeton):

Volume I—Locke, Arthur S.: *Guidance* (1959)

Volume II—Bonney, E. A.; Zucrow, M. J.; Besserer, C. W.: *Aerodynamics, Propulsion, Structures* (1956)

Volume III—Merrill, Grayson; Goldberg, Harold; Helmholtz, Robert H.: *Operations Research, Armament, Launching* (1956)

Volume IV—Besserer, C. W.: *Missile Engineering Handbook* (1958).

Nelson, W. C.: *Selected Topics on Ballistics* (Pergamon, N. Y., 1959).

Newell, Homer E., Jr.: *High-Altitude Rocket Research* (Academic Press, N. Y., 1953).

Newell, Homer E., Jr.: *Sounding Rockets* (McGraw-Hill, N. Y., 1959).

Nielsen, Jack N.: *Missile Aerodynamics* (McGraw-Hill, N. Y., 1960).

Overbey, Charles A.: *Aircraft and Missile Design and Maintenance Handbook* (Macmillan, N. Y., 1960).

Parry, Albert: *Russia's Rockets and Missiles* (Doubleday, Garden City, 1960).

Pendray, G. Edward: *The Coming Age of Rocket Power* (Harper, N. Y., 1947).

Puckett, Allen E. & Ramo, Simon: *Guided Missile Engineering* (McGraw-Hill, N. Y., 1958).

Rosen, Milton W.: *The Viking Rocket Story* (Harper, N. Y., 1955).

Rosser, J. Barkley; Newton, Robert R.; Cross, George L.: *Mathematical Theory of Rocket Flight* (McGraw-Hill, N. Y., 1947).

Shapero, I. I.: *The Prediction of Ballistic Missile Trajectories from Radar Observation* (McGraw-Hill, N. Y., 1959).

Shelton, William R.: *Countdown: The*
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BIBLIOGRAPHY

CONTINUED

Story of Cape Canaveral (Little, Brown, Boston, 1960).

Stine, G. Harry: *Rocket Power and Space Flight* (Holt, N. Y., 1957).

Sutton, George P.: *Rocket Propulsion Elements* (Wiley, N. Y., 1956).

US Air Force: *Fundamentals of Guided Missiles: Design, Theory, Operation, Maintenance* (Aero, Los Angeles, 1959).

US Air Force: *Guided Missiles: Operation, Design and Theory* (McGraw-Hill, N. Y., 1958).

Weyl, Alfred R.: *Guided Missiles* (Temple, London, 1949).

Wiech, Raymond E. & Straus, Robert F.: *Fundamentals of Rocket Propulsion* (Reinhold, N. Y., 1960).

Wimperis, Harry E.: *World Power and Atomic Energy: The Impact* (Constable, London, 1946).

Wimpress, R. N.: *Internal Ballistics of Solid-Fuel Rockets* (McGraw-Hill, N. Y., 1950).

Zucrow, M. J.: *Aircraft and Missile Propulsion, Vol. I, Thermodynamics of Fluid Flow and Application to Propulsion Engines* (Wiley, N. Y., 1958).

High Altitude and Satellite Rockets (Philosophical Library, N. Y., 1959).

Astronautics, Spaceflight

Adams, Carsbie: *Space Flight* (McGraw-Hill, N. Y., 1958).

Alperin, Morton; Stern, Marvin; Wooster, Dr. Harold, editors: *Vistas in Astronautics, Vol. I* (Pergamon, N. Y., 1958).

Alperin, Morton & Gregory, H. F., editors: *Vistas in Astronautics, Vol. II* (Pergamon, N. Y., 1959).

Baker, Robert M. L.: *An Introduction to Astrodynamics* (Academic Press, N. Y., 1960).

Bates, David R., editor: *Space Research and Exploration* (Sloane, N. Y., 1958).

Beard, R. B. & Rotherham, A. C.: *Space Flight and Satellite Vehicles* (Pitman, N. Y., 1958).

Bergaust, Erik & Hull, Seabrook: *Rocket to the Moon* (Van Nostrand, Princeton, 1959).

Bergman, Jules: *Ninety Seconds to Space: The Story of the X-15* (Doubleday, Garden City, 1960).

Berman, A. I.: *Astronautics* (Wiley, N. Y., 1960).

Bonestell, Chesley & Ley, Willy: *The Conquest of Space* (Viking, N. Y., 1958).

Branley, Franklin M.: *Experiments in the Principles of Space Travel* (Crowell, N. Y., 1955).

Clarke, Arthur C.: *Across the Sea of Stars* (Harcourt, Brace, N. Y., 1959).

Clarke, Arthur C.: *Exploration of the Moon* (Harper, N. Y., 1955).

Clarke, Arthur C.: *Interplanetary Flight: An Introduction to Astronautics* (Harper, N. Y., 1951; revised edition, 1960).

Clarke, Arthur C.: *The Other Side of the Sky* (Harcourt, Brace, N. Y., 1958).

Clarke, Arthur C.: *The Challenge of the Spaceships: Previews of Tomorrow's World* (Harper, N. Y., 1959).

Clarke, Arthur C.: *The Exploration of Space* (Harper, N. Y., 1959).

Claus, Francis J.: *Surface Effects on Spacecraft Materials* (Wiley, N. Y., 1960).

Cleator, Phil E.: *Into Space* (Crowell, N. Y., 1953).

Corliss, W. L.: *Propulsion Systems for Space Flight* (McGraw-Hill, N. Y., 1960).

Davis, Clive: *Man and Space* (Dodd, Mead, N. Y., 1960).

Ehrlicke, Krafft: *Spaceflight: Environment and Celestial Mechanics* (Van Nostrand, Princeton, 1960).

Flaherty, Bernard E., editor: *Psychophysiological Aspects of Space Flight* (Columbia Univ. Press, N. Y., 1961).

Gantz, Lt. Col. Kenneth F., USAF, editor: *Man in Space: The USAF Program for Developing the Spacecraft Crew* (Duell, Sloan & Pearce, N. Y., 1959).

Gatland, Kenneth W. & Kunesch, Anthony M.: *Space Travel* (Philosophical Library, N. Y., 1953).

Godwin, Felix: *The Exploration of the Solar System* (Plenum Press, N. Y., 1960).

Gordon, Ted & Scheer, Julian: *First into Outer Space* (St. Martin's Press, N. Y., 1959).

Gubitz, Myron B.: *To the Edge of Space: The Story of Rocketship X-15* (Messner, N. Y., 1960).

Haber, Heinz: *Man in Space* (Bobbs-Merrill, N. Y., 1953).

Hanrahan, James S. & Bushnell, David: *Space Biology: The Human Factors in Space Flight* (Basic Books, N. Y., 1960).

Hoff, Nicholas J. & Vincenti, Walter G.: *Aeronautics and Astronautics* (Pergamon, N. Y., 1960).

Jastrow, Robert, editor: *The Exploration of Space* (Macmillan, N. Y., 1960).

Holmes, David C.: *What's Going on in Space?* (Funk & Wagnalls, N. Y., 1958).

Kinney, William J.: *Medical Science and Space Travel* (Watts, N. Y., 1959).

Leonard, Jonathan N.: *Flight into Space: The Facts, Fancies and Philosophy* (Random House, N. Y., 1953).

Levitt, Dr. I. M.: *A Space Traveler's Guide to Mars* (Holt, N. Y., 1956).

Ley, Willy: *The Conquest of Space* (Viking, N. Y., 1949).

Ley, Willy & von Braun, Wernher: *The Exploration of Mars* (Viking, N. Y., 1956).

Ley, Willy: *Rockets: The Future of Travel Beyond the Stratosphere* (Viking, N. Y., 1944).

Müller, Wolfgang D.: *Man Among the Stars* (Criterion, N. Y., 1957).

Oberth, Hermann: *Man into Space* (Harper, N. Y., 1957).

Ordway, Frederick I., III: *Advances in Space Science, Vols. I and II* (Academic Press, N. Y., 1960).

Proell, Wayne & Bowman, Norman J.: *A Handbook of Space Flight* (Perastadion Press, Chicago, 1950).

Rees, Ed: *The Manned Missile: The Story of the B-70* (Duell, Sloan & Pearce, N. Y., 1960).

Richardson, Robert S.: *Exploring Mars* (McGraw-Hill, N. Y., 1954).

Ryan, Cornelius, editor: *Across the Space Frontier* (Viking, N. Y., 1952).

Ryan, Cornelius, editor: *Conquest of the Moon* (Viking, N. Y., 1953).

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BIBLIOGRAPHY—CONTINUED

Shternfeld, Ahri J.: *Soviet Space Science* (Basic Books, N. Y., 1959).

Tregaskis, Richard: *X-15 Diary: The Story of America's First Space Ship* (Dutton, N. Y., 1961).

Von Braun, Wernher; Whipple, Fred; Ley, Willy: *Conquest of the Moon* (Viking, N. Y., 1958).

Von Braun, Wernher: *First Men to the Moon* (Holt, N. Y., 1960).

Woodbury, David O.: *Outward Bound for Space* (Little, Brown, Boston, 1961).

Space Weapons: A Handbook of Military Astronautics, edited by the Editors of AIR FORCE/SPACE DIGEST (Praeger, N. Y., 1958).

The Men

Bell, Joseph N.: *Seven into Space* (Hawthorne, N. Y., 1960).

Bergaust, Erik: *Reaching for the Stars* (Doubleday, Garden City, 1960).

Bridgeman, William & Hazard, Jacqueline: *The Lonely Sky* (Holt, N. Y., 1955).

Caidin, Martin: *The Astronauts: The Story of Project Mercury, America's Man-in-Space Program* (Dutton, N. Y., 1960).

Crossfield, A. Scott & Blair, Clay, Jr.: *Always Another Dawn* (World, Cleveland, 1960).

Everest, Lt. Col. Frank K., Jr., USAF: *The Fastest Man Alive* (Dutton, N. Y., 1958).

Gartmann, Heinz: *The Men Behind the Space Rockets* (McKay, N. Y., 1956).

Haggerty, James J., Jr.: *First of the Spacemen: Iven C. Kincheloe* (Duell, Sloan & Pearce, N. Y., 1960).

Hunter, Mel: *The Misslemen: A Stirring Story of a New Breed of Men* (Doubleday, Garden City, 1960).

Kay, Terence: *Space Volunteers* (Harper, N. Y., 1960).

Lundgren, William R.: *Across the High Frontier: The Story of Test Pilot Major Charles E. Yeager, USAF* (Morrow, N. Y., 1955).

Myrus, Don: *The Astronauts: The True Story of Man's Greatest Adventure in Outer Space* (Grosset & Dunlap, N. Y., 1960).

Simons, Lt. Col. David, USAF, & Schanche, Don: *Man High* (Doubleday, Garden City, 1960).

Thomas, Shirley: *Men of Space* (Chilton, Philadelphia, 1960).

Williams, Beryl & Epstein, Samuel: *The Rocket Pioneers* (Messner, N. Y., 1955).

Earth Satellites

Bergaust, Erik & Beller, William: *Satellite* (Hanover House, Garden City, 1956; Bantam Books, N. Y., 1957).

Bergaust, Erik: *Satellites and Space Probes* (Putnam's, N. Y., 1960).

Berkner, L. V., editor: *Rockets and Satellites* (Pergamon, N. Y., 1958).

Burgess, Eric: *Satellites and Spaceflight* (Macmillan, N. Y., 1958).

Caidin, Martin: *Vanguard: The Story of the First Man-Made Satellite* (Dutton, N. Y., 1957).

Carter, L. J.: *The Artificial Satellite*:



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Proceedings of the 2d International Congress on Astronautics (British Interplanetary Society, London, 1951).

Chester, Michael & Kramer, Saunders B.: *Discoverer: The Story of a Satellite* (Putnam's, N. Y., 1960).

Clarke, Arthur C.: *The Making of the Moon: The Story of the Earth Satellite Program* (Harper, N. Y., 1957).

Proceedings of Franklin Institute Symposium: Earth Satellites as Research Vehicles (Franklin Institute, Philadelphia, 1956).

Gatland, Kenneth W.: *Project Satellite* (Allan Wingate, London, 1958).

Howard, Neale E.: *Handbook for Observing the Satellites* (Crowell, N. Y., 1958).

Kreiger, F. J.: *Behind the Sputniks* (Public Affairs Press, Washington, D. C., 1958).

Kurnosova, L. V., editor: *Artificial Earth Satellites, Vols. I & II* (Plenum Press, N. Y., 1960).

Moore, Patrick: *Earth Satellite* (Norton, N. Y., 1956).

Van Allen, James A., editor: *Scientific Uses of Earth Satellites* (Univ. of Michigan Press, Ann Arbor, 1956).

Vassiliev, M. & Dobronravov, V. V.: *Sputnik into Space* (Dial Press, N. Y., 1958).

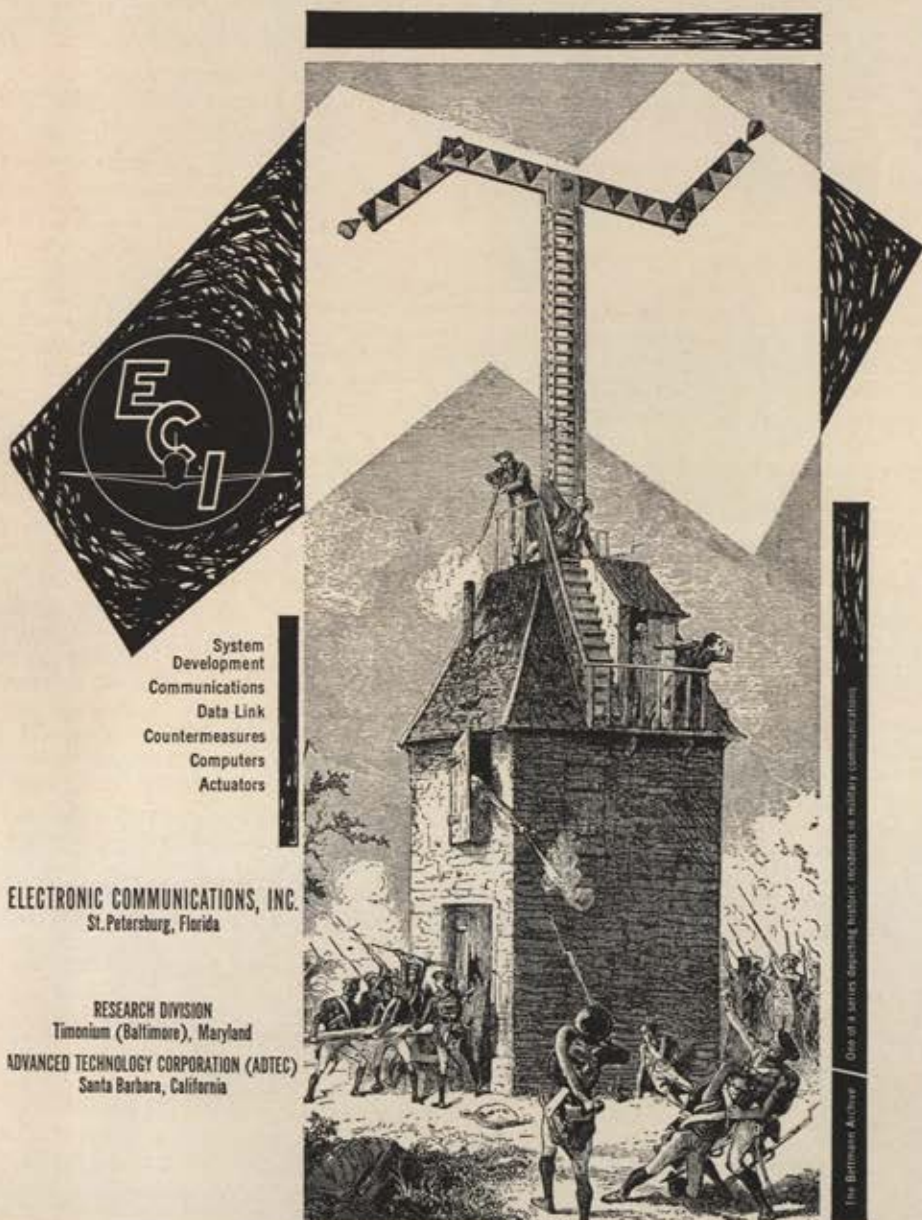
Woodbury, David O.: *Around the World in 90 Minutes* (Harcourt, Brace, N. Y., 1958).

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BIBLIOGRAPHY — CONTINUED

Soviet Writings on Earth Satellites and Space Travel (Citadel Press, N. Y., 1958).

Reference and Research

Air Force Pamphlet #210-1-1, July 1, 1959: *A Chronology of American Aerospace Events, 1903-1959*.

Air Force Pamphlet #11-1-4, October 30, 1959: *Interim Aerospace Terminology Reference*.

AIR FORCE/SPACE DIGEST editors: *Our Air Force* (Putnam's, N. Y., 1961).

Alperin, M. & Stern, M., editors: *Vistas in Aeronautics* (Pergamon, N. Y., 1958).

Ambartsumyan, V. A., editor: *Theoretical Astrophysics*, translated from Russian by J. B. Sykes (Pergamon, N. Y., 1960).

Armstrong, Maj. Gen. H. G., USAF (Ret.): *Aerospace Medicine* (Wilkins, Baltimore, 1960).

Bates, D. R., editor: *The Earth and Its Atmosphere* (Basic Books, N. Y., 1958).

Benson, Maj. Gen. Otis O., Jr., USAF, & Strughold, Hubertus, editors: *Physics and Medicine of the Atmosphere and Space* (Wiley, N. Y., 1960).

Besserer, C. W. & Hazel C.: *Guide to the Space Age* (Prentice-Hall, N. Y., 1960).

Boyd, R. L. F. & Seaton, J. M., editors: *Rocket Exploration of the Upper Atmosphere* (Interscience, N. Y., 1954).

Brodie, Bernard: *Strategy in the Missile Age* (Princeton Univ. Press, Princeton, 1959).

Brown, Willis C.: *Selected Bibliography of Books About Jets, Rockets, and Space Exploration, 1953-1960* (Dept. of Health, Education and Welfare, Washington, D. C., 1958 and 1960).

Caidin, Martin: *Spaceport USA: The Story of Cape Canaveral and the Air Force Missile Test Center* (Dutton, N. Y., 1959).

Clarke, Arthur C.: *The Exploration of Space* (Harper, N. Y., 1952; Pocket Books, N. Y., 1954).

Clason, Clyde B.: *Exploring the Distant Stars* (Putnam's, N. Y., 1958).

Coombs, Charles: *Gateway to Space* (Morrow, N. Y., 1960).

Coombs, Charles: *Skyrocketing into the Unknown* (Morrow, N. Y., 1954).

Davis, Clive: *Messages from Space* (Dodd, Mead, N. Y., 1961).

Davis, L.; Follin, J. W.; Blitzer, L.: *Exterior Ballistics of Rockets* (Van Nostrand, Princeton, 1958).

Draper, Charles S.; Wrigley, Walter; Hovorka, John: *Inertial Guidance* (Pergamon, N. Y., 1960).

DuBridge, Lee A.: *Introduction to Space* (Columbia Univ. Press, N. Y., 1960).

Ducrocq, Albert: *Victory Over Space* (Little, Brown, Boston, 1961).

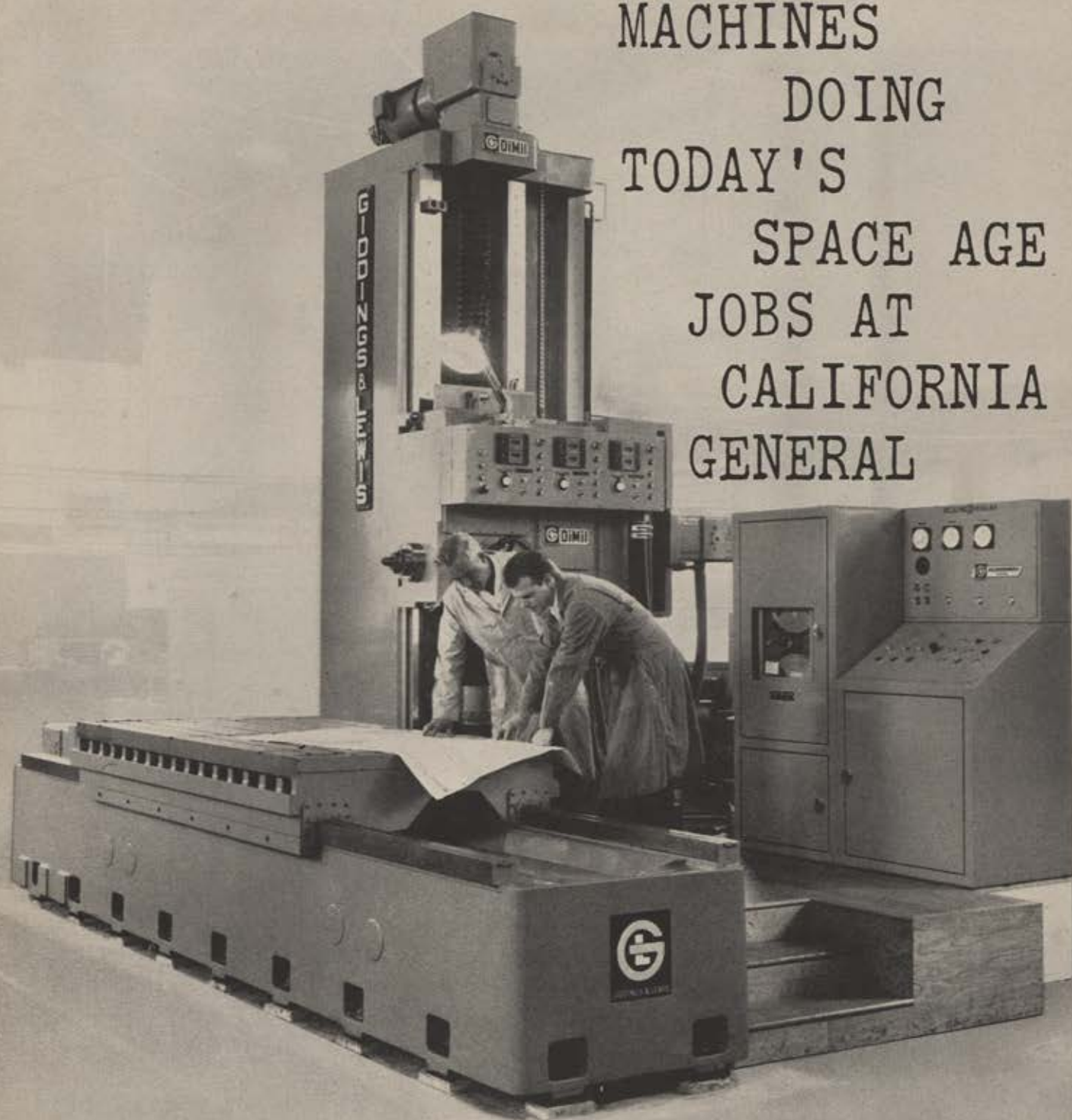
Estep, Dr. Raymond: *An Airpower Bibliography*, Vol. I, 1950-54, Vol. II, 1955-56 (Research Studies Institute, Air University, Maxwell AFB, Ala., 1958).

Estep, Dr. Raymond: *A Space Bibliography through 1958* (Research Studies Institute, Air University, Maxwell AFB, Ala., 1959).

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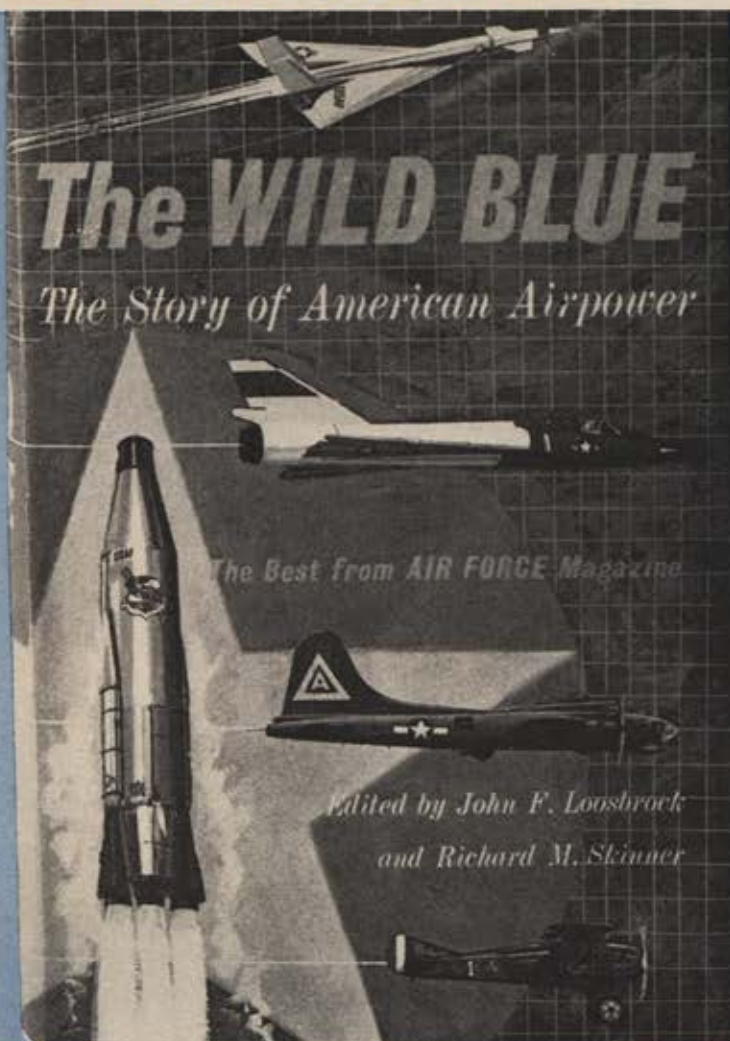


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Fenyo, Eva: *A Guided Tour Through Space and Time* (Prentice-Hall, N. Y., 1959).

Firsoff, V. A.: *Our Neighbour Worlds* (Hutchinson, London, 1952).

Firsoff, V. A.: *Strange World of the Moon* (Basic Books, N. Y., 1960).

Gallant, Roy A.: *Exploring the Planets* (Garden City Books, Garden City, 1958).

Gallant, Roy A.: *Man's Reach into Space* (Doubleday, Garden City, 1959).

Gantz, Lt. Col. Kenneth F., USAF, editor: *Nuclear Flight: The United States Air Force Program for Atomic Jets, Missiles and Rockets* (Duell, Sloan & Pearce, N. Y., 1960).

Gaynor, Frank: *Aerospace Dictionary* (Philosophical Library, N. Y., 1960).

Gaynor, Frank: *Dictionary of Astronomy and Astronautics* (Philosophical Library, N. Y., 1958).

Geophysics Research Directorate, USAF: *Handbook of Geophysics* (Macmillan, N. Y., 1960).

Goland, Martin, editor: *Physics and Medicine of the Atmosphere and Space* (Wiley, N. Y., 1960).

Haggerty, James J., Jr., executive editor: *The Aerospace Year Book, 1960* (American Aviation Publications, Washington, D. C., 1960).

Hanrahan, James S. & Bushnell, David: *Space Biology* (Basic Books, N. Y., 1960).

Herrick, John H. & Burgess, Eric, editors: *Rocket Encyclopedia Illustrated* (Aero, Los Angeles, 1959).

Jessup, Philip C. & Taubenfeld, Howard Jack: *Controls for Outer Space* (Columbia Univ. Press, N. Y., 1959).

Jones, Sir Harold Spencer et al: *The Space Encyclopedia*, revised edition (Dutton, N. Y., 1960).

Kahn, Herman: *On Thermonuclear War* (Princeton Univ. Press, Princeton, 1961).

Kallman, H., editor: *Space Research: The Proceedings of the First International Space Science Symposium* (Interscience, N. Y., 1960).

Kit, Boris & Evered, Douglas S.: *Rocket Propellant Handbook* (Macmillan, N. Y., 1960).

Lee, Asher, editor: *Soviet Air and Rocket Forces* (Praeger, N. Y., 1959).

Levitt, Dr. I. M.: *Target for Tomorrow* (Fleet, N. Y., 1959).

Loosbrock, John F. & Skinner, Richard M.: *The Wild Blue: The Story of American Airpower* (Putnam's, N. Y., 1961).

McClure: *Theory of Inertial Guidance* (McGraw-Hill, N. Y., 1960).

McLaughlin, Charles, editor: *Space Age Dictionary* (Van Nostrand, Princeton, 1959).

Mallan, Lloyd: *Men, Rockets, and Space Rats* (Messner, N. Y., 1958; revised edition, 1960).

Maloney, Terry: *Other Worlds in Space* (Sterling, N. Y., 1959).

Maloney, Terry: *The Sky Is Our Window* (Sterling, N. Y., 1960).

Marberger, John F.: *Space Medicine, the Human Factor in Flights Beyond the Earth* (Univ. of Illinois Press, Urbana, 1951).

Marshack, Alexander: *The World in Space* (Nelson, N. Y., 1958).

Merrill, Grayson, editor: *Dictionary of Guided Missiles and Spaceflight* (Van Nostrand, Princeton, 1959).

Moore, Patrick: *A Guide to the Stars* (Norton, N. Y., 1960).

Moore, Patrick: *A New Guide to the Planets* (Norton, N. Y., 1960).

Moore, Patrick: *The Planet Venus* (Macmillan, N. Y., 1959).

Nourse, Alan E.: *Nine Planets* (Harper, N. Y., 1960).

Oberth, Hermann: *The Moon Car* (Harper, N. Y., 1959).

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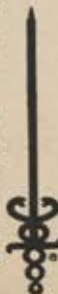
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BIBLIOGRAPHY — CONTINUED

International Missile and Spacecraft Guide (McGraw-Hill, N. Y., 1960).

Orr, Clyde, Jr.: *Between Earth and Space* (Macmillan, N. Y., 1959).

Parkin, Lt. Col. Charles M., Jr., USAF: *Rocket Handbook for Amateurs* (Day, N. Y., 1959).

Pickering, James S.: *The Threshold of Space* (Dodd, Mead, N. Y., 1960).

Ratcliffe, J. A.: *Physics of the Upper Atmosphere* (Academic, N. Y., 1960).

Rawer, Karl: *The Ionosphere* (Ungar, N. Y., 1957).

Sänger, Eugen & Bredt, Irene: *A Rocket Drive for Long-Range Bombers* (privately published by Dr. Robert Cornog, 1952).

Seifert, Howard, editor: *Space Technology* (Wiley, N. Y., 1959).

Sells, S. B. & Berry, Lt. Col. Charles A., USAF, editors: *Human Factors in Jet and Space Travel* (Ronald Press, N. Y., 1961).

Shapley, Harlow: *Of Stars and Men* (Beacon Press, Boston, 1958).

Simon, Col. Leslie E.: *German Research in World War II* (Wiley, N. Y., 1947).

Ulanoff, Stan: *Illustrated Guide to U.S. Missiles and Rockets* (Doubleday, Garden City, 1959).

Urey, Harold C.: *The Planets: Their Origin and Development* (Yale Univ. Press, New Haven, 1952).

USAF Geophysics Research Directorate: *Handbook of Geophysics* (Macmillan, N. Y., 1960).

USAF, Office of Information: *USAF Aerospace Space Craft, Releasable Data*, AFP 190-2-1 (1960).

USSR Academy of Sciences, translated from Russian by J. B. Sykes: *The Other Side of the Moon* (Pergamon, N. Y., 1960).

Vaeth, J. Gordon: *200 Miles Up—The Conquest of the Upper Air*, second edition (Ronald Press, N. Y., 1955).

Van Nostrand's *Scientific Encyclopedia* (Van Nostrand, Princeton, 1959).

Von Kármán, Theodore: *Aerodynamics* (Cornell Univ. Press, Ithaca, 1954).

Weiser, William J.: *The Space Handbook* (Coward-McCann, N. Y., 1960).

White, Clayton S. et al., editors: *Aviation Medicine* (AGARDograph #25, AGARD, NATO, Paris, France, 1958).

White, Clayton S. & Benson, Otis O., Jr., editors: *Physics and Medicine of the Upper Atmosphere* (Univ. of New Mexico Press, Albuquerque, 1952).

Whittle, Sir Frank: *Jet* (Philosophical Library, N. Y., 1955).

Who's Who in *Aeronautics and Astronautics* (American Aviation Publications, Washington, D. C., 1959).

Wilkins, H. L.: *Moon Maps* (Macmillan, N. Y., 1960).

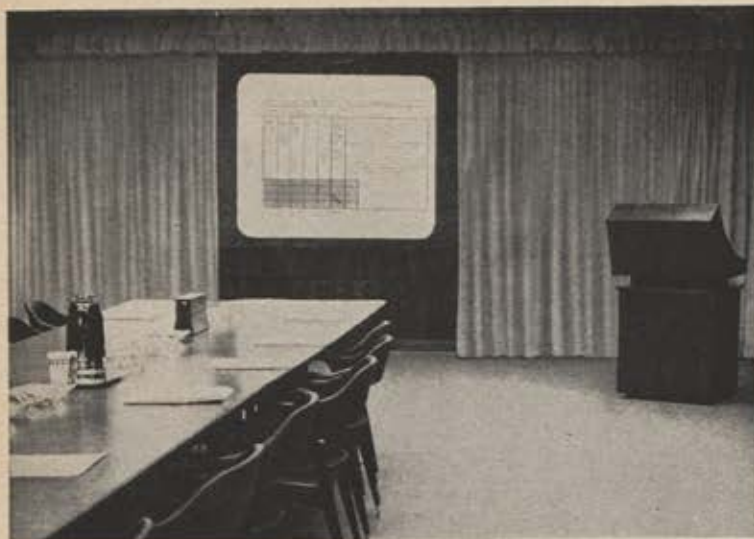
Yeh, Hsuan & Abrams, Joel L.: *Principles of Mechanics of Solids and Fuels, Vol. I—Particle and Rigid Body Mechanics* (McGraw-Hill, N. Y., 1960).

Zaehring, Alfred J.: *Soviet Space Technology* (Harper, N. Y., 1961).

Zarem, Lewis: *New Dimensions of Flight* (Dutton, N. Y., 1959).

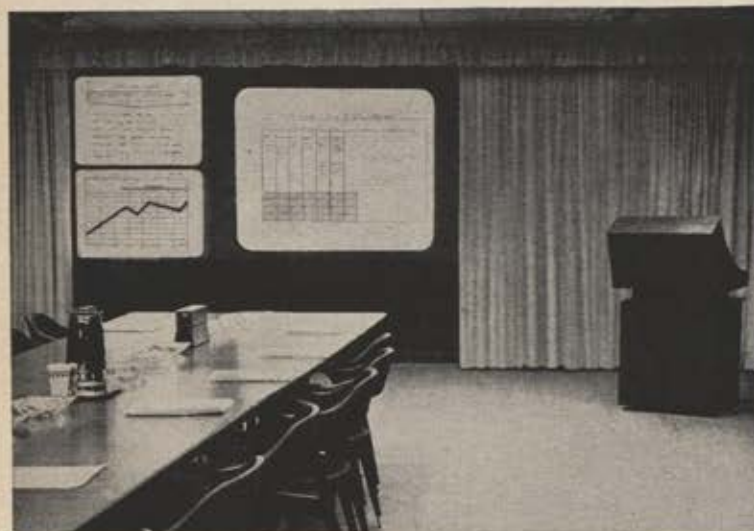
Zelikoff, M., editor: *The Threshold of Space* (Pergamon, N. Y., 1958).

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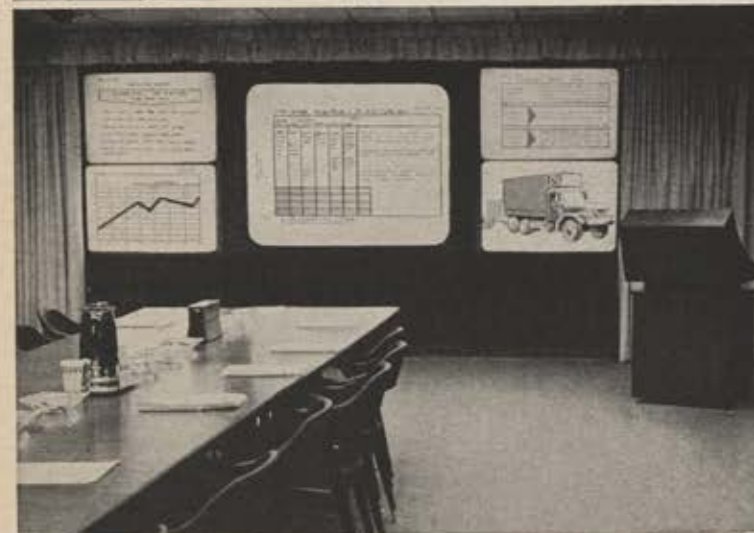


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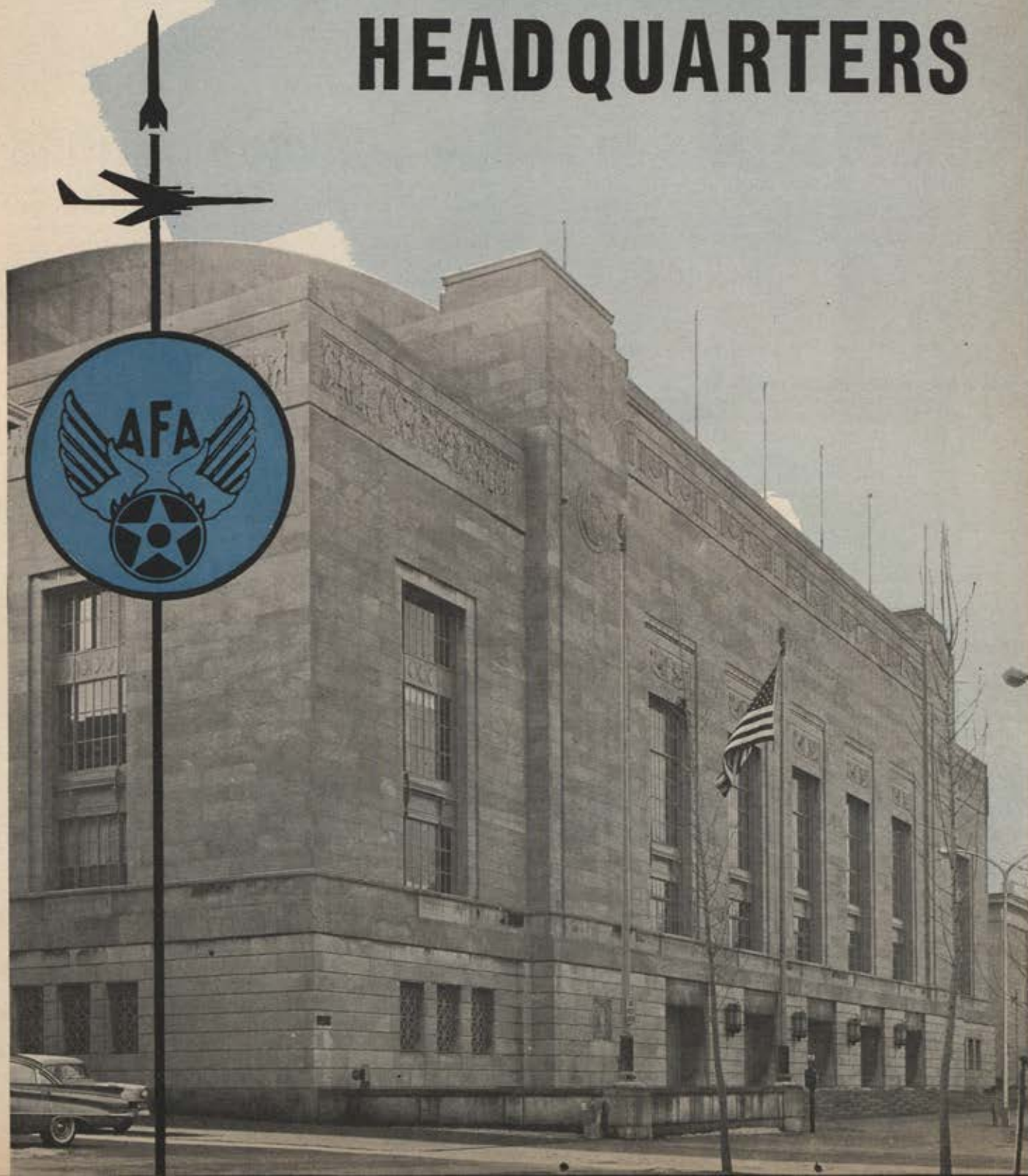


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COMMUNICATIONS SYSTEMS DIVISION
TELEPROMPTER
CORPORATION

The Site of AFA's 1961

AEROSPACE PANORAMA AND CONVENTION HEADQUARTERS



Philadelphia September 20-24



Above: Minuteman unveiling was the theme of AFA's 14th Annual Convention and Panorama in San Francisco last September.

ATTENDANCE • 1960 CONVENTION • SAN FRANCISCO

Convention Registration	3,924
Panorama Attendance	61,962
Program Participants	115
News Representatives	405
United States Air Force	
Secretariat	4
General Officers	71
Colonels	211
Other Officers	201
Foreign Government Representatives	9
US Government Representatives (Other Than USAF)	37
Education	121
Industrial Companies	408
Industrial Representatives	1,796
Presidents and Board Chairmen	131
Vice Presidents	250
Executive Assistants and Consultants	94
Managers	669
Engineering Personnel	132
Purchasing, Sales, and Advertising	229
Other	291
Exhibiting Companies	195

ATTENDANCE • 1961 CONVENTION • PHILADELPHIA

Attendance at the 1961 Fifteenth Anniversary Convention and Aerospace Panorama in Philadelphia (based on advance reservations) will break all previous records. Philadelphia itself is located in a high-density aerospace industry area. It is easy to reach from New York, New England, Baltimore, Pittsburgh, and Washington, D. C.

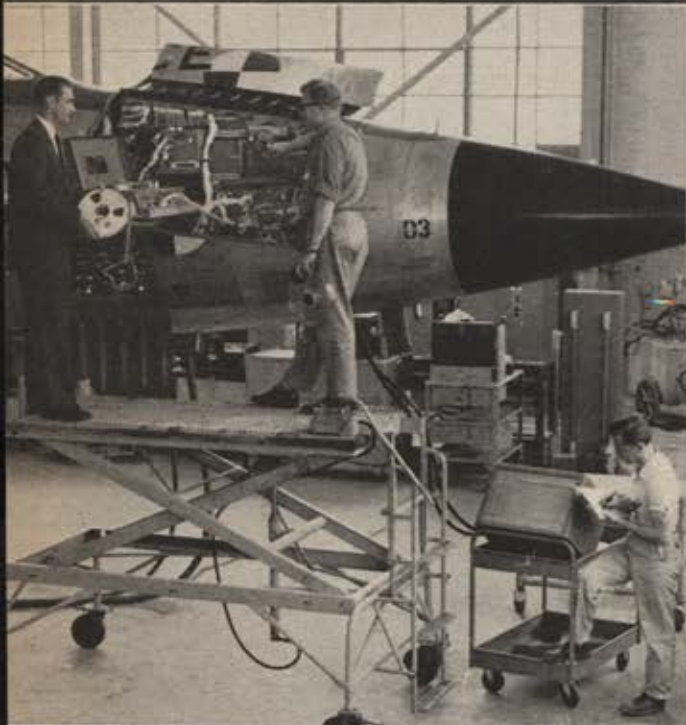
The Aerospace Panorama is a unique platform for prime contractors, associate contractors, and subcontractors to display and personalize their capabilities, services and products to the management men of the multibillion dollar US Air Force-Aerospace industry market. The Aerospace Panorama is an integral part of Air Force Association's National Convention, the largest annual aerospace power and defense meeting in the nation.



Above: View of "new" Philadelphia's Penn Center area from City Hall to the 30th Street Station.

Philadelphia's Convention Hall, headquarters for AFA's National Convention and the nation's largest display of defense products and aerospace equipment.

IN WEAPONS SYSTEM EVALUATION EPSCO DELIVERS ITS SPECIFICATION



Currently in use at EGLIN AFB...

ADVANCED AERO/SPACE DATA SYSTEM DOES 10 DAYS' WORK OVERNIGHT

Since early 1960, this Epsco PCM Data Gathering System has been in use by Republic Aviation Corporation in its flight test program of the new F-105D Thunderchief Mach 2 fighter-bomber.

The Epsco PCM Airborne System samples, multiplexes, and digitizes 84 high- and low-level analog channels, then records these plus 15 auxiliary 13-bit digital inputs on a magnetic tape handler in the test aircraft. When the plane returns to ground, the digital tape is played back on the Epsco PCM Ground Station and the test data efficiently stripped, edited, and recorded in computer format for direct entry into Republic's IBM 704 computer. Through this high-speed data reduction process, all flight test information, including a full computational analysis of the F-105D's toss-bomb computer, is available by the next morning. This overnight speed with which data is made available cuts weeks from Republic's flight test data analysis time, materially speeding up the entire F-105D test program.

Epsco's PCM equipment was selected to meet the exacting test requirements of the F-105D weapons system because of such advanced design features as random programming, adjustment-free operation, system expandability, and operational versatility as well as inherent extreme accuracy and fast sampling speeds.

The advanced PCM system, Model PCM-S-4010, also may be supplied with airborne telemetering capability. For further details, write for Bulletin AE-Aero PCM.

Upper left: Epsco PCM Airborne System in nose of F-105D test ship. Adjustment-free system permits prolonged operation without requiring access to installation.

Lower left: Epsco's PCM Ground Station features extensive search and editing functions to strip out desired data for analysis, prepares data for direct entry into Republic's IBM-704 Computer.

Epsco  **SYSTEMS**

A Division of EPSCO, Incorporated

275 Massachusetts Ave., Cambridge 39, Mass. UNIVERSITY 4-4950

AFA INSURANCE PROGRAMS



A Shield of Protection for Air Force Families

All of the insurance in the world cannot make up the real loss when the head of a family is disabled or dies.

Nor can insurance minimize the hazards that servicemen must accept as part of their lives.

But insurance *can* and *does* ward off the pinch of financial hardship when trouble strikes. An adequate insurance program gives a serviceman the security of knowing that the people he loves most will be provided for—no matter where the future may lead him.

This is why the Air Force Association has developed a complete, three-part insurance program—a *full shield of protection* for Air Force families.

Here are the three parts of the program—

Flight Pay Insurance

Rated personnel on active duty are eligible to participate in this program. AFA has paid more than \$1,750,000 in claims since this program was first introduced in June 1956. Checks go to between 100 and 150 grounded flyers each month.

A flyer who has taken advantage of Flight Pay Insurance, and is grounded, receives 80% of his lost flight pay (tax free) for up to 12 months if he was grounded by illness or ordinary accident . . . up to 24 months if he was grounded by an aviation accident. And protection is guaranteed even for preexisting illness once a policy has been in force for 12 consecutive months.

Life Insurance

AFA Group Life Insurance is available to *all active duty officers and NCOs* of the first three grades. It provides a graded amount of coverage beginning with a top amount of \$20,000, depending on age and flying status.

The unique feature of this plan is that it provides an additional indemnity of 50% of the policy's face value if death is caused by any kind of accident. No other plan of this kind available to active duty personnel offers this feature.

Travel Insurance

AFA Travel Insurance is available to *all AFA members* and their immediate families. It offers year-round accidental death protection for travel in all forms of passenger vehicles, including private automobiles. Travel in both commercial and military aircraft is covered.

It is available in amounts up to \$50,000 with an automatic 5% increase in face value each year for the first 5 years of coverage.

* * *

All three of these insurance programs are administered by the Air Force Association for its members and their families on a nonprofit basis.

If you would like more information about any or all of them, please fill in the coupon below. We will send you complete details by return mail.

AIR FORCE ASSOCIATION

INSURANCE DIVISION • MILLS BUILDING • WASHINGTON 6, D. C.

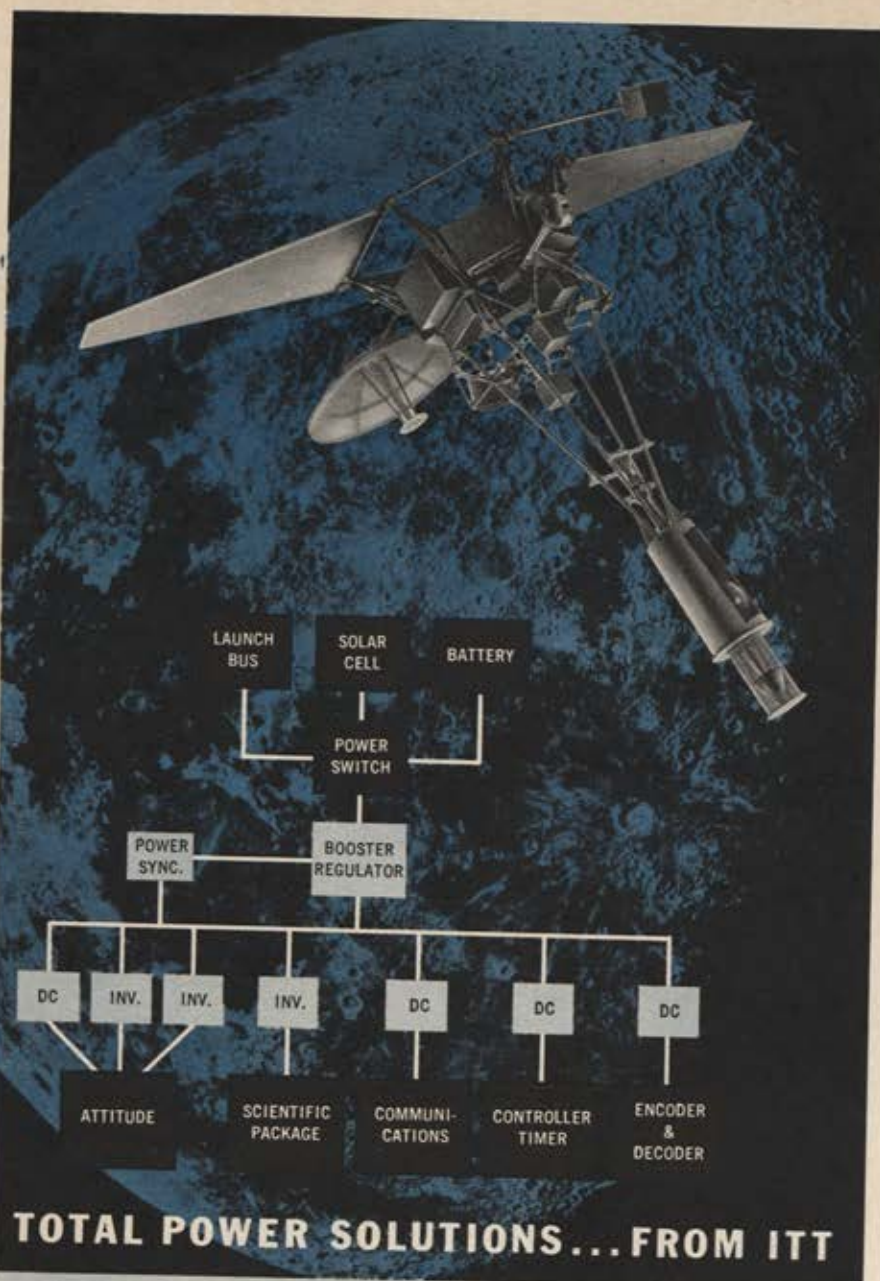
Please send me complete information about the AFA Insurance Program(s) I have checked below. 4-61

- ☐ Flight Pay Insurance
- ☐ Group Life Insurance
- ☐ Travel Insurance



NAME _____ RANK _____

ADDRESS _____



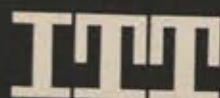
TOTAL POWER SOLUTIONS...FROM ITT

THE MOST ADVANCED POWER CONVERSION JOB YET ATTEMPTED

Shown here is a simplified block diagram of the unique integrated power conversion system now being designed and manufactured by ITT for the Project Ranger moon probe, built for NASA by Jet Propulsion Laboratories. The over-all system provides 27 different DC and AC outputs at several discreet voltages, currents and frequencies... using ground, solar cell and battery power sources.

Total power capability such as this—for conversion, inversion, regulation and control—is readily available from ITT to solve your toughest power problems. Contact your ITT representative, or write for File ASD-1368-1.

ITT and McCormick Selph combine their power and ordnance capabilities to provide the best in exploding bridgewire systems.



Industrial Products Division
International Telephone and Telegraph Corporation
15191 Bledsoe Street • San Fernando, Calif. • EMpire 7-6161

static power conversion • instruments • closed circuit television

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MICRODOT ACQUIRES 4 SPACE AGE COMPANIES

SOUTH PASADENA—Microdot, Inc., has recently concluded a planned expansion-through-acquisition program designed to broaden the product line and telemetry capabilities of its Instrumentation Division. Each of the acquired companies has been a highly successful, specialized manufacturer of electronic products. These companies are:

1) MICRO-TEST, INC., manufacturer of strain measurement devices. Through this addition, Microdot now offers the only high-temperature strain gage in the U. S.—a device capable of continuous measurement at 750° F. and dynamic test to 1500° F.

2) LERCO ELECTRONICS, INC., manufacturer of a wide range of electronic hardware, including molded terminals, terminal boards, handles, Mil-spec knobs, and many others. In all, Lerco catalogs over 380 standard part numbers.

3) NACIMCO PRODUCTS CO., manufacturer of temperature measuring devices and systems. Nacimco is the developer of a special method of producing miniaturized transducer sensing elements through the use of a unique deposited platinum film process.

4) SPECTRALAB INSTRUMENT CO., provides Microdot with outstanding capabilities in the field of VHF and UHF cavities and related instrumentation. This was the first company to have an operational UHF telemetry transmitter and continues to accomplish advanced work in the UHF telemetry field.

According to Microdot President R. S. Dickerman, "At Microdot we keenly feel a dual responsibility: first and foremost to make a positive contribution to the defense of our nation, and secondarily to show a satisfactory growth performance for our shareholders. We believe that we have served both purposes through our recent acquisitions. By strengthening our specialized capabilities, we are achieving a high degree of technological advancement, at utmost speed, with maximum economy."

MICRODOT INC.



220 Pasadena Ave.
South Pasadena, California
SYcamore 9-9171 MUrray 2-3351

No man in his right mind would start another war

Granted. Everybody knows it.

Only one trouble. Not everyone is
always in his right mind.

Remember?

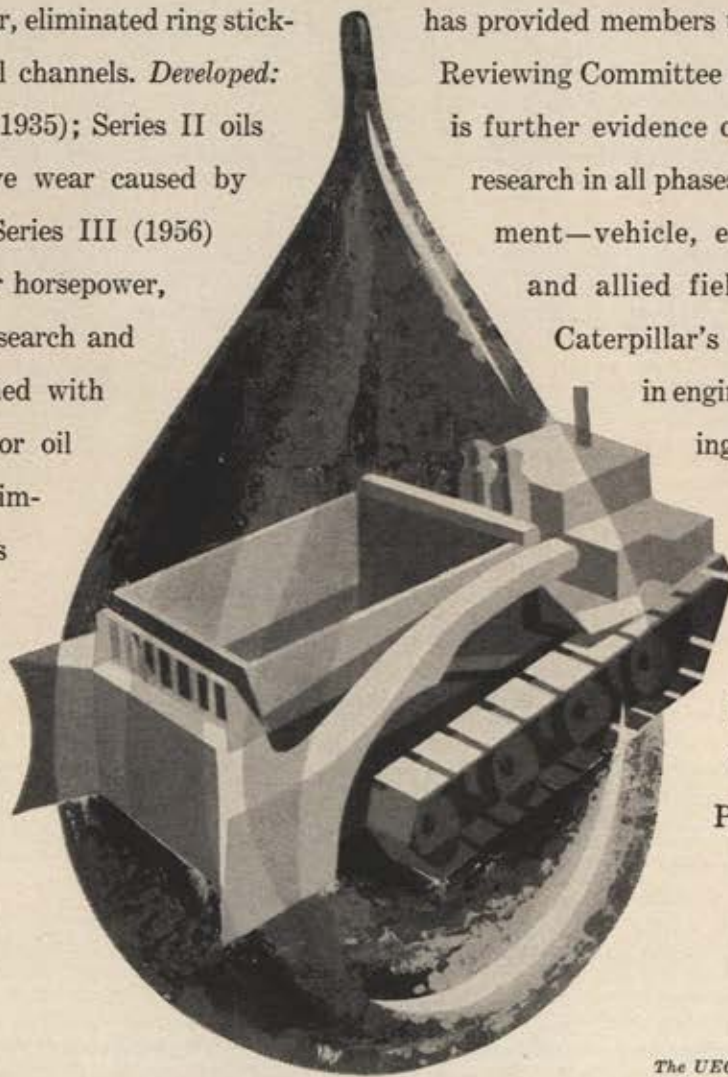
That's why those of us in the defense
business should pause from time to time to
take stock of what we are really doing ...
keeping fingers off buttons.

Because the real
business of the defense business
is survival.

CAPABILITY IN POWER AND MOBILITY *for defense*

Problem: carbon, lacquer and gum deposits on working parts of diesel engines. *Needed:* diesel lubricating oils that minimized deposits, resisted scratching and parts wear, eliminated ring sticking and assured open oil channels. *Developed:* "Superior Lubricants" (1935); Series II oils (1948) to fight excessive wear caused by high sulfur fuels; and Series III (1956) for use in today's higher horsepower, higher speed engine. Research and testing were accomplished with the cooperation of major oil companies. To speed oil improvement, Caterpillar's single-cylinder test engine is now used in 67 laboratories throughout the world. Among other accomplishments,

Caterpillar helped develop the first military oil specifications and has contributed heavily in developing current revisions. In addition, Caterpillar has provided members to Ordnance Engine Oil Reviewing Committee since its beginning. This is further evidence of Caterpillar's intense research in all phases of equipment improvement—vehicle, engine and component and allied fields. Besides research, Caterpillar's experience and talent in engineering and manufacturing are available to meet your requirements. For more details, write for Bulletin No. 40-20265, Defense Products Department, Caterpillar Tractor Co., Peoria, Illinois.



The UECEM, currently under development, is representative of the ability of Caterpillar research in all phases of vehicle development.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

WASHINGTON, D. C.

PEORIA, ILLINOIS

RESEARCH • DEVELOPMENT • MANUFACTURING FOR DEFENSE

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CONTINENTAL PACKETTE POWER *USE-PROVED* Round the Globe



PC-30
2-cyl. 34 hp.



PC-60
4-cyl. 70 h.p.



PE-90
4-cyl. 110 hp.



PE-150
6-cyl. 175 hp.



PE-200
8-cyl. 250 hp.



Ground support equipment built around Packette power is proving itself today on defense installations all over the free world.

Developed by Continental Motors, with the famous Continental air-cooled aircraft engines as their basis, these five Military Standard models [Mil. E-26248 (USAF)] range from 30 to 250 hp, combine compactness and light weight with ease of servicing and upkeep, and operate at any temperature from equatorial heat to polar cold. Of special interest and importance, as simplifying maintenance in the field, is the wide interchangeability of parts among the several Packettes, and between them and the models in the Continental aircraft engine line.

They're use-proved NOW in air conditioners, compressors, crash trucks, generators, test stands, refuelers, heaters, blowers, Rollagons, multi-purpose tugs and other applications. Experience is proving: IF THE APPLICATION FALLS WITHIN THEIR POWER RANGE, NO OTHER ENGINE WILL DO THE JOB SO WELL.



WRITE FOR COMPLETE INFORMATION



**Continental Motors
Corporation**

AIRCRAFT ENGINE DIVISION

MUSKEGON, MICHIGAN

HERE'S GOOD NEWS FOR EVERY AFA ACTIVE-DUTY MEMBER

You can now keep your AFA Group Life Insurance at the same low rates when you leave the service!



■ There's one condition you must meet. Your coverage must have been in force for more than a 12-month period immediately prior to the date you leave the service. This means that if you insure yourself now, and leave the service any time after April, 1962, you are entitled to keep your group coverage at the same low group rate until you reach age 65. ■ And you still get all the benefits of this remarkable policy whether you remain on active duty or not—

1. 50% additional benefit for all accidental deaths.
2. Longer protection—to Age 65—provided your policy is purchased prior to Age 60.
3. One low premium for all (\$10 per month) regardless of age or flying status—a premium we hope to reduce even further by payment of dividends as soon as sufficient reserves have been established.
4. Guaranteed conversion privilege gives you complete flexibility. When you leave the service, you may either keep your low-cost group insurance or convert it to a permanent plan of insurance, depending on what's best for you and your family. If you choose to convert your policy, you would be eligible to convert to any permanent plan of insurance then being offered by the Underwriters, United of Omaha—**regardless of your health at that time.**
5. No physical examination, no medical questionnaire to fill out. Your signature on the application is all you need. ■

50% ADDITIONAL BENEFIT FOR ALL ACCIDENTAL DEATHS

SCHEDULE OF BENEFITS

DEATH FROM NATURAL CAUSES

Amount of Insurance

Your Age	On Flying Status	Not on Flying Status
20-24	\$10,000	\$20,000
25-29	11,000	20,000
30-34	12,500	20,000
35-39	13,000	20,000
40-44	13,500	17,500
45-49	12,500	13,500
50-54	10,000	10,000
55-59	10,000	10,000
60-64*	7,500*	7,500*

*Continuing benefits. Policy must be purchased prior to Age 60.

ALL ACCIDENTAL DEATHS

Amount of Insurance

Your Age	On Flying Status	Not on Flying Status
20-24	\$15,000	\$30,000
25-29	16,500	30,000
30-34	18,750	30,000
35-39	19,500	30,000
40-44	20,250	26,250
45-49	18,750	20,250
50-54	15,000	15,000
55-59	15,000	15,000
60-64*	11,250*	11,250*

*Continuing benefits. Policy must be purchased prior to Age 60.

EXCLUSIONS—FOR YOUR PROTECTION. There are naturally a few exclusions which apply to your policy, and to keep the record straight, they are listed here in detail, as follows:

Death benefits for suicide or death from injuries intentionally self-inflicted while sane or insane shall not be effective until your policy has been in force for 12 months. The Accidental Death Benefit shall not be effective if death results: (1) from injuries intentionally self-inflicted while sane or insane, or (2) from injuries sustained while committing a felony, or (3) either directly or indirectly from bodily or mental infirmity, or poisoning, or asphyxiation by carbon monoxide, or (4) during any period while the policy is in force under the waiver of premium provision of the master policy.

MAIL YOUR APPLICATION TO AIR FORCE ASSOCIATION TODAY!

YOUR CHOICE OF CONVENIENT PAYMENT PLANS.

Your premium may be paid either by monthly government allotment, or direct to AFA in convenient installments. See the Application Form below for details.

AIR FORCE ASSOCIATION GROUP LIFE INSURANCE

(UNDERWRITTEN BY UNITED OF OMAHA)

Rank (please print) Name

Address

City Zone State

Date of Birth

Beneficiary Relationship

This insurance is available only to AFA members.

☐ I enclose \$6 for annual AFA membership dues.

☐ I am an AFA member.

I understand the conditions governing AFA's Group Life Insurance Plan. I certify that I am on active duty, that to the best of my knowledge I am in good health, and that I have successfully passed an Annual Physical Examination within one year.

Signature of Applicant Date

Application must be accompanied by check or money order. Send remittance to: INSURANCE DIVISION, AFA, 312 MILLS BLDG., WASHINGTON 6, D. C.

Please indicate below the form of payment you elect:

☐ Monthly government allotment (I enclose \$30 to cover the period necessary for my allotment to be processed.)

☐ Quarterly (I enclose \$30)

☐ Semi-annually (I enclose \$60)

☐ Annually (I enclose \$120)

☐ I am currently on flying status.

☐ I am not currently on flying status.



NOW! 5-SECOND DETECTION FOR MAXIMUM PROTECTION!



FAIRBANKS MORSE RADIATION MONITORS

New from Fairbanks Morse! The fastest Radiation Monitors on the market! Our two new instruments measure contamination and maximum protection levels in just 5 swift seconds! Result—the ultimate in personnel protection. Both new types of Monitors feature Dual Phosphor detection systems that measure Alpha and Beta, simultaneously.

Our Radiation Monitors are designed to meet the rigid contamination limit requirements of nuclear laboratories, atmospheric contamination control, missile, and satellite studies.

FAIRBANKS MORSE HAND AND CLOTHING MONITORS: New model measures contamination and MPL in only 5 seconds! Speeds detection even more because it uniquely checks one person's hands as it monitors the clothing of two others. Features "unit construction" to insure absolute reliability—under continuous operation. Also features automatic

subtraction of background radiation for true contamination readings.

FAIRBANKS MORSE MONITORS: Revolutionary, 5-second fast Portable Monitors separate pitch warning notes for Alpha and Beta... providing instant identification, accurate measurement. Featuring all-transistor circuitry for constant, accurate readings over wide temperature ranges... our Portable Monitors weigh just 11 pounds... are perfect for measurement on planes, missile parts, re-entry vehicles, clothing and benches.

5-second Radiation Monitors are available only from:

**FAIRBANKS MORSE
ELECTRONICS DIVISION**
West Hartford, Conn.

...NEW DIMENSIONS IN ELECTRONIC DEVICES

F-M CLOSED CIRCUIT TV

NEW "EYES" FOR NUCLEAR AND MISSILE PROJECTS



F-M announces two reasons why our new, Closed Circuit TV can help you observe and improve your operations. Our exclusive, 650 line horizontal resolution provides pin-point picture detail in regular size cameras. Ideal for the exacting needs of missile, rocketry, and other nuclear or space project site observations. Another advance—our new, 3-in. diameter camera for wind tunnel and rocket motor testing bed observation! Color and Infra Red Closed Circuit TV also available. For further information on F-M Radiation Monitors or Closed Circuit TV, write: Nucleonics Dept.; Electronics Division; Fairbanks, Morse & Co.; West Hartford, Conn.

FAIRBANKS MORSE
A MAJOR INDUSTRIAL COMPONENT OF
FAIRBANKS WHITNEY

**Nucleonics Dept., Electronics Division
Fairbanks, Morse & Co.,
West Hartford, Conn.**

Gentlemen: Please send full information on Electronics equipment checked below:

☐ Closed Circuit TV ☐ Radiation Monitors
☐ Automatic Weighing and Proportioning Equipment

Name _____
Company _____
Address _____
City _____ State _____

HAVE YOU MADE YOUR RESERVATION FOR **AFA'S** 15th ANNUAL CONVENTION AND PANORAMA

Philadelphia, September 20-24, 1961

AFA HOTELS, MOTOR HOTELS, AND RATES

HOTEL	Single	Twin & Double	1 b/r Suite	2 b/r Suite
Adelphia	\$ 6-10	\$14-18	\$25-35	
Barclay	\$16-21	\$16-21	\$30-36	\$54-60
Bellevue Stratford	\$10-17	\$14-23	\$32-60	\$52-80
Ben Franklin	\$ 8-12	\$11-18	\$30-35	\$45-53
Drake	\$12.00	\$14-18	\$24.00	
John Bartram	\$ 6-12	\$ 9-16	\$20-25	\$40.00
Sheraton	\$10-14	\$16-18	\$35-45	\$42-68
Sylvania	\$ 8.00	\$12-15	\$28.00	
Warwick	\$12-15	\$16-21	\$32-42	\$52-80
MOTOR HOTELS	Single	Twin & Double	1 b/r Suite	2 b/r Suite
Cherry Hill Inn	\$11-14	\$16-20	\$29-50	\$70.00
Franklin Motor Inn	\$12.00	\$16.00	\$26-32	
Marriott Motor Hotel	\$10-14	\$14-20	\$30.00	\$50.00
Treadway Inn	\$ 9-12	\$13-16	\$30.00	

IMPORTANT

Please complete this form in FULL and mail to the following address:

**HOUSING OFFICE
AIR FORCE ASSOCIATION
HOSPITALITY CENTER
16th ST. & PENNSYLVANIA BLVD.
PHILADELPHIA 2, PENNSYLVANIA**

Be sure to list first, second, and third choices of hotels and arrival DATE and TIME. If room is not available at rate requested, next nearest available rate will be assigned. For arrivals after 6:00 p.m., reservation requests MUST be accompanied by a WRITTEN GUARANTEE OF PAYMENT.

HOTEL RESERVATION FORM

• 1961 AIR FORCE ASSN. CONVENTION

Philadelphia, Pennsylvania • September 20-24

TYPE OR PRINT

Date _____

Name _____ Rank, if Military _____

Firm/Organization _____

Mail Address _____

City & State _____

1st Choice Hotel

2nd Choice Hotel

3rd Choice Hotel

Type of Room—Be specific for double or twin room.

Desired Rate

Others Sharing Room

Arrival Date and Hour

Departure Date

NOTE: For arrivals after 6:00 p.m., reservation requests must be accompanied by a written guarantee of payment.

4-61

This Is AFA

The Air Force Association is an independent, nonprofit airpower organization with no personal, political, or commercial axes to grind; established January 26, 1946; incorporated February 4, 1946.

Objectives

- To assist in obtaining and maintaining adequate airpower for national security and world peace.
- To keep the AFA members and the public abreast of developments in the field of aviation.
- To preserve and foster the spirit of fellowship among former and present personnel of the United States Air Force.

Membership

Active Members: Individuals honorably discharged or retired from military service who have been members of, or either assigned or attached to, the USAF or its predecessor services, or who are currently enrolled in the Air Force Reserve or the Air National Guard. \$6.00 per year.

Service Members (nonvoting, nonofficeholding): Military personnel now assigned or attached to the USAF. \$6.00 per year.

Cadet Members (nonvoting, nonofficeholding): Individuals enrolled as Air Force ROTC Cadets, Civil Air Patrol Cadets, or Cadets of the US Air Force Academy. \$3.00 per year.

Associate Members (nonvoting, nonofficeholding): Individuals not otherwise eligible for membership who have demonstrated their interest in furthering the aims and purposes of the Air Force Association. \$5.00 per year.

Industrial Associates: Companies affiliating with the Air Force Association on a nonmembership status that receive subscriptions to AIR FORCE Magazine and SPACE DIGEST, special magazine supplements, and Industrial Service Reports.

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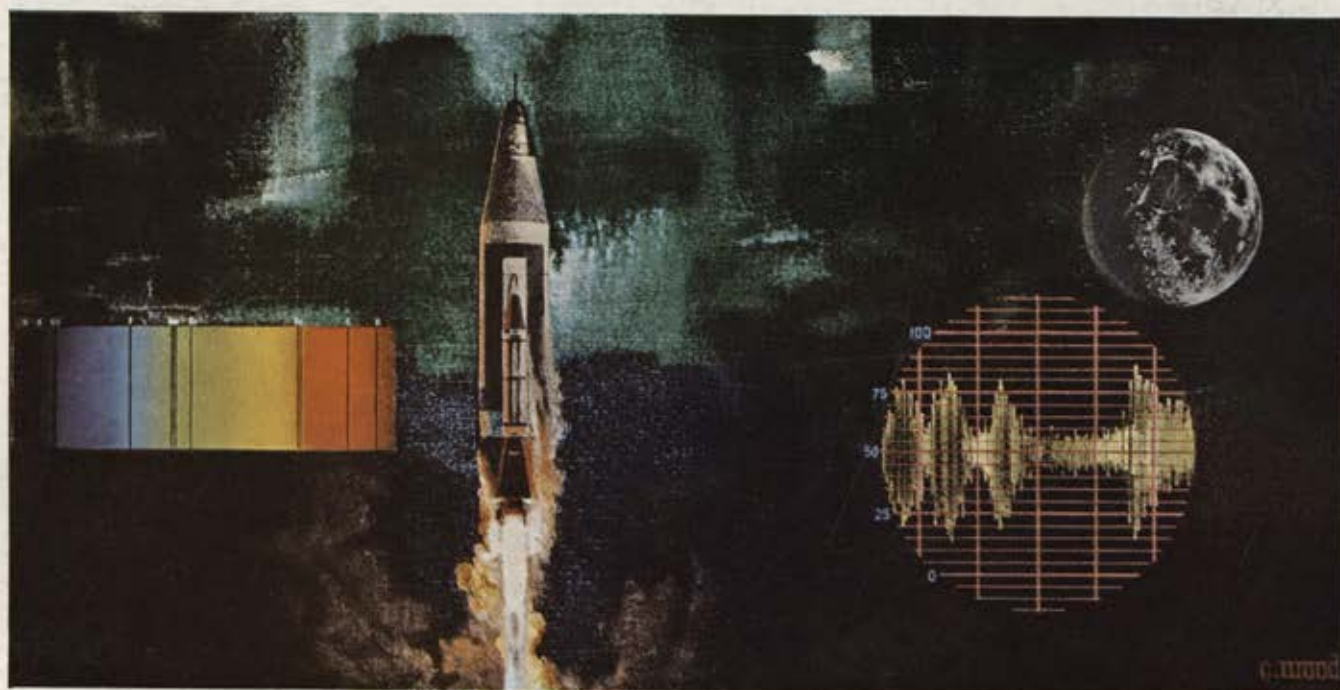


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