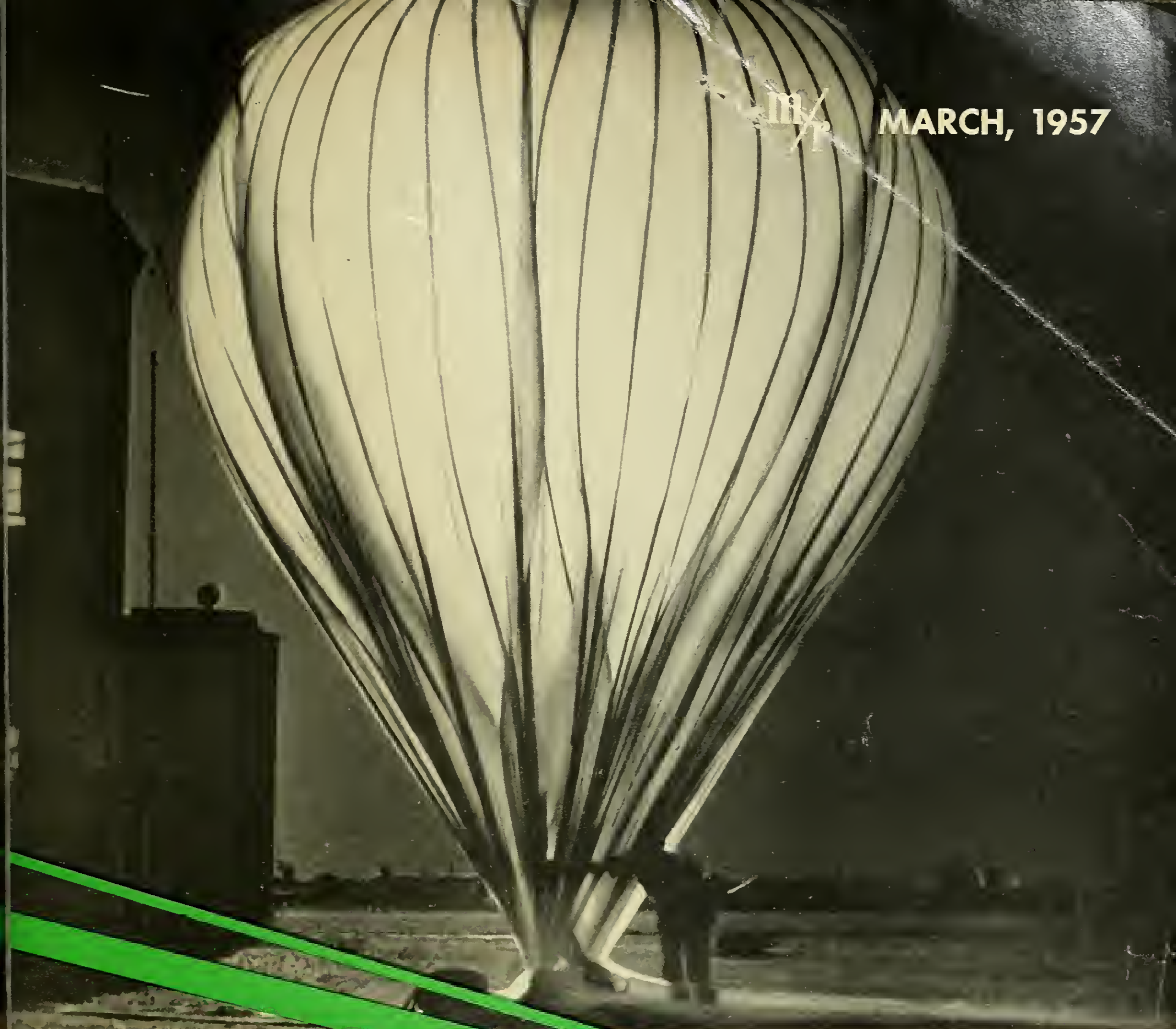
MARCH, 1957



missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

n This Issue:

ROUNDUP ON UPPER AIR AND LUNAR RESEARCH ROCKETS

missiles and rockets

Magazine of World Astronautics

March, 1957 Volume II, No. 3

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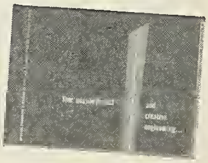

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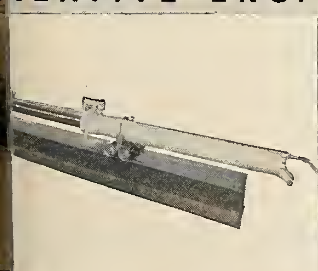
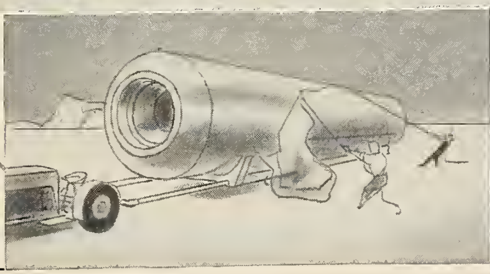
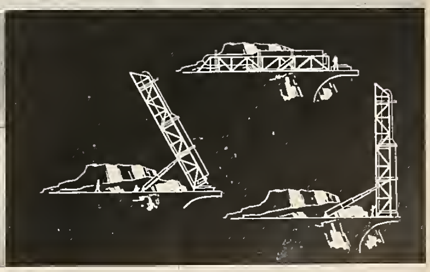


L ge hydraulic actuator for support- i a fighter plane underneath the fu lage of a B-36 Bomber.



Artist's rendering shows a storing-transporting vehicle suitable far over-the-raad ar airborne movement. It was designed and developed by Cleveland Pneumatic's Special Products Division for a large missile manufacturer.



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Magazine of World Astronautics

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Rockets Have Peaceful Uses

Military developments have so far obscured all other present and potential uses of rockets that it almost seems anachronistic to discuss their peacetime uses.

This issue of Missiles & Rockets, however, states the "Rockets for Peace" case very clearly.

Much of the valuable data obtained by scientists in recent years about the upper atmosphere—data affecting our everyday lives in such fields as geodesy, meteorology, navigation, medicine, and others—would not have been available without high-altitude rocket research.

From the bits of information obtained from instruments in upper-air rockets, research groups throughout the country are gradually amassing a complete analysis of phenomena which have determining affects on such things as magnetic storms, radio black-outs and various other aspects of air navigation and weather forecasting.

Most of this work is being done under auspices of universities and is handicapped by insufficiency of funds. Even the work on upper-air research by the Office of Naval Research and by the Army and the Air Force is relatively insignificant in scope because of lack of funds.

True enough, an extensive program is scheduled for the International Geophysical Year, but it is still limited in view of what *could* be done.

A well-organized large-scale program is called for. Based on rockets now available and the number of scientists who have expressed interest in upper-air rocket research, the results could have a genuine impact on our civilization and incipient conquest of space.

The possibilities are so extensive that only the government, in the final analysis, can organize, sponsor and finance a large-scale program.

All that exists today in the way of centralized activity is an informal group that calls itself the Upper Air Rocket Research Panel. The members get together now and then to discuss informally their experiments and experiences. It could well be that this informal panel is the proper nucleus for an expanded national program.

WAYNE W. PARRISH

What Is Lintz Basalt? Why Does It Defy Gravity?

To the editor:

The column "Missile Miscellany" of the February 1957 of MISSILES & ROCKETS contains a statement concerning the properties of a material referred to as "the silicate, Lintz basalt." According to this, Lintz basalt generates heat spontaneously at 2.36x10[4] calories per hour per gram, and in free fall won't accelerate at 980 centimeters per second[2]. I am sure you will agree the latter in particular is an amazing quality.

I would like to obtain more information concerning Lintz basalt.

I enjoy reading MISSILES & ROCKETS and find it contains a great deal of interesting and valuable information.

Dr. Paul W. Kruse
Senior Research Physicist
Minneapolis-Honeywell Regulator Co.
Hopkins, Minn.

To the editor:

If you have further information on item 2, Missile Miscellany department, page 99, February 1957 issue, it will be greatly appreciated.

G. M. Greene
Asst. to Vice President-Engineering
Hughes Aircraft Company,
Culver City,
California

To the editor:

In reading MISSILES AND ROCKETS, Feb. 1957, a short paragraph in the Editor's Column, page 99, stated among other things, "*The silicate, Lintz basalt . . . in free fall condition does not accelerate at 980 cm/sec²*"

. . . Any further information that you have on this matter would be appreciated.

Mr. Charles Summes.
2186 47th St.,
Los Alamos, N. Mex.

To the editor:

In the February issue of m/r in the "Missile Miscellany" column on page 99. you made the statement, "why in free fall (the silicate, Lintz basalt) won't accelerate at 980 cm/sec²." . . . I would like to see your source.

Incidentally, I enjoy your magazine very much. This latest issue on Russian missiles is excellent.

Leslie M. Bagnall
5840 Coleman Street
Fort Worth, Texas

To the editor:

In answer to your questions in your "Missile Miscellany" column in the February issue of m/r: Has anyone ever used modern theory to explain why the silicate, Lintz basalt . . . may I suggest that there may be a correlation between these phenomena and those observed in the so-called Biefeld-Brown Effect . . . and that the answers to your questions might properly be found in the current research that is now going on with regard to "anti-gravity" . . .

I think it would be very interesting if you would report on current progress in "anti-gravity" research.

Clifford B. Haughton, Jr.
Senior Development Engineer
Gas Turbine Department
Lycoming Division
Avco Manufacturing Corporation
Williamsport, Pennsylvania

The work with Lintz Basalt was performed by Charles Francis Brush and was later checked out by the National Bureau of Standards. The reference for the item in "Missile Miscellany" is as follows: The Proceedings of the American Philosophical Society; Vol. 65, April 23, 1926, a paper by Brush—Ed.

Glad Missiles May End War

To the editor:

. . . I am a civilian instructor in electronics fundamentals at Lowry AFB in the guided missile school and I felt quite encouraged by your optimism that missiles and rockets may be the means of ending wars . . . The senior instructor in our branch subscribes to your magazine MISSILES & ROCKETS and we find that it enables us to gain a much broader view of the whole industry than we could otherwise . . .

George James Pritchette
850 Oliver St.,
Denver, Colo.

Builds Solid Fuel Ramjet

To the editor:

. . . We at Experiment Incorporated were very pleased to see the mention of solid fuel ramjets by Alfred Zaehringer in "Propulsion Notes" (December m/r), since this is a subject close to our hearts.

The initial investigation of this engine type in the United States was made by Experiment Incorporated and Continental Aviation and Engineering Corporation. Later, Experiment Incorporated conducted a research and development program for the Navy Bureau of Ordnance which included flight tests, in January 1952, at NOTS China Lake.

These tests represented the first successful supersonic flights of a solid fuel ramjet (contrary to m/r's information that ". . . SF ramjets have been 'flown' only in test stands . . ."). Incidentally, both the PTV—N—4e flight vehicle and the solid fuel ramjet engine which powered it were designed and fabricated by Experiment Incorporated. Attached is a photograph of the vehicle ready for launching.

Other pioneers in this field were NACA and the Bureau of Mines . . .

V. W. McMahill, Jr.
Contracts Manager
Experiment Incorporated
Richmond 2, Virginia

Would See Satellite Launch

To the editor:

I am a sophomore in North Platte Senior High School and am very much interested in Missiles and Rockets. I would like to be present at the launching of the Satellite in Florida. Would you please give me the address of whom to write for further information regarding whether I could secure permission to be present at the launching.

Thanking you very much in advance. I enjoy your magazine MISSILES & ROCKETS very much and have increased my knowledge greatly through your magazine

Robert D. Stensvad
811 E. Third St.,
North Platte, Neb.

The Department of Defense is horrified at the thought, but maybe if enough people write requesting permission to see Vanguard take off, something will be done to make it possible. Write to: Cmdr. V. C. Thomas, Navy Press Desk, Office of Public Information, Department of Defense, Washington 25, D.C.—Ed.

Why No TV in *Vanguard?*

To the editor:

What with all the talk of establishing tracking systems for the satellite program, I'm a little surprised to read that nothing has been mentioned about installing a TV or movie camera within one of the satellites to provide us earthbound creatures with a view of our earths' area as the satellite goes whizzing by. Has this been thought of and found impractical, or what? TV cameras are available which are small and powerful; and movie cameras, also small and able to operate by remote control, could be jettisoned automatically and parachuted to earth before the satellite burns itself out. Just curious.

R. Paulson
332 Prospect
La Jolla, Calif.

It would take a satellite weighing 100 lbs. to carry a TV camera and power supply. The current launching system is designed for only 21 lbs. USAF is working on camera equipped satellite. —Ed.

Would Banish LOZ, LOX

To the editor:

. . . Your recent "Propulsion Notes" by Alfred J. Zaehringer (m/r, December 1956) contained a reference to liquid ozone that stirred the cobwebs of my memory and recalled a shattering experience that occurred back in the early days (some ten months ago) of ozone research.

I refer to Mr. Zaehringer's coinage of the word "LOZ" as a contraction of "Liquid Ozone." One of our research engineers, brought up in the LOX school of rocket technology, boldly prepared a report that not only pushed back the frontiers of science, but also tried to expand the confines of lexicography by mating the initial letters of "liquid" and "ozone" and giving birth to "LOZ."

The blessed event was viewed with disdain by an Ivy league chemistry professor who reviewed the report and commented as follow:

"——Now, turning from the sublime to the ridiculous, we have the question of lox and loz. I understand the derivation of the word lox as you use it, but I do feel that the salmon should have a voice in this matter. This business of loz is louzy. In your recent communication there is difficulty in separating 1 oz. and loz. It would also seem much better English if this word would be loze, but that makes it even more ridiculous, because people will think we are a theater chain of the same name.
Yours for Fowler's Modern English Usage."

LOZ thereupon died a painless death. The rebirth was inevitable, but we write in hope (but hardly expectation) that we can kill off the little offender once and for all . . .

Stephan Kidd

Solar Is Big Missile Supplier

To the editor:

. . . Congratulations on MISSILES & ROCKETS. I have just had the pleasure of seeing your December issue and wish to congratulate you on the material it contains as well as the interesting way in which it is presented. The chart "Subcontractors', Guide to Missile Production and typical Contractors," appearing on page 130, was of particular interest. We were somewhat surprised to note that the Solar Aircraft Company's name was omitted from this chart.

Solar's interest and activity in the missile field extends back for some years. We participated in the original development and manufacture of the *Hermes* missile and the *Corporal* rocket engine. Our activities in the missile field have continued to grow. Not only do we manufacture missile components for Aerojet-General Corporation, Jet Propulsion Laboratory and Rocketdyne, a division of North American Aviation, Inc., but we also manufacture the fuselage for the Falcon missile on a subcontract for Hughes Aircraft Company.

Fred S. Hage, Jr.
Director of Public Relations
Solar Aircraft Company
San Diego, Calif.

Would Reproduce m/r Article

To the editor:

. . . I thought it an excellent job and you may be sure that it has received favorable comment from many of our people.

May we trouble you once more for written permission to reproduce? I'd like to distribute copies of the General Medaris article and the one on the Aeroballistics Lab to interested personnel . . .

Gordon L. Harris
Public Information Officer
Army Ballistic Missile Agency,
Huntsville, Alabama.

High School Rocket Engineers

To the editor:

After reading the article on "Education . . . for the Missile Age" by Kurt R. Stehling, I felt that another phase of missile education which has been in most cases sadly neglected, should be mentioned. This is the phase including amateur study and experimentation which is presently being carried on at the high school level by many individuals.

Among these is the Seattle Astronautical Research Society, a group of high school students interested and presently majoring in science with a slant toward rocketry. This group, of which I am a member, has been studying astronautics for over 2½ years, and has carried on experimentation for the past 1½ years in static testing of rocket motors.

With the help of the Northwest Section of the American Rocket Society, and companies in various parts of the nation, we have been able to gain a wealth of knowledge and practical information on the science of rocket motors.

However, the attitude of complete indifference shown by some large corporations to our endeavors has made us question the extent of demand for scientists and engineers in the field of missiles and rockets.

I believe a well-supervised, nationwide program for potential missile engineers should be organized to catch interest where it counts most: At the point in high school at which students decide on vocations and colleges.

Leon Leonard, Research Director
The Seattle Astronautical Research Society
17347 Densmore Ave.,
Seattle, Wash.

Keep up the good work, Leon—Ed.

Solid Rockets Not So Safe

To the editor:

With reference to your article, "Break-up in Army-Navy Jupiter Program," I fear you are guilty of some unnecessary over-simplification in describing the advantages of solid propellants. In particular, I refer to the following:

"The solid rocket doesn't require the outer shell or container. It doesn't require the propellant insulation gear nor any additional booster or torpedo powerplant. Pressurization requirement is insignificant.

"Furthermore, because of the water resistance, a missile moves rather slowly underwater. It burns only a small amount of propellants before popping out of the sea; the water back pressure on the combustion holds the burning back."

Published data on solid propellants, both composite and double base types, indicate an increase in burning rate, rather than a decrease, with an increase in pressure. Of course the "mesa" type discontinuity exhibited by double-base propellants tends to minimize this dependence of burning rate on pressure. The effect of initial propellant temperature on its performance has been one of the primary disadvantages of its use. Some . . . of the propellants in use are extremely hygroscopic and require extreme care in handling and packaging . . .

Matthew J. Pastell
2210 W. 169th Pl.,
Torrance, Calif.

Missile Reliability Road Show

To the editor:

I read with great interest your Industry Highlights Section of MISSILES & ROCKETS issued in December, 1956, in particular about the Reliability Road Show that the Hughes Aircraft Company has provided for their subcontractors.

We of the Bendix Missile Section are completing a second Reliability Road Show . . . featuring a new movie produced by Bendix entitled *"Talos*—Flight 440." This movie deals with workmanship problems and their effect on the overall reliability of the *Talos* Missile... this show explained in the layman's language the meaning of reliability to the *Talos* workers . . .

Questionnaires were submitted to workers . . . soliciting comments. These comments . . . pointed out that normal aircraft standards that have been widely accepted by the industry are not adequate for the missile industry.

The information supplied by these questionnaires indicated that many intangible benefits have been brought about and we are certain that over-all missile reliability will benefit from the fact that each worker in the *Talos* program now has a better understanding of the importance of top workmanship and the necessity for personal responsibility on his part.

R. R. Wendt
Project Engineer
Reliability Department
Bendix Aviation Corp.,
South Bend, Ind.

Who's On Top?

To the editor:

One of our subscribers to THE ENCYCLOPEDIA AMERICANA has requested information which you may be able to supply.

The subscriber would like to know "What is the record height attained, in miles, by a man-made rocket or missile. I'm interested in distance straight up, rather than horizontal distance traveled."

We would appreciate any help you can give us with this matter. Thank you.

Margaret M. LaSala,
The Americana Institute.
2 W. 45th St.
New York 36, N.Y.

The official record is held by a two stage vehicle consisting of a V-2 and a WAC-Corporal fired from White Sands, New Mexico, in December of 1949. It went 250 miles up. However, the actual record—unofficial because it hasn't been publicly announced by the Pentagon—is held by a Jupiter-C missile fired by the Army Ballistic Missile Agency from Patrick Air Force Base on September 20, 1956—680 miles which would seem to be more out than up.—Ed.

IBM Military Products?

Systems Engineers oversee the engineering support provided by the Systems Coordination and Specification Group to the factory on the AN/ASB-4 Bombing-Navigational System. Air Force requirements are analyzed and the resulting engineering changes evaluated to determine effect on system performance and accuracy. Mathematical error analyses are run. *Do you belong on this team?*

Systems Analysts anticipate performance and recommend design criteria before and during development of equipment. Later, they compare dynamic performance accuracy and reliability characteristics with what has been anticipated. Other assignments include Digital Computer Systems Engineering, Input-Output and Analog-Digital Conversion Engineering. *Do you belong on this team?*

Quentin Marble (left): B.S.M.E. 1951, Syracuse. Joined IBM in 1951; promoted to Design Engineer in 1952; May, 1955, promoted to Associate Engineer, and then to Project Engineer, Manager of the Systems Coordination and Specification Group, Production Engineering Department, in February, 1956; shown here describing a unique cooling design to a new employee in his group.

Monroe Dickinson (left): B.S.E.E. 1952, W.P.I.; M.S.E.E. 1954, M.I.T. Technical Engineer in analog and alternate computer techniques for weapons systems, 1952; Associate Engineer responsible for systems design and analysis, 1954; December, 1955, Staff Engineer, responsible for research planning; here reviewing set-up on laboratory analog computer of a sampled data control problem.

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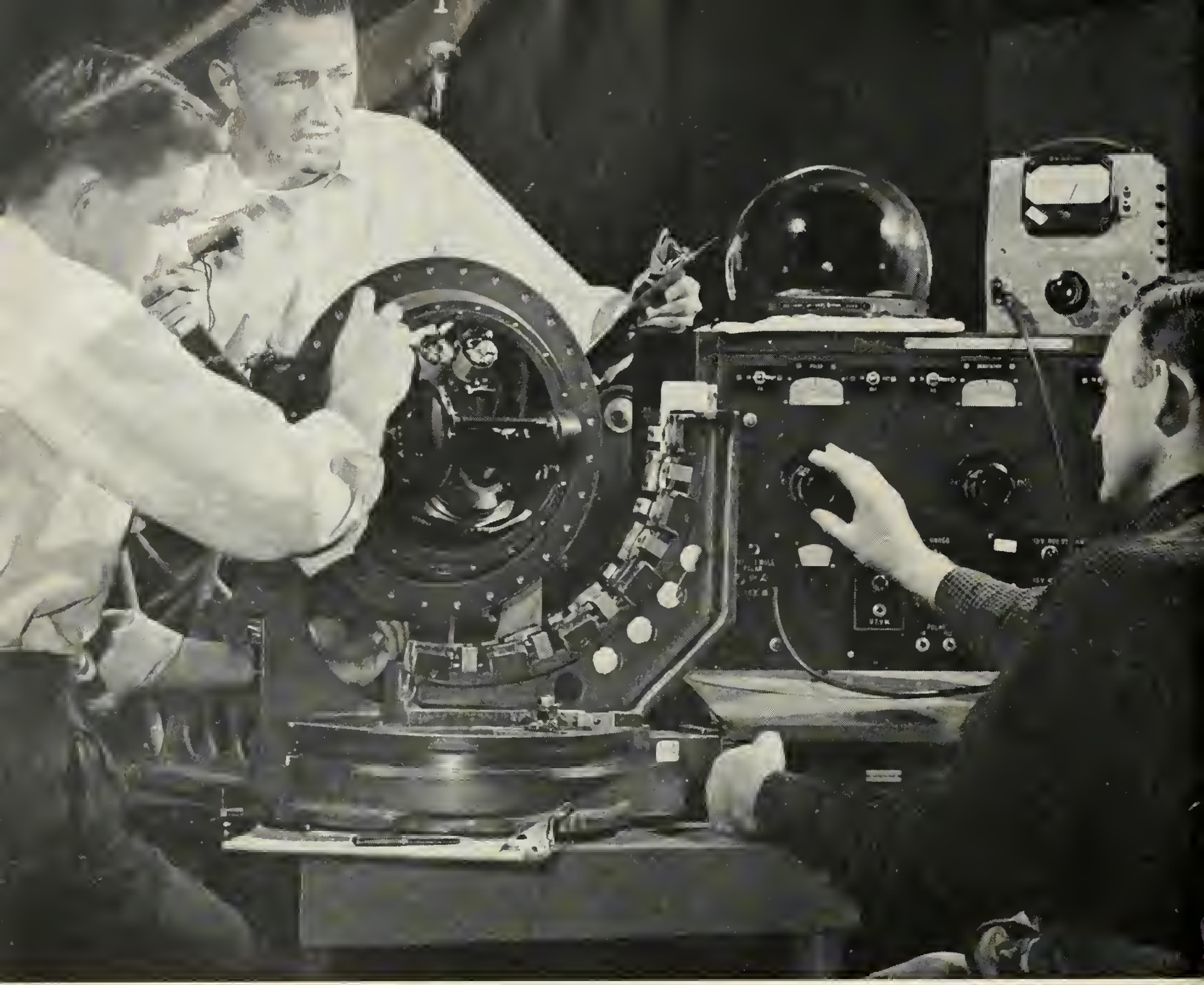
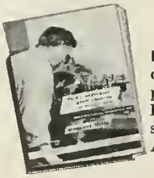




features

news & trends

rocket engineering

industry spotlight

next issue:

U.S. AIR FORCE LONG-RANGE MISSILE DEVELOPMENT

cover picture:

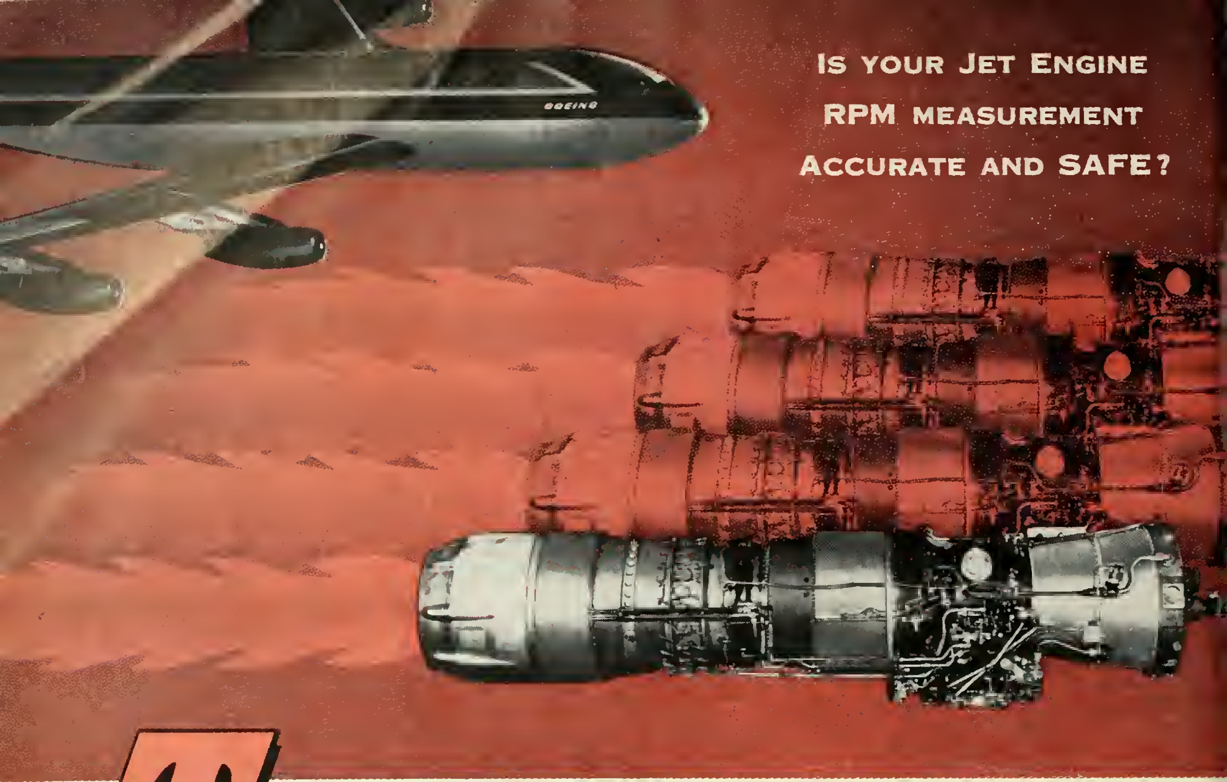
Few could have guessed that a carnival toy of the Bourbon Court of France would be a high-step to space. Then it was smoke-filled, silk and gaily printed. Today's high altitude rocket research balloon is a polyethylene giant. m/r's cover shows a General Mills, Inc., balloon readying for pre-dawn launch. On page 50, Otto C. Winzen, modern balloon pioneer and Winzen Research, Inc., (WRI) President, tells how they probe the ionosphere.

columns

departments

photo credits:

U.S. Army, p. 27; USAF, p. 89; U.S. Navy, pp. 33, 42, 83; General Mills, pp. 51, 52; Convair, pp. 25, 86; Rand, p. 26; Giannini, p. 29; Martin, p. 93; Republic, pp. 60, 61, 62; Aerojet, p. 41; E. Hull, pp. 31, 56, 57, 109; University of Minnesota, p. 31; Winzen, pp. 50, 52; Bristol p. 77.



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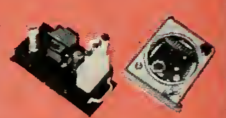

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MARCH

Nat'l Conference on Aviation Education, Mayflower Hotel, Wash., D. C., Mar. 7-9.

Nuclear Congress & Int'l Atomic Exposition, Convention Hall, Phila., Pa., Mar. 11-15.

IAS Flight Propulsion Mtg. (classified), Cleveland, Ohio, Mar. 14-15.

IRE National Convention, Waldorf Astoria Hotel and New York Coliseum, New York City, Mar. 18-21.

151st National Meeting of the American Meteorological Society, University of Chicago, Mar. 19-21.

American Society of Tool Engineers, Silver Anniversary Annual Meeting, Shamrock Hilton Hotel, Houston, Tex., Mar. 25-27.

10th Western Metal Exposition & Congress, American Society for Metals and others, Ambassador Hotel and Pan-Pacific Auditorium, Los Angeles, Mar. 25-29.

Educational Colloquium on Radiation Effects on Materials, sponsored by ONR and Glenn L. Martin Co., Johns-Hopkins University, Baltimore, Md., Mar. 27-29.

APRIL

SAE Aeronautic Meeting and Production Forum, New York City, Apr. 2-5.

Spring Meeting, American Rocket Society, Sheraton Park Hotel, Wash., D. C., Apr. 3-6.

British Radio and Electronic Component Show, Grosvenor House and Park Lane House, London, England, Apr. 8-11.

Annual Industrial Electronics Educational Conference, sponsored by IRE, Armour Research Foundation, Ill. Institute of Technology, Chicago, Ill., Apr. 11-13.

Southwestern IRE Conference and Electronics Show & Nat'l Simulation Conference, sponsored by IRE, Shamrock-Hilton Hotel, Houston, Texas, Apr. 11-13.

IRE PGTRC National Symposium on Telemetering, Sheraton Hotel, Phila., Pa., Apr. 14-16.

Symposium on Nondestructive Tests in the Field of Nuclear Energy, Morrison Hotel, Chicago, Ill., Apr. 16-18.

Second National Industrial Research Conference, sponsored by Armour Research Foundation, Conrad Hilton Hotel, Chicago, Ill., Apr. 24-25.

MAY

1957 Electronic Components Symposium, sponsored by IRE, DOD and National Bureau of Standards, Morrison Hotel, Chicago, Ill., May 1-3.

Spring Meeting and Exhibit, Society for Experimental Stress Analysis, Hotel Statler, Boston, Mass., May 1-3.

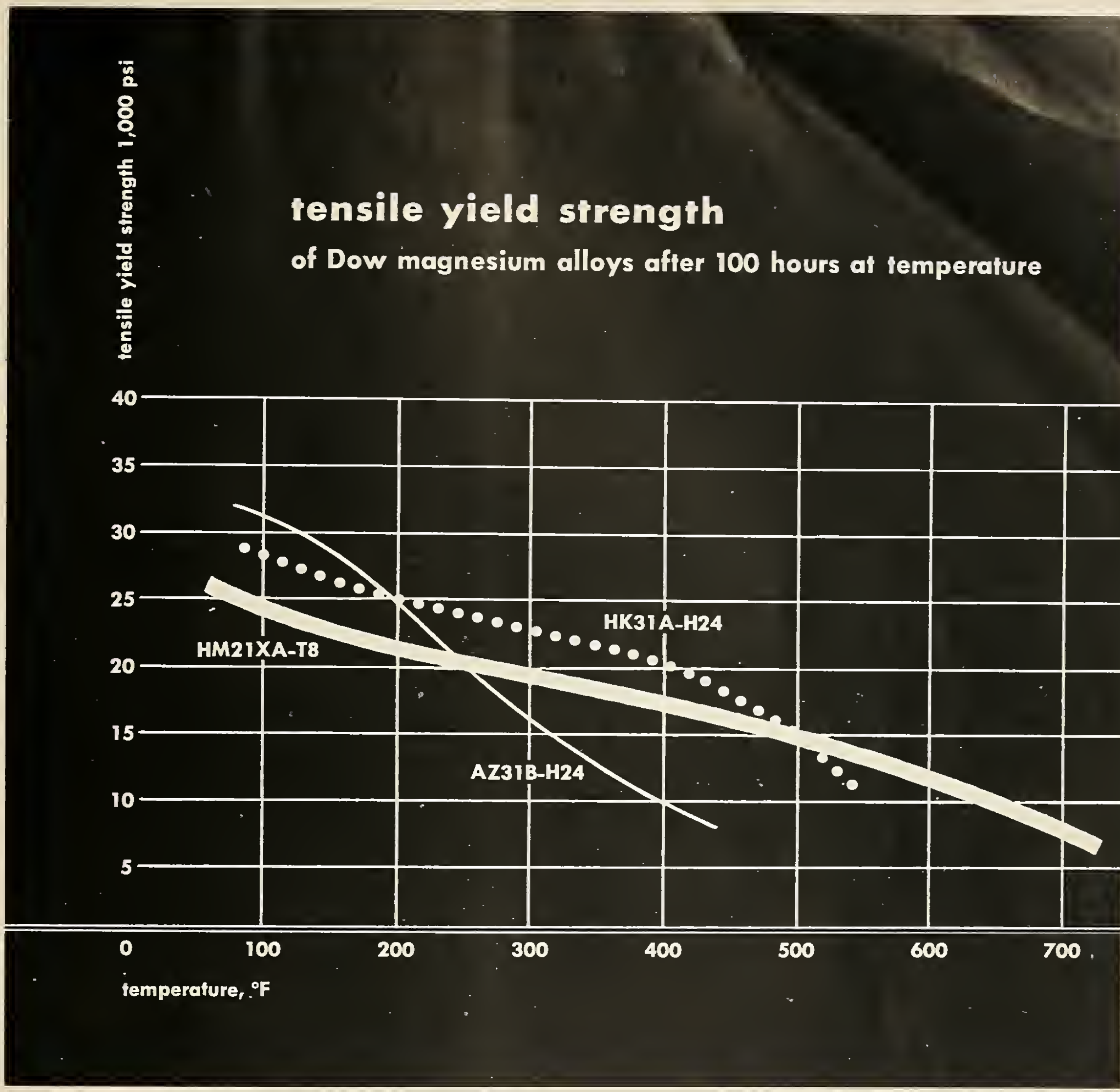
National Telemetering Conference, Hotel Cortez, El Paso, Texas, May 27-29.

JUNE

First Annual National Technical Career Conference, Sherman Hotel, Chicago, Ill., June 8-12.

Fourth International Automation Exposition and Military Automation Exposition, (Richard Rimbach Associates), Coliseum, New York City, June 9-13.

National Conference on Military Electronics, sponsored by IRE PGME, Sheraton Park Hotel, Wash., D. C., June 17-18.



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book reviews

The Zeppelin in the Atomic Age. *By Edwin J. Kirschner, 100 pp. $3.50, The University of Illinois Press, Urbana, Ill.*

The rigid airship (or zeppelin) may be with us again, this time with nuclear-powered engines. Certain obvious uses for the atomic-powered rigid airship are pointed out—as a missile launching platform and anti-missile defense weapon.

The author makes a strong case for the redevelopment and use of the rigid lighter-than-air aircraft. He cites facts and figures showing that there is a place in the commercial transportation picture for aircraft that is faster than the steamship and can carry more than the airplane. Since national policy greatly influences the total transportation system, he proposes an overall national transportation agency that would also encourage the development and operation of the extra long-range zeppelin.

The military rigid airship would be versatile and capable of performing many jobs where speed is not the sole criterion. Other important factors are also taken into account: cost, capability, utilization, safety, and dependability. Radar-equipped rigid airships could provide a relatively permanent electronic-detection umbrella as early-warning outposts to the Western Hemisphere and around the world. Present airborne and ground-radar equipment have their operational limitations, while an early-warning rigid airship, powered by nuclear engines, would be capable of carrying powerful radar equipment, and of extending the range of our early warning system a reported 500 miles.

To make the early-warning airship "combat ready," it could be designed to house, send off, and hook on to parasite jet fighters, and operate platforms for firing rockets and missiles in defensive and offensive military operations. Such a weapon Kirschner predicts would be capable of radar surveillance and to interdict an attack before it could reach the Western Hemisphere, at the same time dealing an immediate counteroffensive. The existence of such a force as this encircling the American continent would aid in making an attack unprofitable to the enemy anywhere within the range of these aerial 'minute men' platforms.

The author particularly sees the atomic-powered airship as an aerial reconnaissance ideally suited for the kind of patrolling suggested by President Eisenhower's "open-sky" plan. It would be used as a platform in conjunction with jet-photo aircraft or satellite platforms for special inspection assignments requiring close examination of critical areas for indefinite periods of time.

The first part of the book is devoted to an illustrated history of lighter-than-air aircraft. Our airship history has shown that the United States has lacked experience and interest in the development of the rigid airship. Until now, the United States has built only three rigid airships and flown four. The fourth was the *Los Angeles* which was built in Germany and successfully operated by the U.S. until its retirement before the Second World War. Germany has built more successful rigids than all the rest of the world combined—approximately 150—and is commonly accepted as the foremost airship nation in history.

The spectacular death of the German hydrogen-filled *Hindenburg* at Lakehurst, New Jersey, in 1937 sparked a staggering blow to zeppelins in the U.S. Thirteen persons were killed. At the time, the U.S. National Advisory Committee for Aeronautics reported that airships had helped aviation development tremendously and could contribute much more of value to the future of aeronautics. They emphasized that the airship should not be allowed to stand idle while other branches of aeronautics are developed.

An economical and safe aircraft is pictured by Kirschner for the atomic-powered, helium filled, rigid airship. The book is highly interesting, and merits consideration for vocational purposes.

A Technical Dictionary of Rockets and Astronautics. *By Glauco Partel (A.I.R.), 107 pp. $1.61, Published by Istituto Poligrafico Dello Stato G. C., Rome, Italy.*

This paper-bound dictionary lists over 1300 rockets and astronautics terms in Italian, German, English and French in four side-by-side columns. Included also are word finder lists in all four languages as well as extension conversion tables from the metric to the English system and back. It is a complete presentation in all four languages and should be a very valuable addition not only to technical libraries but to the collection of handbooks and the like scientists and engineers keep on their desks.

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The development and production of sub-miniature precision gyroscopic type instruments are exacting problems. These problems can only be solved by combining the skills of creative, seasoned research development and production engineers within the framework of an organization long experienced in the problems of precision instrumentation.

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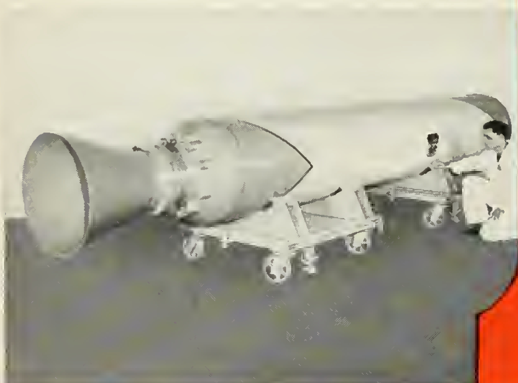
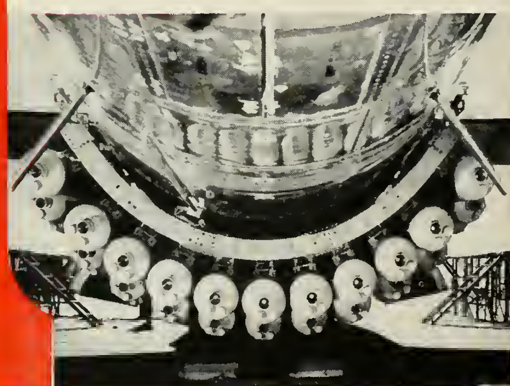


Giant PUSHER rocket made from low cost, petroleum-derived materials gives tremendous thrust for short durations.



The M15 JATO loaded on Boeing B-47. The first JATO to meet rigid Air Force performance tests. (Boeing Airplane Company photo.)

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USAF to Start Moon Rocket Program

Vehicle Circling The Moon Will Be Ready In Less Than Five Years; Companies Rush Proposals; Convair Heads List Of Hardware Bidders

By Erik Bergaust

SAN DIEGO—What might turn out to become the most significant event of our century has been confirmed to m/r during the Convair/AFOSR space flight symposium here: the Air Force is getting ready to start a moon rocket program.

In an exclusive interview Brig. Gen. Hollingsworth F. Gregory, Head of the Air Force Office of Scientific Research, told this reporter the Air Force "probably will have a rocket circling around the moon in less than five years."

"Several moon rocket study contracts are in the works," the general said, "and it is imperative that we carry out these scientific research projects to stay ahead of the Russians. When I say that we will have a moon rocket in less than five years, it is a conservative estimate."

The general also confirmed that ICBM power-plants are likely to be used for the Air Force moon rocket, and that it might be considered a "logical step" to launch "modified" ICBMs toward the moon as part of the Air Force training program for ICBM launching crews.

During the three-day symposium m/r also learned reliably that Convair is heading the list of companies about to submit proposals for actual hardware contracts for Air Force moon rockets. Other companies include Lockheed, Marquardt, Boeing, Douglas, Martin, Grand Central Rocket and Systems Laboratories. Most of these companies are involved in moon rocket study work. Convair's proposal is said to involve a circumlunar vehicle with a 200-pound payload consisting of camera and "television" equipment.

The Rand Corporation, meanwhile, has been conducting a moon rocket *study* for the Air Force for some time, and other study contracts for the various phases involved in launching lunar vehicles have been let but not disclosed, although it is known that Systems Laboratories has an AFOSR contract.

In a banquet speech here Western Development Division Commander General Bernard A. Schriever indirectly confirmed the possible availability of ICBM engines, components and hardware for the forthcoming lunar rockets. He said that out of the tremendous IRBM/ICBM effort will come a wealth of design information and hardware that will be useful for other things beyond that for which they were designed. These airframe, propulsion, and guidance subsystems developments and the data which will become available as ballistic missile test flights are made, will make possible a whole series of follow-on projects.

"The same propulsive unit that boosts a heavy nose cone-warhead to 25,000 feet per second, could boost a somewhat lighter body to the escape velocity of 35,000 feet per second or to an orbital path around the earth, General Schriever said.

"Using the same number of stages, the ratio of thrust to weight would be greater by using a lighter payload, and higher accelerations and velocities could be reached before burnout. Or with our present state of knowledge, it would be relatively easy to add another stage. We have already done that successfully on our re-entry test vehicle, the X-17. The same guidance system that enables the warhead of a ballistic missile to reach its target within a permissible accuracy would also be sufficiently accurate to hit a target much smaller than the size of the moon, even at that increased range," General Schriever said.


Brigadier General Hollingsworth F. Gregory tells m/r how Air Force hopes to send rocket to the moon.

Two Inevitable Moon Rockets

According to some of the nation's top missile and rocket engineers here two different moon rocket projects will be attempted within the next few years. A relatively small rocket—such as has been studied by the Rand Corporation (see line drawings)—will be built to land on the moon's surface. A second type, the circumlunar vehicle, will be brought into an orbit that takes it around the moon and back to earth, although it will not be attempted to retrieve the rocket. "I think this is the kind of lunar rocket that we will attempt first," General Gregory told m/r. This vehicle might carry up to 200 pounds of electronic video tape recorder equipment. Pictures will be taken of the moon's unseen side while it is illuminated by the sun, and as the rocket "returns" to earth the stored information will be transmitted back to earth.

Tribute to Air Force Office of Scientific Research

General Hollingsworth F. Gregory, outspoken scientific-minded Air Force brigadier general, told m/r AFOSR's mission is one of fundamental, theoretical or experimental investigation to increase man's knowledge and understanding of the natural world and to "recognize the implications of new scientific knowledge upon weapon systems concepts." Its capability to carry out this mission is represented by scientists throughout the free world working in universities, in industry, in foundations, and in government agencies under approximately 650 research contracts totaling about $30 million awarded by his organization, he said.

Exploratory Research Provides Capabilities For New Concepts

"We define our program as one of exploratory research. This is research with a view toward adding to man's total knowledge, in our case in areas of Air Force interest. Exploratory research provides 'capabilities'—capabilities for developing new concepts of weapon systems that may revolutionize the art and science of aerial warfare. In the Air Force Office of Scientific Research, these capabilities are represented by some 250 laboratories spread throughout the worldwide scientific community.

"We are concerned with three Air Forces," General Gregory said. "First, the Air Force of today, next the Air Force of tomorrow or the next five to ten years, and, finally, 'the Air Force of after tomorrow,' which might well be operating space vehicles rather than B-52s. AFOSR is particularly concerned with this Air Force. It is quite conceivable that the nation which controls the space around our globe will control the peace on the globe."

"So, consequently," General Gregory continued, "information about space, that is, a scientific understanding of cosmic rays, ionization, temperatures, densities in space, is of the utmost importance to us. We must understand the natural laws that will dictate tomorrow's defense. Man is climbing higher and higher, and it seems probable that a system of man-made satellites—coupled with the moon—could well become the necessary weapons system needed to tell the other fellow to keep peace, or else . . .

Air Force To Stay Ahead Of Requirements At All Times

"This thing of sending rockets to the moon is a natural result of current research in the field of advanced studies of weaponry as well as investigation of the natural laws and challenges that we must pursue and understand . . . and don't forget: we have to stay ahead of requirements at all times, and our Air Force must have the very best at all times . . . instead of trying to catch up when we learn that the other fellow already has achieved something big," the general said.

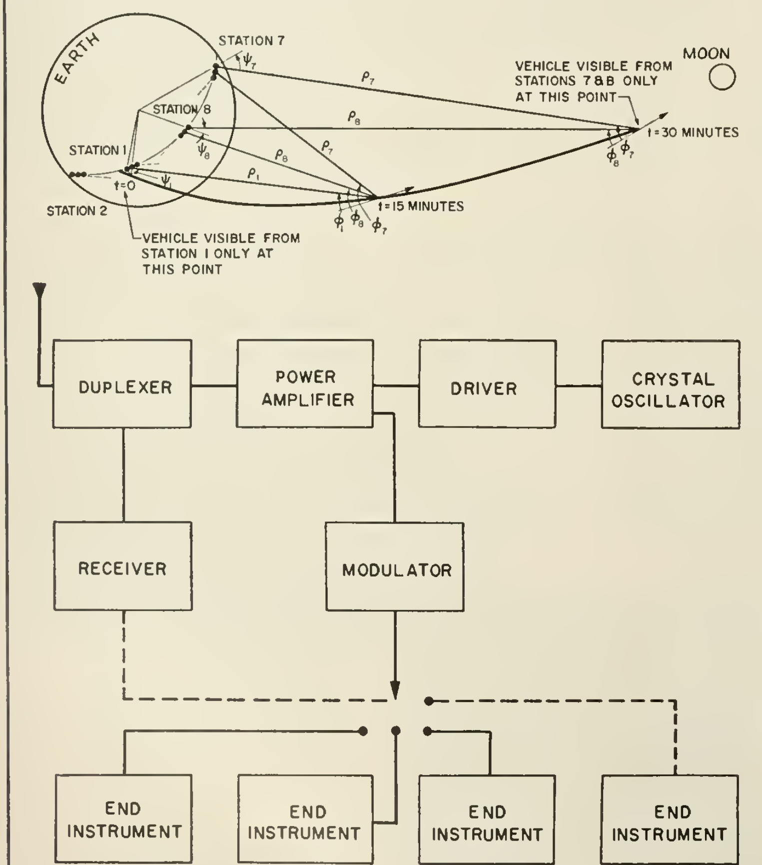
"There are several moon rocket study contracts in the works," General Gregory disclosed, "and it is quite possible that we may make some headway here when the first ICBMs become 'operational,' that is, when components such as the engines are tested and are ready to go. After all, it seems logical that the Air Force, when the ICBMs become operational, will want to train their launching crews and test their vehicles under realistic conditions—and a good way to do it might well be to send modified versions of these vehicles into orbits around the moon."

Asked whether Air Force lunar rockets will be designed to land on the moon General Gregory said it is possible the first lunar rocket will be designed to go into a semi-circular orbit around the moon to obtain scientific data.

Imperative for Air Force To Keep Up With The Russians

"This feat might well be accomplished within the next five years," he predicted. "And when I say five years I probably am quite conservative. Furthermore, several moon rocket study contracts have been in the works for some time now, and we visualize that it won't take too long before we can activate a lunar rocket program. It certainly is imperative that we keep up with the Russians in this respect since we know that they understand fully the concept of space operations and are extremely interested in space flight."

Says one rocket engineer: "The Air Force Office of Scientific Research certainly should be commended for its foresight and its interest in what may turn out to become man's greatest scientific adventure." *(See follow-up article on the moon rockets on page 82).*



Rand Corporation—a non-profit organization established to conduct research work for the Air Force—has released some information from its moon rocket studies. Top drawing shows flight path of small instrument-carrying rocket and location of tracking stations on Earth. Diagram illustrates proposed instrumentation for small moon rocket.

Huntsville Won't Give Up Fight for Jupiter

HUNTSVILLE, Ala.—News of the successful firing of the Jupiter IRBM ushered in the month of March in this old Southern city that finds itself the center of the Air Force-Army controversy—and the calendar found most of the inhabitants acting like lions.

The whole argument between the services as to the merits of the *Jupiter* and the *Thor* has been simmering throughout the community since Secretary Wilson issued his now-famous memorandum of Nov. 26th assigning responsibility to the Air Force for all missiles with a range of more than 200 miles. But little has been said publicly about it until now. Now, the lid is off.

"Charlie Wilson has put his foot in his mouth again—and this time I hope he chokes on it," declared the usually amiable editor of the *Huntsville Times*, the city's only daily. He was reacting to the statements of the Secretary earlier in the week regarding the "cancellation" of the *Jupiter* project. The "misinterpretations" and "clarifications" of his statements about the *Jupiter* and the *Thor* served only to raise the community's boiling point even higher.

There were reports that talent scouts from unnamed industries were seeking to lure away various members of the famous von Braun team of some 125 missile and rocket research scientists. Dr. von Braun himself, who is already under contract to Walt Disney in addition to other duties, was reported in a restive mood—but a check with him and with several of his associates brought the response that they were happy in Huntsville, that they had spurned many outside offers and that, income tax considerations being what they are, they would prefer to stay. However, as one put it: "We'd really like to go to the moon instead of aiming at puny targets 200 miles away."

The surging anxiety of the community was somewhat calmed by the assurances of Maj. Gen. John B. Medaris, commander of the Army Ballistic Missile Agency, that there would be no appreciable slackening of activity at the ABMA in the foreseeable future. Hiring at the Arsenal and ABMA continues unabated, and applications average 1,200 a month.

Meantime, the case of Col. John C. Nickerson became entangled in the hot discussions of Secretary Wilson's various remarks.

The community has stared with wide-eyed awe at the spectacle of the Colonel being escorted through town by armed guards when he comes in from the Arsenal to visit his attorneys.

As Secretary Wilson's latest press conference remarks were published here, there arrived on the desks of various community leaders registered letters from Army Secretary Brucker. The gist of these communications was that the Army's intelligence service had reported that these individuals had received copies of the noted brochure, "Considerations on the Wilson Memorandum" which was circulated to civic leaders and Senators and Congressman shortly after Wilson's memorandum of Nov. 26. Mr. Brucker asked that such copies as remained in circulation be returned to him or that he be given assurances that they had been destroyed. He referred to the brochure that Col. Nickerson is supposed to have released to "unauthorized persons."

Then on Feb. 28th arrived the vanguard of what bids fair to be one of the largest gatherings of nationally known newsmen to assemble in the South in some time. Their purpose was to find out when and where the court-martial of Col. Nickerson would be held and what the defense might be.

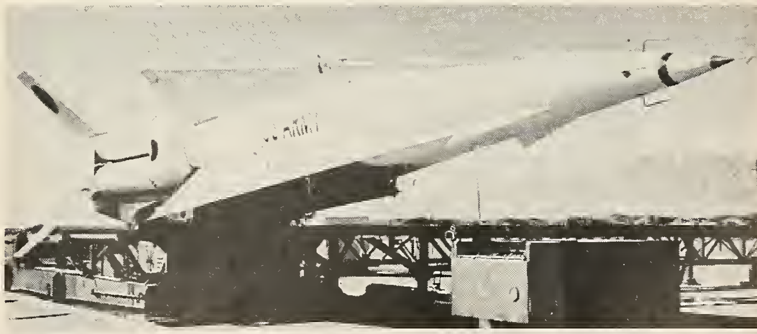
The next day, a Friday, two *Jupiters* were launched from Patrick AFB and on the Monday following, Third Army Headquarters announced its decision to go ahead with Col. Nickerson's court martial, probably in early April. In Huntsville there is widespread speculation that the case may not only develop into something like the Billy Mitchell case but provide as great a journalistic circus for the South as the Scopes monkey trial in nearby Dayton, Tenn.

The Colonel's civilian counsel will be Robert K. (Buster) Bell, of the Huntsville law firm of Bell, Morring & Richardson. Mr. Bell during World War II was top assistant to the late Brig. Gen. Edward Betts, also of Huntsville, who was chief legal officer to Lt. Gen. J. C. H. Lee of the Army Service Corps in the European Theatre of Operations. Mr. Bell in 1950 conducted a spirited campaign for Governor of Alabama and is noted throughout the state for his sharp legal acumen, biting wit and verbal resourcefulness.

With its phenomenal growth of the past six years threatened—from 16,000 to 60,000 population under the impact of the Arsenal and ABMA—the town has reacted in a manner understandable only to students of Southern psychology. A cotton mill with five modern steel and concrete buildings and an area of 800,000 square feet, plus a huge parking lot, became vacant when the Northern absentee landlord decided to sell off the machinery. Some 700 textile workers were laid off. Within the space of a week, 30 Huntsville citizens raised enough cash to purchase the property which is insured for $3,-500,000. They are now offering this space to industries interested in the climatic, labor, water, TVA power and other advantages of the area.

The Army Guided Missile School, often overlooked here and elsewhere, will continue to train all the thousands upon thousands of officers and enlisted technicians who will be required as the nation takes the giant step from manned to unmanned defense. That may be ten years in the making, but 153 year-old Huntsville, the first capital of Alabama, can wait. It's betting most alert firms now engaged in aeronautics and astronautics will find it advantageous in terms of enlightened self-interest to arise and come to Huntsville.

A local wag consulting his almanac the day *Jupiter* flew read under March: "*Jupiter* will rise . . . in opposition."



NIKE HERCULES, Army's atom-loaded ground-to-air missile now undergoing final tests. Within the year NIKE HERCULES will begin to be integrated into the NIKE AJAX bases that now ring many major American cities. Note NIKE HERCULES' larger warhead and heavier boosters. It is claimed to be faster and higher than its predecessor.

Link Simulators — *rehearsal for reality*

The Martin TM-61 Matador, deadly ground-to-ground tactical missile of the USAF, already is standing guard over Free Europe's Eastern frontiers. And with the help of a Link radar signal simulator for the Matador, the potent weapon soon will be controlled by the world's best-trained missile guidance crews.

The Link simulator, which the Air Force recently incorporated into its state-side training programs, serves as a "stand-in" for the expensive Matador during simulated training missions. Using their own operational missile control equipment, guidance crews can direct the make-believe Matador from launching to a direct hit on an "enemy" installation . . . and the simulated mission is just as realistic as an actual one.

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Plasma Jets Give Minutes of ICBM Reentry Heat

In Los Angeles Giannini Research Laboratories reports development of a plasma jet with temperatures of 10,000°K. Simultaneously, the University of Chicago and General Electric's Missiles and Ordnance System Department at Philadelphia jointly announce a water stabilized arc plasma flow with temperatures exceeding 14,000°K (nearly 26,000°F) and velocities up to 4,000 ft. per second. The surface temperature of the sun is 6,000°K.

Working with an input power of 3,000 kilowatts the stabilized arc has developed a heat transfer rate of 2,000 BTU per square foot per second about four diameters from the nozzle. This compares to 800 BTU obtained from rocket engine nozzles.

Both the GE and Giannini devices can be run continuously for minutes at a time.

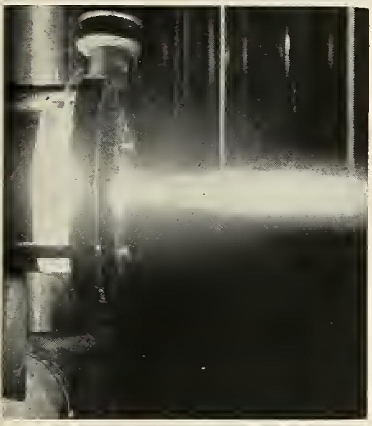
Developed under the direction of Dr. T. R. Hogness, Director of the Chicago Midway Laboratories and Dr. L. Steg, Manager, MOSD Aerosciences Laboratory, the first water stabilized arc—a one-quarter inch model—was built in Chicago last July. Recently a one-and-a-quarter inch model went into operation. Present plans are to build a three-inch model which will require 8,000 KW of power. MOSD has built an evacuated test chamber for its arc in order to better control environment.

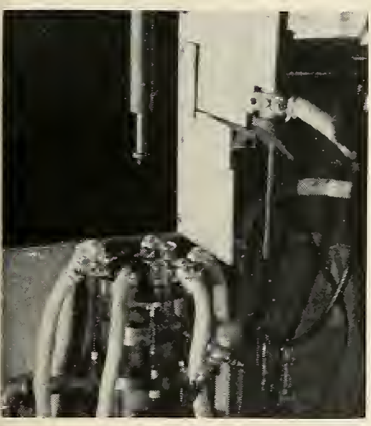
This arc is not new. Stabilized arcs go back as far as 1904 when Sweden used gas-stabilized arcs to make nitrous oxide. In 1922 H. Gerdien and A. Lotz of Siemens-Schuckertwerke, an electrical firm in Berlin, were the first to use the water-stabilized arc. Dr. Lochte-Holtgreven of the University of Kiel is a recent pioneer in the field.

The geometry used and the manner of extracting the plasma from the arc follows the experimental set-up of R. Weiss, Institute for Experimental Physics, of the University of Kiel.

Using air instead of water stabilization, plasma flow velocities in excess of Mach 10, heat transfer rates of over 6,000 BTU and still higher temperatures are anticipated.

Researchers consider that plasma jets are to heat transfer research what the shock tube is to hypersonic aerodynamic study.





Top picture shows Giannini Research Laboratories' 10,000°K plasma jet in operation. In the middle is General Electric's water stabilized arc plasma flow producer, prior to test. Bottom: A nose cone model under test in GE unit glows white hot as it is bathed with atomic vapor at temperatures over 14,000°K.

Quotable Quotes from Clark, Wilson, Rickover

Every winter when Congress gets back to work and the main concern of Government Departments is once again money, the tempo of things done and said quickens. Last month Navy missile chief Rear Admiral John E. Clark set forth the Navy's missile position; Defense Secretary Wilson defined the role of scientists in his Department; and Navy nuclear propulsion head Rear Admiral H. G. Rickover demonstrated that missile engineers aren't the only ones with "that" trouble. Here, in direct quotes, are some of their words:

JOHN E. CLARK: "We can't set up launchers in great numbers . . . our launchers must be capable of rapid reloading with a minimum of readiness time . . . Missiles must be capable of stowage in large numbers in confined magazines . . . Aerodynamic engineers . . . must get the absolute maximum out of small and folding wings and the aerodynamic body of the missile . . .

"The special problems faced by the Navy in developing guided missiles for the fleet has resulted in many cases of apparent duplication in programs between the Navy and the other services. I believe that in many of these cases the charges are unfair to all concerned. It doesn't make much sense for the Army, for instance, to have imposed special Navy problems on their contractors and in the case of the Air Force to have imposed our special aircraft requirements on their contractors. As a matter of fact, while the development costs were large, each missile, apparent duplication though it might be, contributed tremendously to the art in general and each produced much that the others were able to use . . .

"Mr. Wilson's 'Roles and Missions' memorandum of November last . . . simply restated for the Navy the policy that development and operational employment of ship-based intermediate range ballistic missiles would be the sole responsibility of the United States Navy . . ."

CHARLES E. WILSON: "The difference between an engineer and a scientist is perhaps not as great as some people try to make out. There is a question of invention comes into it, also. Most scientists are a little more theoretical; perhaps have delved a little deeper into higher mathematics and written papers on various kinds of advanced things, but most engineers understand the language of scientists, whether they are scientists themselves or not. The important thing here in the Defense Department is to have somebody in this assignment who has administrative and executive ability; understands how to cooperate with other people and coordinate work. The real majority of our research work and our engineering work is done in contractors' plants; a smaller amount of it in laboratories and arsenals and places like that; plants that are operated by the services. The Defense Department, itself, has practically no activities. So that to some degree, I sense that this assignment is a misunderstood job. The responsibility of the staff in the research and engineering and of the Assistant Secretary in charge of it and his deputy is to review and audit activities, to make reports to me, when we get into controversy between the services to attempt certain standardizations to be worked out with the services to eliminate duplication and overlapping of activities; to help establish an order of importance of some of our activities and advice on troubles and difficulties that we get into. And the Assistant Secretary of Research and Engineering has no authority to operate, as such. He simply advises the Secretary what he thought up after the staff makes a study, which should be done in a particular case, and whether it is done or not is up to the Secretary, and the services and the people that do it . . ."

H. G. RICKOVER: ". . . But one factor which today most severely limits our exploitation of nuclear power is neither legal nor governmental. It is not a lack of new ideas, nor even a lack of understanding of recently developed ones . . .

". . . New problems are being reasonably well solved . . . It has been very difficult to get sufficient effort directed toward the more conventional aspects of nuclear plants—the heat exchangers, the pumps, the valves, the instrumentation. Here normal engineering and manufacturing techniques have proved to be inadequate when applied to nuclear plants . . .

". . . Our invariable experience has been that industry cannot deliver this equipment as quickly as it is needed . . . We had expected that industry's technological know-how was sufficient to take care of these modest departures from conventional practice. We found this not to be so . . ."

U.S. Senators Due At ARS Meeting

The program for the American Rocket Society's Spring Meeting in Washington, D.C. is firmed up. Guest speaker at the banquet Saturday, April 6, will be Dr. Athelstan F. Spilhaus, Dean, Institute of Technology, University of Minnesota, and Member of the Executive Board of UNESCO. Several members of the Senate Armed Services Committee have been invited to attend.

Russian Dogs Probe Upper Air

ARS is introducing a series of sponsored breakfasts and luncheons with brief speeches and panel discussions. Among the sponsors are North American Aviation Inc., Grand Central Rocket Co., Harvey Aluminum Co., Chance-Vought Aircraft Co. and Reaction Motors, Inc. Speakers include Maj. Gen. David H. Tully, Ft. Belvoir Commanding General, discussing rocket propulsion and guided missiles in the atomic age, Dr. Theodore von Karman and a special panel provided by NAA.

ATHELSTAN F. SPILHAUS

The ARS program will include 16 papers on high-speed rocket sleds and rocket tracks. There will also be a session on Space Sociology with Dr. Wernher von Braun, Andrew G. Haley and Dr. S. Fred Singer among the speakers.

This is the first time the ARS meets in Washington, and, since it coincides with Cherry Blossom Week, many wives are expected to attend. The International Society of Aviation Writers meets simultaneously in the nation's capital.

Most significant feature of the Spring Meeting will be the Rockets and Satellite Exposition. Over 50 industry booths have already been signed in addition to exhibits by NACA, Army, Navy and Air Force.

ARS Spring Meeting Chairman, Andrew G. Haley told m/r: "We expect a record turn-out . . ." The meeting will be held at Washington's Sheraton Park Hotel April 3-6.

The Moscow newspaper Trud, February 16, described a series of rocket flights carrying dogs to an altitude of 110 kilometers. In the February 23 issue of Pomfomolfkaya Pravda more details were released wherein Professor Anatoly Bladolravo claims the Russians now know how to send men aloft in rockets. Bladolravo is Chief of the Technical Sciences Branch, Soviet Academy of Sciences.

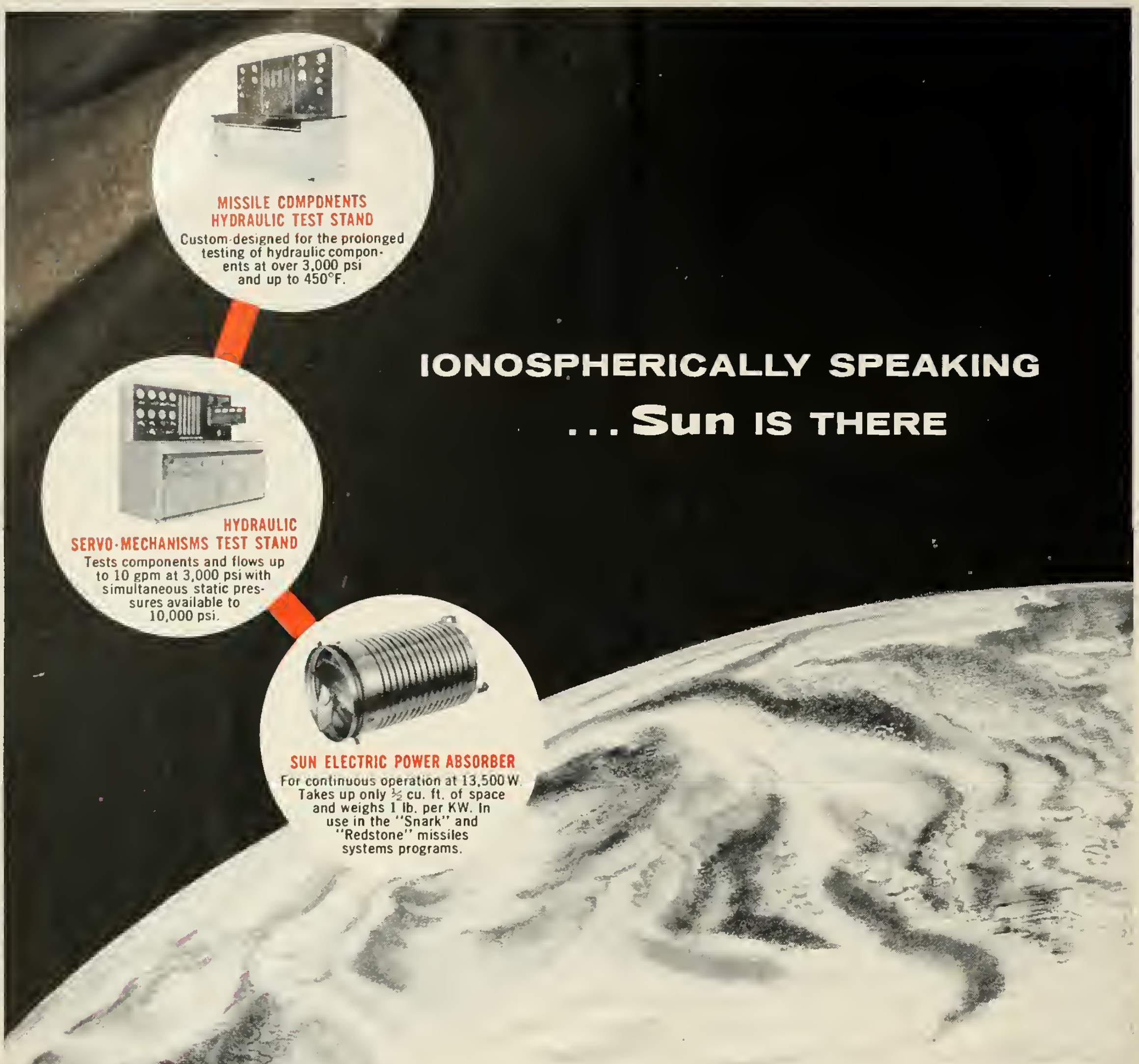
In the first group of dog-carrying rocket flights, which reached an altitude of 100 kilometers (62.1 miles), the dogs were put in an air-tight compartment in the rocket head, containing a system of "air regeneration." Equipment carried by the rocket automatically registered the temperature and air pressure in the compartment; also took the skin temperature, respiration rate and pulse of the dogs. A camera recorded the animals' reactions. Results showed that the dogs' physical condition during the flights did not change substantially, according to Pokrovsky. There was only a small deviation from normal in the pulse rate and character of respiration. Body temperature remained almost constant, and reflexes after flight were normal.

The second series of tests reached the maximum altitude of 110 kilometers. The dogs were placed in a non-airtight compartment in the rocket head. Two catapult capsules were installed in the compartment. Inside each capsule, a dog, not wearing an oxygen mask, was placed in a special "diver-like helmet." However, an oxygen supply "sufficient to keep a dog alive in the helmet for several hours" was attached to the catapult capsule along with a parachute device and recording instruments. Weight of the capsule was about 70 kilograms (154 lbs). The parachute allowed a vertical speed of approximately 6 meters (about 19.7 ft) per second. The dogs were placed in the helmets daily for steadily-lengthened periods of time for two months preceding the rocket flights.

Launchings usually took place three to five minutes before sunrise. At the top of the trajectory, the rocket head containing two dogs separated from the body of the rocket. At a height of 80-90 kilometers, during free fall, the dog in the right capsule was catapulted. Speed of capsule ejection from the rocket head was about 700 meters (2,296 ft) per second. The parachute opened three seconds later at a height of 75-85 kilometers. "For an hour the animal was subjected to the direct effects of all external factors in the upper levels of the atmosphere."

The rocket head, freed of the right capsule, continued its rotating free fall. The second dog, located in the left capsule, was catapulted at an altitude of 35-50 kilometers at a speed of 1,000-1,500 meters per second. This free-fell to an altitude of three-four kilometers, where its parachute opened.

During the entire rocket flight, up to the moment of catapulting the capsules, a camera took pictures of the animals. According to *Trud*, some dogs made several rocket flights. It said that no animals were killed by the experiments. They were about the size of cocker spaniels.



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Regulus II Trainer Has Boundary Layer Control

Chance Vought's better-than-Mach 1.5 *Regulus II* made its first official public bow at the Navy League meeting this month in Washington, D.C. Though faster by far than its predecessor, *Regulus I,* the 57-foot long bird still incorporates wheels in the test and training version. It has a 20-foot wing span. Missile placed on display was number seven.

Well along in its land test program at Edwards Air Force Base, Texas, preparations are now being made to launch it at sea. It's expected that it will become operational in about a year. It will fit *Regulus I* submarine stowage and launching gear with only slight modifications.

The supersonic Chance-Vought missile incorporates many proven *Regulus I* components, such as the same Sperry auto-pilot; same beacons; and the same system for recovery.

In landing after test, *Regulus II* hits the runway at a hot 250 knots. It has no flaps; uses only a drogue parachute to slow it down. Even at this high landing speed it still requires boundary layer control for the wheeled versions. Photographs to the left show the air intake for this system. Bottom photograph shows the boundary layer exhaust duct. This will not appear on the operational missile.

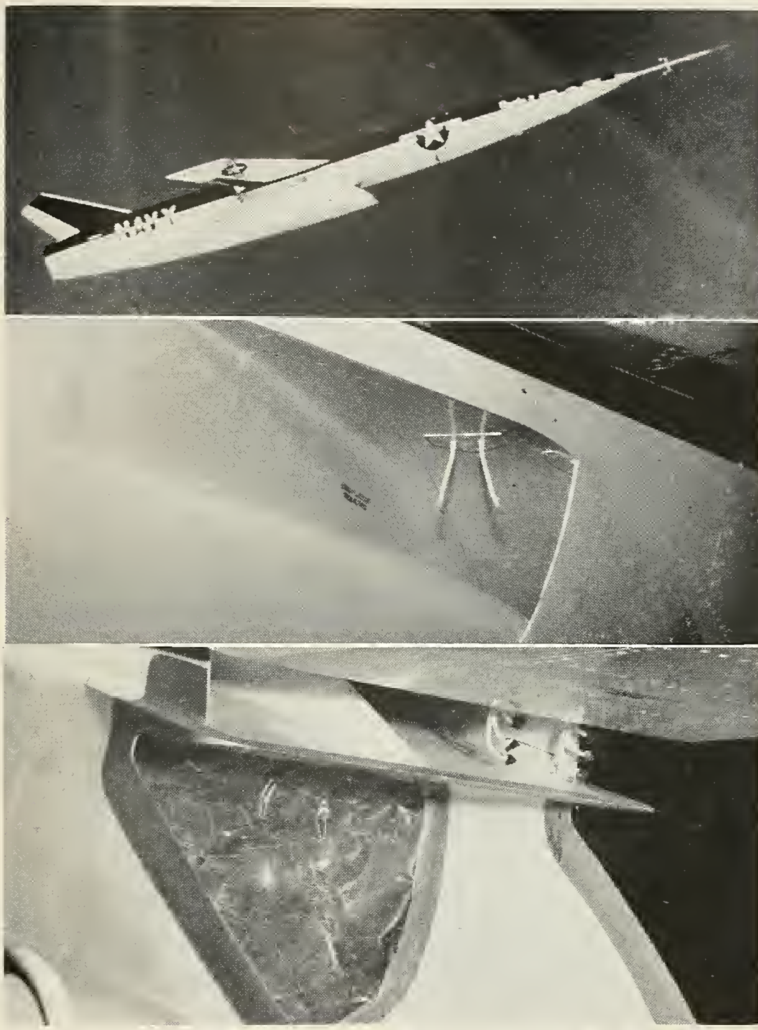
Also, like its predecessor, *Regulus II* carries a nuclear warhead, either fission or fusion. It has already flown over 50,000 feet and has an all-weather range of over 500 miles. As of March 1, there had been thirteen *Regulus II* flights—six with the same missile.

While *Regulus II* was making its first public appearance, it was announced that *Regulus I* had successfully completed more than 500 flights. Also, it was reported that *Regulus I* was now being tested under near-Arctic operational conditions in the North Atlantic. In addition to being able to perform its mission from either land, surface ship or submarine, the *Regulus I* has been developed into a highly successful target drone.

Regulus II's production power plant will be the General Electric J-79 with full afterburner.

This engine is currently rated at 12,000 pounds dry thrust and 16,000 wet, which should make *Regulus II* nearly hypersonic in its final dive.

There are reliable reports that the effective range of the *Regulus* missile series may be increased to as much as 1,000 miles by the addition of podded fuel tanks.



Trainer-test version of Regulus utilizes boundary layer to enable it to make wheeled landings for full recovery. Designed as a one-way missile, it has virtually no low-speed aerodynamic characteristics, landing at 250 knots. Middle picture shows boundary layer exhaust duct. Bottom shows in-take just over main engine intake.

Rocket Trends

By Erik Bergaust

Convair did an outstanding job on its space flight symposium co-sponsored by AFOSR in San Diego last month. This is the kind of thing the American Rocket Society should have undertaken long ago. "We ought to have these symposiums at least once a year," AFOSR Brig. Gen. Hollingsworth Gregory told this writer. The symposium was attended by more than 500 engineers and scientists. It was the first of its kind, and it was successful, indeed. Congratulations to Convair's Dick Gottschall and the entire PR staff for the fine way they handled press relations; they went all out to help newsmen get the right kind of story across to the public about these highly scientific subjects. Several companies said they would consider taking on next year's symposium. By the way, the first symposium was a punchy inauguration for the Air Force in its *psychology campaign* for justification of the forthcoming space flight programs.

Lockheed is pushing the X-17 real hard. During our quick tour of the Los Angeles missile boom area, we were told the X-17 is "a most successful test vehicle." In fact, we learned reliably that Lockheed has proposed a new *weapons system based on the X-17.* The monster can zoom to 300 miles straight up if desired. However, the three-stage missile is designed to topple over. Re-entry then becomes a *powered downward flight* of Mach 15 velocity. Lockheed's missile group has several missile proposals in the works. Among others, the company is understood to have prepared a couple of space flight proposals. The Air Force reconnaissance satellite remains a mystery, and Lockheed officials cannot say a thing about it. Said one AF official: "That kind of satellite will become part of a gigantic future weapons system." Other than the fact that the reconnaissance satellite is being planned, the project is hush-hush.

Northrop is justifiably proud of its Mark I guidance system for the *Snark.* Within security limits this reporter was given the opportunity to watch the production phase of the all-Northrop inertial system. *Snark* production—in general—is getting underway at an accelerated rate, indicating General Curtis LeMay wants his long-range missiles as soon as possible. (He could have had them two years ago if the Air Force had been somewhat more enthusiastic in carrying out its long-range missile program.) Northrop can't tell you how many successful *Snark* flights they've logged, but they are numerous. Of course, you don't hear about the successful ones . . . Northrop also showed this writer a new 7-minute *Snark* movie—quite spectacular—that will be made available soon to interested groups. Company officials couldn't confirm that Northrop is working on a super-duper missile. But one Northrop scientist said: "We would be off our rocker if we weren't looking ahead for new challenges."

Grand Central Rocket will hire another 100 engineers this year. Expansion is in full swing and *Dart* powerplant production (plus two classified missiles) is in the undertaking. A low-and-slow sightseeing trip by light plane over the company's newly acquired 8,000 acre test site in the remote Riverside County area revealed a million-pound thrust cell—the first of many. Says technical director Frank Marion: "We will compete with the liquid boys soon—*20% more specific impulse and 5% better density is what we need.* And we're working hard to achieve it. We'll do it." The company has all kinds of projects in the mill and are submitting frequent proposals. *Vanguard* third-stage engine tests are routine now, numerous successful firings having been conducted. Grand Central's Bob White will be out killing rattlesnakes again this spring, because the company's noisy engine tests fail to scare the diamondbacks away.

Washington Spotlight

By Henry T. Simmons

The precarious future of the *Navaho* intercontinental missile is dramatically illustrated by the fact that there are no funds for its support in the fiscal 1958 Air Force budget. The program was almost wiped out during preparation of the new budget, but was saved through some financial leger-de-main with fiscal 1957 funds. The project was re-oriented along purely research lines and a number of XSM-64 test *Navahos* were lopped off. USAF will decide in fiscal 1958 whether the project will get full support or die a quick death. Cutback forced North American to lay off 300 *Navaho* workers and re-assign another 300, but it still hopes to finish tests of the ramjet-powered prototype on schedule.

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This view of the cutback may sound like rank optimism, but it rests on some important considerations. The XSM-64, for example, is equipped with landing gear and is theoretically recoverable with a dead-stick landing procedure developed on its predecessor, the turbine-powered X-10. Judging from the good results with the X-10 (Number One was fired 11 times before plunging into the sea), a smaller number of "X" *Navahos* will suffice for the test program. Perhaps more important, the SM-64A production version now in the design stage incorporates so many improvements over the test model that the original elaborate program is no longer deemed necessary.

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Attempts to launch the XSM-64 got under way at Patrick AFB, Fla., late last year, but as this is written, the Air Force is still looking for its first successful firing. The initial try in December came to grief when the huge missile reached 9,000 feet; a rate control gyro malfunctioned and the test was aborted. Later efforts were plagued with range difficulties. On one occasion, a freighter wandered into the booster dump zone off Cape Canaveral; by the time the count-down could be resumed, a down-range tracking station broke down and the test had to be canceled. Although these troubles suggest the *Navaho* will prove at least as cantankerous to develop as any other advanced weapon system, its supporters insist that the new bob-tailed program still allows for such setbacks.

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Latest explanation of the testing troubles of another Air Force missile, the *Thor,* blames the January launching stand explosion on foreign matter which was allowed to contaminate the fuel. If so, the hardware of the IRBM—including the North American engine—is absolved of guilt in connection with the mishap.

•

Future Navy interceptors may carry mixed loads of missiles—one radar *Sparrow* and one infra-red *Sidewinder*. Latter weapon is immune to countermeasures, but can't be used in rain or heavy clouds while the former is an all-weather weapon. Hughes is developing an infra-red *Falcon,* indicating USAF may follow this approach.

•

The new air-to-air rocket with the nuclear warhead which Defense Secretary Charles Wilson announced last month is the Douglas *MB-1*, a liquid-propellant missile now in operation with the Air Defense Command. It used to be called the *Ding Dong,* but disgruntled USAF security officers changed it to *High Card* when it leaked out. The second name also leaked, so the weapon was given its present inglorious moniker. The Northrop F-89J and the Convair F-102 and F-106 will carry the new weapon, later versions of which will use a solid-propellant motor.

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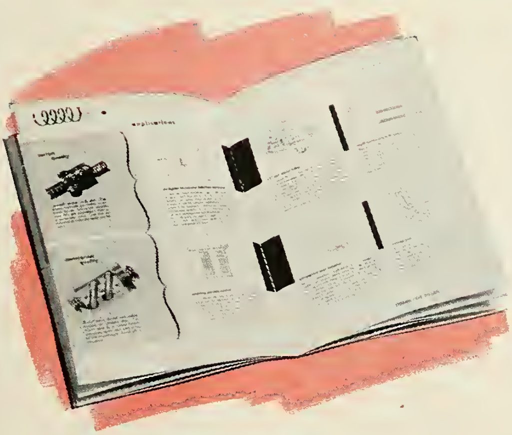

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VOL. 3 NO. 2

MARCH, 1957

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

m/r exclusive:

1957 Research Rocket Roundup

The first sustained use of the rocket vehicle for upper atmosphere research followed the close of World War II, when some 100 of these rockets were brought over to the U.S. At that time V-2's were available in considerable quantity. By early 1946 the Upper Atmosphere Research Panel had been established. The name was changed in 1948 to the Upper Atmosphere Rocket Research Panel. Its members included top scientists concerned with upper air research from Evans Signal Laboratory, Naval Research Laboratory, Air Force Cambridge Research Center, etc., as well as universities, observatories, and private companies.

U.S. scientists and military firing crews launched the first V-2 in the U.S. on April 16, 1946. On June 28 the first completely instrumented, high-altitude research V-2 took off from the White Sands Proving Grounds. One was launched from the U.S. aircraft carrier Midway in late 1947.

General Electric Co.'s Project Hermes fired the most research V-2's, gaining great experience from the German scientists who worked in this country after the war and from translated German reports. Army Ordnance was the cognizant military agency.

Standard and Modified V-2's

The standard V-2 warhead had about 16 cubic feet of space available for instrumentation. In a number of V-2's redesigned by the USAF, instrumentation space was increased to 80 cubic feet, increasing the rocket length about five feet, increasing the length from 524 to 589 inches. However, the V-2 still had disadvantages. It was an old missile. Many parts were unreliable and had to be rebuilt. It was much too big. For stability reasons, its full one-ton payload had to be carried, and because a ton of instruments cannot be crammed into such a small space, useless ballast had to be added.

In general, the use of military missiles for research is not particularly attractive. But the V-2 was available, and it launched a very important and sustained U.S. research program.

Of the 70 odd V-2 firings undertaken by the U.S. about 75% were considered successful, meaning they hit altitudes of 50 miles or more.

Staging Sets Record

An important step in the program was the mating of the V-2 with a small American WAC-*Corporal.* A series of these *Bumpers* were fired, including one that broke all altitude records and another that broke the atmospheric velocity record. Most of them were fired from White Sands Proving Ground, but two were launched from the Patrick Air Force Base Missile Test Center in Florida in an attempt to gain maximum range and velocity. The fifth *Bumper* rocket, fired from New Mexico, hit over 5,000 miles per hour, and the small WAC-*Corporal* reached a peak top altitude of 244 miles. This world's record was only recently broken by a three-stage rocket using a *Redstone* missile as the first stage and modified *Sergeants* (or *Recruits*) as second and third stages. These early *Bumper* flights taught scientists how to: communicate beyond the ionosphere; work with staging problems; ignite motors at extreme altitudes.

m/r presents herewith what it believes to be the most complete roundup of the history and specifications of research rockets ever compiled at one time. The research rocket is a peaceful vehicle. The data it gathers pioneers man's approach to outer space. Frederick I. Ordway III and Ronald C. Wakeford, who are to be congratulated for authoring this roundup, are President and Research Engineer, respectively, of General Astronautics Corp.

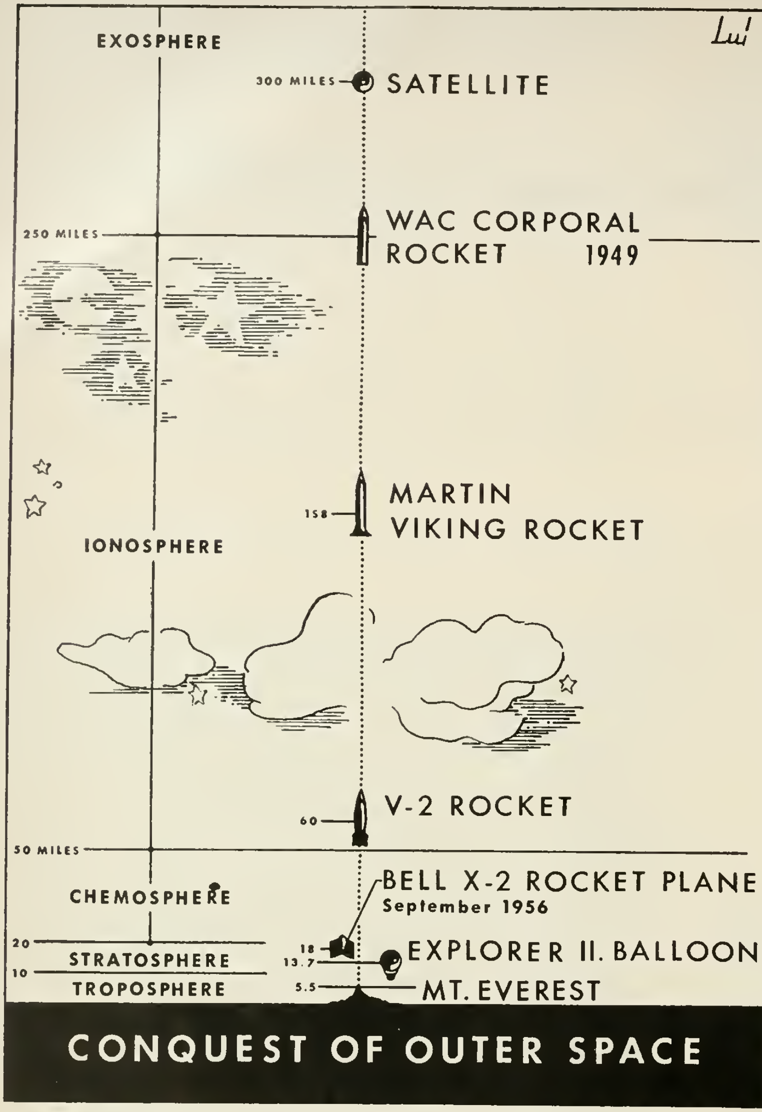
By July 1, 1951 Project Hermes ended, a success. Under Hermes, the peak altitude gained was 116 miles. There were also a number of test firings made by White Sands personnel and other agencies. One of these, an uninstrumented rocket launched in late October, 1951, reached 132.5 miles.

America Makes Its Own Rockets

About 1930 the Daniel Guggenheim Foundation provided Dr. Robert H. Goddard with the grant that gave U.S. rocket research its start. At California Institute of Technology's Guggenheim Aeronautical Foundation, a group of rocket researchers worked into the late 1930's. At the same time, on the east coast, the American Rocket Society was performing its research work and later a group of experimenters at the U.S. Naval Academy also did rocket research.

During the war at Cal. Tech's Jet Propulsion Laboratory the first sustained government supported rocket research began. This led directly to the development of research rockets. One of the first steps was the *Private A* rocket and later the *Private F.* These small, fixed-finned rockets were launched from steel booms about 36 ft. long, ascending on four guide rails and were boosted during their travel in the small steel guide booms. Many tests were made during 1944-45 at Barstow, California, and later at Ft. Bliss in Texas.

The group that designed and developed these rockets was called ORDCIT—Ordnance Contract to the California Institute of Technology. They were asked to develop a sounding



This shows the stage-by-stage advance of research vehicles towards free space. The JUPITER-C, of course, with a record altitude of 680 miles, is off the chart.

rocket to carry a small 25 pound payload up to, perhaps, 20 miles. They built the *Baby*-WAC, which was test fired during July, 1945, at the California Goldstone Range. It was a one-fifth scale model of the 16 foot long, 665 pound WAC-*Corporal* that was later developed from it.

The first firing of the WAC-*Corporal* was on September 26, 1945, at the White Sands Proving Grounds, some six months before the first V-2 launching in the U.S.

Aerobees and Aerobee-Hi's

While the V-2 was too big, the WAC-*Corporal* was too small for many research purposes. This led to the first specifically designed upper air research vehicle, the *Aerobee*, developed by the Applied Physics Laboratory of Johns Hopkins University and the Aerojet Engineering Corp.

Most of these *Aerobees* have been built by the Douglas Aircraft Co. The first *Aerobee* contract was let in 1946 by the Navy Bureau of Ordnance in close cooperation with the Office of Naval Research. The preliminary order for 20 was later considerably increased.

Other services, such as USAF, have also ordered *Aerobees*. The first full firing occurred (dummy missiles had been booster-launched earlier) in November of 1947. By 1948 an *Aerobee* had reached 70 miles, and somewhat later another soared 100 miles. Like the V-2, they also have been launched from shipboard.

A variation of the *Aerobee*, the *Aerobee-Hi*, was developed and by 1955 it reached 124 miles. Later, the world's single-stage altitude record was broken by a 164 mile flight.

Aerobees have been used by all services and are most versatile and successful. Up to last summer some 150 had been launched, with 128 operationally successful. They were fired as follows: Johns Hopkins University, 17; U.S. Army Signal Corps, 33; U.S. Navy, 35; U.S. Air Force, 65.

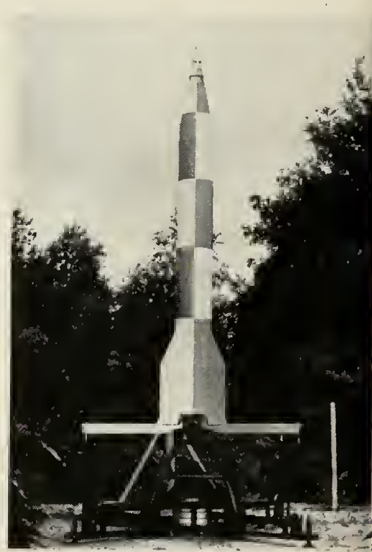
More than 50 *Aerobees* will be fired from Ft. Churchill and Holloman during the International Geophysical Year. Experiments will include free-electron density studies, ultra-violet radiation, cosmic ray, Lyman-alpha and day brightness investigations, and research on the existence and density of interplanetary matter to 200 miles.

Air Force Program

In 1952 the Air Force negotiated a contract with Aerojet to improve the *Aerobee*. Two basic improvements were made: 1) The propellant tanks were enlarged to handle 32 per cent more fuel and oxidizer; and 2) these tanks were made of lighter 410 stainless steel. This improved the mass ratio from 3.17 to 4.62. On its first flight in April, 1955, with a payload of 196 pounds, it soared to 124 miles.

Navy Program

Because of a desire to get into the F region of the ionosphere the Navy program called for the thrust chamber as well as the overall rocket to be completely pressure-sealed. This would eliminate the danger of escaping gas



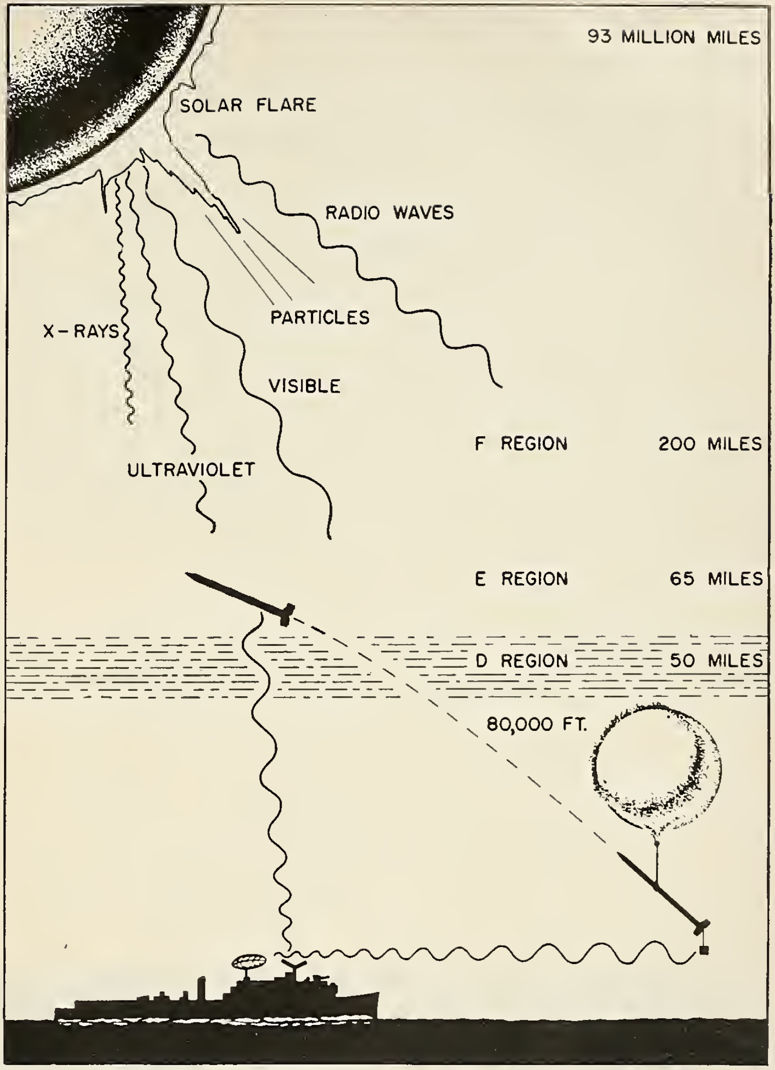
Veronique, star of France's missile effort, was developed under the Ministry of Defense. The vehicle hits 3200 mph, carries 133 lb. payload.

from contaminating the ambient conditions and thereby invalidating upper air experiments. Not only did the Navy use the AF's improved steel tank material but it further increased the propellant capacity of the vehicle, improved the thrust chamber assembly, and of course, the mass ratio. A chemical gas generator replaced the helium tank.

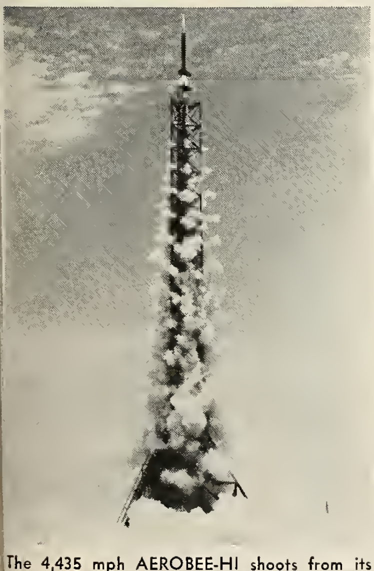
Due to the lack of time and the urgencies of the IGY, the development efforts of the chemical pressurization system will be suspended, and Navy *Aerobee-Hi* rockets will use helium pressurization techniques during the next few years. However, a better acid appears to be on the way as well as an uncooled combustion chamber.

The basic aim of this program is to reach 180 miles with a 150 pound payload. In pre-IGY tests at Fort Churchill, Canada, additional RT-N-13B's were successfully fired, as well as a RV-N-13C which carried 156 pounds to 157 miles. The Air Force Model AJ-11-6 carries a 150 pound payload to about 140 miles, and, due to different launching conditions, to 165 miles at White Sands Proving Ground. The Navy RV-N-13B carries its 150 pound payload to 147 miles; to 162 miles if launched from White Sands. If the payload is lowered to 120 pounds both these missiles should gain another 17 miles under sea level launch conditions and an Arctic atmosphere.

According to Townsend (in an American Rocket Society Annual Meeting lecture), when the Navy *Aerobee* changes its tanks to the new type it should gain another 10 miles. Eventually both the Air Force and the Navy models will probably use a ceramic lined thrust chamber (such a chamber is now under development, to deliver 5,000 pounds of thrust). A Navy *Aerobee-Hi* should reach 167 miles with a 150 pound payload under Arctic atmosphere and sea level launch conditions. If this chamber is used with a 120 pound payload, a 188 miles altitude would be possible and if fired at White Sands, an additional 15 miles.



Artist's sketch of ROCKOON, 68-foot diameter plastic balloon and a 12-foot solid propellant DEACON sounding rocket at they will perform during the IGY.



The 4,435 mph AEROBEE-HI shoots from its launcher at White Sands Proving Ground, N. M. is used for ionosphere research.

Vikings Replace V-2's

Going back to 1946, and picking up the thread from the East Coast companies, we find the *Viking* program underway. At NRL plans had been hatching for some time to develop and build a fairly large U.S. rocket vehicle capable of replacing V-2. It was apparent that the supply of V-2's in the United States would not last forever and that if the U.S. wanted large rocket missiles when this supply was exhausted, it would have to begin work immediately. NRL contracted with the Glenn L. Martin Co. in August, 1946, for 10 large rocket vehicles. Later this was upped by four additional missiles. The powerplant award contract went to Reaction Motors, Inc., organized in 1941 by a group of American Rocket Society experimenters. First called the *Neptune*, the name was changed to the *Viking* so as not to confuse it with the Navy *Neptune* airplane. Until recently the 158 mile altitude reached by a *Viking* was the world's record.

Vikings have undergone continued change during the overall development program. The first seven were relatively similar, as are the latter series. For example, the earlier *Vikings* were more than 48 feet high; the later *Vikings* were less than 42 feet. This can be compared with the 46 foot V-2. The first series were only 2 feet, 8 inches in diameter, the second series nearly 4 feet. Compared with the nearly 5½ foot V-2 rocket, both missiles are slim. The thrust generated by the *Viking* rockets ranges from 20,000 to 21,500 pounds, compared to the 56,000 to 60,000 pounds of the V-2. The rockets weighed anywhere from a little under 10,000 to a little under 16,000 pounds, which again compares with the much heavier German vehicle.

Some element of success attended all the *Viking* firings with the exception of No. 8, which broke away in a static test.

The payload of missiles has changed a lot in recent years. Formerly, it was common to carry on a fairly wide variety of experiments from one vehicle having payloads of many hundreds of pounds. Today it is amazing what can be done with relatively low (25 to 50 pound) payloads. The tendency now is to use a given rocket for a given experiment. For one thing altitudes will vary depending on the experiment. Some experiments should be made near the peak of the rocket trajectory. Others can be profitably made on the upward trajectory or on the downward trajectory. If too many different experiments are made with a given rocket, damage to some of the other experiments may occur, and consequently, we find that the general philosophy of one rocket for one experiment (or at least very few experiments) is gaining favor.

While most vehicles are being fired in a vertical or near vertical trajectory, attitude control is not always necessary. Some vehicles have to have this attitude control for certain experiments such as following the sun. Others that might want to go into a special trajectory (such as the *Vanguard* rocket when it launches the Earth satellite) require spin stabilization, and so forth.

As with the *Aerobee* rocket, the problem of contamination is very important in making atmosphere composition experiments. For example, if exuding gases from the rocket are allowed to enter the atmosphere and contaminate the sampling bottles, accurate chemical analysis is impossible. For that reason clean rockets are needed.

The recovery of data is, of course, extremely important. Biological specimens, photographs, etc., have to be directly recovered by some sort of a drogue or parachute technique, or by aerodynamic descent following separation of the nose cone from the vehicle.

It is one of the characteristics of the 1950's that all too little money is available for upper air rocket research; so it is all the more important the price be kept as low as possible. An *Aerobee,* for example, costs between $30,000 to $40,000 per rocket, somewhat less than the *Viking. Deacon* and *Cajun* rockets are less expensive than the *Aerobee*, a great advantage to the private companies and universities that may want to fire them. In addition to the rocket other costs include logistics, instruments, personnel, etc.

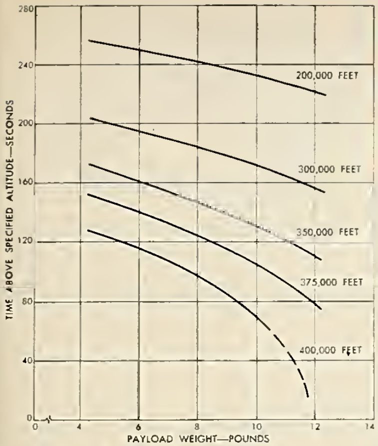
In a recent American Rocket Society paper on future sounding rockets, the *Spaerobee* was introduced, which adds a second stage to an *Aerobee* to give an altitude capability of about 350 miles. The payload would be 40 pounds. A second new vehicle is the *Aerosound* which is launched from an airplane in a vertical attitude. It would carry 40-pound payloads to perhaps 45 miles or 20 pounds to 54 miles. A two-stage *Aerosound* would fly to over 100 miles with identical payload weights.

U.S. Research Rockets — The Finer Details

Consistent with observations of changing techniques in rocket research, we find a whole new crop of small, efficient vehicles entering the pre-IGY scene. They carry such names as *Rockoon, Rockaire, DAN, Nike-Cajun, Terrapin, Asp,* and *Wasp* and generally cost only small fractions of *Viking* and *Areobee* rockets. Capsule information is presented on these vehicles in so far as it is now available.

One of the factors that led to the *Nike-Cajun* combination was that the *Rockoon* rocket was hard to track to

Rocket's eye view from about 100 miles up. The Navy believes this to be the largest earth area ever photographed from one spot.



Time that Terrapin remains above specified altitude for vertical launch.

its point of impact. This was because the exact time of discharge from the balloon could not always be told, nor could the precise location of the balloon be known because of drift. In 1954 work started on providing the *Deacon* with a *Nike* booster. The aim was to bring 50 pounds up to about 75 miles. A coasting period between the exhaustion of stage one and the firing of stage two was planned. Result was the *Cajun* rocket little more than a *Deacon* with an improved solid-propellant charge. Army Ordnance supplied boosters, and instrumentation was provided by those agencies carrying out the experiments. Successful tests were made during the fall at Fort Churchill, Canada, one of which carried 100 pounds up to 70 miles.

Weight, pounds 1,550
Wt. of *Cajun,* loaded, pounds ...250
Length, booster & rocket feet . . . 26
Coasting period (between separation of the rockets and firing of the top stage), seconds .... 10 to 20
Number of *Nike-Cajuns* to be fired during IGY . . . 65 (42 will be fired from Churchill, and the rest from ships, at Guam, or at White Sands).
Record altitude for a *Nike-Cajun* . . . 95 miles (flight by the Ballistic Research Laboratories on 9 Aug. 1956. Payload was 60 pounds).
Cost . . . $4,000 (not including instruments, the booster costs an additional $3,700).

Recently four fairly successful firings of these rockets have been made. Scientists had hoped for somewhat higher altitudes than obtained.

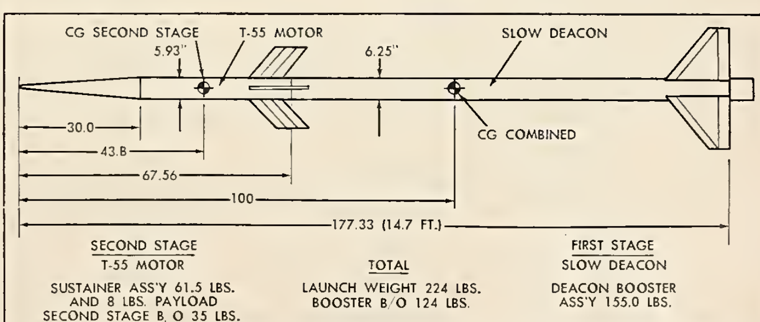
DAN

If an unimproved *Deacon* is used, we have what is known as the *DAN* (*Deacon* and *Nike*). This program was initiated by NACA. It is obvious that

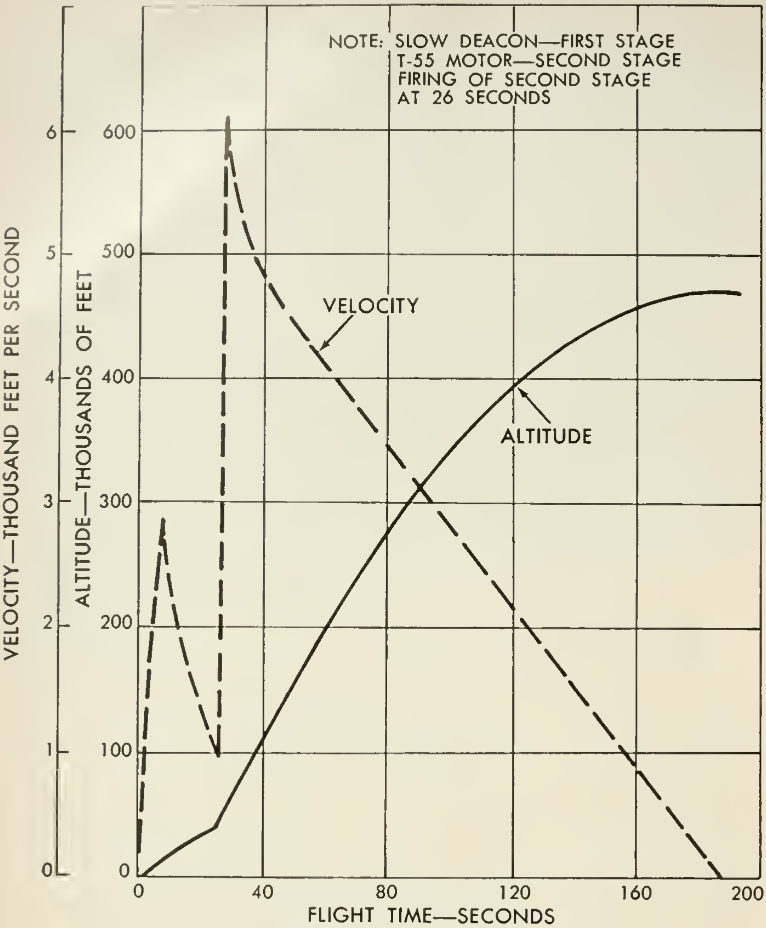
Artist's conception of an IGY satellite over a Minitrack ground station antenna array.

DAN and *Nike-Cajun* are essentially the same thing. A few figures quoted for DAN appear below:
Contractor . . . NACA and U. of Mich.
Cognizant agency ........U.S.A.F., Cambridge Research Center.
Weight, booster, pounds 1,324
Weight, second stage, pounds . . . 216
Payload, pounds 10-60
Altitude, miles 70-95
Altitude, separation, feet . . . approximately 5,000
Velocity, maximum . . . . . Mach 5
Instrumentation ....Free-fall accelerometer sphere (air density measurements).

DAN has recently been replaced by the *Nike-Cajun.*



TERRAPIN Two-stage high-altitude research rocket developed by Republic Aviation Corp.



Velocity—altitude time history for 4.25 pound payload.

IRIS and ARCON

Two of the newer basic research rockets currently sponsored by the Navy are the *Iris* and *Arcon*. Both are being developed by Atlantic Research Corp. of Alexandria, Virginia. Details of the design specification indicate that the vehicles are propelled by solid fuel motors. The *Iris* rocket will have a burning time of 40 seconds and will undertake upper atmosphere experiments similar to those of the *Aerobee-Hi* (probably eventually replacing it). Preliminary information indicates that neither *Iris* nor *Arcon* will be boosted. It is expected that *Iris,* a fin stabilized vehicle, will be launched during the latter half of 1957 or early in 1958. *Arcon,* a somewhat simpler vehicle to produce, and further along than the *Iris,* is almost sure to be fired in 1957.

TABLE NO. 1

VIKING SERIES

Viking No.	Launch Date	Altitude (Miles)	Payload (Pounds)
1	3 May 1949	50	464
2	6 Sept. 1949	32	412
3	9 Feb. 1950	50	528
4	11 May 1950	105	959
5	21 Nov. 1950	108	675
6	11 Dec. 1950	40	373
7	7 Aug. 1951	136	394
8	6 June 1952	4	
9	15 Dec. 1952	135	765
10	7 May 1954	136	830
11	24 May 1954	158	825
12	4 Feb. 1955	144	887
13	8 Dec. 1956	125	

TABLE NO. 2

Time Viking Rocket No. 7 spends above:

Kilometers	Seconds
30	400
40	385
100	315
120	200

Data	Iris	Arcon
Diameter, inches	12	6
Length, overall, feet	14.83	11
Weight, pounds	1,000	250
Payload, pounds	100	40
Altitude, miles	200	70

TERRAPIN Rocket

Another in a series of small, solid propellant rockets, the *Terrapin,* was first flown late last year at NACA's Wallops Island facility. So far it has been used to make cosmic ray, temperature and rocket spin and acceleration measurements. Instrumentation includes all transistorized telemetering equipment, geiger counter and transmitter. It will be used for sustained upper atmosphere research in the 80 mile region. Several dozen rockets will probably be produced.

Contractor . . . Republic Aviation Corp.

Cognizant agency . . . . Navy Bureau of Ordnance via U. of Md.

First stage motor contractor . . . Alleghany Ballistics Laboratory—Navy Bureau of Ordnance.

Second stage motor contractor . . . Thikol Corp. with the Redstone Division of the Army Ordnance.

Vehicle type . . . . Two-stage

Launcher . . . Collapsible zero length

Weight, overall, pounds 224

Instrumentation, pounds 6

Length, approximate, feet 15

Diameter, inches 6¼

Velocity, maximum, mph 3,800

Time to impact, minutes 5.6

Altitude (first flight), miles 80

Temperature (skin), max, °F . . 1,000

Propellant . . . . Solid

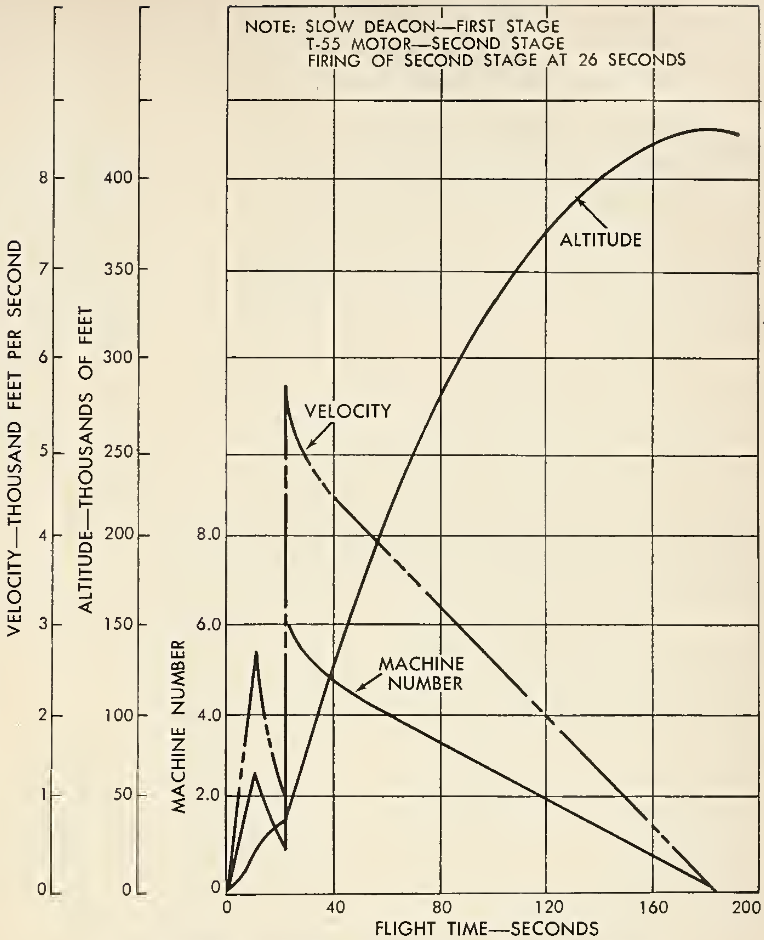
Operational sequence: The solid propellant first stage engine carries the *Terrapin* to nearly two miles in six seconds. (Speed: 1,900 miles an hour). Then the first stage separates from the second stage, which coasts to about 7½ miles. The second stage motor now fires, bringing the missile to 9½ miles at a speed of Mach 5.8 (3,800 miles an hour). It coasts to peak.

ROCKOON Missiles

The *Rockoon* system of high altitude research, begun in 1954, was the result of the Naval Research Laboratory's efforts to obtain basic data from high altitude at less cost than was possible with larger rocket vehicles.

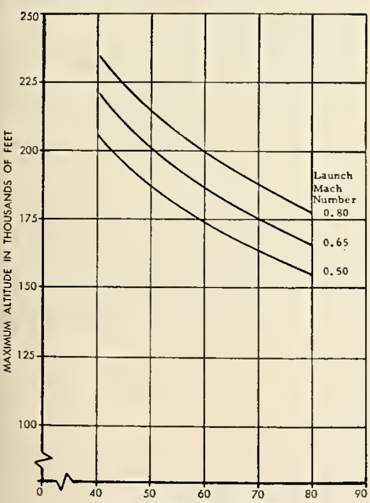
The configuration consists of a *Deacon* rocket suspended from a 68 foot diameter plastic balloon (Skyhook). At 15 miles altitude the rocket is fired into the lower ionosphere. In July of 1956 ten such arrangements were launched to obtain information on solar flare activities. These balloon/-*Deacon* firings were supervised by Dr. H. Friedman of NRL Optics Division.

Contractor . . . Douglas Aircraft Co.
Powerplant manufacturer . . . Allegany Ballistics Laboratory.
Cognizant agency . . . U.S. Navy via State U. of Ia.
Length, feet 12.3
Diameter, inches 6.6
Weight, loaded, pounds 218
Weight, payload 20-30
Thrust, pounds 5,700-6,000
Propellant . . . . Solid
Altitude, miles 50-70
Guidance . . . . Fin stabilized
Firing time, seconds 3-3½



Velocity—altitude—mach number time history for 8.25 pound payload.

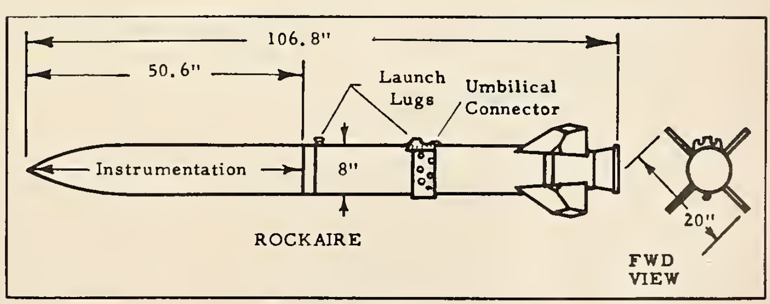
ROCKAIRE Missile



ROCKAIRE

This program was born of the desire to fire rocket missiles in areas other than where established large launching areas are located. The small rocket has drawbacks, particularly in its altitude capability. For example, a *Deacon* rocket could hardly get any higher than a balloon if launched from the surface. So these small rockets either have to be boosted or launched by balloon or aircraft. This *Rockaire* combination is a *Deacon* launched from an aircraft in an almost vertical attitude, for maximum height attainment. According to Air Force Cambridge Research Center's R. M. Slavin, a 40-pound payload *Deacon* gains 7,000 feet in zenith altitude for each 1,000 foot increase in launch altitude.

Principal contractor . . . . . . Douglas Aircraft Company.
Typical launching technique . . . At 6 or 7 miles altitude an F-86 airplane assumes a near vertical attitude and launches the rocket.
Launching area . . . Holloman Air Development Center.
Tracking . . . The rockets will be tracked from ground stations. (Later a C-131B aircraft will carry the tracking devices as well as telemetry receiving devices).
Altitude, max. expected, miles . . . 100



Schematic of the ROCKAIRE research rocket.

TABLE NO. 3

COMPARISON TABLE—Vikings 7 and 9, and V-2

Item	Viking 7	Viking 9	V-2 (U.S. adapted)
Length, feet	48.75	42	46.5
Diameter, feet	2.66	3.75	5.42
Payload, pounds	394	825	2500 (average)
Burning time, seconds	72	103	68 (typical)
Time to peak, seconds	266	309	220 (average)
Thrust, pounds	21,080	21,400	56,000
Weight, overall, pounds	10,730	15,005	28,300-29,000
Velocity, mph.	4,000	4,300	3600
Altitude, peak, miles	136	158	132 (Flight TF-1)
Acceleration, g (maximum)	7	8	6.6 (Typical)

TABLE NO. 4

WAC-CORPORAL

	Rocket	Booster
Length, feet	6	5
Diameter, inches	12	12
Weight, loaded, pounds	665	546
Weight, payload, pounds	25	
Altitude, without booster, miles	19	
Altitude, with booster, miles	45	
Velocity, mph.	2,800	1,700
Thrust, pounds	1,500	50,000
Propellants	nitric acid/aniline	solid
Specific impulse, seconds	195	202
Firing time, seconds	45	0.6

Navy ROCKAIRE

Meanwhile, the Navy has been working on a *Rockaire* system for high altitude investigations. Instead of employing *Deacon* rockets, it has taken both the standard 2.75 inch aircraft rocket and the 5 inch HVAR and adapted them so that they could be near-vertically launched from F2H-2 fighters. One cosmic ray instrumented 2.75 inch *Rockaire* soared to a peak altitude of 34 miles. When instrumented, the nose cone is lengthened slightly by half an inch.

ROCKAIRE X113C4 Motor

Thrust ....7,800 lbs.
Burning time ......2.15 secs (60°F)
Total thrust ....15,000 lb-sec
Propellant wt ....70.3 lb.
Specific impulse ....210 sec
Launch weight (inc. 40 lb. p. l.) . . . 181.4 lbs.

2.75 Inch Rocket Data:

Cost $50.00
Length, feet 4
Diameter, inches 2¾
Weight, pounds 18.1
Weight, head, pounds 6.5

Firing Data:

Average firing altitude, miles 5½
Average airplane speed, knots 215
Aver. airplane climb angle, degrees 86
Flight time, minutes 3½
Period above 100,000 feet, seconds . . . 120-140

Possible Experiments:

Cosmic ray
Solar ultra-violet
Atmospheric composition
Temperatures and winds

The ASP Missile

Asp (Atmospheric Sounding Project) is employed in making meteorological, cosmic ray, and geomagnetic experiments in the upper atmosphere. Due to its high velocity it may eventually be used in hypersonic testing.

Contractor Cooper Development Corp.
Powerplant contractor . . . . . . Grand Central Rocket Co.
Cognizant agency . . . Bureau of Ships, U. S. Navy (contract NObs-72000).
Program ....Operation Redwing
Length, overall, feet 144
Diameter, inches 6.5
Span, inches 20
Launching weight, pounds 245
Empty weight, pounds 95
Payload, pounds 25
Summit altitude, miles 40
Burnout velocity, mph. ....3,700-3,900 (depending on launch location).
Firing time, seconds 6
Thrust, average, pounds 5,850
Specific impulse, seconds 211
Impulse to motor weight ratio 162
Initial launch angle, degrees 30
Propellant . . . Solid 201-C (amonium perchlorate-polysulfide, rubber type).
Telemetering head . . . Consist of. a) antenna, b) insulator, c) ogive, d) thermal barrier, e) telemetering and instrumentation mounting structure.
Antenna . . . Quarter wave spike antenna threaded to 91 LD fibreglass.

Asp has been tested at Naval Air Missile Test Center, Pt. Magu, California, and Naval Ordnance Missile Test Facility, White Sands Proving Ground, New Mexico, and is fired from a monorail launcher. It is a single stage rocket with telemetry head, missile body, motor case, and fin and aft skirt assembly.

Wasp

The *Wasp*, *Asp's* small brother, is manufactured by the same company. It is an extremely light-weight vehicle, and is intended for meteorological and other scientific research at moderate altitude. Two boosters are available for use with this vehicle.

TABLE NO. 5

PRIVATE A*

Length, feet	8
Weight, loaded, pounds	500
Weight, payload, pounds	60
Range, miles	> 11
Thrust, pounds	1,000
Thrust, booster, pounds	21,000
Firing time, seconds (sustainer)	30

*Private F was a slightly modified model with trimmers at nose, five foot span.

TABLE NO. 6

RECORD BUMPER FLIGHT

Flight No.	5
Date	Feb. 5, 1949
Loaded weight, pounds	
First stage	28,297
Second stage	621
Velocity, m.p.h.	
First stage	2,615
Second stage	5,150
Altitude, miles	
First stage	63
Second stage	244

TABLE NO. 7

RESEARCH ROCKET FACTS

ROCKET	Approximate NO. FIRED	Maximum ALTITUDE, Miles	DATE, FIRST FIRING
WAC-CORPORAL	10	71	26 September 1945
V-2	< 70	132	15 March 1946 (static firing, No. 1) 16 April 1946 (no. 2)
AEROBEE	< 200	164	24 November 1946 (No. A-4; A-1, 2, 3, were dummy firings) (First Aerobee-Hi; April 1952)
VIKING	13	158	3 May 1949
DEACON	70 <	< 100	21 August 1952

Contractor . . . Cooper Development Corporation.
Configuration . . . Single stage-boosted
Length, overall, feet 8.58
Length, rocket, inches 40
Length, booster, inches 63
Diameter, rocket, inches 1 3/8
Diameter, booster, inches 3
Weight, gross, pounds . . . 24 (Type-1 booster), 29 (Type-2 booster).
Thrust, Type-2 booster, average, pounds 2,000
Velocity, with Type-2 booster, mph. .... > 3400
Total time to peak, with Type-2 booster, seconds 100
Altitude, maximum, miles . . . 21 with Type-1 booster .... 28 with Type-2 booster.
Launching technique . . . Adaptable for ground or shipboard launch.
Propellant ....Solid

Instrumentation for Research

In almost all high altitude research vehicles the problem of obtaining the maximum returns for each flight is becoming increasingly important. The use of large, high-cost military vehicles for this research has been abandoned, and since the newer rockets have limited payloads, instrumentation is becoming a one experiment proposition.

In determining the physical conditions of the upper atmosphere, a multitude of experiments have been conducted. These include studies with mammals and insects, wind at altitude, pressure, density and temperature measurements, upper air sampling, etc. Detection of micrometeorites and solar physics get special attention.

IGY Experiments

The IGY program starts this year. This concentrated effort on a worldwide basis should solve many fundamental problems. The U.S. will fire about 200 rockets, many carrying multiple experiments.

Definitely planned United States IGY experiments include:

Number of rockets to be fired	Experiments
60	Pressure, temperature, and density measurements of the atmosphere.
19	Radio propagation experiments.
115	Aurora measurements in Arctic and Antarctic.
10	Distribution of ozone determinations.
95	Earth's magnetic field measurements at high altitudes.
57	Cosmic ray studies.

TABLE NO. 8
GENERAL AEROBEE FIGURES

Background	Design and Development in 1946
Development	Applied Physics Lab. Johns Hopkins University; Aerojet General Corp.
First contract	U.S. Naval Bureau of Ordnance, May 1946
Later contracts	U.S. Air Force (ARDC), May 1949 U.S. Army, Signal Corps, February 1951
Stabilization	Fixed fins
Chamber cooling	Regenerative
Pressurizing agent	Helium
Booster thrust, Aerobee-Hi, pounds	18.000
Sustainer thrust, Aerobee-Hi, pounds	4,100 (Navy RV-N-13B) 4,000 (AF AJ 10-25)
Vehicle length, inches	283.4 (Navy RV-N-13B) 227 (AF AJ 10-25)
Diameter, inches	15
Dry weight, pounds	269 (Navy RV-N-13B) 300 (AF AJ 10-25)
Launch technique	150 foot tower

TABLE NO. 9
PERFORMANCE OF FIRST AEROBEE FIRING

Date	24 November 1947
Altitude, peak, miles	38
Velocity, maximum, mph.	2,100
Thrust, pounds	2,600
Firing time, seconds	36

TABLE NO. 10
TYPICAL AEROBEE-HI SPECIFICATIONS

Length, feet	23.58
Weight, loaded, pounds	1,482
Weight, empty, pounds	269
Weight, propellants, pounds	1,056
Propellants	Red fuming nitric acid/aniline-furfuryl alcohol
Thrust	4,000*
Booster, thrust, pounds	18,000
Booster firing time, seconds	2.5

*In 1949 the Air Force let a contract to increase the thrust to 4000 pounds.

TABLE NO. 11
RECORD AEROBEE-HI FIGURES

Model number	AGUL-0113C
Firing date	29 June 1956
Thrust, S.L., pounds	4,100
Specific impulse, second	200
Firing time, seconds	50.6
Acceleration, maximum, g	11.1
Velocity, maximum, mph.	4,600
Altitude, maximum, miles	164

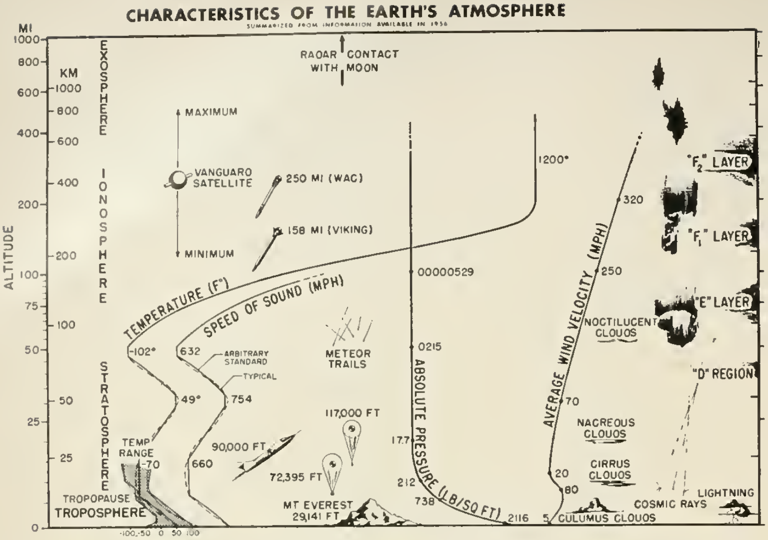
TABLE NO. 12
AIR FORCE AND NAVY AEROBEE-HI ROCKETS*

	Air Force Model	Navy Model
Maximum expected altitude, miles	150	170
Approximate payload, pounds	150	150
Late model designations	RTV-A-1A	RTV-A-10A, B, C

*Signal Corps models are XASR-SC-2.

TABLE NO. 13
NAVY AEROBEE-HI ROCKET FIRINGS

DATE	MODEL NO.	REMARKS
1954	RTV-N-10B	Successful test rocket. 98 miles altitude.
1955 (2 flights)	XRV-N-13	Hot gas pressurization. Improved thrust chamber. More propellants, carried in lighter tanks. Flights unsuccessful.
1956 (3 flights)	RV-N-13-A	Improved and lighter thrust chamber, more propellants, and other improvements. One lost, another reached 117 miles and the third, only 43 miles after thrust chamber failure.
1956 (1 rocket)	RV-N-13B	This used a standard 4,000 pound thrust Aerobee combustion chamber instead of the Aerobee-Hi combustion chamber. Flight NRL-50 reached a peak of 164 miles with a 145 pound payload (an altitude record).



Foreign Research Missiles: Few But Good

Like the United States, many other nations are closely concerned with research in the upper atmosphere. Among the foreign nations to participate in rocket experiments during IGY are: France, Britain, Germany, and Japan, with possibly a small contribution from Australia. Russia's status is not yet clear. It may be that she will carry out her own rocket program independently.

French Rocket Research

The postwar missile efforts of France through the Laboratoire de Recherches Ballistiques Et Aerodynamiques in Vernon have been varied and successful. Of the many fine missiles developed the most notable is the *Veronique*. This missile was developed under the Direction des Etudes et Fabrications d'Armement which is part of the Ministry of National Defense.

VERONIQUE Missile (Model NA)

Cognizant agency . . . Ministry of National Defense.
Length, feet 24
Diameter, feet 1.8
Velocity, mph 3,200
Firing time, seconds 45
Acceleration, g. 8.2
Altitude, maximum, miles 84
Payload, pounds 133
Weight, propellants, pounds 2,160
Weight, loaded, pounds 3,180
Propellants . . . White fuming nitric acid and deisel oil.
Alternate propellant ......Turpentine
Igniting system . . . Hypergolic igniter consisting of furfuryl, alcohol.
Stabilization . . . 4 delta shaped fins
Tank construction ....Steel plate
Telemetering system . . . Transmits 20 measurements proceeding from potentionometric pick-ups.
Carrier frequency, megacycles . . . 152
Spacing of impulses . . . The information signals offer the aspect of uniformly spaced impulses (intervals are 950 seconds, duration 100-750 seconds with a 4 microsecond interruption).
Ground reception . . . The time modulation is converted to an amplitude modulation by 2 different methods.
Improvements being made . . . These include a superior metal for the manufacture of the propellant tanks. Future performance should improve.

ATEF Missile

The Comité d'Action Scientifique de Défense Nationale of France has the following solid propellant ATEF under development.

Configuration . . . Three-stage (small)
Altitude, maximum ....50 miles
Status . . . In development (it is expected that the 50 mile altitude will increase as the model improves).

Japanese Research Rocketry

The Japanese contributions to research rocketry have been thoroughly covered in an article "Japanese Rocket Research," in the October 1956 issue of this journal. *Kappa*-128-J rockets have been fired from Akita Beach during the past year. Other rockets include a *Rockoon* system, the *Baby* series and the Pencil program.

German Rocket Research

It has been reported that the German Association of Rocket Engineers (AFRA) will fire research rockets from a Cuxhaven test base to altitudes of 12 miles during the IGY.

British Rocket Research

The British, who have so far given out very little information on their guided missile programs, have finally released details of their rocket contribution to the IGY program.

Their *Skylark* has been developed under the auspices of the Gassiot Committee, and the Royal Aircraft Establishment. The instrumentation is being devised and experiments conducted by several British universities.

Proving trials were scheduled to start at the end of 1956. If initial trials are sucessful it will be extended into the middle of 1957. First flights are expected at Woomera this spring.

Research programmers . . . Royal Aircraft Establishment & U.K. universities
Cognizant agency . . . Supply Ministry
Length, feet 25
Diameter, inches 17½
Payload, pounds 65
Altitude, miles .....76 (booster 132)
Burning time, seconds 30
Thrust, pounds 11,500
Propellant . . . Solid (Raven motor)
Stabilization ....3 fixed fins
Skylark nose cone, inches 65
Launching . . . . . . From an 80 foot trainable launching tower.
Guidance ....Unguided
Instrumentation . . . Telemetry—Doppler & *Deacon* tracking equipment.
Experiments . . . Possible experiments to be made with these vehicles.

1. Temperature and wind studies at 30 to 100 kilometers using grenades.
2. Winds at altitude from 20 to 70 kilometers by radar tracking of chaff released from the rocket.
3. Sodium vapor experiments, using the sodium emission to be studied by an interferometric method.
4. Day and night airflow experiments.
5. Ion mass spectrometer studies.
6. Electron and ion concentration.
7. Electron densities using radio propagation techniques.
8. Pressure and temperature.

British-Australian ROCKOON

Another program under way in both Britain and Australia is that of balloon launched rockets. These launchings will be similar to the U.S. *Rockoon* project, and will be made during IGY. Balloon launch altitudes of 13 miles have been mentioned. Initial experimental firings will be made about the middle of this year by engineers of the Weapons Research Establishment, Woomera, South Australia. Reports indicate that the vehicle to be used in this balloon/rocket combination is 18 feet long and 10 inches in diameter. Peak altitude predicted is 60 miles. ★

IONS & PHOTONS

Speculating ahead to the days of intergalactic space travel, the popular press in recent weeks has blasted off on flights of fancy about the hardware "now being built" to enable man soon to traverse the void at the unrelativistic speed of 669,600,000,000 miles per hour—i. e., the speed of light.

Aside from shaking at least one learned ion and photon researcher's confidence in the language and the press, these stories have served to compound the misconceptions that prevail among the public.

However, Convair-Astronautics Space Flight Symposium last month should have served to sharpen perspective at least a little bit. In brief, the state of the art of ion and photon propulsion research can be stated thus: theories and paper work bounded by "if's" and "when's." Assuming sources of electric power and ions of compatible weights—yet to be realized—the technology of a nuclear-powered ion rocket is known in principle. In the case of the photonic rocket, the technology is not even known in principle. Work is all theoretical.

For Those Who Don't Know

The basic theories of both systems of propulsion is pretty simple. In the case of the photon, modern theory tends to discredit the simple mechanical wave theory of light, or at least to sharply modify it. The suggestion is that rather than light mechanically distorting a "jelly-like" ether into spherical waves, light is made up of elementary quanta—small indivisible bits—of light energy known as photons. But as mass has energy, so does energy have mass, and the mass of different photons, theory goes, can be considered as varying—with the mass of an infra-red photon, for example, being half that of ultra-violet. Or, looking at it another way, ultra-violet photons have twice the energy of infra-red photons.

An ion, in general terms, is an atomic or molecular system that is mechanically balanced but electrically unbalanced. The metal sodium, for example, has one planetary electron in its outside ring. Mechanically, it "wants" to get rid of this "extra" electron so that the then-outside ring (the one remaining) will have eight. Similarly, a non-metal like chlorine has seven planetary electrons in its outside ring; also wants eight. Transfer sodium's extra electron, and the mechanical wishes of both elements are fulfilled. But they are electrically unbalanced, sodium being positive and chlorine being negative. So they stay together as sodium chloride—common salt.

However, separate them, as when they go into solution or upon the application of energy and the resultant electrically unbalanced particles are ions, both negative and positive. Being charged, they can be accelerated to very high velocities by electrical and magnetic fields. Accelerating suitable ions in this fashion is the basis of the ion rocket. It is something that is already done in the laboratory and with particle accelerators like bevatrons, cyclotrons, etc. The problem in adapting this principle to propulsion is the weight of equipment for producing power and handling all the functions that have to be handled.

The principle of photon propulsion is $E=mc^2$, where E is the energy produced; m, the mass; and c, the speed of light. It is Einstein's basic mass-energy relationship.

Dr. Ernst Stuhlinger of Redstone figures ion propulsion units could be designed to produce exhaust velocities of 100,000 meters per second and with an acceleration of 0.0001 gravities. Obviously such a system would be useful only after escape from nearby gravity fields had been accomplished.

Photon propulsion, however, contemplates conversion of mass with 100 per cent efficiency. Exhaust velocities of 300,000,000 meters per second would be achieved and produce an acceleration of one-to-two gravities. Unfortunately, nobody has a conclusive idea at the moment of how to accomplish mass-to-light conversion.

Comparison of different space propulsion systems.

Propulsion System	*Exhaust Velocity m/sec*	*Acceler. g*	*Power/-Thrust kw/kg*	*Technical Feasibility*
Chemical	3,000	1 to 8	15	Technology proven
Nuclear or Solar Power plus light gas	4,000 to 6,000	.01	20 to 30	Technology known in principle
Nuclear power plus ions	100,000	.0001	500	Technology known in principle
Phototonic	300,000,000	1 to 2	3×10^6	Technology unknown

Space, times and distances of space flight showing differences between ship time and earth time as affected by Einstein's time lengthening principle.

Trip	*Mass Ratio*	*Ship Time*	*Earth Time*	*Distance*
Half around earth	1.00007	47 min.	47 min.	2×10^4 km
Moon	1.0003	3.5 h	3.5 h	4×10^5
Planets	1.006	2 d	2 d	10^8
d Centauri	20	3.6 y	6 y	4×10^{13}
Center of galaxy	10^4	20 y	6×10^4 y	2.8×10^{17}
Andromeda nebula	10^{11}	26 y	2.5×10^6 y	7×10^{18}
Round trip through Universe	10^{19}	42 y	4×10^9 y	3.2×10^{22}

Plastic Balloons in the Rocket Age

. . . the giant offspring of the refrigerator bag helps speed space flight

By Otto C. Winzen

As M/R GOES TO PRESS, three *Rockoon* flights are being made off Guam. Tests are being conducted at the Atomic Energy Commission's Nevada test site 70 miles northwest of Las Vegas to determine the feasibility of using plastic balloons to carry aloft a nuclear device for detonation experiments. The Navy's Projects *Skyhook, Rockoon, Strato-Lab,* and the Air Force's Project *Moby Dick* and its animal cosmic ray flights have contributed much to upper air research.

These operations point up the significant role plastic balloons are playing in space study. The October issue of m/r contained an interesting article by Kurt R. Stehling and Richard Foster discussing how a four million cubic foot plastic balloon could be used to carry to 70,000 feet a solid-propellant three-stage rocket capable of carrying a four-pound payload to the moon.

Stehling, as early as mid-1955, suggested a balloon launching method for small orbital satellites. A 3,000,000 cubic foot plastic balloon would be used to carry the proposed three-stage vehicle weighing 13,500 pounds to 75,000 feet for launching.

Small solid-propellant rockets have been successfully launched from balloons for some time. The idea for balloon launched rockets, using a cluster of balloons, was first shown in a 1947 report to the Navy by the author.

The first balloon-rocket combination was developed by Dr. James A. Van Allen of the University of Iowa's Department of Physics for the Office of Naval Research in 1952, as an inexpensive means of conducting cosmic ray research at altitudes beyond the range of the *Skyhook* balloon itself.

At about the same time the first Aerobee was being developed, the author and his associates had successfully flown the first plastic *Skyhook* balloon (OCW patent 2,526,719) on September 25, 1947. It reached an altitude of 100,000 feet and precipitated the Office of Naval Research Project *Skyhook* program designed to study cosmic rays, temperature and density of the atmosphere, and other high-altitude data.

Van Allen realized that it would be some time before upper-atmosphere research firings of large, expensive rockets could be conducted on the comprehensive world-wide basis necessary for obtaining a wide variety of scientific data. As a consequence, he devised the inexpensive *Rockoon* system with which it has been possible to explore altitudes up to 65 miles with balloon and rocket costing altogether about $1,500.

The current *Rockoon* flights are a preliminary to upper air research to be conducted during the International Geophysical Year. Such launchings are made aboard ship away from inhabited land areas and established air and shipping lanes. *Rockoon* launchings have been made by WRI and General Mills, Inc. for the Office of Naval Research from waters off San Diego, Greenland and Guam.

The 12-foot *Deacon* weighing 184 pounds is one of the rockets which is sent aloft suspended from a 72.3 foot diameter plastic balloon of 150,000 cubic foot volume. The balloon carries the rocket to an altitude of approximately 80,000 feet, where it continues to float until the decision to fire is reached. During the experiments last summer, the USS Colonial served as the launching vessel, the destroyer USS Perkins tracking the balloon with radar. When a decision to fire has been made, the rocket igniter is fired by radio control from the ship.

Used in the *Rockoon* expedition was the 72.3-foot diameter Winzen balloon made of .0015" gage polyethylene plastic film with integrally heat-sealed load bands. There were no balloon failures in 27 launchings of this type. All balloons had reefing sleeves, and weighed an average of 115 pounds.

Suspended from the balloon by a 100-foot nylon line is the *Deacon* rocket. The line terminates in a steel ring on which is hooked the rocket motor. The hook is placed so that the rocket axis is inclined at an angle of 7.5 degrees from the vertical. At the moment the rocket is actuated, the hook slips out of the ring and the rocket shatters the balloon. In the next 90 to 120 seconds, the rocket attains an altitude of 60 to 70 miles above the earth's surface. In its trajectory it telemeters data on the strength of radiations to the observing station aboard ship. The rocket-balloon combination was usually launched during the morning while the ship moved in the direction and at the speed of the wind. It was committed to firing within approximately eight hours of flight time.

The load line of a typical *Rockoon* flight consists of the following instrumentation. First, a safety control instrument designed to release the load in case of balloon failure and/or after a predetermined length of time has elapsed, to insure that the rocket will be jettisoned before drifting out of the control area. Next, there is a radiosonde (400 MC) or a WRI beacon which telemeters continuous altitude data and serves as a DF tracking beacon. Next there is often a series of radar corner reflectors. Finally, there is the rocket with its firing box which allows for a 30-second time delay to permit the electronic rocket instrumentation to reach operating temperature. The *Deacon* rocket is normally covered with a loose plastic envelope to prevent convective cooling during the ascent through the extremely cold tropopause without reducing heating by solar radiation.

When fired from the White Sands Proving Grounds, the *Deacon's* maximum altitude did not exceed 100,000 feet, due primarily to aerodynamic drag in the lower atmosphere. A tremendous boost in altitude is achieved by launching the same rocket using a balloon as the launching platform.

Payloads in the nose cone of the *Deacon* range from 20 to 60 pounds depending upon the maximum altitude desired. If electrical potentials over several hundred volts are to be used, a sealed nose is necessary so that sea-level pressure can be maintained in order to reduce the risk of corona or arc-over at high altitudes.

Following a series of three test flights of fully-instrumented rockets launched at White Sands Proving Ground in June and July 1952, the first real test of the *Rockoon* system was made off Greenland above the Arctic Circle in August 1952 for the purpose of cosmic ray investigation.

Seven successful flights were made during the initial tests, one of which was launched at 57,000 feet and reached an estimated altitude of 295,-000 feet. No significant deviation of the trajectory from the vertical occurred. Since then, rockets have been launched from balloons as high as 90,-000 feet, carrying payloads of 30 pounds into the D-region of the ionosphere and well into the E-region for a vehicle cost of less than $2,000.

Additional cosmic ray flights were conducted off Greenland in 1953, 1954 and 1955. This area was chosen because it is near the geomagnetic pole which competes with the geomagnetic equator (off Guam) as areas of special interest to cosmic ray scientists.

Even higher altitudes may be reached using the *Rockoon* system for launching inexpensive two-stage solid-propellant rockets. The October 1956 issue of m/r disclosed first details of successful flight tests using a combination of a *Nike* missile booster and an Allegany Ballistics Laboratory *Deacon* sustainer as a two-stage rocket called *Dan* for meteorological sounding at extreme altitudes.

Two test firings of the *Dan* rockets indicated that when launched from the ground, altitudes between 385,000 and 487,000 feet may be reached with payloads ranging from 10 to 60 pounds. The complete weight of the *Nike* booster was 1,324 pounds and the *Deacon* 216 pounds, giving a total weight of 1,540 pounds. Plastic balloons are currently available for carrying a *Dan* rocket to an altitude of 70,000 to 90,-000 feet. This would mean that the *Dan* could be fired above 97 per cent of the earth's atmosphere and would reach substantially higher altitudes than when launched from the ground.

In July 1955 Kurt R. Stehling suggested a method for balloon-launching an earth satellite rocket. Even more recently, he has proposed using a giant plastic balloon to carry to 70,000 feet a solid-propellant step-rocket capable of carrying a four-pound payload to the earth's satellite.

Recent progress in the development of heavy-duty plastic balloons cause projects of this type to take on new meaning. It now appears feasible to carry aloft the orbital rocket vehicle Stehling suggests with existing balloon equipment and launching methods.

The 2,000,000 cubic foot WRI balloon would be able to haul a 12,000 pound rocket to an altitude of almost 60,000 feet. The 3,000,000 cubic foot balloon, now also in production, will carry this load to approximately 67,000 feet. The proposed 5,000,000 cubic foot balloon, weighing 2,000 pounds, should reach an altitude of 75,000 feet.

Main advantage of the larger balloons lies in their increased load carrying ability. In one launching method developed for ONR by WRI for Stratolab heavy-duty plastic stratosphere balloons, the aerostat is launched from the bottom of an open pit iron mine. Other launching techniques, including shipboard launchings, are considered practical with heavy loads. More work is necessary in developing cluster balloon launching techniques for greater loads or higher altitude.

The development in 1955 of a balloon construction with integrally heat-sealed load bands enabled the construction of a balloon which would carry heavy loads without placing undue stress upon the plastic balloon film. In the original *Skyhook* plastic balloons, adhesive load tapes were used but the adhesive failed to adhere at low temperature in the stratosphere, made prolonged storage impractical, and such tapes could not be applied uniformly along the meridians. This resulted in balloon failures. The heat-sealed load bands eliminated these difficulties.

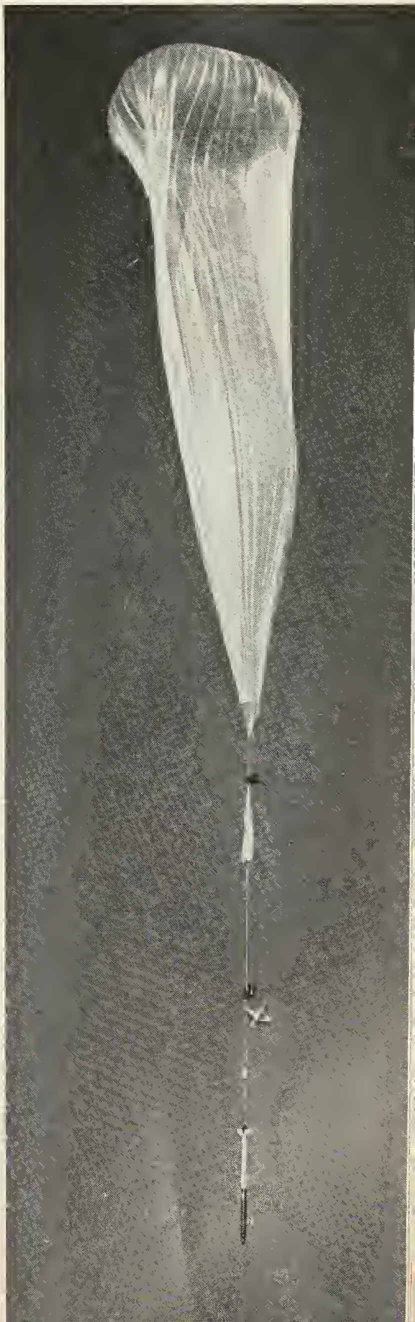
Load bands are available with glass fiber, nylon and fortisan filaments with high breaking strength. They transmit the lift from the fabric to the load along equally-spaced meridians of the balloon. The fabric then serves primarily as a barrier material for the lifting gas and secondarily as a load-carrying member, not as the main load carrying member as in the case of the former rubberized-fabric balloon.

The load-bands of the desired breaking strength are heat-sealed into the seams of the gore material. In the two million cubic foot heavy-load balloon, there are a total of 120 stressed load bands. The balloon shape is determined on the basis of minimum latitudinal stresses for a given fabric, weight and load.

While the balloons discussed here employ two mil gage polyethylene, heavier or stronger materials are available as are load bands of several times the 500-lb. test bands used in the two million cubic foot heavy-load vehicle which has a theoretical bursting strength of 20,000 pounds.

WRI, in addition to other balloon instrumentation, has developed several positioning devices to provide precise firing orientation. These are simple servo systems originally developed with ONR to orient cameras along a given azimuth and elevation for the purpose of astronomical studies from balloons. The plastic stratosphere balloon floating at ceiling altitude represents an extremely stable platform free from oscillation and of very low rotational

Rocket goes aloft by plastic balloon.



velocity. A carefully designed rocket suspension system can therefore be maintained in a known attitude without difficulty. Stability along the vertical axis is not a critical problem.

For the azimuth angle of the rocket, the servo systems developed employ an earth-inductor compass as a reference and the payload is rotated against the inertia-mass of the balloon which is of a very high order of magnitude. Two systems have been designed. One, automatic, in which a rocket could be held in an attitude of a pre-set direction and elevation automatically. Two, controllable, in which the attitude of the rocket could be changed at will from the control center on the ground by radio command.

Both systems will telemeter attitude angles to ground stations. The resolution of such systems can currently be held at least to one degree with closer control possible. The orientation devices are simple since they needn't include gyro-stabilization.

A further extension of the use of balloons in rocket research would be the use of a five million cubic foot balloon to carry aloft research gliders or rocket planes. The weight of present research rocket planes is in the vicinity of 10,000 to 16,000 pounds. The aircraft could be carried to a height as great as 80,000 feet on the five million cubic foot balloon before it is released. Ascent time would be one and a half hours. Cost would be less than the present method of taking research rocket planes aloft by a mother plane. Release altitude would be 40,000 to 50,000 feet higher, and the plane could spend a greater portion of its flight time at high altitudes.

One disadvantage of this system would be the absence of attending personnel such as are present in the mother airplane. This could be remedied by using a gondola which would contain personnel and equipment and power for monitoring the aircraft during the ascent, and assisting in the launching of the rocket aircraft. Assuming a gondola weight of about 2,000 pounds, the launching altitude would be reduced only 3,000 feet using a five million cubic foot balloon.

Round the World Balloons

A recent issue of *Newsweek* suggests that upper atmosphere researchers are considering putting their instruments aboard around-the-world balloons which would be slow-freight companions for the artificial earth satellite. One handicap to tracking the satellite from ground stations presently proposed would be the difficulty in doing so during extended periods of bad weather. A balloon gondola suspended in space with two observers could visually track the satellite by telescopes without having to worry about weather. The capability now exists to maintain such a space laboratory aloft at an altitude of 80,000 feet for a week. It would be hard to imagine a better observation platform for tracking the satellite than such a space station. When aided by the jet stream at the base of the stratosphere, circumnavigation of the earth could be accomplished in 100 hours or less. It would also give *Vanguard* scientists an opportunity to check out their airborne and ground equipment devised for the tracking of the satellite.

Much of the balloon's work is done at lower levels. Its feats of endurance and long distance voyages are nothing short of remarkable as it floats for days over oceans and continents.

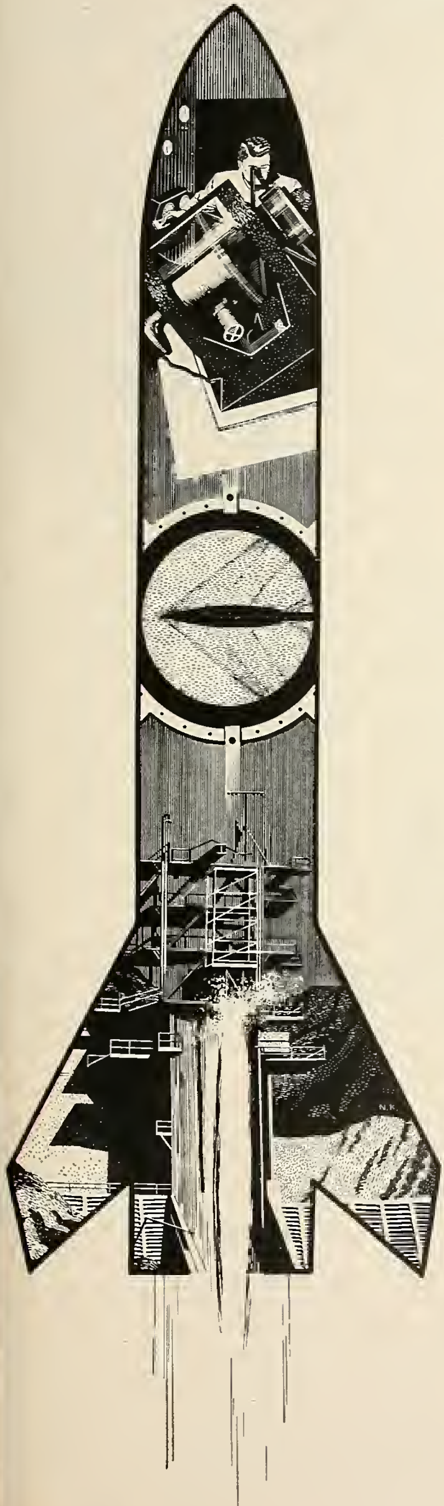
The balloon floating at altitudes currently up to 145,000 feet is a floating laboratory—an ideal observatory as demonstrated by the University of Minnesota—as it hangs motionless with respect to the surrounding atmosphere. In a sense it is a satellite of the earth. It is a stable platform ideal for the execution of research experiments.

So the balloon, man's oldest aerial vehicle, and the rocket, man's newest aerial vehicle, have been linked in discovering the secrets of space. ★

Rocket launching balloon at its peak altitude, as photographed through telescope.

Plastic high-altitude rocket research balloon being inflated at night.

Special 111-conductor Rome cable solves tough guided missile problem



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Astronomer Fred Whipple

. . . wants more basic research by Defense Department

. . . urges start of post-Vanguard projects now

Last month Defense Secretary Wilson abolished the office of Assistant Secretary of Defense for Research and Development and combined its functions under the newly established Assistant Secretary for Engineering and Research. This personal report *emphasizes the growing danger of de-emphasizing basic research in the Defense Department. Astronomer Dr. Fred Whipple is the country's leading upper air researcher. He knows the increasingly close relationship between basic discovery and modern weaponry. He has been a proponent of space flight for many years.*

Q. *Dr. Whipple, you are Chairman of the Upper Air Rocket Research Panel. Is that right?*

A. Yes. I wear several hats. I'm professor of astronomy at Harvard. I'm also Director of the Smithsonian Astrophysical Observatory. My interest is basic research. As you well know, that's the spring that feeds all the rest. If it dries up, we're out of luck.

Q. *Do you feel we're spending enough money on basic research?*

A. It's not so much the amount of money we're spending, but the way it's spent. Many people in basic research cannot or do not plan ahead.

Q. *Do you feel a Czar is needed to coordinate and direct basic research in this country?*

A. You do not need somebody to coordinate or organize basic research. You need enough communication so that the interested scientist knows what others are doing. And you need enough continuing long-range support so that they know what they can do. If you provide communications and continuity of funds, then you don't have to coordinate; you don't need a czar in basic research. This is a critical point, because in development you do, and when you get to hardware you certainly have to have it. But in basic research, freedom is essential.

Q. *Is communication satisfactory the way it is now?*

A. I'm not sure it is for all basic research. It is, for example, in terms of upper air parameters. There, we're dealing entirely with unclassified material. The weakness is in funding procedures. Research contract renewal too often takes place after the end of the previous year's contract. It takes a research man with a lot of persistence to get into this when the funds are so erratic.

Q. *Is this a function of the Congressional method of making appropriations?*

A. Partially, though I think Congress is very appreciative of these problems and has done very well. It is simply that there are a lot of steps in the chain. You can have high level policy; you can have Congress saying "we want basic research done"; you can have the Bureau of the Budget backing them up; you can have top-flight Defense men in each of the services backing them up. But by the time it gets down through the chain of command and the various people, the original intent is lost. Long-range programs, thus, are very difficult to set up.

Q. *Since World War II, haven't we established different organizations—Office of Science Research and Development, National Science Foundation—that are supposed to do precisely this?*

A. Yes, and given time, I think the National Science Foundation will do so. It had very limited backing at the beginning, but it's probably growing now about as fast as it can and still be effective. There is a point I want to make here. I feel more basic research should be conducted within the Defense Department. The policy of removing basic research from Defense which unfortunately still continues is, I feel, basically unsound. The military must make extremely grave decisions in guiding the future of our defense. The instrument of war a decade from now is perhaps still a spark in some scientist's head today. Now these decisions must always be made by administrators essentially in the Defense Department. If they have research scientists in their organizations who also are constantly aware of defense needs, then those men will have good judgment and can advise their administrators wisely. If, however, Defense administrators must go to outside consultants, then they are going to get good judgment in regard to science, but they are probably not going to get good judgment as to its utility as a weapons system. They must have research scientists—and I rather stress this point—must be research scientists within the Defense Department because no scientist who has given up his research and gotten into heavy administrative work can have this judgment any more. I think he loses it very rapidly when he leaves his laboratory and his pure research interests. Now good scientists who work in Defense tend to leave.

Q. *He goes into industry and becomes a project engineer which is heavily administrative. He's good, Because he's good, we lose him.*

A. Right. In Britain, it's said, if a man proves himself a good scientist, they give him three assistants and tell him to go ahead. In America, everybody pats him on the back and gives him three new jobs. I'm afraid there's a little truth to this.

Q. *In this regard, there's another advantage British scientists have, though we might consider it as a disadvantage. They lack money. They can't use the shotgun approach to a problem. They have to think it through first. They say; "There are a hundred possible ways of doing this"—They figure out the best ten and then maybe choose three of them. This is what they did in their atomic power program. It requires a lot of good, clear, careful thinking before you mount a test tube or turn a lathe, so to speak.*

A. This is relevant to the point I made a moment ago about the need for the basic research scientist in the Defense establishment. They can point out those areas that are most likely to succeed. If we have lots of money, we can apply the shotgun technique. The difficulty is that nobody then has the courage to cut off useless, unpromising development. Basic research should be judged by its quality, not by whether it is successful or promising. Development, on the other hand, must be judged as to whether it is successful and promising and you must cut off development when you see you are going down a blind alley. In Basic research you must explore all these alleys because they may turn out not to be blind after all.

Q. *Negative results are answers as well.*

A. That's the point.

Q. *Do you feel defense has a proper appreciation for basic research?*

A. My impression has been since World War II that the group of people most appreciative of basic research in this country, outside the universities, is the military. But there are certain policy matters that get the thing tangled up.

Q. *What do you think the primary function of an organization such as the National Science Foundation should be in the case of basic research?*

A. It should determine the needs and help fund them on a long-term basis. NSF can do this if it is given further backing by Congress so that it can grow to a larger size.

Q. *Do you think it would be a good idea for the Defense Department, say once a year or so, to sponsor basic research symposiums in different fields, such as upper air research, inviting people from industry, universities and the three services to discuss problems and progress?*

A. I certainly think it would. I want to make it clear that quite a bit of my criticisms are broader than upper atmospheric research. I've talked about basic research generally, materials, solid state physics, etc. All are relevant.

Q. *Can you state briefly where knowledge begins and leaves off in upper air research?*

A. First, you must know how much air is up there. We can do very well to something like 100-to-150 miles with sounding rockets. Then the rocket technique essentially fails because the density is too low for the instruments. Also the outgassing of the rocket provides more gas density than the air. You must leave the rocket up there long enough to de-gas, which obviously you can't. Then you have the problem of ionization. This affects communication. Astronomical methods, radio astronomy, reflections from the moon will tell you the total electron content of the entire ionisphere all the way to the moon and back again. The problem of telling the distribution is difficult. Then another area in which we know nothing of these high altitudes concerns magnetic fields. In all these cases we have to turn to the satellite.

Q. *Won't magnetic measurements require a heavier satellite than the Vanguard?*

A. It's hoped that six pounds will do it.

Q. *Would the six pounds provide for continuous readings in flight or would it store the data and play back?*

A. It would probably take periodic measurements and play them back over telemetering stations.

Q. *On returning to earth, at what altitude would the satellite get so hot it ceased to function?*

A. Well, in a nearly circular orbit that is contracting, it will begin to become hot at some 40 miles.

Q. *Can you tell us something of the latest plans for launching satellites during the International Geophysical Year? Aren't we going to launch something like 10 or 12?*

A. That was the original plan, but that has been cut back to six. The optimists say we're going to get most of them up, and on the other hand the pessimists say, well, we might not get any up. I think the expectation of those closest to it is that about two out of six will be successful.

Q. *What's the criterion for success?*

A. That it goes into an orbit with a minimum perigee of 200 miles and an apogee of anywhere from 300 to 1500 miles. In an orbit of this sort, it should stay up for about a year. The program as it's planned now, includes four prime experiments. After at least one or two shots for testing, Number One will carry experiment Number One. If the satellite is successful, satellite Two carries experiment Two. But if One fails, satellite Two will carry experiment One. If that also fails, satellite Three will carry experiment Two. Each experiment gets two chances. Now, of course, that doesn't guarantee that Four gets to fly at all.

Q. *If the Army Ballistic Missile Agency were to come up with another launching vehicle, as they claim they have, is there anything in the nature of IGY to prevent the use of launching methods other than* Vanguard?

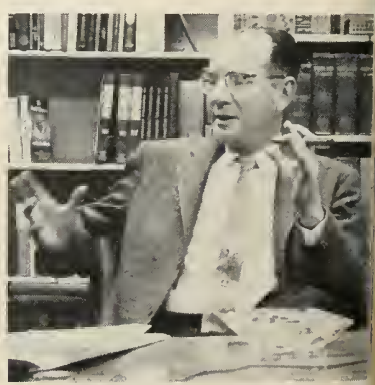
A. I would put it this way. In order to put a satellite in another vehicle, it would have to have different dimensions and would have to be integrated to that vehicle. And it's probably too late now to start any new plans for the period of the IGY.

Q. *What about follow-up satellite plans to continue on where the IGY program leaves off?*

A. Well, they should have been started by now. This illustrates the research planning problem I mentioned earlier. There are a number of people who would like to start working on experiments for satellites. It takes a long

Don't need a czar . . .

In basic research, freedom is essential.



Negative results are also answers.

time to develop those things, and the more time you have the better you do. Two years is not a long period at all.

Q. *In the IGY, you're concerned with tracking the satellite aren't you?*

A. Yes, one of our big projects is the satellite tracking camera.

Q. *How many of these are you going to make?*

A. Twelve—only two to be stationed in this country near White Sands and in Florida. Others will be in the Netherlands Antillies, Peru, Argentina, South Africa and Australia. That's seven. Five will be stationed around the earth between 35 degrees north and south latitude—Hawaii, Japan, India, Iran or Egypt and Southern Spain.

Q. *You're not sending one to Russia?*

A. No, we haven't been invited to send one. But the primary reason is that we're trying to space them in the low latitudes.

Q. *Has there been much liaison with the Soviet Union in this program? Sedov at Rome and Bardin at Barcelona made statements, for example.*

A. That's right. I saw Bardin at Barcelona. They have made no embellishments on these statements whatsoever on an official basis. They indicated they were going to cooperate, but from my knowledge, no official information has come from them concerning the obvious questions you would ask—what, when, where?

Q. *Will any of the satellite experiments be designed to contribute to the basic study of matter, subnuclear particles, for example?*

A. Nearest to it will be the studies by James Van Allen, Iowa State, of cosmic rays, high energy problems. Of course there are those who would like to plan more fundamental experiments, particularly to distinguish between two types of time as suggested by Milne many years ago—astronomical time and nuclear time—to see whether there is a fixed relationship between them as modern physics assumes. Dr. Markowitz at the Naval Observatory has a program on this, carried out with cesium clocks on the one hand and moon clocks on the other. He expects some sort of answer to this by, I believe, 1973.

Q. *Suppose the relationship does vary. Where does that leave us?*

A. Just one step further along the way—one step further into mystery. This is the way science progresses.

Q. *What about Einstein. Will the satellite be used to confirm time lengthening or other Relativity postulates?*

A. Probably not in the IGY satellites, though nearly everyone interested in the field seems to think it might be possible. You have to be able to put an atomic clock in a satellite. Those now in use weigh hundreds of pounds. I've talked to Professor Zacharias at Cambridge about this and he thinks he might get one down on the order of 50-to-60 pounds, including power supply.

Q. *If the satellite stays up a year, would it be possible to confirm the perigee advance?*

A. I think not, because of the amount of interplanetary material as well as what we might call high atmospheric material. This would have too much of an effect on the satellite's orbit for the very small perigee advance to be measured. In order to overcome this uncontrollable margin of error, your satellite would have to be on a pretty grand scale.

Q. *What is the outlook for making visual observations by satellite?*

A. Well, I do not take very seriously these manned satellites as being the proper answer. The next step is a large enough satellite and a small enough power supply, nuclear or solar, that they can be brought together with very moderate weights—100 pounds or so. Then you can put in television. This opens a whole new area of research that cannot be done by the IGY satellite.

Q. *How about a telescope in the satellite?*

A. Well, a 40-inch reflecting Schmidt, though with a somewhat longer focal length than the Palomar Schmidt, would give you all the resolving power of a 200-inch telescope under the atmosphere. Also, you could do tricks with pairs of interferometers. An interferometer on earth is limited to something like 20 feet before the atmospheric scene knocks it out.

Q. *Are there plans for capturing and identifying such things as subnuclear particles?*

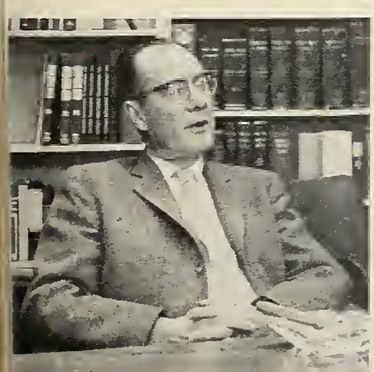
A. Yes, possibly from the sun. I'm extremely interested in micro-meteorites, the fine dust in space. We know very little about this dust in outer space.

Q. *How are you going to study these?*

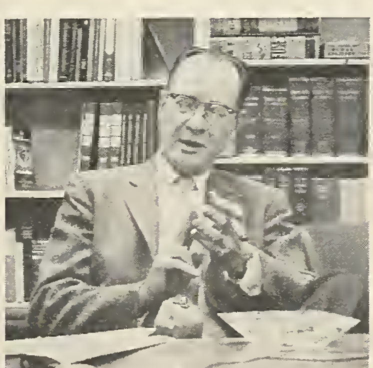
A. Well, some have been brought back on rockets with plastic surfaces.

Q. *Will you have devices on one of the IGY satellites to tell if a particle hits?*

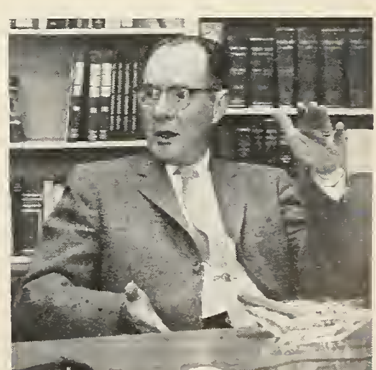
A. Yes, in the first satellite experiment (Naval Research Laboratory) there will be pressurized sections which larger dust particles would puncture. We can record this with telemetering equipment. We will also measure sound. Through a combination of all these I think we will get some answers. ★



We have to turn to the satellite.



A larger satellite . . . smaller power supply.



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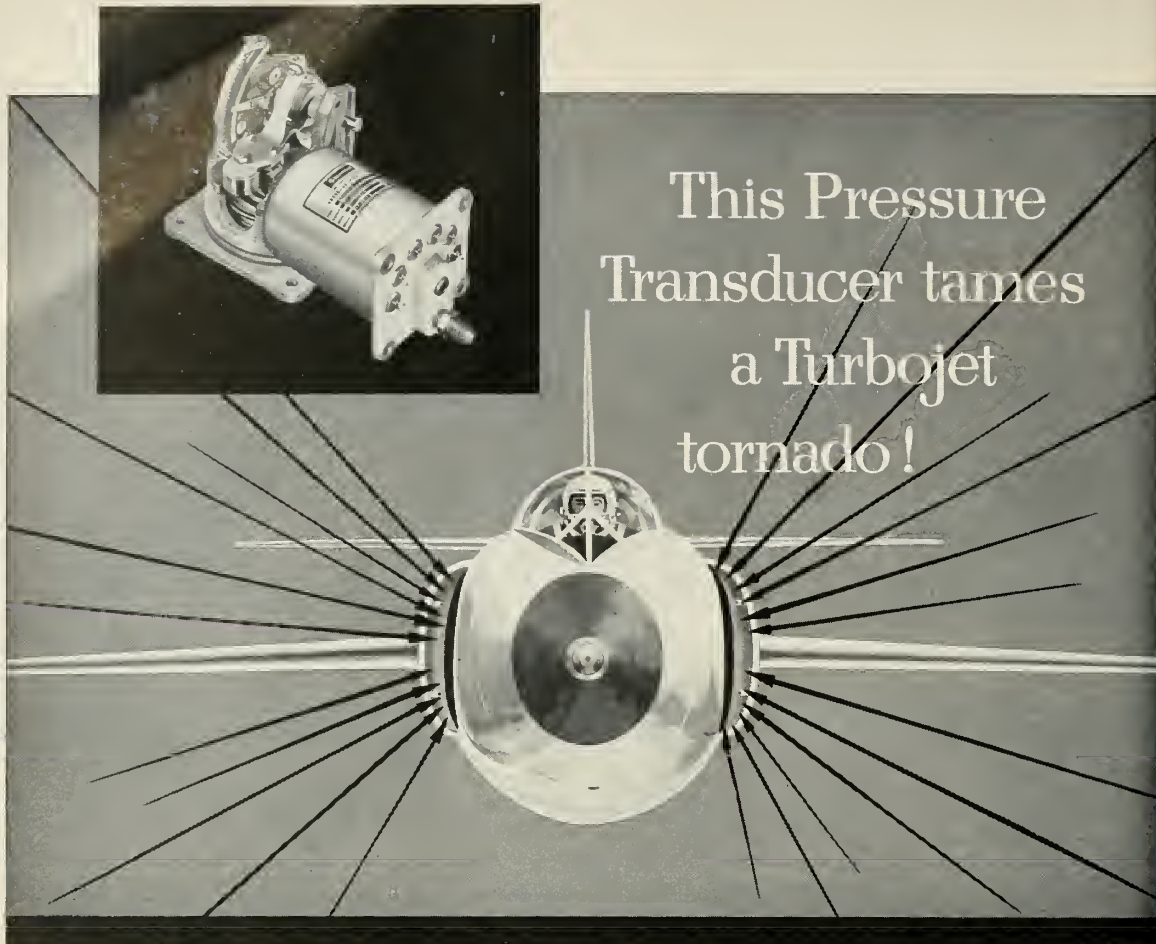
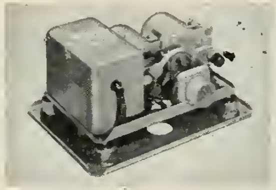


Controlling the tornado of intake air consumed by supersonic jets is the latest assignment of Giannini's High Resolution Pressure Transducer. This versatile instrument plays a key role in maintaining optimum efficiency of today's newest and most advanced high performance turbojet engines.

Two of these transducers form the heart of the Giannini designed and produced Variable Inlet Control System which limits diffuser air to a steady subsonic flow at all speeds and altitudes. Static and total air pressures in the diffuser throat are sensed by absolute and differential versions of the transducer, and this data is transmitted to a computing element. The ratio of pressures is compared to a stable reference, and error signals are fed back to position a variable obstruction, or ramp, in the inlet duct.

By using these unique pressure instruments as sensing elements in the Giannini system, several distinct advantages result: the transducers can be located near the pressure probes, minimizing pneumatic tubing length; no stable amplifier is required since the high level output of the transducer potentiometer pickoffs can be used directly; no repeater servo is required; the system is flexible, control pressure ratio being altered merely by adjusting the reference; the computer can be located remote from the transducers.

The Giannini Variable Inlet Control System is typical of applications to which this instrument can be put. **Capabilities** of 350 volt output, 2000 wire resolution, 0.8% linearity, repeatability to 1% of *reading,* and its rugged insensibility to vibration and shock make it ideal for use in the most critical airborne controls and systems... In case you're not interested in taming a tornado—perhaps it's only a mild breeze—Giannini High Resolution Pressure Transducers are admirably suited for telemetering and control applications requiring the ultimate in accuracy and sensitivity.



Giannini Variable Inlet Control System

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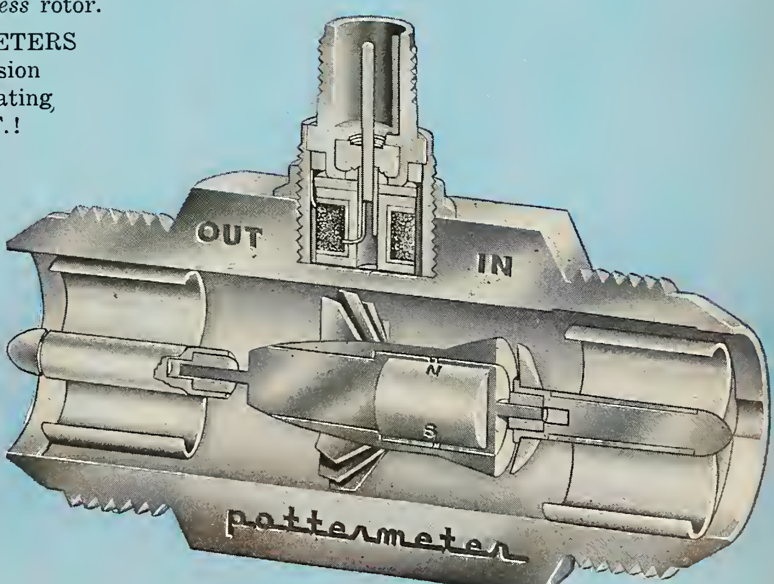

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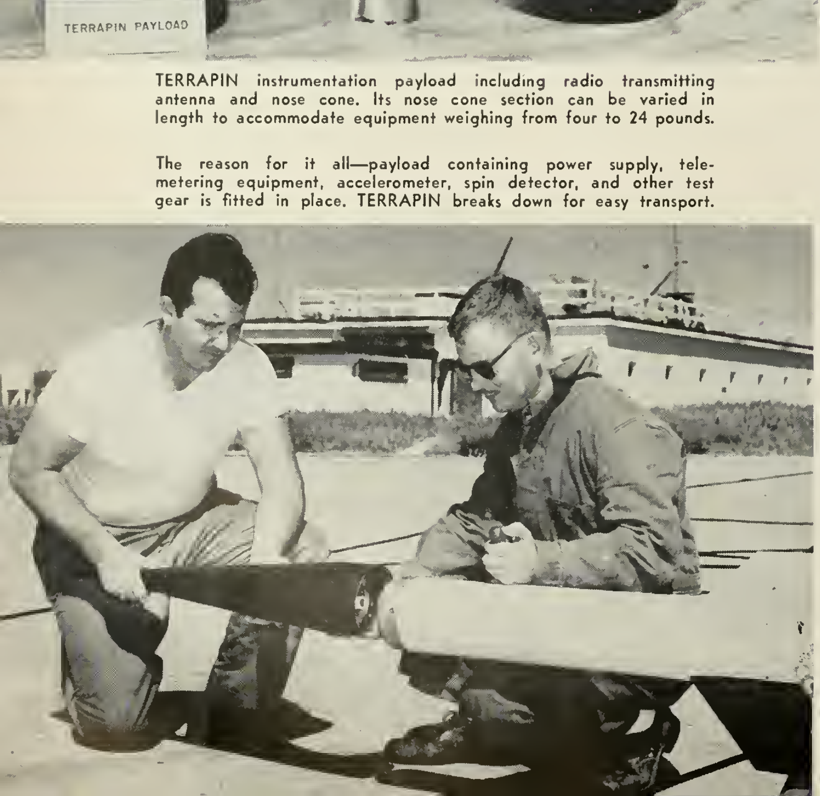
TERRAPIN ---

the do - it - yourself rocket

TERRAPIN instrumentation payload including radio transmitting antenna and nose cone. Its nose cone section can be varied in length to accommodate equipment weighing from four to 24 pounds.

The reason for it all—payload containing power supply, telemetering equipment, accelerometer, spin detector, and other test gear is fitted in place. TERRAPIN breaks down for easy transport.



By Professor S. F. Singer

Physics Department
University of Maryland

THE BASIC FUNCTION of a University is teaching, and the justification for research at a university is that it is the best method for teaching advanced work. At the present time, when there is a great demand for trained scientists in the field of rocket technology, telemetering techniques, upper atmosphere physics to name just a few, there is a woeful lack of facilities for training such personnel.

It is of greatest importance from a national point of view, as Captain Grayson Merrill has pointed out, to establish such training for qualified young engineers and physicists at academic institutions of higher learning.

One of the best means of carrying on a graduate teaching program in these fields is through the medium of high-altitude research with small rockets. This work embodies all of the technological phases, such as rocket propulsion, aerodynamics, telemctering techniquies, electronic instrumentation and in addition, it provides an opportunity for research in upper atmosphere physics, cosmic rays and othe extra-terrestrial radiations. These field of research have basic significance fo geophysics, astrophysics, and in gen eral, give us a better understanding o the environment of the earth. This re search will gain considerably in prac tical importance as means are devel oped for projecting vehicles into th space around the earth.

2.75-in. FFAR costs $50

A number of universities are nov involved in high altitude rocket re search: Colorado, Iowa, Michigan Utah, to name just a few. Here at th University of Maryland we are doin high altitude research by concentratin on the small research rocket, with em phasis on the word "small." We starte out by undertaking the development o an aircraft launched sounding rocket the little 2.75 inch FFAR which weigh only about 15 pounds and costs $50

Our first task was to squeeze int its tiny warhead, a few cubic inches: cosmic ray counter, high voltage sup ply, premodulator circuits, 403 m transmitter, and of course batteries t drive the instrumentation. Through co

Attaching TERRAPIN'S second-stage rocket engine assembly to second-stage fin section. Left to right: Republic Guided Missiles Div. Project Engineer MORRIS ROTH, NACA's GEORGE CUTTER, and SIDNEY HELFMAN, Republic's Aerodynamics Div. Chief.

Attaching firing box before raising TERRAPIN on its zero-length launcher are ROY HINDLE and EDWARD MATHEWS of NACA. First firings of the TERRAPIN were conducted jointly by representatives of Republic Aviation, NACA and Maryland University.

operation with the Office of Naval Research we arranged for 5 test firings and although reasonably successful, it soon became apparent that dependence on an aircraft is not very satisfactory for a university operation. We needed a do-it-yourself, or rather launch-it-yourself vehicle.

We therefore concentrated next on a two-stage ground-launched rocket following a general scheme pioneered by the NACA, but again on a much smaller scale. In collaboration with Republic Aviation we designed the *Ter-rapin* high altitude sounding rocket, a 200 pound midget, consisting of a modified ABL *Deacon* first stage and a *Thiokol* T-55 second stage. This rocket with some slight modifications is capable of carrying 25 pounds some 80 miles into the ionosphere and is becoming our work-horse for upper atmosphere experiments.

Initial instrumentation on the *Terrapin* was concerned as much with sending back readings on the rocket itself as it was with sending back readings on the upper atmosphere. This was necessary to check the performance of the vehicle itself, since being a new configuration, it had never been fired before.

Ease of Handling, Launching

The great advantage of the small rocket is its ease of handling and launching. In the case of the ground-launched rocket vehicle, where the dispersion is low and range safety requirements can easily be satisfied, it becomes possible to conduct firings from the continental U. S. We have made several firings now from the eastern shore of Maryland, only a couple hours drive from our laboratory. We look forward to the day when 2 or 3 of us can simply leave in the morning with half a dozen instrumented rocket heads in our little stationwagon (which also serves as the telemetering receiving station), arrive on the proving ground, set up the launcher in a matter of a few minutes, put up the rockets and fire one instrumented head after another, collect our data, and drive home again after a good day's work. Things are almost at that stage now, and with further experience, rocket experiments may become so simple that they will not interfere with the other duties of a university graduate student.

We are now in the beginning stages of a small-rocket upper atmosphere program, which will investigate many important high altitude phenomena; cosmic rays, solar radiation, micrometers, the earth's magnetic field, the day airglow and night airglow, the aurora, magnetic storms and others.

From this work master's and Ph.D. theses are beginning to flow. Typical publications by students include: "The design of an FM/AM transistorized telemetering system"; "The design of heat sinks for rocket telemetering instrumentation"; "Radiation equilibrium and temperatures of earth satellites."

Upper air research at a university often leads to basic progress in sounding rocket technology. For example, we have looked into a method of theoretically optimizing the design of a two-

It takes only three men to raise the completely assembled TERRAPIN into firing position. Pins in the launcher platform can be set into the earth to supplement the sand bags in holding the launcher firm. Pictures were taken during first TERRAPIN tests.

2.75-in. FFAR research payload. It takes some real doing to cram so much gear in so little space.

Though TERRAPIN was designed specifically as a research rocket, and FFAR is converted weapon, the latter is still a good research tool for Universities. And it costs only $50. Its disadvantage, however, is that it must be aerially launched.

stage rocket in the presence of atmospheric drag. This theoretical work has paid off in terms of a new design to project a five pound payload to over 1,000,000 feet, the vehicle as a whole weighing only 75 pounds.

When this vehicle is finally built we hope that it will be a truly low-cost University research rocket, one that will be simple and flexible enough to fit in comfortably with our unelaborate transportation and launching facilities. It must be kept in mind universities cannot justify the time and expense of setting up and maintaining a full scale test-missile launching base.

The simpler rocket scheme, however, makes the instrumentation job more difficult in terms of weight and space, but this emphasis has its advantages. It forces our students to consider the important aspects of an experiment and the telemetering instrumentation, and it forces us to compress the essential circuitry into the minimum space with the minimum weight.

We are approaching the day when the small rocket will be a commonplace research tool, as commonplace and (perhaps) even more useful than the rubber balloon which has been used in previous years to investigate the stratosphere. For the leaders of this research we must look to the men who are now receiving their training in this field as university students. ★

TERRAPIN in its launcher and ready to go. A major design objective was to cut preflight assembly and preparation time to a minimum.

TERRAPIN, named for the slow-moving turtle, streaks skyward at 3,800 mph and telemeters back research data during its 80-mile trip.

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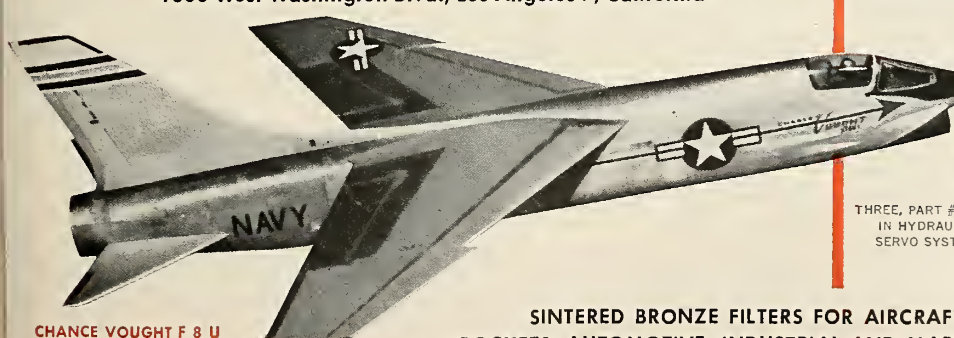

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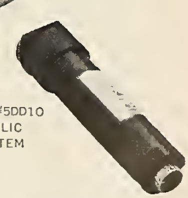

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Circle No. 5 on Subscriber Service Card.

Scientific Methods Replace "Fire-Fighting" Approach

By Henry P. Steier

MISSILE MANAGEMENT from design to combat use may some lay be as scientific as mathematics.

Based on a numerical evaluation of certain missile program factors it is predicted this new science could do much to improve missile weapons system effectiveness.

These factors, according to E. H. Bender, Office of the Assistant Secretary of Defense (Engineering), Guided Missile Directorate, are: producibility, operability, reliability, maintainability, and performance capability.

In a talk before the recent National Symposium on Reliability and Quality Control in Electronics, Bender said best missile program management requires a trade-off of the relative values of these "abilities" during design, development, production and field test.

The derivation of measurement techniques for assigning numerical values to the abilities appears to be within reach but requires much improvement and refinement, Bender declared.

When they are available in the future, worthwhile savings in time, material, manpower and money are expected. End result would be earlier delivery of more effective guided missile systems to the armed forces.

The "fire fighting" approach used today to complete a missile system uses pronounced overlaps between program phases. Overlap occurs when design, development and prototype construction, etc. are done concurrently.

It is the aim of studies underway by OASD to remove the overlap and to save time through the development of a more scientific approach by optimization of the controllable abilities.

Thus far work by OASD has shown reliability to be the area which could yield the greatest improvement in weapon system effectiveness. This is because of the existing low reliability level and high cost per missile.

For its purpose, OASD defined reliability as the inherent ability of electrical, electronic, and mechanical equipment is a weapon system to produce the planned operational effect while operated by military personnel.

When it undertook its missile management improvement program OASD set these goals for its work in the reliability area:

- Reduction in development time without telescoping of phases, or crash programs.
- Improved reliability level with reduction of workload on facilities and manpower.
- Reduced weapons system and evaluation costs.

Ground rules for the approach to these goals were based on five "convictions." The convictions established the questions and problem areas to which various groups of an adhoc committee were to direct their studies.

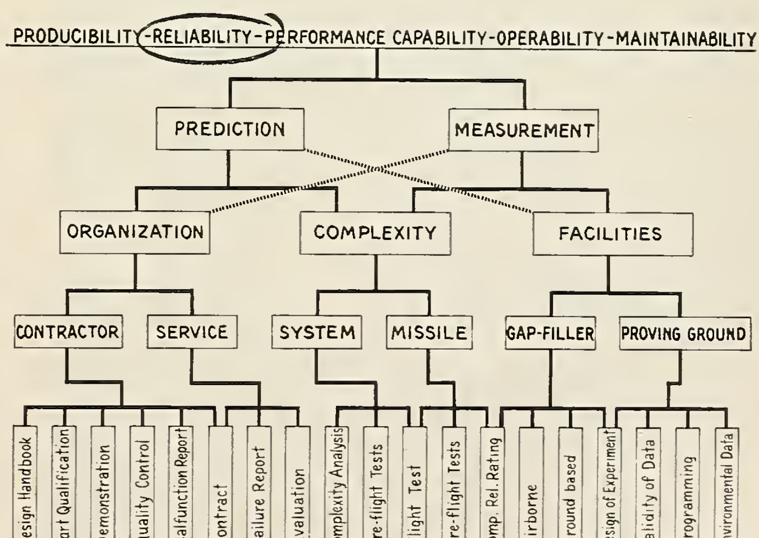
First, OASD believed reliability could be improved. Some people are pessimistic to the extent that they hold unreliability is a necessary evil. OASD reached its conclusion based on maturation of new techniques and observation of progress in other areas.

It is believed reliability should be a design parameter and should be specified and designed into equipment just as performance parameters are.

Accurate methods of predicting equipment reliability are needed and can be obtained. When they are, realistic procurement specifications can be written, and realistic weapons use planned. The basis for this prediction would be relationship between design, operating environment and reliability.

The committee felt shortened test cycles and improved validity and accuracy of information would accrue from scientific experimental design techniques. This would come mainly from use of simulators, high speed test tracks, flying test platforms, and restrained firings. These "gap fillers" would reduce missile test flight limitations imposed by cost and proving ground time available.

Lastly, the committee was convinced that present equipment specifications do not insure a satisfactory level of reliability over the intended service life of the missile system. Although accuracy and lethality are specified in almost all missile system contracts, these parameters are often demonstrated and then accepted on the basis of limited data based on impact or distance of burst from the targets.



Earlier delivery of more effective guided missile systems is expected if the "abilities" shown could be handled on a numerical measurement basis. Shown are relationships of factors under study by Defense Department to aid in developing reliability as such a management science.

Other system parameters may have been varied from realistic tactical conditions.

To establish recognition of individual problems among the different abilities under study, objectives were delineated and a problem structure organized as shown on preceding page.

Beginning with "prediction" and "measurement" in the case of reliability, OASD's initial effort was to move from an empirical measurement to an analytical prediction technique.

An area feeding into this prediction technique is "complexity." Initially the committee looked into the complexity versus reliability area. For this a working group used nine representative guided missile projects to get examples.

Examples needed were: methods of operation used in the three services; three main classes of missiles, air-to-air, surface-to-surface, surface-to-air; various stages of development and production for missile program maturity.

Also, key mechanical elements covering functional items such as hydraulic, propulsion and movable surfaces were tabulated.

From these data an evaluation of in-flight missile reliability versus electronic complexity was made. It showed a decrease in reliability with an increase in number of electronic parts.

Although the data showed a missile with 200 electronic parts has a reliability of about 83 percent against about 75 percent for one with 3,000 parts, this may actually represent a measure of missile program maturity rather than reliability, Bender said.

On mechanical complexity versus reliability, the OASD group has been unable to correlate complexity with missile program growth or missile environment. This may be because mechanical designs are more reliable or mechanical failures are easier to isolate and correct before flight.

Research in these matters is new and the committee is continuing its data collection work. Already, however, some benefits have come from the work. Bender reported that several large missile makers have reviewed and reorganized their reliability programs as a result of these findings.

Full publication of a consolidated report on findings of the Department of Defense Advisory Group on Reliability of Electronic Equipment is expected early in 1957.

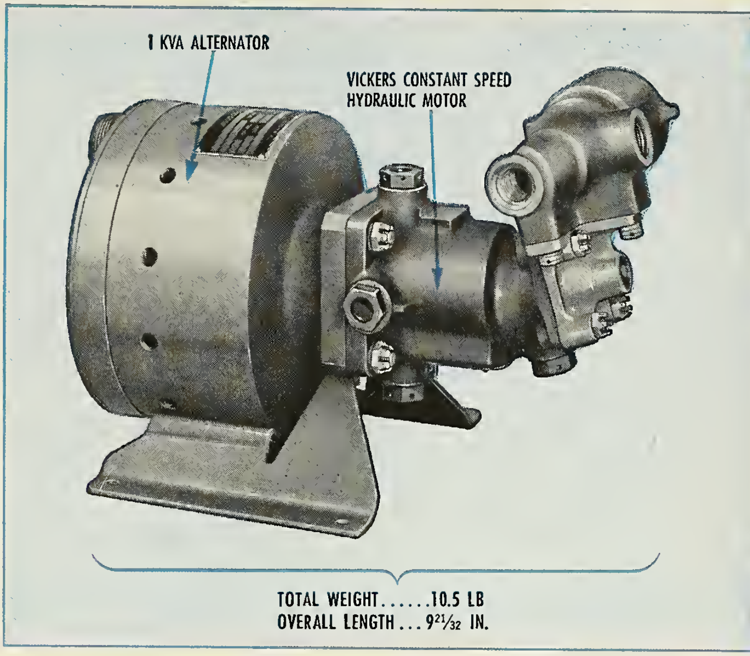
According to J. M. Bridges, Director of Electronics, OASD (Eng publication of this report will represent the most complete and valuable analysis of the major phases of a reliability program ever compiled.

This should provide a basis for numerical analysis and control of reliability from design to delivery.

New Vickers Airborne Electrical Power Package

. . . Saves Weight and Space

Utilizes the Hydraulic System for More Efficient Production of AC Power



This new isolated electrical power package provides closely regulated AC power with minimum weight and envelope while drawing its power from a hydraulic system. In new designs or when adding electronic equipment to aircraft designs in which the electrical system is already loaded to capacity, this versatile package provides the needed AC power from flow available in the hydraulic system. This generally is permissible without system change as the full flow is seldom demanded except for a few seconds under rare circumstances. Even in such cases, full flow can be guaranteed to these hydraulic functions through the use of a simple priority valve which starves the AC power package momentarily.

Less Weight and More Efficient

Important weight savings are achieved through the use of this package instead of an inverter which may also require an increase in the DC generator and line capacities. In one instance, the 10.5 lb 1 kva package replaced a 38 lb inverter for co-pilot instrumentation. An additional advantage is that the package has 62% overall efficiency while that of the inverter was 35-40%.

Extreme altitude operation is no problem as the Vickers isolated electrical power package contains no brushes or other altitude-sensitive components.

Features of AC Generator

The permanent magnet type AC generator has excellent life and reliability. It requires no bulky voltage regulator . . . is inherently smaller and lighter than conventional generators due to the elimination of the exciter and slip rings. It also has higher overall efficiency resulting from elimination of all excitation losses. Additional advantages are that the permanent magnet is unaffected by momentary short circuit, or separation of field and armature without keeper, or by temperature cycling. It is also not susceptible to aging or shock. This unit is 120/208 volt, three phase, wye connected with 400 cps at 8000 rpm. It is capable of continuous duty under environments of 0-55,000 feet altitude and ambient temperatures from −65 F to 250 F.

Hydraulic Motor Drive

The generator is directly driven by a Vickers Constant Speed Hydraulic Motor having fixed stroke and an integral flow control valve that maintains an 8000 rpm speed setting within ±2½% regardless of the load (as long as valve inlet pressure is greater than load requirement). For the unit shown above, maximum operating pressure is 3000 psi while rated output of 1 kva requires operating pressure of 2200 psi. Special configurations will maintain 400 cps frequency within ±0.1% regardless of load. This motor has a very high horsepower-weight ratio and its overall efficiency exceeds 92%. It is a time-proved design capable of many hundreds of hours of continuous service without attention.

Many Uses and Sizes

The applications for this isolated power source are numerous. For multi-engine aircraft, its use for co-pilot instruments provides dual reliability. This package has been used to supply controlled frequency AC power in emergencies when the only source of power in the airplane is a ram air turbine driven pump. The efficiency of this arrangement minimizes the size and weight of the ram air turbine necessary to provide emergency hydraulic and electric power. 7492

Now available in the sizes listed below, larger packages can also be supplied from existing components. Vickers is prepared to develop the package best suited to a specific need. For further information, write for bulletin A-5213 or get in touch with your nearest Vickers Aircraft Application Engineer.

Vickers Airborne Electrical Power Packages

kva output	weight, pounds
0.5	7.0
1.0	10.5
1.5	12.5
2.0	15
2.5	17
3.0	19

Larger capacities with minimum weight are available.

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Circle No. 7 on Subscriber Service Card.

Air Associates Renamed; Builds *Vanguard* Control Timing Computer

Air Associates, Inc. of Teterboro, N. J. has been reorganized under the new corporate name of Electronic Communications, Inc. and will shift its headquarters to a 75-acre site near St. Petersburg, Fla. later this year.

The name Air Associates will be retained, but only as the identity of an aviation supply division of ECI.

President Frank W. Godsey, Jr. said the new corporate name will reflect a redirection of the company's aims. As part of this program, Dr. Donald D. King, formerly of Johns Hopkins Radiation Laboratory has joined ECI and will head a new laboratory being built in Baltimore.

Dr. King and staff will direct their efforts toward electronic countermeasures research, fire control system studies, infrared work and related military electronics research of an advanced development nature.

The new emphasis on electronics is an outgrowth of past Air Associates activities at Orange, N. J., including the Navy *Vanguard* satellite pilot-computer, a device to be used for injecting the *Vanguard* into its orbit.

GODSEY

Electronics Communications, Inc. builds the coasting-time computer that will control timing of *Vanguard's* second stage jettisoning and ignition of the third stage.

The first computer will be delivered to the Martin Company in March and additional units will follow in line with the launching schedule.

Task of the computer is to gather flight data up through the second stage rocket's thrust period. From these data the device will compute correct coasting time between the end of this period and the operations which follow it.

Astrionics

By Henry P. Steier

Today has been called the "solid-state electronics era." In this issue of m/r Frederick Ordway notes what can be done with small research rockets. He says, "Today it is amazing what can be done with relatively low payloads of 25-50 pounds." It can also be said that the major portion of research rocket capability would not be where it is without the new science of—solid-state electronics.

The great amount of information today's rocketeer gets out of a very small instrumented rocket can be credited to the circuit engineer's early cognizance of the electric, magnetic and photic properties inherent in the new tiny, lightweight, low power consuming offspring of solid-state physics now taking the field. From talks and boosted attendance at the 1957 Transistor and Solid State Circuits Conference in Philadelphia last month came strong indication of early application.

Not so long ago the low input impedance and low voltage breakdown of semi-conductors was a real application hurdle. Engineers are finding a way out though. Now RCA has a bootstrapped collector emitter follower circuit that gives a 105-volt sweep generator signal. The follower has an unheard-of input impedance of 100 megohms. General Electric is using multi-holed ferrite core "transfluxors" as a means of digital to analog conversion. They are used as a combined memory ac gate and can be obtained from RCA at 50¢ each.

A counting circuit by Bell Telephone Labs. uses a ferroelectric capacitor that acts as a battery and switch in series. Depending on the capacitor charge the switch opens and closes. Two of the ferroelectrics in a particular circuit can simulate a "ladle and bucket" effect so that a count is not transferred until the second ferroelectric gets a given number of pulses. The device uses a barium titanate crystal and is in limited production by Hershel Chemical Co., Cleveland, Ohio. The IRE Professional Group on Circuit Theory proceedings covering the conference ought to give circuit engineers a lot for the money.

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Western U.S. users of National Bureau of Standards for obtaining a calibration service of their instruments against national standards will get much better service in 1957. NBS is building a $2 million center at Boulder, Colo. to perform calibrations on instruments and components ranging from direct current to 40 kmc devices. Eventually a calibration service up to 100 kmc will be added.

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Latest contribution to research missile data acquisition is RCA's AN/FPS-16 instrumentation radar. Availability of production units of the new system in December 1957 should improve instrumental accuracy by a factor of ten over available units and permit immediate reduction of data without manual operations or film processing. Space-time data will be obtained as direct digital read-out and be as good as, or better than, theodolite data. The FPS-16 is third of a series of radars for missile work by RCA. Others were the Bumblebee radar developed jointly by Johns Hopkins Lab. and RCA, and the Terrier radar for Army use of the Navy *Terrier* missile. RCA's prototype of the AN/FPS-16, the XN-2 will track *Vanguard* when it takes off.

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FIRST IN RAMJETS

Aerophysics

By Seabrook Hull

Confusion over what the Army's IRBM *Jupiter* did or did not do on firing day, March 1, at Patrick AFB may be explained by the fact that two were fired. Three missiles were supposed to have been tested. One is reported to have been a Northrop *Snark*. From a reliable source this column hears that the other two were *Jupiters*—that one left the atmosphere and was 60-to-70% successful before malfunctioning near the end of its firing period, that the other apparently tipped off course and had to be exploded not far from Delray, Fla., about 40 miles from Patrick. Neither was carrying operational guidance gear. In any case, members of ABMA's Redstone Arsenal team are highly gratified with the results and are busy readying the next *Jupiter* for test.

The ability to study the thermodynamics of hypersonic flow has received a terrific boost with the announcement of Dr. Gabriel Giannini's 10,000°K plasma jet and GE's MOSD's water stabilized arc that has officially achieved temperatures of 14,000°K and a heat transfer rate of 2000 BTU per square foot per second. Unofficially, this device is credited with a heat transfer rate of 6000 BTU. These rates exceed by wide margins ICBM requirements.

•

Dr. Edward Van Driest, NAA, participating in the space flight symposium emphasized the importance of design to reentry, whether by a satellite, space vehicle or ICBM warhead. The heat transfer rate through a turbulent boundary layer exceeds that through laminar flow by a factor of 10. Significantly, the advent of turbulent flow is delayed by cooling the nose cone. Van Driest also reported that boundary layer sensitivity to surface roughness apparently decreased with increasing Mach number.

In this same field, Dr. Fred Riddell, AVCO Research Laboratory, noted that in checking heat transfer theory against actual shock tube experiments, agreement between the two was good. He suggested that proper design precautions might enable the *Vanguard* satellite to survive reentry intact.

At Washington, D. C. Dr. J. H. Doolittle, Chairman of the National Committee for Aeronautics announced that NACA research rockets have "attained somewhat higher speeds" than the Mach 10.4 (6800 mph) revealed at last Fall's Langley Laboratory inspection. These new tests have, in fact, achieved 8000 mph. NACA is in the process of developing rocket techniques for in-flight study at between Mach 20 and Mach 30—up to 20,000 mph.

NACA this year is asking Congress for $41.5 million for new research facilities, 50% of which will be for hypersonic study equipment, including a hypersonic physics test plant to cost nearly $2 million.

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An uniquely designed gyro-compass capable of rotational speeds up to 30,000 rpm utilizes a single airbearing instead of the six conventional ball bearings, detailed in Commerce Department's Office of Technical Service's report number PB 121405 translated from a 1954 German paper on Water and Air Bearings with Pressure Lubrication.

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The area of contribution of the Vanguard Satellite during IGY will be confirmation and expansion of data from altitudes between 30 and 150 miles and the supply of entirely new data from 150 miles to possibly 1,500 miles.

International Scene

By Anthony Vandyk

The British Army's first guided-missile regiment is being formed this month at Aldershot, the nation's traditional military base. Equipment for the new unit is the *Corporal* which is being procured in the U.S. Since the U.S. is not allowed to sell fission of fusion warheads nor to release any information about their design, the *Corporals* will be supplied to Britain without a warhead.

The next phase in the development of France's Trident fighter will be the elimination of the pilot. Remote control will be used to bring the pilotless rocket-powered aircraft back to base after it has launched its missile. The final stage in the "missilization" of the Trident is likely to be the transformation of the model into a VTO vehicle. The project is now being conducted by Sud Aviation which has been established to take over the operations of Ouest Aviation and Sud-Est Aviation. The Trident was developed by Ouest Aviation.

Cooperation between the British and French industries in the missile field is likely to increase very markedly. The French missile range in the Sahara desert could be made available to the British industry thereby cutting down the need for sending guided weapons all the way to Woomera in Australia for testing. Britain's coastal facilities are inadequate for all but the most elementary short-range launchings.

The Japanese government has requested the U.S. to supply seven types of missile: *Honest John, Nike, Terrier, Sparrow, Bomarc, Talos* and *Falcon.* It has not been made clear which of these guided weapons will in fact be supplied although the Department of Defense has agreed to let the Japanese have "certain unclassified equipment" including guided missiles for R&D purposes.

It's no secret that Sweden's only airframe manufacturer, Svenska Aeroplan AB, is very active in the missile field. It was recently disclosed that SAAB has been working on missiles since 1946 when the design of an "air torpedo" for the Swedish navy and the government's Board of Inventions was started. Another Swedish company, STAL, was also involved in this project which had its share of initial teething troubles. The first completely successful firing finally took place on June 3, 1947 at the Karlsborg experimental station on Lake Vaettern. The missile used a pulsejet engine developed by STAL.

There is high hope in Britain for the de Havilland heat-homing AAM which has been developed in conjunction with the Mullard electronics company. *The Economist* says: "After a period during which it was as easily distracted as a puppy, it has now grown into a well disciplined and reliable hunter." The British paper contends that the de Havilland missile "has an edge over its American counterparts."

Main contenders for French AAM production contracts are Matra and SNCA du Nord. The former company's position has been strengthened by the conclusion of an agreement of cooperation with the Floirat group which includes Breguet and RBV-RI. Breguet is a major airframe manufacturer while RBV-RI is an important electronics company. Both are headed by one of the most dynamic men in French aviation—Henri Ziegler, a former president of Air France.

That old bogey security is impeding European companies in their efforts to determine the market for their missiles. The British industry is able to furnish virtually no information to its NATO allies and to members of the British Commonwealth. The success of the British industry in the export market since WW II has been largely due to foreign sales of military models—mainly fighters. Unless the missile can take the place of the fighter, Britain's exports will suffer.

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Bristol Super Ramjet Makes Good

THE STORY OF the troubles and triumphs of the Bristol Aeroplane Company in evolving ramjet test vehicles has been released by the British manufacturer. To date Bristol has produced well over 200 *Thor* ramjet-powered test vehicles. They are rocket-boosted from standstill to speeds of over 1,000 mph in a few seconds during which time the *Thor* must light up and attain full power from a cold start. In this respect 100% reliability has been achieved.

The requirement was for a test vehicle with the following qualifications:

1—The ramjet was to be of flexible layout so that ready alterations could be made to the entry, burner, and to the tailpipe.

2—The telemetry transmitter had to be housed away from the ramjets where it would not be affected by vibration. The telemetry equipment had to be easily accessible.

3—Adequate space was to be allowed for installation of various fuel control systems for flight test.

4—It was important that the diameter of the ramjet did not exceed the maximum which could be bench tested over a wide altitude range.

These requirements were met by using twin 6-in. ramjets mounted outboard on each side of a center body in which the telemetry, fuel tank, fuel control and expulsion system were housed.

Fuel supply to the ramjets was effected by compressed air and controlled at a constant pressure by an air blast valve and a fuel pressure valve. The fuel was stored in a flexible bag situated in the tank forming the nose of the vehicle, and compressed air released from a pressure bottle in the front section of the center body, forced the fuel out of the bag along feed lines to the combustion chamber fuel jets.

Bristol fitted damping plates to the ramjets in one of its experimental test vehicles to raise the critical flutter speed well beyond that encountered in current operating range.

To accelerate the test vehicle up to the speed at which the ramjet engines begin to function, a cluster of cordite boost motors was used. One of the first problems which had to be faced was the separation of the exhausted boost motors from the vehicle without upsetting its flight path.

The first test vehicles had dummy ramjets and were fired to investigate the structure, stability and boost separation mechanism. Initial tests showed flutter and later, at Mach 1, instability which resulted in structural failure. Structural modifications were undertaken and a stable configuration was achieved. During these tests flight times had to be curtailed to five seconds owing to the limited size of the firing range.

As a result of the information gained from these dummy runs, Bristol produced a further redesigned version of the vehicle, influenced mainly by the major consideration of drag reduction.

By June 1950 the final design of the new vehicle had been completed, and drawing work for the launcher and loading trolleys was in progress.

The first flight of the redesigned test vehicle confirmed the accuracy of the theoretical drag estimates, showing a considerable reduction. By the end of September, two live rounds and five dummy rounds of the new vehicle had been fired, one of these being fitted with telemetry equipment. The first live round met with partial success—in both cases the ramjets fired, but were extinguished just before boost separation.

By the end of the year several more "hot" rounds had been fired to investigate light-up techniques. Some aerodynamic instability was experienced during the boost phase, but was cured by re-positioning the boost motors farther forward in relation to the vehicle. A redesigned separation gear was also adapted. This was an aerodynamically cleaner arrangement and allowed high speeds to be reached before separation of the boost motors.

During a continued study of light-up techniques, two short-range hot rounds were fired, and significant results were obtained from the second of these during the boost phase—one ramjet extinguished at about Mach 1 but the other continued burning until Mach 1.3 was reached, and telemetry readings indicated that it gave thrust. It was discovered that most of the trouble had been caused by interference to the airflow into the ramjets during boost separation. Telemetry recordings in "cold" ramjets showed a sudden drop in internal pressure at the time of separation, enough to cause the flame to be extinguished. As a result, it was decided to adopt a tandem boost configuration placed aft of the centre body, and between the ramjets.

However, success with the tandem boost brought on a new problem. More powerful boost motors were now being used, giving the vehicle an acceleration of over 20g and a velocity of 1,220 mph at separation. At this speed a completely new type of flutter was experienced. At that time flutter was known only on the wings and tail surfaces of an aircraft, but in the case of the ramjet test vehicle it was found that the greater fineness ratio of the body made possible a further type of flutter, in which the whole body was seen to flex at a fairly low frequency. The telemetry bay was therefore stiffened on all subsequent rounds and damping plates were attached to the ramjets. Theoretical investigation had shown that these measures would raise the critical flutter speed well beyond the operation range, and Mach numbers of 1.8 (1,350 mph) were later achieved without any recurrence of the trouble.

On July 19, 1951, the first objective of the program of ramjet development was reached. A short-range live round flew successfully. This success marked the first sustained supersonic flight to be made by a British designed and built ramjet powered missile.

By 1952 the test vehicle had served its purpose, and the program was brought to a conclusion. It reached the stage where it had provided a valuable means of flight testing and proving the components of a ramjet engine. ★

Much of the development program for Bristol's THOR ramjet was carried out with the aid of ground test rigs. Here water sprays quench the flame of a ramjet on test.

World Astronautics

By Frederick C. Durant III

Last year a symposium on the scientific uses of earth satellites was held at Ann Arbor, Michigan, under the auspices of the Upper Atmosphere Rocket Research Panel. Invitations were limited to authors from universities, government laboratories and selected research institutions. No press or contractors were invited. Thirty-one proposals for on-board instrumentation met initial screening requirements by the Technical Panel on the Earth Satellite Program and were referred to a working group in internal instrumentation for study and recommendation. This was much more than enough for the IGY program, which is still limited to six launchings.

Proposals were assessed on the basis of (1) scientific importance, (2) technical feasibility, (3) competence of source and (4) necessity to the proposed work of a satellite vehicle. The proposals covered ten specific subjects to be measured internally: UV and soft X-rays from sun, meteoric impacts, cosmic rays, cloud cover of earth, extreme solar UV radiation (500A), electron density of ionosphere, atmospheric density, geomagnetic field, auroral radiation, and galactic radiation. Priorities have been juggled in accordance with the scheduled development of instrumentation to meet environmental, power and weight requirements.

Press of time in preparing for the IGY satellite program, has prevented the Academy of Sciences from wider solicitation of suggestions for (1) kinds of satellite measurements, (2) measuring techniques to be used and (3) design of measuring equipment capable of meeting the extreme weight and dimensional limitations of the satellite payload. It may be that many important concepts and ideas have not been forthcoming because the basic problems themselves have not yet been brought to the attention of researchers here as well as abroad.

The IGY satellite program will be a single series of launchings. But most authorities expect this program will be followed by others, after the IGY has been concluded because of the demand by scientists for more extensive data obtainable in no other way. IGY satellite data will be limited and fragmentary. Some data will be in support of theory, other data will be paradoxical and unexplainable. Further, more extensive, measurements will be required.

Why not set up the mechanics and organize a long range program now, to be carried out under less pressure and with more thought than is possible for the IGY program? Such a program would appeal to those researchers who are repelled by deadlines. It would also offer an opportunity to tap the knowledge of brilliant scientists outside the United States. Research funds spent in such a way would be more efficient than in the current "crash" program.

From East Germany comes a report that a Soviet scientist is working on a preliminary design study for an unmanned, non-returnable reconnaissance rocket to orbit Venus. The planet would be TV-scanned and images transmitted to earth. The Venus "probe" would be launched from earth orbit of 22,000 miles. The rocket would be fueled by five "ferry" rockets (presumably manned) and make the trip to Venus orbit in 146 days.

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Italy has nearly completed outfitting the cruiser, Garibaldi, with missile launchers in anticipation of operational surface-to-air missiles. Minister of Defense Taviani has also announced that Italian air-to-air missiles are being developed.

Space medical research is being undertaken by the Italian Ministry of Defense at the Research Center of Aeronautical Medicine. According to a recent report, test apparatus has been built to study subgravity conditions for short periods of time.

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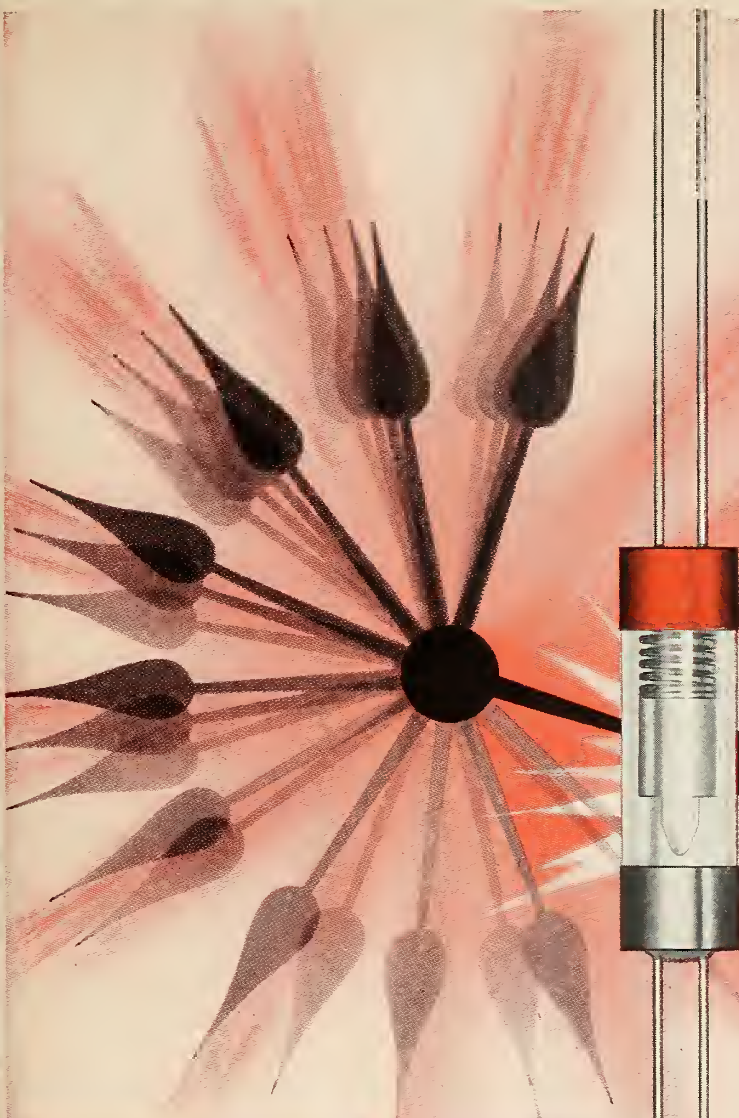

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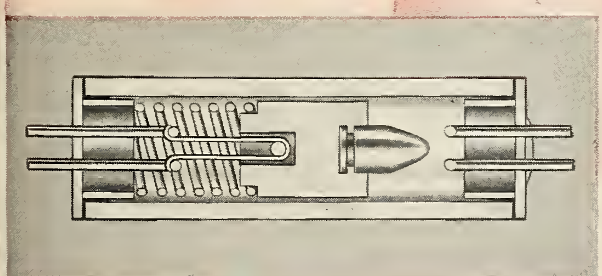

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How research rockets will tackle

The Conquest of the Moon

. . . and tell us what's on the other side

By Erik Bergaust

SEVERAL OF THE 10 ARDC centers are expected to synchronize their exploratory research activities shortly for the forthcoming USAF lunar rockets.

Although no decision has yet been made as to which moon rocket will come first, it is anticipated that it will be decided as soon as our ICBMs become ready for flight testing, i.e. within one year, and as soon as super-propellants and especially tailored control systems become available. Possibly two years later the first lunar rocket launching will be attempted. So one clear night, when weather conditions are perfect for the first firing, specimens of our intercontinental test missiles will zoom aloft from Patrick Air Force Base in Florida.

Under the impetus of its powerful, roaring rocket engines, the 80-90 foot missile will hurtle through the dense lower layers of the atmosphere. Some 30 miles up, the main stage of the rocket will have burned out and be jettisoned. A smaller bank of engines in the second stage will push the space vehicle on into interlunar space. Only a few minutes after blast-off the rocket will have reached escape velocity and in a matter of four days the vehicle will have made it to the moon, some 250,000 miles away.

The ambitious missile scientists behind the lunar rocket proposals feel the projects won't be too difficult to undertake. Of course, for centuries man's limited technology has ruled out "the trip to the moon" as something inconceivable, something for dreamers and storybook authors only. But not so today. Most scientists seem to agree the splitting of the atom actually was a far more difficult task than to send a rocket to the moon. Says one lunar rocket engineer: "The moon rocket is inevitable. There's not a question any longer of how to do it, but when. And this question has its answer in the availability of our ICBM engines."

"Even a redesigned *Vanguard* vehicle might have lunar capability," another rocket scientist says.

The gravity pull of the earth is significant enough to slow the rocket down on its way into space, but not sufficient to stop it. As the rocket approaches the moon, another gravity factor becomes involved, namely the pull of the moon itself. So the rocket will start to pick up speed again after having passed the "neutral" point where the gravity pull of the earth and that of the moon are in balance.

As the lunar vehicle comes in closer to the moon's surface and accelerates faster and faster toward Luna's mystic and majestic mountains, automatic devices will trigger the guidance and rocket power needed to adjust the missile's path into an orbit around the moon. While observers with powerful instruments on earth lose track of the missile as it disappears over the rim of the moon, instruments in the rocket's nose section will begin to scan the unseen side of the moon—an area as big as the North American continent, and an area never seen by man.

During the time the missile circumnavigates the moon, scientists on the earth will have no contact with it. But suddenly, it will be registered in the observing instruments as a tiny dot coming from behind and over the moon's rim on the opposite side. Then, at a precalculated moment, the engines will be fired again and the missile will leave the moon and return to earth.

The stored information will be telemetered to the ground station in Florida and the missile might be left in an orbit as a satellite. Eventually it will probably start descending into the denser atmosphere and evaporate like a meteor or it will disappear into space.

But the world's astronomers, geologists and other scientists will have obtained the most sought-after information of all time. But more important than just getting a look at the bashful side of the moon, enormous gains to science will be realized. These may include a very exact measurement of the velocity of light; determination of the

Ever since the days of the first Chinese "fire arrow" history has been sprinkled with stories on proposals for moon rockets. As revealed in our exclusive news story on page 25 we are getting close to realization of the first lunar vehicle. Here m/r details the why's and wherefore's, the significance and promise of the forthcoming Air Force venture.

residuum of an atmosphere on the moon; secondary radiation from the moon's far side; gravitational constants; microwave propagation; hydrogen clouds and drifting electrical fields.

Soviets Interested Too

But the Russians could beat us to the moon. Professor G. A. Chebotarev, a doctor of physics and mathematics and a senior scientific worker in the USSR Academy of Sciences' Institute of Theoretical Astronomy, made these observations in *Moscow News* recently:

"Once the artificial satellites are created, the next step in the conquest of cosmic space will be to send 'automatic rockets' to the moon and the nearest planets in the solar system and to guide them back to the earth. Until now it was thought that such flights would require an enormous amount of fuel and that for this reason they would not be practicable at present. However, this is not so.

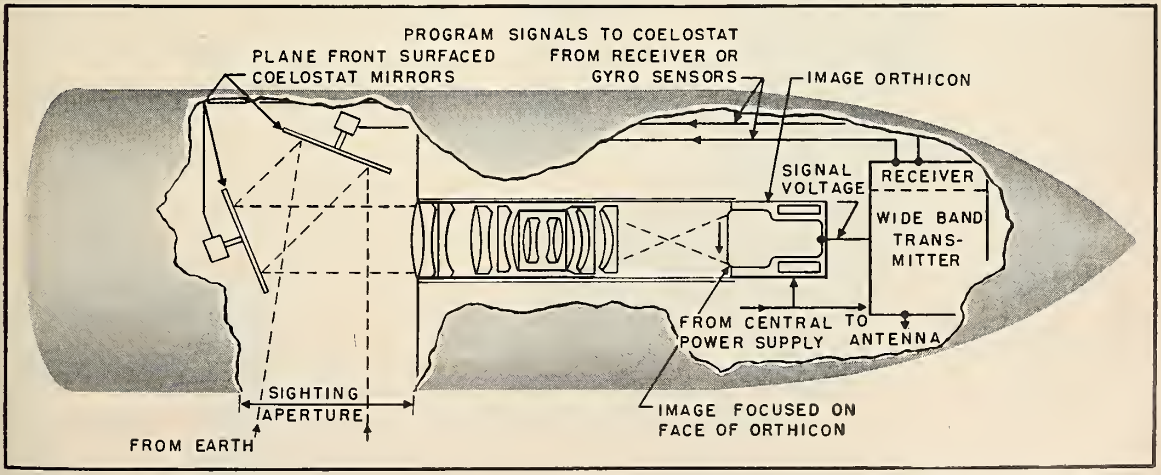
"The initial speed of such a rocket must be 6.8 miles per second. Near the moon this speed will drop to zero. This will make it possible for us to make observations of the side of the moon which is away from the earth. We shall be able to do this for about 60 hours with the help of various automatic devices which will be installed in the rocket," the Russian professor says.

The Russians have calculated that the rocket will come within 17,932 miles of the moon. Its maximum distance from the earth will be 258,489 miles. The total duration of the flight from the earth to the moon and back will be 236.14 hours, about ten days.

At present orbits have been worked out which will allow the rocket to come within a distance of 3,100 to 3,700 miles from the moon, according to Russian scientists.

"During the rocket's return to our planet, its speed will increase once more to 6.8 miles per second. In order to retard the fall of the rocket, parachutes and gliders will be put out when it comes into the earth's atmosphere," says Professor Chebotarev. The Reds say this "new" discovery makes it pos-

According to Brigadier General Hollingsworth Gregory, man's first moon rocket may be a small instrumented vehicle designed to circumnavigate the moon and collect information of scientific value. Information on the unseen side of the satellite will be registered.



Variable focus Zoomar System television-type camera likely to be carried in the Air Force reconnaissance satellite. This video scanning system could give continuous photographs of 200,000 square-mile areas. Similar system might be employed in moon rocket. Mirrors reflect picture through telescope; orthicon unit converts picture into signals that are sent back to earth.

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sible to say that the solution of the problem of sending a rocket to the moon and bringing it back is of the same order of difficulty as that of creating an artificial satellite of the earth.

The Other Side of the Moon

Now, what *is* on the other side of the moon? And why is it that we never see it? Of course, our moon rotates around its own axis, as do all the other planets and their moons in our solar system. Our moon, however, is peculiar in its rotational behavior.

Walk around a circular table in the center of a room, and you will notice that upon completing the circuit you have at the same time turned around once. You have faced in turn all the pictures on the walls in the room, and to do so you are bound to turn around, to look at those which were exactly behind you when you started on your circular tour. In the same way, the moon is circling around our planet, always keeping the same face turned in its direction, while completing the orbit around the earth during the course of a month.

Because it is always keeping the same face turned towards us, we can never observe the moon's other side. This absence of rotation relative to us means that the earth must remain fixed in the lunar sky, never rising or setting. Owing to a slight "wobble" of the moon as it travels in its orbit, the earth would seem to move in a small circle around its average position, but this would hardly be noticeable, except at points near the visible edge of the earth's satellite.

Here there would be a narrow zone where the earth would bob up and down on the horizon—and beyond this belt there would be the region where our planet is forever invisible. For some reason this is often called the "dark side," but of course it would receive just as much sunlight as the rest of the moon—nor is there reason to presume that it will be very different in other ways, scientists believe.

Despite the seeming beauty of the moon, the Queen of Night has no light of her own. Her silver mantle is borrowed sunlight. The moon is a dead world—dusty, dry and airless—according to most astronomers.

"Silence of Death Must Prevail"

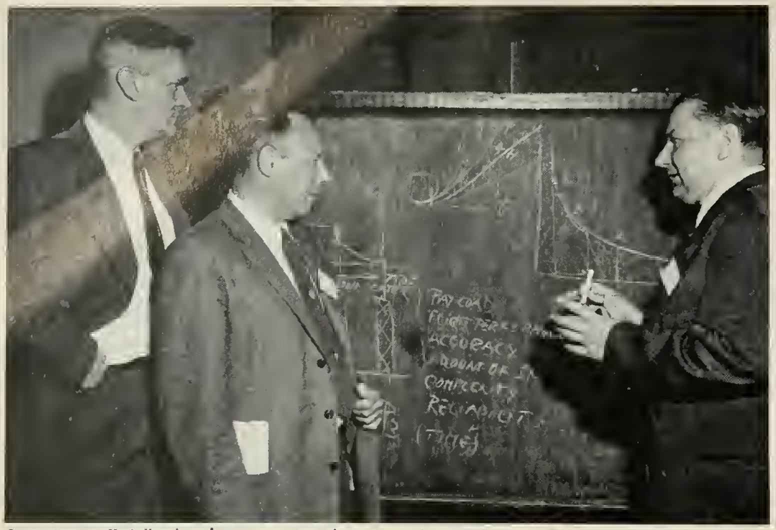
"There is not a sign of life, not a tree, a flower, or even a blade of grass to relieve the dreary monotony of boundless plains, mountain heights, or of yawning chasms," a scientist writes about the moon. Not a sound can be heard on its surface; speech will be utterly useless, as there is no air to carry the sound of a voice.

"The silence of death must prevail, the absence of air must also produce startling effects in a lunar landscape, distant mountains appearing sharply outlined against a sky black as at night, their outlines only brought into sharp relief when illumined at sunrise," says astronomer Mary Proctor.

To the question "Is there life on the Moon?" most astronomers until quite recently would have returned an unequivocal "No," pointing out that the lack of air and the temperature extremes ruled out the possibility. Many astronomers still maintain this position, but a considerable number of experienced observers say they have detected changes in certain areas which suggest the existence of vegetation.

"It is by no means difficult to imagine that plant life might adapt itself to lunar conditions (some terrestrial cacti thrive in almost equally unpromising environments!) but for the present this must remain speculation," says astronomer Arthur C. Clarke.

There is no water on the moon's surface, nor the "seas" so fancifully named by Galileo, such as the Sea of Serenity, the Sea of Tranquility, the



Convair, unofficially, has been mentioned as one of several companies preparing moon rocket hardware proposals. This picture shows three Convair "moon rocket" experts. Left to right: Director of Scientific Research, DR. CHARLES CRITCHFIELD; Chief Engineer, K. J. BOSSART and Preliminary Design Chief KRAFFT A. EHRICKE.

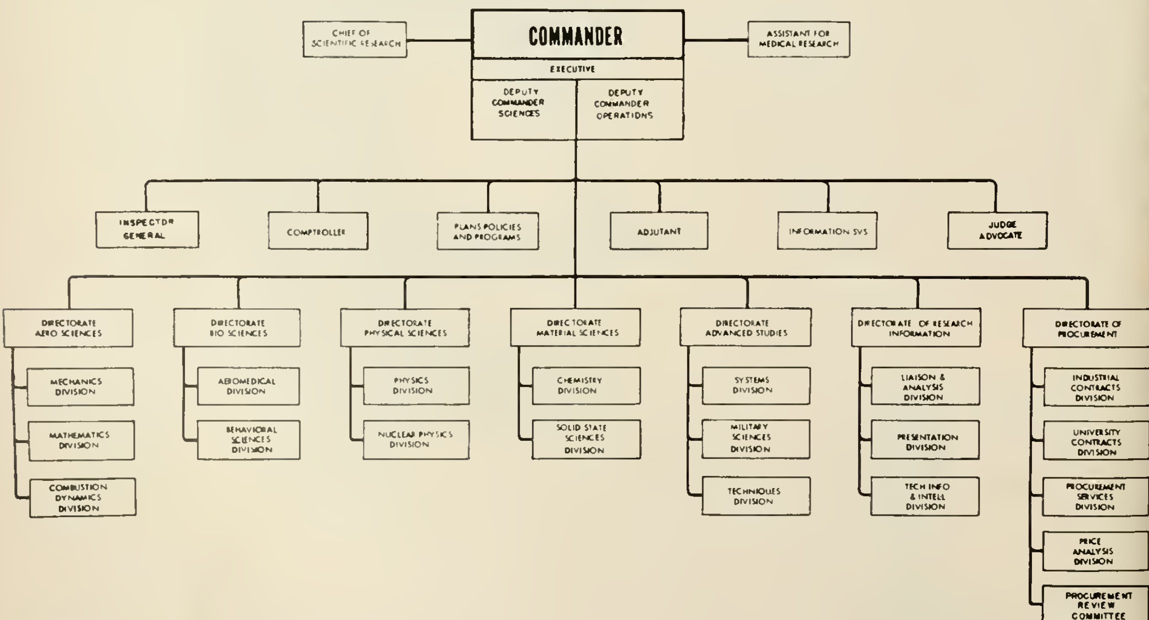
Bay of Rainbows, and others of like kind. However, these names are still retained on maps of the moon. Galileo named the greatest chain of lunar mountains after the Apennines, and this range on the moon borders on the Ocean of Storms. It extends some 460 miles, and is surmounted by a peak 21,000 feet high. Another mountain range named the Alps juts out from the Sea of Cold, and proves to be an exceedingly steep and lofty chain of mountains, one of its peaks called Mont Blanc reaching upward some 14,000 feet.

The height of many of the lunar mountains is equal to that of some of the highest on our planet. As the sun rises on the moon, the black shadows of these lofty peaks fall to a great distance as they creep across the plain below. As the sun approaches the point overhead, the shadows slowly decrease in length. At sunset on the moon the shadows fall in the opposite direction across the plains, until the mountain peaks only are illumined by the sun's light. The height of a lunar mountain or depth of a crater can be measured with considerable accuracy by means of its shadow.

Because of the moon's wobbling our researchers of the skies have been able to peek over the rim for some limited distance from time to time. What have they seen? Mountains, and more mountains. Most of them typical, ring-formed crater-type mountains, dark and cold, but impressive, spectacular.

Astronomers seem to think the rest of the moon's unseen side is filled with much of the same type terrain that can be seen from the earth. But we don't know. And since science cannot accept guesses or assumptions, since nothing but facts must prevail for our researchers in their effort to map the history of the universe we live in, tools for photographing the other side of the moon are most welcome. Only the United States Air Force can provide these tools; characteristically enough, the greatest of weapons, the intercontinental ballistic missile, will serve humanity in this research. It could happen as early as 1959, according to some engineers. By 1962 according to the Air Force's "conservative" estimate. But it *will* happen. ★

The Air Force Office of Scientific Research is in charge of the various moon rocket study contracts now being carried out. As the program progresses several other ARDC centers will become involved, particularly the Western Development Division.



Tactical Reliability—the Main Test

Combat Performance Determines Missile Quality

By Captain Patrick W. Powers, U. S. Army

AT A RECENT guided missile reliability symposium, a participant stated that a certain missile system had 14 out of 15 successful firings. Thus, it was 93% reliable, which is commendable indeed! However, judging from the murmurs of dissent from the audience, largely military, it was evident that his definition of success was not in agreement with that of the majority.

The usefulness of a missile as a weapon depends not only on its performance once it's launched but also on whether it gets unstuck at the precise time required by the military situation. Test range reliability is one thing; tactical reliability is quite another and the one, after all, that really counts.

There is a real need for a valid definition of tactical reliability expressed in explicit terms of weapon use. Reliability percentages without regard to operational firing conditions and functions don't give an adequate idea of a missile's usefulness as a weapon. Research and development firings are so different from military usage that figures are misleading.

The product of the reliabilities of critical components in a missile system is useless to the military commander in the field. He defines tactical reliability as the probability that a missile system will detonate the warhead at an effective distance from the target when he wants it—not at some random future time.

Often when discussing missile reliability we lose sight of the only military requirement for a guided missile: to get an effective warhead on target on time. The relationship between the warhead and the missile becomes, then, of critical importance and must be included in any concept of reliability.

Where the warhead detonates is broken down into a three-dimensional problem. A height of burst bracket is determined by the fuzing system and a range and azimuth error by the guidance system. The actual accuracy requirement depends on the effect desired on the target to be attacked and on the type and size of the warhead used. For some surface-to-air missiles, the guidance and fuzing systems may be combined but there remains a maximum three-dimensional miss distance outside of which the warhead will not be effective on an attacking aircraft.

A likely target for a surface-to-surface missile might be a large body of troops concentrating for a river crossing. The mission of the missile attack might be to render 50% of this mass of soldiers combat ineffective for a period of eight hours. To accomplish his mission, the commander would determine from his firing tables and warhead effects manuals the height of burst bracket and maximum miss distance to insure the proper effect on the target. Depending on the tactical reliability of the missile system and its accuracy, he might have to prepare one or more to accomplish the mission.

The accuracy or miss distance of successful missiles can be stated as a circular probable error or median radial miss distance with a maximum miss distance to include 95% of all missiles fired in the sample used. This approach will then more precisely define what is meant by a successful firing for testing and training purposes and give the commander reasonable accuracy limits on which to base his decisions for combat firings. For tactical purposes, an arbitrary miss distance is n ot valid since it would depend on the effect desired for a given target.

With a large and continuous personnel turnover, expert crews seldom

Martin Matador. It's a weapon and it's reliable only if it delivers its warhead where and when the field commander requires. In a combat situation, there is no second chance.

Trial Number	Preflight Successful	Inflight Successful	Remarks
1	No	No	Not fired; late
2	Yes	No	Fired; excessive miss distance
3	Yes	Yes	
4	Yes	Yes	
5	Yes	Yes	
6	No	No	Not fired; late
7	No	No	Not fired; late
8	Yes	Yes	Fired; third attempt
9	Yes	Yes	
10	Yes	Yes	

- *Actual Missiles Fired—7*
- *Preflight Reliability (7/10)—70%*
- *Inflight Reliability (6/10)—60%*
- *Tactical Reliability (6/10)—60%*

can be realized for an appreciable length of time. This requires reliable, soldier-usable equipment that can be operated under severe conditions.

Only combat experience will provide valid figures. A hypothetical example of the inflight reliability of a ballistic missile system based on these types of firings might be the following: success criteria—armed within 2000 meters of target; total missiles fired—10; successful missiles—6; inflight reliability—60%; accuracy—with a median radial miss distance of 800 meters and a maximum radial miss distance of 4000 meters.

Preflight Reliability

To meet a firing time, the missile system must have a high checkout or preflight reliability. Time is always of the essence in a tactical situation. The rejection rate of components that malfunction must be at a minimum so that combat firing deadlines can be met. Repair parts must be carried to replace defective components. Since only a limited amount of spares can be on hand, the checkout reliability must be high. Once the missile and associated equipment have been checked out, there may be a long wait period while system components are warmed up and turned off several times.

For air defense weapons and long range missiles, this cycling may occur for months and probably years, thus emphasizing the fact that these components must have a long life even if the missile is a "one shot" weapon.

Meeting a firing time also depends on the maintenance of complex electronic and mechanical equipment. This involves both training problems and a built-in system of maintenance. This perhaps can best be met by module packaging with a means for quickly isolating and replacing a defective unit. Maintenance support through various echelons of maintenance must assure field commanders that the firing organization will get parts and repairs for major items of equipment in an expedited fashion.

The key to the reliability of the military operators is a set of valid, troop-tested operating procedures. The commander hopes there will be no deviations from these procedures. However, the continuous equipment changes and modifications to a system after it is put into operational use makes this impossible. The responsibility for getting changes through to the field begins with the developing agency and extends down through the military channels to the operator.

If the missile system cannot detonate the warhead at an effective distance from the target at the proper time, then the tactical reliability is zero for that mission just as surely as if the target were missed by an excessive distance. For military training and contractor test firings, this time factor must be established and an unsuccessful trial charged against the system when it fails to meet the required time. Thus, a missile may eventually be fired successfully although previously charged with several unsuccessful trials because it failed to meet specified times.

Using the same ballistic missile system as in the previous example with a 30-minute time bracket specified as a trial, the three reliabilities might result as shown in the table above. Note that this missile system failed to make the firing times in trials 1, 6, and 7.

Maintaining and Improving Systems Reliability

Once a missile system has been issued to the field, the commander must be assured that tactical reliability will be maintained and improved. This reliability is a function of the reliability of the critical components of the entire missile system and of the reliability of the military operators. Without such recognition of these critical reliability factors, the finest research and development missile system will never become a successful tactical weapon.

Continued training by mock and live shoots must be emphasized. Units stationed away from one of the few missile ranges in the U.S. seldom get to fire their weapons. When they do fire, they can expand only a few missiles. This makes maintenance of a high level of proficiency very difficult. There is no substitute for actually using a weapon whether it is a rifle, an airplane, or a guided missile.

Consequently, the field commander must turn to mock firings, simulators, and technical assistance teams composed of experienced combat-arms soldiers to accomplish his task. The tactical reliability of a guided missile system and a military crew on the alert for months will indeed be low if an intense program is not followed to keep the state of readiness and training up to a high pitch.

A current analysis of firings must constantly be made to improve the missile system. Military training firings can be utilized for this if telemetry is used. In fact, telemetry should be used if possible for all tactical firings as a feedback of vital information to isolate malfunctions that otherwise never would be known. The developing agency must be on the alert to quickly solve technical problems that appear with tactical use.

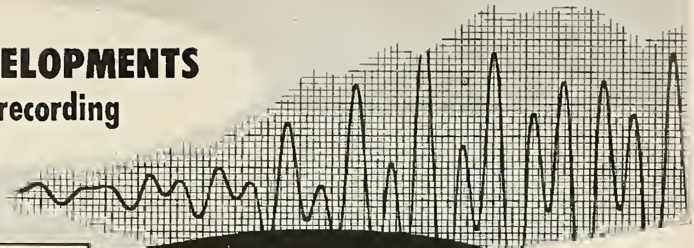
The most efficient means of managing the complex guided missile system from the contractor to the field is centralized technical control under the direction of a single office. Integrating missile channels of supply, maintenance, and information with conventional weapons does not solve the unique problems that have their roots in the firing organization. Remedial action must be immediate if readiness is to be maintained.

Summary

If the symposium participant mentioned earlier had stated that his missile system had detonated the warhead at an effective distance from the target within a specified time for 14 out of 15 trials under simulated military-tactical conditions, the cheers of the audience still would be ringing in his ears. This would have meant that our guided missile program had arrived at the threshold of absolute tactical reliability.

The results of military training and contractor test firings will be much more valid using such concepts of preflight and inflight reliability. In fact, the only way to compare and evaluate the reliability of different missile systems is to use a standard method of determining reliability based on the intended use of the weapon. ★

TECHNIQUES and DEVELOPMENTS
in oscillographic recording



FROM
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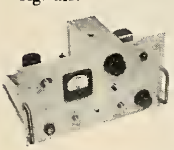
PHASE SENSITIVE DEMODULATOR PREAMPLIFIER PROVIDES A DC VOLTAGE PROPORTIONAL TO AN INPHASE COMPONENT OF AN AC VOLTAGE WITH RESPECT TO A REFERENCE.

The measurement of the amplitude of an AC voltage component is often necessary in performance studies of servo systems or of suppressed carrier signals over the carrier frequency range from 60 to 10,000 cps. In such cases the demodulator responds to inphase signals and rejects quadrature signals.



A circuit with these characteristics for use in an oscillographic recording system can he seen in the Model 150-1200 Servo Monitor (Demodulator) Preamplifier. It was developed hy Sanhorn as one of twelve interchangeahle, plug-in front ends for "150" Series equipment, to be used with the appropriate Driver Amplifier-Power unit in any channel of a "150" system. Elements comprising the circuit from input to output, include: compensated stepped attenuator and cathode follower input circuit, phase inverter, push-pull mixer and demodulator stages, differential DC output amplifier and low pass filter. In addition, the chassis contains a VTVM to facilitate accurate adjustment of the reference voltage, and an overload indicator which lights a warning lamp when excessive quadrature voltages exist.

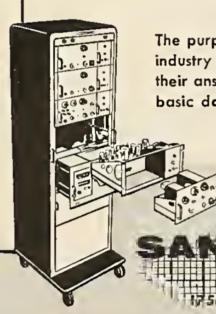
Adaptability to a fairly wide variety of applications is accomplished through hroad input voltage, reference voltage and frequency ranges. In order, these are 50 mv to 50 v (for full scale 5 cm deflection), 10 v to 125 v; 60 cps to 10kc. Rise time with low frequency plug-in demodulation filter is 0.1 seconds; with high frequency filter, 0.01 seconds. Quadrature rejection is hetter than 100.1; for carrier frequencies up to 5000 cycles.

Two representative uses of the Servo Monitor Preamplifier are in the design and adjustment of servo systems, and with instruments used in the design, development or adjustment of other apparatus. The first is illustrated hy use of the Preamplifier and associated equipment in the recording of the output shaft amplitude and driving frequency of an AC positional servo; the second hy recordings made with a similar setup of the difference hetween output signals from a gyroscopically-controlled stabilizing device and the "pitch" and "roll" signals generated hy a "Scorshy Tahle" used for testing the device under dynamic conditions.

For a detailed discussion of the principles and design considerations involved in the Servo Monitor Preamplifier, refer to the February, 1955 issue of the Sanborn RIGHT ANGLE, for Dr. Arthur Miller's article on "Measurements with the Servo Monitor Preamplifier."

BASIC FACTORS IN SELECTING OSCILLOGRAPHIC RECORDING EQUIPMENT

When considering any oscillographic system or equipment for your application, three useful "yardsticks" to apply are (1) the recording method, (2) equipment adaptability, and (3) variety of equipment available. Here are the answers to the three, as they apply to Sanborn systems. In the record, rectangular coordinates accurately correlate multiple traces, simplify interpretation and eliminate errors. Permanent traces, produced by a hot ribbon stylus without ink, provide sharp peaks and notches, and clearly reveal all signal changes. One percent linearity results from current feedback driver amplifiers and high torque galvanometers of new design; maximum error is ¼ mm in middle 4 cm of chart, ½ mm across entire chart. From the standpoints of "adaptability" and "variety", Sanborn "150" equipment offers the versatility of 13 different plug-in front ends for any basic system . . . the choice of one- to eight-channel systems . . . the variety of nine chart speeds, timing and coding controls, console or individual unit packaging . . . availability of equipment as either complete systems or individual amplifier or recorder units.



The purpose of the foregoing information is to better acquaint industry with typical oscillographic recording problems and their answers, design considerations in Sanborn equipment, and basic data on what Sanborn makes and how it is being used.

Technical literature and engineering assistance on specific problems are always available from our engineering department.

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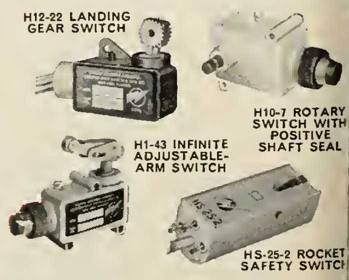

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Million - to - One Shot

Reliability Engineering—A New Science to Cut Missile Misses to One-in-Twenty

By William Shepard West
The Martin Company

TO THE ARMED services the proof of a guided missile is in its reliability. A missile is a brilliant weapon, but only when it proceeds to target upon receipt of the first command to launch. There is no second chance.

Military insistence on bug-free missiles finds emphatic expression in a contractual clause that quality control experts soon learn by heart. The clause commits the manufacturer to a reliability standard of, say, 95 per cent. His acceptance is a flat guarantee that when 100 of his missiles are fired, fewer than five will turn out to be duds. The remaining 95 must impact in the target area.

The 95 per cent standard is such a large order that odds of a million to one have been quoted against its achievement. The reliability engineer faces an engineering frontier newly born of military necessity. Outsiders have only a loose understanding of what he is up against. An attempt is made here to explain the reliability engineer's job and to suggest the magnitude of his responsibility.

Most of us started thinking of associated reliability concepts before we were in high school, linking them with dependability. The old college football team was reliable; it could always be counted on to "hold that line." Our first car was reliable; we knew it always would start by the time it had coasted down the hill. Our dog is reliable; she always barks when someone rings the doorbell.

Numbers and Reliability

Let us consider the dog and the doorbell through 10 days in terms of the simplest mathematics associated with reliability. Assume the doorbell is operated 10 times each day for a total of 100 operations. If the dog barks only when the bell operates, we would expect her to bark 100 times in this period. Let us assume that once each day she happens to be asleep when the bell rings, and when she sleeps she doesn't bark. The probability that she will bark when the bell rings, therefore, is 9 out of 10 each day, or 90 per cent of the time.

Suppose that we have five such dogs, each sleeping at random times, and that the doorbell also is operated on a random basis. What is the likelihood that all of the dogs would bark each time the bell rings? Only 60 per cent of the time, by the same simple probability—$0.9 \times 0.9 \times 0.9 \times 0.9 \times 0.9 = 0.59$. We have assumed that since the dogs do not hear the doorbell when they sleep, they will not hear the other dogs barking.

Briefly restated for the dog-doorbell situation, the problem area is this: a system employing only five items, each of which is 90 per cent reliable, will produce an over-all system reliability of only 60 per cent.

Extending this elementary concept gives rise to some surprising numbers. Consider a hypothetical missile system that has an electronic transmitter, command giver, and a missile—three subdivisions. The transmitter comprises at least a hundred items—wires, resistors, capacitors, tubes, soldered connections. Now if each of these hundred items is 99 per cent reliable, we figure that the over-all reliability of the set is $(0.99)^{100}$, or about 36.3 per cent.

Now it is common knowledge that radios are more than 36 per cent reliable. So the inference is plain that each component in your radio, operating in the environmental condition of your home, with circuits and components of conservative design, performs at a reliability rate higher than 99 per cent. The more highly powered transmitter, with its hundred or more items, works under a greater handicap than does the home set, making achievement of 99 per cent reliability of components somewhat more of a problem.

Environment and Design Objective

The minimum environmental conditions that virtually all systems must be able to withstand are set forth indirectly in the test procedures of military specifications, which imply temperatures from -65 to 160°F, altitudes from sea level to 50,000 feet, various conditions of vibration, shock and acceleration, etc. The detail specification and the tactical use of weapon systems often exceed the requirements.

Accordingly, the demand on components is vastly more rigorous in tactical use than under typical laboratory or home conditions. Something that works well on a living room table may be inadequate in the deep freeze.

Another difference is the requirement for small size and light weight—a must in military missile applications, but sometimes a sign of cheapness in the home radio. In sum, the rigors of tactical weapon system environments obviously do nothing to encourage the highly dependable operation that the design objectives demand.

More Wood for the Fire

Referring back to the hypothetical missile system, we see that if the transmitter has 100 components, each of which is 99 per cent reliable, the transmitter is about 40 per cent reliable. No doubt, the other two subdivisions—the command giver and the missile itself—are each equally reliable. Our system then has little value because it is (0.40 x 0.40 x 0.40) per cent, or 6.4 per cent reliable, which is virtually useless. What can we do here?

For one thing, we could make each component more reliable. But is our analysis correct? Will the failure of any one component cause the missile to miss the target? There is ample evidence that it will. No item may fail during its intended tactical life.

How about increasing the reliability of the components from the 99 per cent figures we arbitrarily selected until all components and workmanship are 100 per cent reliable? Excellent for missile system reliability, but an impossible assignment. Why this will never happen is discussed by Marcus A. Acheson's "Electron Tube Life and Reliability." Pertinent extracts follow: ". . . if we remove all potential defectives in a lot, we will have removed the entire lot, whether it be a lot of tubes, a lot of people, or the pyramids of Egypt. Nothing lasts forever, and everything existing is a potential defective—we can only discover a rate at which this probability occurs, and lay our bets accordingly on the living population."

If you still demand 100 per cent, try to get an automobile with a guarantee that it will be 100 per cent reliable for its intended life. The writer, actively assisted by a skilled procurement organization, has experienced difficulty getting some component vendors to guarantee that their product will be 97 per cent reliable. Nevertheless, complex missile systems still must live up to an over-all reliability of at least 95 per cent. Our standard of reliability for each vital component and assembly, therefore, must exceed 99 per cent. The problem is familiar to missile manufacturers everywhere.

Financial policy makers might turn to reliability control as a means of reducing the staggering maintenance costs as well as insuring better field systems. Should the cost of developing and manufacturing a weapon system be doubled or tripled thereby, there would still be a net saving.

Framing the Issue

With statistics you can line up a million-to-one case against the probability of 95 per cent missile reliability. Even so, the missile builder has accepted the challenge.

The engineers at Martin have been conscious of the problem of aircraft reliability through the years, but the yardsticks used for aircraft reliability do not apply directly to missile systems. In fact, missile requiremenets are so exacting and their ramifications so diverse that Martin has established teams of experienced technical personnel to work solely for missile reliability wherever it is at stake. In practice, they move in to monitor every step from drafting board to target, including the design, test, production, and operational phases. Working with mathematics, testing methods, and design techniques, they integrate the requisite reliability control into the original engineering releases. Follow-up studies lead to recommendations for corrective measures in all phases affecting the missile system.

The total reliability cost for a typical Martin missile system amounts to roughly $3-million yearly. This figure includes expenditures for testing components, systems and equipment both in the laboratory and on the firing range. Roughly five percent of the engineering man-hours in this project go directly into the reliability effort. This compares to zero hours and zero dollars a few years ago before reliability became a missile problem.

In order to assure optimum results at minimum cost, it has been necessary to formalize the position of reliability engineering in the company's research, development and production structure. An article detailing how this has been done is planned for a later issue of m/r. ★


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Cold Facts on a Hot Seat . . .

Rocket Sleds Help Supersonic Bailout Design

By Norman Baker
Boeing Aircraft Company

Thirteen major aircraft companies now are working cooperatively on an ejection seat development program. The objectives of this program will be to develop a standard upward ejection seat that will be compatible to the new supersonic jet fighter-type aircraft. The Industry Crew Escape Systems Committee (ICESC) was set up to coordinate overall program activities.

The ARDC has assigned Convair Division of General Dynamics Corp. to coordinate the ejection seat development program. Convair, in this capacity, has subcontracted portions of the development to other companies.

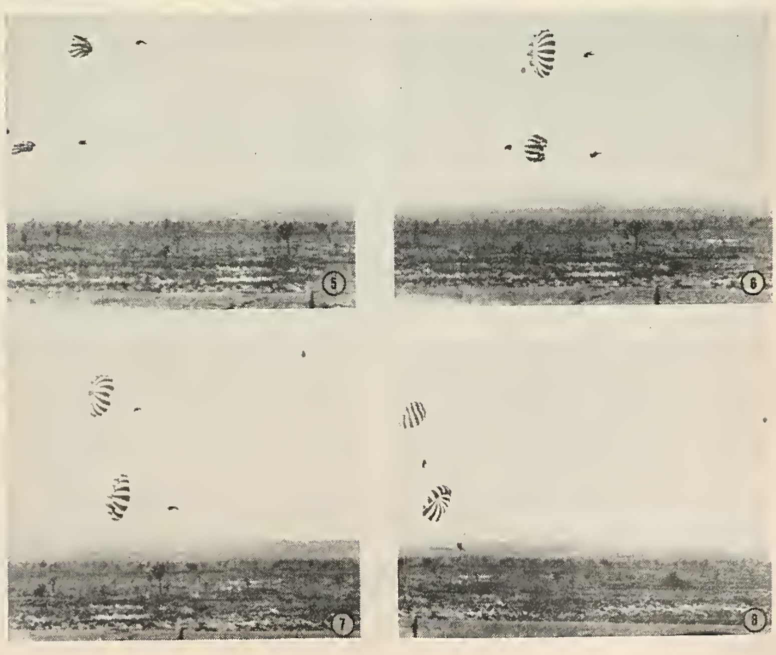
The most recent and outstanding ejection accomplishment of this program has been the development of the RESCU Mark I ejection seat (Rocket Ejection Seat Catapult Upward). RESCU Mark I seat is produced by Talco Engineering Co., Inc., Hamden, Conn. It combines a normal cartridge catapult with rocket propulsion.

RESCU Mark I operates on a two-step principle. The first step in the ejection sequence ignites a ¼ lb charge which propels the pilot's seat vertically. This phase of the operation operates in piston fashion similar to the standard M3 telescoping tube seat catapult. The M3 ejection system propels the pilot upwards, clear of the plane, where he is subjected to the force of the windblast. The tremendous deceleration due to the windblast is the contributing factor for reducing the pilot's chance for survival. The rocket propulsion unit on the RESCU Mark I fires as soon as the seat is clear of the cockpit. A 5-lb. propellant grain fired through a canted nozzle carries the pilot further from the aircraft.

Thrust of the rocket is in a line through the center of gravity of the seat-pilot combination. This adds a forward force vector to the ejection line of travel imparting a resultant forward force which tends to offset the force of the windblast. The thrust through the center of gravity of the seat-pilot unit creates dampening forces which reduce tumbling.

Convair Engineering Test Laboratory engineers and Air Force technicians recently made comparison tests

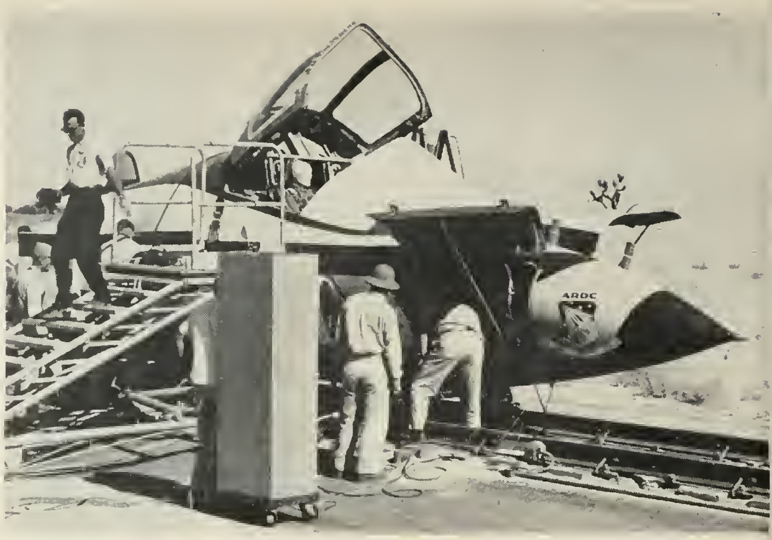
High-speed sequence camera records ejection of two dummies from Convair TF-102A rocket sled at Edwards AFB in California. 1) RESCU Mark I seat, trailing smoke from rocket clears cockpit. 2) M3 cartridge seat (arrow) is ejected as RESCU Mark I rocket burns out. 3) Rocket seat follows trajectory well above M3 seat. 4) Dummies separate from the seats. Elapsed time: less than one second. 5) Parachutes on dummies start to open. 6) Parachute of RESCU Mark I has opened fully. 7) Rocket propelled dummy starts to assume vertical attitude while M3 propelled dummy is still horizontal. Seat is upper right. 8) RESCU Mark I dummy (upper) making safe normal descent .M3 dummy is still in an unstable attitude.



of the M3 and RESCU Mark 1 ejection systems. Two instrumented anthropomorphic dummies were mounted in seats on a TF-102A nose section rocket sled at Edwards AFB test track. The side-by-side seating of the TF-102A trainer cockpit afforded the engineers an excellent opportunity for comparing the RESCU Mark I and the M3 ejection systems.

One seat was ejected by the RESCU Mark 1 unit, while the other seat was ejected by the M3-type cartridge catapult. Recent tests at Edwards, first of a long-range development program, were run at Mach .3 and Mach .73. In these initial tests the rocket propelled seat followed a much higher trajectory and the parachute attached to the dummy blossomed more fully than that of the dummy ejected by the M3. This resulted in a more stable, normal descent by the RESCU Mark 1 propelled dummy.

In the first test at Mach .3, the rocket seat propelled its dummy 124 feet above the ground. During this time M3 ejected seat had hoisted its dummy to a height of only 55 feet. During the second test at Mach .73, the rocket seat ejected the dummy to a height of 60 feet above the TF-102A's vertical fin. The seat ejected by the RESCU Mark I system experienced a smooth acceleration, instead of the explosive jolt produced by the M3 cartridge. This reduces the hazard of spinal compression which could be experienced during the ejection by the M3.



Preparing for takeoff. Air Force and Convair engineers ready TF-102 sled for seat ejection test.

The entire sequence of ejection was recorded during these test runs by still, high-speed-sequence and motion picture cameras. Two telemeter transmitters were located on the sled and one in one of the dummies for further correlation of test information.

John G. Kalogeris, Convair engineer in charge of tests at Edwards, states that the new rocket seat "for the first time gives the pilot a good chance of ejecting safely from ground level in case of emergency."

Tailoring Molecules *for* Rockets

by Dr. David Z. Lippmann

A member of the Chemistry Department Staff at Reaction Motors, Inc., Dr. Lippmann specializes in combustion processes and theoretical analysis. He received his B. S. and M. A. in Chemistry at the University of Texas and his Ph. D. in Physical Chemistry at the University of California at Berkeley. He has been with RMI for three years.

The practical future of rocket power depends upon a great many factors—not the least of which is the solution of the problems facing the rocket propellant chemist. The ultimate rocket chemicals—whether nuclear, solid, liquid (mono- or bi-propellant), hybrid or the new "exotic" chemicals—must lie within the limited parameters of certain rigid requirements. This discussion deals with some of those basic considerations which influence the chemist's search for improved high energy rocket propellants.

The conventional rocket motor is a heat engine which converts the chemical energy of propellants into heat and the heat into kinetic energy. Propellants react in the combustion chamber of the rocket motor, releasing heat and forming gaseous products, which expand through a nozzle; the expansion converts part of their heat energy into kinetic energy. The gases, now moving at high velocity, are exhausted to the rear, and by the reaction principle they impart a forward force, measured in pounds of thrust, to the motor.

The thrust exerted by a rocket motor is proportional to the exhaust velocity of the reaction products. To produce a high exhaust velocity, the reaction of the propellants must yield a large quantity of heat per unit mass and this heat must be converted into kinetic energy efficiently.

The heat produced is the difference between the heat of formation of the propellants and the heat of formation of the reaction products; so the propellants should have large positive heats of formation and give products with large negative heats of formation. Because of the requirement for large heat of reaction per unit mass (not per mole), only the lightest elements are used in propellants. The most desirable elements are hydrogen, lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, magnesium, aluminum and silicon; elements heavier than chlorine are rarely used. The heats of formation of propellants are maximized by incorporating high energy groups such as $-C\equiv C-$, $>N-N<$ and $-OO-$ into the propellant molecules.

The efficiency of conversion of heat into kinetic energy is inversely proportional to the mean molecular weight of the reaction products. Therefore propellants are designed to give light products, such as H_2, H_2O and CO.

These three requirements, i.e., that the propellants have large positive heats of formation, that the products of reaction have large negative heats of formation, and that the products have low molecular weights, cannot all be optimized simultaneously. A good propellant must have an optimum balance among them. In addition, a propellant should have other desirable properties, such as stability and high density.

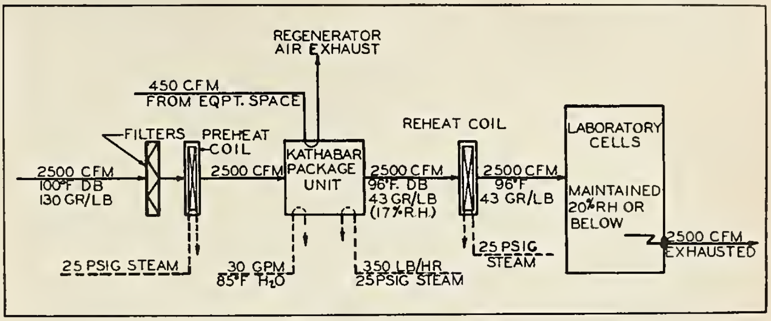
The chemistry laboratories at RMI, in support of the applied research, development and production of advanced rocket power systems, are staffed with a team of specialists, highly qualified in many phases of chemistry and chemical engineering. This team is constantly working toward the achievement of this optimum balance of properties in their search for advanced rocket propellants. The well-rounded program of research, analysis and evaluation which contributes to this goal includes such typical activities as mathematical analysis, theoretical chemistry, propellant formulation, combustion chemistry, organic and inorganic synthesis, physical properties and analysis, with special sections devoted to solid and liquid propellant research.

4870

Rockets for Black Gold

Proving that what goes up must come down, Grand Central Rocket Co. has developed a rocket for ramming new life into old and tired oil wells. Using a specially designed, controlled burning rocket motor sealed in the bottom of the well to build up pressure that exhausts through blowout plugs, oilwell engineers have exerted downward pressures equivalent to 5000 hydraulic horsepower in a single surge. In some cases the resulting soil fractures have enabled pumping rates to be increased 300 per cent. In the drawing, the igniter is at the top; rocket fuel in the middle; and firing nozzle at the bottom. The entire unit is only seven-and-a-half feet long and is dropped readily down the well casing. This is the first commercial use of one of Grand Central's solid rockets. The company also has the third stage Vanguard contract.

Humidity Control for Rocket Propellants



Schematic layout of Phillips Petroleum Co.'s humidity control system.

Working under a United States Air Force contract, Phillips Petroleum Company is utilizing related petroleum and chemical technology, their research knowledge and experience to develop new solid rocket fuels. These propellants are prepared and tested in small rocket motors at Bartlesville, Okla.

A chemical-type humidity conditioning system which serves this laboratory plays a vital role in the success of this program. Some of the chemicals used to compound these propellants are extremely hygroscopic. Both the physical and ballistic properties of the propellants are dependent on moisture present during processing. Tests on successive charges from a single batch could vary widely if change in moisture content occurred.

Solid propellant JATO units have been used for several years but have been made of expensive ingredients having limited availability. Phillips researchers are striving to develop a solid, less expensive propellant made of ingredients readily available in this country in large commercial quantities.

Several have been developed and are now being tested. Relatively simple devices, they ignite and burn in bottles or motors which can be made of inexpensive steel. Burning evenly and rapidly, the resulting gases travel through the nozzle at tremendous speeds.

In the ideal JATO rocket there is little flash or smoke and the gases are not toxic or corrosive. Once compounded and sealed in the motor, it should not vary in physical or firing properties even under tropic or arctic storage conditions.

Need for Humidity Control

Much of the solid propellant fuel development is "classified" for security reasons. Actual components cannot be named. It can be said, however, that the principal ingredients are a chemical oxidizer mixed with a binding agent which serves as the fuel.

Some of the chemicals used to form these charges are hygroscopic and are dried before use. To protect their physical properties during compounding and to insure accurate ballistic results from an entire batch, charges must be protected from moisture regain.

Initially a dessicant system was installed to maintain conditions in the laboratory cells at from 25 to 30 per cent relative humidity. In this humidity range the moisture in the air and that in the chemicals were barely at equilibrium. This dehumidifying equipment proved unsuccessful as it could not handle the sudden, high moisture loads placed upon it.

Many of the test cells are regularly hosed down to cleanse the surfaces of accumulated propellant dust particles. After various other systems were investigated, a very successful chemical-type dehumidification system was installed.

These units, two of which are used in the laboratory, are Kathabar Humidity Conditioners, manufactured by Surface Combustion Corporation, Toledo, Ohio.

Air Conditioning System

In Figure above is shown a schematic flow diagram of one of the Kathabar systems. All fresh air is used to avoid the accumulation of rocket fuel dust in filters and ductwork.

The 2500 cfm of air is shown entering the system at 100°F dry bulb and 130 grains of moisture per pound, maximum summer design conditions. This air passes through filters and enters the unit's air washer chamber. Both the preheat coil and the afterheat coil are for winter operation.

This system uses a liquid absorbent called Kathene. Its moisture absorbing capacity is a function of its concentration and temperature.

Thus, the Kathene solution at a set concentration is cooled in the air washer chamber to the temperature predetermined for proper dehumidification. Automatic regeneration in a separate chamber is accomplished by heating the solution with steam.

In the air washer chamber the air stream contacts a flood of the Kathene solution as both pass over the extended surface cooling coils. The coolant in these coils both cools the absorbent solution to the right temperature for dehumidification and cools the air. The air is dehumidified and goes on to the distribution duct system. The solution falls into a sump from which it is pumped back to the top of the air washer chamber for additional dehumidification passes. A small quantity of solution is also pumped to spray heads in the regenerator.

When the solution becomes diluted, steam is passed through the coil in the regenerator. This heats the solution, forcing it to give up the absorbed moisture. The solution falls into the sump once more and the released moisture is entrained by a scavenger air stream, 450 cfm as indicated on the drawing, and vented outside. Regeneration is completely automatic.

After the dehumidification pass, the air, at 96°F, 46 gr/lb (17% RH) is ducted to each test cell. The cells are constructed of double reinforced concrete, one foot thick. They are baffled to contain shrapnel in case of an explosion and have blow-out panels to allow the explosion force and gases to escape.

Maximum utility requirements of this system are 30 g.p.m. of 85°F water and 350 lb/hr of 25 psig steam. The unit has a wide range of turn-down. When outside conditions are not maximum design, it will deliver air at 17 percent RH and much lower, still using only 85°F water. Less steam is also required when outside conditions are below 100° F and 130 gr/lb. The second unit, 1350 cfm capacity is now placed on standby. Connected to the same duct system it can be utilized if increased activities should overload the first unit, or when planned expansion is authorized in the future. All duct work in the system is interconnected to allow the entire 2500 cfm to be directed to one, two or any combination of test cells if needed.

In the southwest, electric power is more expensive than any other energy source. Since this unit has only a ¾ h.p. pump motor and a 1 h.p regenerator air fan, operating costs compared to other systems are much less. As these are the only moving parts of the system, only routine maintenance is necessary.

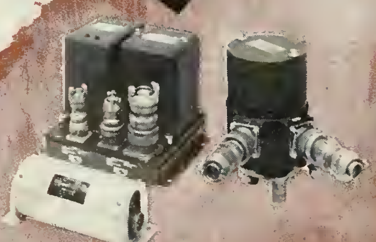
Another factor in favor of this system is that there is no "carryover" of absorbent solution in the leaving air stream. Carryover of any kind would impair the accurate compounding and testing of rocket charges. ★

HOW FAR IS "A Stone's Throw?"

Pretty far, when the 'stone' is the Army's Redstone Missile, which is the responsibility of the Army Ballistic Missile Agency at Redstone Arsenal in Alabama. While range figures are classified, you can be sure the Redstone can carry its warhead a long way.

Servomechanisms, Inc. designed and developed the Redstone's Thrust Controller system, which operates to maintain constant pressure in the Rocket Thrust Chamber. As an indication of its accuracy and reliability, the system controlled pressures to within 1% of the CHAMBER PRESSURE in hundreds of hot firings

This is an excellent example of how Servomechanisms, Inc. has utilized the experience acquired through years of developing accurate and reliable sub-systems for high performance jet aircraft, to make a substantial contribution to the guided missile field. Many other developments in this field are now in progress



SERVOMECHANISMS INC.

WESTERN DIVISION, Hawthorne, California

EASTERN DIVISION, Westbury, L. I., New York

MECHATROL DIVISION, Westbury, L. I., New York

MECHAPONENTS DIVISION, Hawthorne, California

Propulsion Notes

By Alfred J. Zaehringer

California Research Corp. has patented a rocket fuel (acyclic mercaptans with 1-5 carbon atoms) for hypergolic use with nitric acid. Mixed mercaptans obtained from naptha cracking process can be used. The fuel can also be blended with up to 50% volume of hydrocarbon fuels. Small additions (2-to-20%) of nitric oxide, sulfuric acid, or $NOHSO_4$ to the oxidizer reduces ignition delay. A 1:3 (volume) mixture of ethyl mercaptan and nitric acid (with 15% sulfuric) gave an ignition delay of 10 milliseconds at —40° F.

Add to the growing list of "Zip" investigators. Diborane flame studies have been reported by Battelle Memorial Institute and the Royal Aircraft Establishment. In stability studies Battelle ran into unusual flame holding effects and other abnormal behavior, apparently caused by the deposition of large amounts of B_2O_3 slag in flameholders.

The French have devised a continuous method for producing isopropyl nitrate. The direct interaction of nitric acid and isopropyl alcohol gives a 78% yield based on the original amount of alcohol.

Eugen Saenger of the Research Institute for Physics of Jet Propulsion (Stuttgart, Germany) hypothesizes that "photonic gas," a type of radiation, may govern the mechanism of propellant combustion and the detonation of solid and liquid explosives.

British Imperial Chemical Industries has come up with a new solid propellant for low-pressure or rocket propulsion. Oxidizer is guanidine nitrate (88.75%). Polymitrophenols or polynitrosophenols (10-35%) are used to "sensitize" the thermal decomposition of the oxidizer. Catalyst is vanadium pentoxide (0.2-1%). Other additives are asbestos fibers (0.5%) and potassium nitrate (0.25%). Apparently the propellant is formed into grains by compression.

General Electric has in operation a $2 million Propellant Development Lab. at Evendale, Ohio for exploring the combustion of new fuels "with heavier hydrocarbons than JP fuel."

Hydrazine for propellant use is still small. Present cost is $2-3/lb. Present producers are Olin Mathieson and Fairmount Chemical. Stanford Research Institute is now working on a non-aqueous electrochemical process which could bring costs way down.

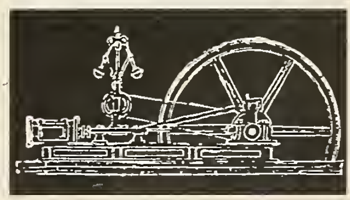
Next producer of UDMH may be Metalectro (Laurel, Md.) recently acquired by National Distillers Products Corp. Present producers are Commercial Solvents, Food Machinery, and Olin Mathieson.

The Navy has awarded a $38 million contract to Callery Chemical to build a high energy chemical fuel plant. Probable production: pentaborane for chemically fueled bombers.

Ammonium picrate for solid propellants now seems dead. The last government production plant at Little Rock, Ark. is to be sold.

Look to Canadian Industries, Ltd. to enter the solid propellant field. Location may be at its Nobel Works in Ontario, Beloeil Quebec, or Edmonton, Alberta.

Production of hydrogen peroxide is now near 45 million lbs./yr. Latest entries in the production field are Solvay Process at Syracuse, N. Y., Shell Chemical at Norco, La., and Columbia-Southern at Barberton, Ohio. Estimates are that 30-50% of total production goes into military use.



FRED G. BALL, JR.

Graduated from New Mexico A & M College in 1948 and came to Bell two years later as Missile Coordinator on the Shrike Project. He became a member of the Systems Specifications Group in 1950 and Group Engineer for Test Equipment for the Rascal, Shrike and Meteor Missiles in 1951 Mr. Ball as Assistant Section Chief since 1953, is now a Section Chief in Bell's new Guided Missile Division.

...Assistant Section Chief 1953

Fred Ball's rapid progress from "fresh out of school" through positions of ever-increasing professional importance in not unusual at Bell Aircraft. Men with ability traditionally move fast in this progressive organization.

And now, with the recent formation of a completely autonomous Guided Missiles Division, opportunities are broader than ever before for engineers with the skills needed to contribute to the success of a team dedicated to Weapon Systems Management in all its many aspects. In this and other fields, a wide diversity of interests are insurance that you'll never be blocked by the lack or limited scope of projects when you decide on a professional career at Bell.

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- Magnetic Amplifier Specialists
- Mathematical Analysts
- Mechanical Engineers
- Microwave Engineers
- Miniturization Engineers
- Operations Analysts
- Physicists
- Power Plant Designers
- Pressure Vessel Designers
- Project Engineers
- Publication Engineers
- Radar Systems Engineers
- Rocket Test Engineers
- Servo Systems Engineers
- Servo Valve Engineers
- Statisticians
- Stress Engineers
- Structures Engineers
- Specification Writers
- Technical Writers
- Test Equipment Engineers
- Transformer Design Specialists
- Transistor Application Engineers
- Thermodynamic Engineers
- Telemetering Engineers
- Turbine Pump Designers
- Vibration & Flutter Analysts
- Weapons Systems Engineers
- Wave Guide Development Engineers
- Weights Engineers

In Washington for Defense Department's recent missile auxiliary power unit symposium were Paul Ricks (facing away), AiResearch Project Engineer and ex-Peenemunde researchers Rudolph H. Reichel and Fred R. Kunze, both with Bell Aircraft.

T. I. Paganelli has been appointed ngr. of the Special Radar Projects Secion, General Electric's Heavy Military Electronic Equipment Dept., which is reponsible for development of new elecronic systems for ballistic missiles. **E. P. Heinemann** has been named managernaterials of General Electric's Light Miliary Electronic Equipment Dept.

Harrison A. Storms, Jr., succeeds **C. . Hansen** as chief engineer of the Los Angeles Div. of North American Aviation. Mr. Storms was formerly mgr. of research nd development.

J. Raymond Berry, Jr. has been apointed Washington representative for North American's Missile Development nd Rocketdyne divisions.

Former CAA Administrator **Fred Lee** as joined Olin Mathieson Chemical Corp. s asst. to **W. Foster,** executive v.p. in harge of high energy fuel operations.

Dr. Louis F. Doty, recently supervisor f weapons systems planning in General Electric's Nuclear Propulsion Dept., rejoins Aircraft Armaments, Inc. as head of the Aerodynamics Dept.

J. F. Forster, vice president and asst. eneral mgr., Vicker's, Inc., has been apointed executive v.p. in charge of all Vickers operations.

Andrew F. Haiduck has been named xecutive v.p. of Lear, Inc., supervising nd coordinating activities of all company ivisions and subsidiaries, as well as asuming duties of **A. G. Handschumacher,** ice president and director of sales, who as joined another company.

Norman F. Trost, formerly with Genral Motors' Aeroproducts Div., has been ppointed president of Narmco Mfg. Co.

Jesse Zabriskie, division mgr. of Bell ircraft's Guided Missiles Div., announced e appointment of **Tex S. Lines** as his ssistant and **John C. Parkin** as director f engineering.

B. F. Coggan was elected vice presint and manager of Convair-San Diego d **Charles F. Horne,** vice president and anager of Convair-Pomona.

Robert H. Noorduyn has been apinted Dallas district mgr. for Walter idde & Co.'s Aviation Div.

Walter T. Runiewicz and **William M. unwody** have been named chief comnents engineer and chief systems enneer, respectively, for Clifton Precision roducts Co.

Harold C. Erskine, general mgr. of the castings division, has been named asst. general production mgr. for Aluminum Company of America. He was formerly director of the Aluminum and Magnesium Div. of Business and Defense Services Administration, Dept. of Commerce.

PAGANELLI

Senior AiResearch project engineer C. F. Drexell shows press FALCON power unit.

TROST

Richard A. Maber has been appointed chief engineer of Hoffman Laboratories; **Carlton Wasmansdorff,** vice president, has been assigned to the research and development of new electronic systems and products; **E. Philo Davis** has been named manager of advertising and sales promotion; and **Tom C. Clark** has been appointed director of military sales.

Eugene J. Venaglia will be manager of Sperry Rand Corp's new electronics laboratory at Clearwater, Fla.; **Paul T. Cullen** has been promoted from surface armament sales representative to asst. to the president and general mgr. of Sperry Gyroscope Co. **Charles S. Rockwell** has been named vice president and general mgr. of the Ford Instrument Co. div. of Sperry Rand Corp.

C. E. Pappas was named asst. director of scientific research for Republic Aviation Corp.; **Travers Auburn** has joined the company as chief industrial engineer.

Roland C. Webster and **Rudolf H. Edelston** have joined the Chemistry Div. of Atlantic Research Corp., Alexandria, Va., where Webster will work on the development of rocket-powered seat ejectors and Edelston with the design of rocket components and rocket testing equipment.

Franklyn E. Dailey, Jr., has been appointed mgr. of the applied science section, Research and Advanced Development Dept. of Stromberg-Carlson.

Harry E. Pinkerton has been named president of the International Electronics Corp. (Intec), a joint American-French venture into the field of electronics.

Cliff Anliker was appointed supt. of manufacturing of Robertshaw-Fulton Controls Co.'s Aeronautical Div.

Louis E. Benitez has been promoted to director of customer relations for armaments systems, **Thomas J. Mitchel,** to director of electronic systems, and **Perry Smith** to director of commercial sales, Crosley Div., AVCO Manufacturing Corp.

W. R. Miller has been appointed vice president of Longren Aircraft Corp., in charge of Longren de Mexico.

John S. McCarthy was selected as McDonnell Aircraft Corp.'s Dayton, O. representative to handle military relations and engineering.

R. B. Young has been appointed general mgr. of Aerojet-General Corp.'s liquid rocket plant at Sacramento; **Dr. John V. Atanasoff** has been named resident mgr. of Aerojet's Ordnance Engineering Div. at Frederick, Md.

COLE

L. E. Dalton was elected vice president in charge of manufacturing for all divisions of the Kelsey-Hayes Co.

Herman J. Pelkey has been named plant mgr. of the Kellett Aircraft Corp.

Robert A. Cole, supervisor of computation and data processing for Boeing Airplane Co.'s Bomarc project since its inception, has joined Tally Register Corp. as chief engineer.

Dr. James E. Shepherd will direct Sperry Gyroscope's Electronic Tube Div. to be located at Lake Success, N.Y.

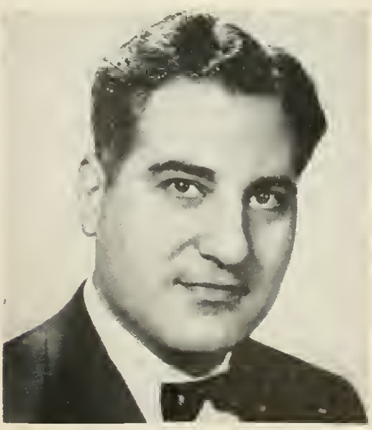
A. A. Demetriou is in charge of new office at Huntsville, Ala., to represent Northrop Aircraft and subsidiary, Radioplane Co., at Redstone Arsenal.

Andrew A. Nargizian, a pioneer member of the World War II Manhattan Project, has been appointed assistant to the president of Avion division of ACF Industries to coordinate missiles systems activities at the Avion plants in Paramus, N. J., Alexandria, Va., and Los Angeles.

Carl W. Bollum, Sr., former deputy chief of the Army Ballistic Missile Agency's Washington Office, was named engineering asst. to the general mgr. of Fairchild Guided Missiles Div.

Douglas B. Nickerson has been appointed chief engineer of Hydro-Aire, Inc., replacing **Richard M. Degen,** resigned. **Lt. Gen L. C. Craigie** (USAF, ret.) has resigned as vice president-engineering of Hydro-Aire but will continue to serve as a director and consultant.

Richard L. Bean has been appointed public relations mgr. of Lockheed Aircraft Corp.'s California Div., succeeding **William R. Wilson** who has been assigned as director of market development in Lockheed's expanded aircraft sales organization.



NARGIZIAN

Raymond J. Condon has been appointed vice president in charge of government projects for Minneapolis-Honeywell, with headquarters in Washington, D.C.

Stanley W. Burriss and **John H. Carter** have been named managers of the weapon system organization, Lockheed's Missile Systems Div., at Sunnyvale and Palo Alto, Calif. respectively.

Richard B. Gulliver has been appointed mgr. of industrial relations of the Fairchild Guided Missiles Div., replacing **Lynn G. Walck,** resigned. **John W. Robinson** has been named public relations asst. for Fairchild Engine and Airplane Corp.

Dave N. Peterson, formerly executive advisor to vice pres. **Stan Smithson,** has been named facilities administrator for North American Aviation's Missile Development division. **Norman P. Hays,** retired Air Force colonel and formerly chief of the Armament Laboratory's Strategic Bombing Branch, was appointed asst. to the gen. mgr. of the Autonetics division. **Robert J. Clark** has been named mgr. of North American's new European office in Geneva, Switzerland.

BOLLUM

C. A. Gongwer, co-inventor of the MiniSub, has been appointed to the new Large Solid Propellant Rocket Advisory Committee of the Aerojet-General Corp.

Donald E. Brown has been appointed chief engineer of Consolidated Electrodynamics Corp.'s Glendale div.

Under a new setup at Northrop Aircraft, Inc., **Robert R. Miller,** vice president and gen. mgr. of the present company, becomes corporation vice pres. and gen. mgr. of the Northrop Div., embracing the company's aircraft and missile facilities; **Dr. William F. Ballhaus,** chief engineer of Northrop, was elected vice pres. and chief engineer of the Northrop Div.

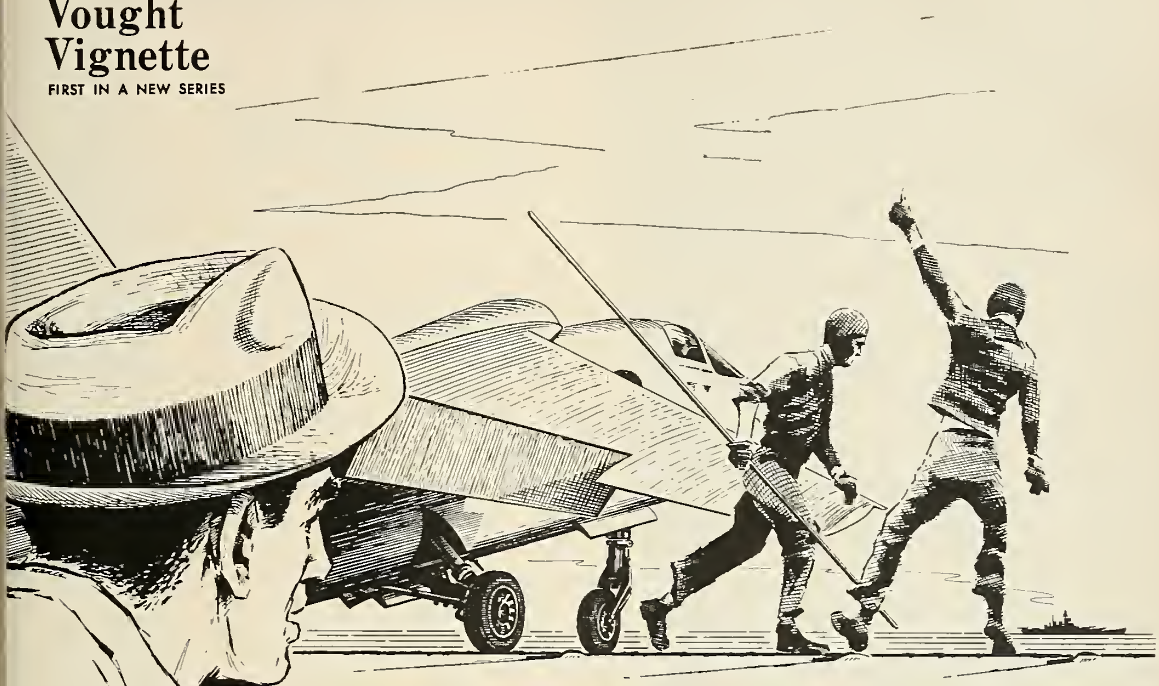
Charles E. Arnold has been appointed mgr. of the Avionics Laboratory of Sylvania Electric Products Inc. and **Frederick J. Anderson** is assistant mgr.

Frank M. Viles, Jr., has been named vice pres. in charge of manufacture of semi-conductors of Federal Telephone and Radio Co., a div. of International Tel. and Tel. Corp.

George H. McKaig is the new mgr. of production planning and **James T. Jones** has been named mgr. of production engineering at Hughes Aircraft Co.'s manufacturing div.

A Vought Vignette

FIRST IN A NEW SERIES



The Aircraft Designer Who Went to Sea . . .

IT WAS A ROUTINE CRUISE for the *Bon Homme Richard*. But for Wayne Burch, it was a memorable climax to months of hard work. Aboard the carrier with the Chance Vought design specialist was the white-lacquered fighter he'd worked on so long.

★

Wayne had joined the Crusader dayfighter project in Preliminary Design, on alighting and arresting gear. He'd transposed his initial drawings into detail design and, later, he'd watched his gear pass jig and aircraft drop tests. At the Navy Test Center, the Crusader's gear absorbed maximum sink speeds and arresting tension, and Burch once more was there.

★

Now, Navy pilots on the *Bon Homme Richard* were taking the Crusader to sea, and Burch was going along. This time his assignment was simply to watch, and this time the Crusader was to be just part of the picture. Vought wanted him to experience carrier life and to see how his new weapon fitted in. For Wayne, whose sea log began and ended with one day's fishing from a 20-foot launch, it promised to be an eye-opening voyage.

For six days the designer shared quarters with Navy fighter pilots and had coffee with maintenance men. He studied aircraft spotting and catapulting, and he learned the sign language of the LSO (Landing Signal Officer). He marveled at the fingersnap timing of the Navy's deck handlers and at the *Bon Homme Richard's* mid-voyage refueling of two bobbing destroyers.

★

Wayne calls it "one of the most enjoyable weeks of my life" . . . and, as other sea-going Vought engineers have discovered, "one of the most profitable, too.

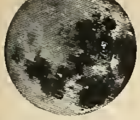
"Now I know the pilot's job, what maintenance wants . . . how really big the operation is.

"It's something you don't get if you stick too close to design.

"I guess you'd call it *perspective*."

At Chance Vought the designer stays in touch with his product . . . Contact begins in development, extends through test and includes, when possible, a study by the designer of the tactical environment in which his weapon will serve.

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS



Missile Miscellany

An old and thinking friend who actually doesn't wish to quarrel with Einstein has a question about a clock at speed that goes slower: "According to Relativity, the clock in motion can be considered at rest, and the clock at rest, in turn, can be considered to be in motion. Doesn't this raise the possibility that when the journey's finally over and the two clocks are back together, each will be slower than the other?"

Relativity also requires the equivalence of gravitic and inertial mass. If so, explain why a gravity pendulum with a bismuth bob gains one beat in 17.432 by another pendulum of exactly the same oscillation length having a zinc bob; and why torsion pendulums act similarly.

And out of Chicago, an industrial designer with some engineering knowhow feels the "blasting off" rocket is about as primitive as a Chinese firecracker, and as close to what a space ship will look like as the ornithopter was to the airplane.

A rocket engineer cloud-walking the recent space-flight symposium figures berrylium liquid propellants may result in a 0.96 mass ratio and a practical two-step moon vehicle . . .and from elsewhere, recent reports of exotic additives to solid propellents. This page also hears of concern over the possibility of radiation damage to rocket fuels at high altitudes . . . And then, there's the AF major who wants to transport ice and water from Jupiter to Venus so as to make the latter inhabitable.

Navy, researching a way to make domesticated algae do a quicker conversion job of CO_2-to-O_2, is bothered by algae who shade their brothers from light source—wonders how to "mix light in" with little fellows. Is this for permanently submerged atomic submarines, or space ships?

This page too has its "authoritative sources", one of whom tells that in exchange for missile knowhow and hardware, Britain will supply U.S. with IRBM bases.

Overheard from a disgruntled radar operator dangling his toes in the blue Pacific: "A Regulus launched from a submarine made it unscathed to target through combined coastal defenses". . . . This page also learned that some one finally thought of podded tanks for extending range of the air-breathers now in service . . . a sound system expert with a 25-year interest in rocket mail reports that Italy last year issued a stamp with a satellite circling the world . . . of Wernher von Braun's products, this comment from a major missile component supplier: "—cast iron products that look like flying washing machines, but practical" . . . a reference to the Pentagon as the puzzle palace from a Navy combat count-downer . . . while lunching, an aerodynamicist after a frustrating morning trying to rationalize Reynolds numbers, laminar flows and transfer heating rates concluded: "What we're trying to do is sphere the cylinder". . . . with all the talk of hyperthermantic flight, an industry PR who knew no better asked why we don't take aerodynamic heat into the vehicle and put it to work . . . then we met a grinning structures man who's discovered that epoxy-resin bonded fibre-glass now does many hot missile jobs with ease . . . not long ago a Redstone with delusions of Jupiter went 500 miles . . . an Army missile general figures if he waits Wilson will— . . . and in memoriam, acknowledgement to Chinaman Wan-Hoo: about 1200 A.D. he rigged 47 war rockets in fatal attempt at powered flight . . .

INDUSTRY SPOTLIGHT

By Joseph S. Murphy

Plastics Mold Missile Age

A carrying case at 150 feet from ground zero survives an atomic blast virtually undamaged . . . A guided missile nose cone stands the heat and friction generated at three times the speed of sound . . . A vibrating conveyer's springs take 10 million cycles without failure.

These are some of the wonders of reinforced plastics, the 12-year old industrial youngster which is helping smooth the way for the missile age.

Over 1,200 business and industry representatives from a dozen countries looked over the latest offerings of the reinforced plastics industry at its 12th annual Exhibit and Conference in Chicago early in February. The displays showed clearly why almost 140 million pounds of reinforced plastics were consumed in 1956—almost a third more than 1955. A similar rise is expected in 1957.

The versatility of the material, a combination of plastic resin and reinforcing material, seems limitless: from fishing rods to electronic equipment to railroad boxcars. It goes into pleasure boats, patio roofs, sports car bodies, air conditioner housings and tooling.

The aircraft industry ate up 20 per cent of the industry's output in 1956, followed by the construction industry with 16 per cent. The remainder was divided up as follows: boats 16 per cent; consumer products such as luggage, sleds, etc., 10 per cent; automotive, 8 per cent; containers, trays, tanks, 5 per cent; appliances such as laundry tubs, refrigerator liners, water softener housings, etc., 5 per cent; miscellaneous, 20 per cent.

Although polyesters still make up the bulk of the resin used in reinforced plastics, others are moving in: epoxy resin, low pressure phenolic, polystyrene, silicones, melamine, vinyl. Of the 140 million pounds of reinforced plastics sold in 1956 resins accounted for half with reinforcements and fillers making up the remaining half. Breakdown of the resins: 65 million pounds polyesters, 4 million—epoxies, half a million—phenolic and the remaining half million divided among silicones, polystyrene, melamine and vinyl.

The production of polyester resin has jumped from 3½ million pounds in 1945 to 71 million in 1956.

This year's exhibit made a big play for the consumer, displaying a large number of new products currently in mass production:

Streamlined super-market check-out counters (one is being molded every 2½ minutes with more than 7,000 already produced); lightweight translucent silo covers (the potential is thought to be in six figures); outboard cruisers (40,000 reinforced plastic boats in 1956); record players, adding machines, parcel post scales, hammer handles that would take 3,000 pounds to separate from their heads; a sports car with plastic components.

The conference stressed the growing importance of the industry in the electronic equipment field. Increasingly small parts molded of reinforced plastics premix and molding compounds are finding their way into automotive and electronic equipment. More and more, the missile industry is also turning to plastics of different types to fill its exacting and various needs.

A 74-frame color slide film and script, "Designing with Reinforced Plastics," is available for $15 from the Public Relations Department, Society of the Plastics Industry, Inc., 250 Park Ave., New York 17, N. Y. The film probes the uses of reinforced plastics in a wide variety of industries.

Kemsco to Specialize In Cryogenics Field

Kemsco, Inc. of Santa Barbara, Calif. his discontinued manufacture of maritime supplies and will devote future operations exclusively to the field of cryogenics (low temperature), according to its new president James K. La Fleur.

First major missile item it will build is a high-pressure stainless steel reciprocating pump of special design to handle liquid oxygen and nitrogen. It is intended for use at test centers and operating bases in pressurizing missile fuel chambers.

The Kemsco low temperature pump, first of which was due to enter service last month, is designed for a maximum pressure of 10,000 psi and normal operating pressure of 5,500 psi at a flow of 5 gallons per minute.

According to La Fleur, the company has equipped itself for engineering, development, modification and testing of all equipment to be used for low-temperature service. La Fleur was formerly associated with The Garrett Corp. and was chief engineer of Wall Cryogenics before joining Kemsco.

Rototest Opens Facility For 'White Noise' Testing

First independent commercial "white noise" test facility, capable of simulating the noise spectrum of jet and rocket engines up to 150 db, has been opened by Rototest Laboratories, Inc. at Lynwood, Calif.

White noise, an acoustics term that refers to all-frequency testing, is distinguished from discreet noise which refers to a given frequency.

The new Rototest facility is designed to test aircraft and missile components and equipment to the 150 db sound level intensity and produce it over a cross sectional area of 64 sq. in.

According to Rototest, at least three missile producers—Convair, Boeing and Bell—already have included "white noise" test requirements in their specifications for certain components. Company officials also said this type testing is expected to become a standard requirement of the military services in the near future.

New Supersonic LAB Under Construction

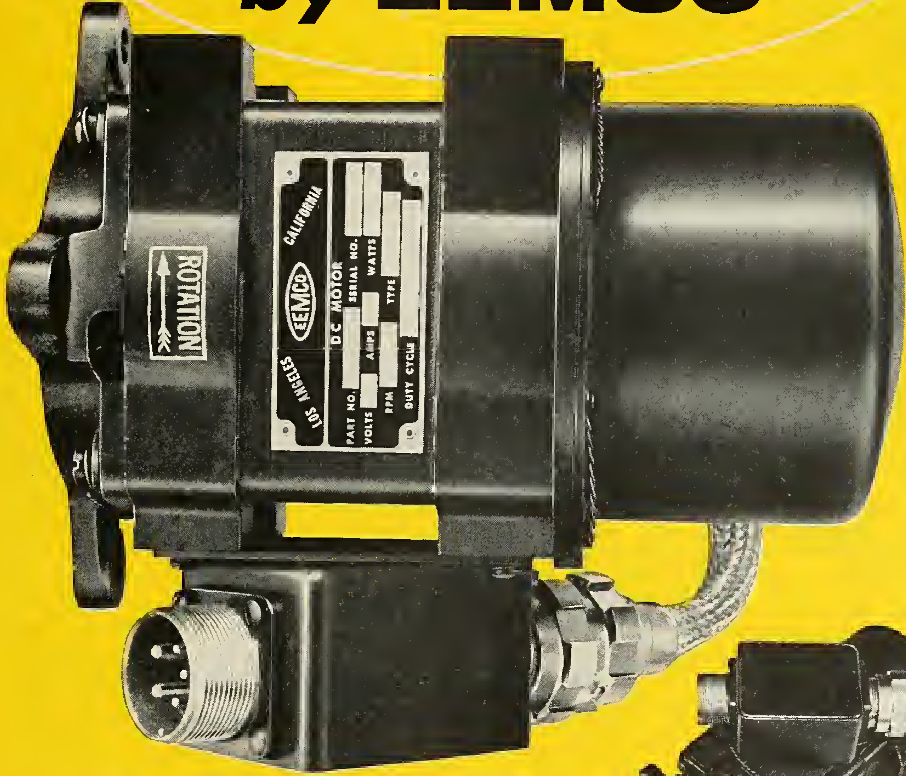
New supersonic combustion laboratory being built by Fairchild Engine Division, Fairchild Engine and Airplane Corp., is expected to be completed by mid-May. It will be used for experimental work in aerodynamics and thermodynamics.

Avco Builds R&D Center

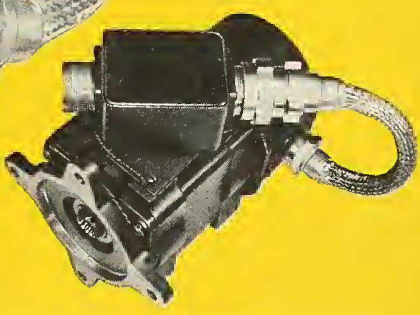
Avco Manufacturing Corp. last month broke ground for Wilmington, Mass. for the $15 million R&D center of its Research and Advanced Development Division. Company expects new facility to be in full operation by mid-1958.

Here's another

New DC Motor by EEMCO



Type D-932, designed and produced as an alternator drive for a 400 cycle supply on a new missile.



EEMCO Type D-932 DC motor operates continuously at a regulated speed of 12,000 rpm, plus or minus ½ of 1%, under the following varying conditions:

From .5 HP to 2.6 HP with a terminal voltage of 27.5 DC, plus or minus 1.5 volts.

The constant speed of 12,000 rpm is maintained by a frequency regulator that supplies the control field of the double-field stator of the motor. Type D-932 has an internal spline, and can be supplied with or without a radio noise filter, which is shown in the illustration.

Type D-932 is another in the series of new AC and DC motors being custom designed and produced currently by **EEMCO** for the latest missiles and supersonic jet aircraft. In fact, there is an **EEMCO** motor or actuator system on the majority of such new weapons now in production or projected for use by our Armed Forces.

This, we believe, is an expression of confidence in **EEMCO**, which for the past 15 years has specialized exclusively in the design and production of motors and actuators, both linear and rotary, for prime and subcontractors in the aircraft industry.

SPECIFICATIONS FOR TYPE D-932

Type: DC motor for alternator drive for 400 cycle supply on a missile.
Speed: Continuous at 12,000 rpm, plus or minus ½ of 1%.
Speed Control: By frequency regulator supplying control field.
Load: From .5 HP minimum to 2.6 HP maximum.
Terminal Voltage: 27.5 DC plus or minus 1½ volts.
Weight: With radio noise filter—13.9 lbs. Without same—12.4 lbs.

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DESIGNERS AND PRODUCERS OF MOTORS, LINEAR AND ROTARY ACTUATORS . . . EXCLUSIVELY!

Industry Highlights

By Fred S. Hunter

Some 80 past and present associates of Dr. W. B. Klemperer, chief scientist for the missiles engineering department at Douglas, organized a surprise dinner to observe his 20th anniversary with the company in a fitting and proper manner. Klemp is an old Zeppelin man who has been through a lot since then and the party brought out considerable reminiscing. Such as how before World War II the Douglas company began to give consideration to the intercept problem and put Klemp to work on it. He came up with a big fat report that Douglas thought a highly intelligent piece of work. It was so good Douglas decided Wright Field should be given the opportunity to see it. Wright Field liked it too. So much so it promptly slapped a great big secret stamp on it. Yep, they had secrets in those days, too. After that no one at Douglas was allowed access to the report, including Klemp himself.

The Klemperer dinner reminded Bernard Benson, president of Benson-Lehner Corp., of the early days of missile firing. First, they chased the cows off the range. Then they touched a few wires together and counted one, two, three—GO! "That was before we learned to count backward," grinned Benson.

•

Magnitude of an ICBM test program is illustrated by the fact that Convair has had personnel assigned to the Air Force Missile Test Center at Patrick AFB since 1953, where one of these days, now four years later, the *Atlas* will be launched over the range extending out into the Atlantic. By the time Convair is up to full-scale test operations on the *Atlas* it will have a payroll of 450 people at Patrick. Convair also has had test personnel at the Edwards Rocket Base in California since 1955, two years, working on the test program for the *Atlas* power plants.

North American's engine test site at Santa Susanna represents another example of what rocket testing entails. Rocketdyne has 19 test stands at Santa Susanna and averages one test per stand per shift (2) per day. It uses 250,000 feet of oscillograph paper a month and 300,000 feet of magnetic tape recording the data.

Little things add up: Lockheed Missile Systems division saved 1000 man-hours on a mockup job by switching from plaster to stryofoam, a lightweight plastic that can be cut to any shape and then solidified by an overcoat of plastic-painted glass cloth. A safety committeeman at MSD observed that constant hammering broke down the surfaces of blunt-edged chisels, leaving sharp rough ends that chipped off into flying bits of steel that imbed themselves into workers' fingers, hands and arms. He suggested that chisel tops be kept round and polished. An inspection turned up only one that did not need repolishing.

•

Engineering data unit at Atomics International has replaced the standard file cabinets formerly used by engineering drawings with an open library-type steel shelf rack. Boyd Corwin, unit supervisor, estimates the 12 x 7 ft. open rack takes the place of 20 file cabinets, a saving of 50% in floor space and a substantial amount in equipment cost. Filing is easier, so handling time is reduced.

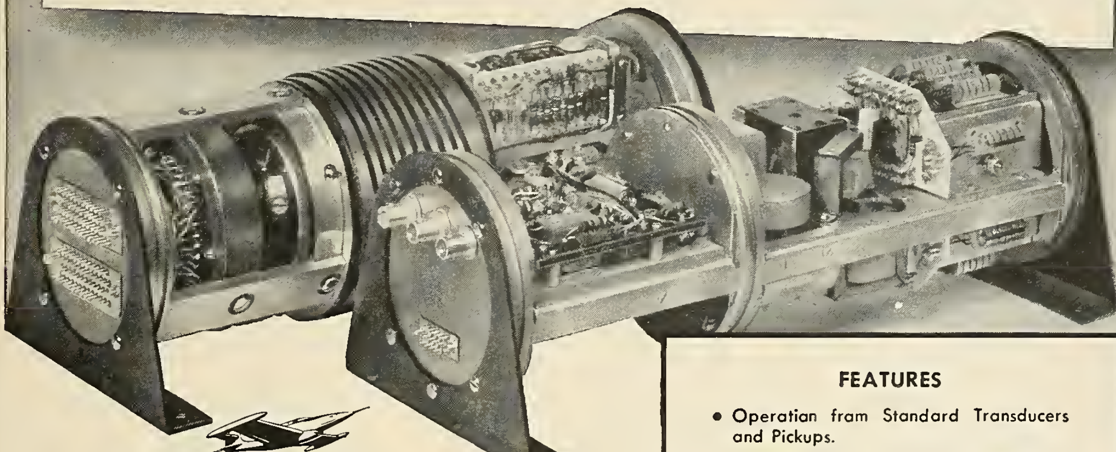
•

Tripling of Northrop Aircraft's Torrance facility is related to growing projects on the intercontinental Snark . . . Marquardt Aircraft netted a substantially increased profit in 1956, but Roy Marquardt says the earnings will be reinvested in the business to pay for future growth.

NEW FROM ASCOP

LOW LEVEL PW MULTICODERS

Open a Whole New Field of Mobile Instrumentation!



Announcing a ***NEW*** *Line of*

SUPERSENSITIVE PW AIRBORNE EQUIPMENT

For Remote Measurement, Recording, Transmission

The new ASCOP D Series PW Multicoders provide, for the first time, supersensitive, low-level remote measurement of data from airborne vehicles. The extremely high input sensitivity, fast sampling rate, and wide selection of data channels (up to 88) of these new Multicoders . . . together with their critical accuracy, ultra-high altitude pressurization, and rugged design . . . suit them ideally to today's most important testing and prototype applications involving recovery and repeat use.

Provides A Complete Data System

The new ASCOP Multicoder, combined with ASCOP M Series Ground Station Equipment and suitable transmission or recording equipment, constitutes a complete data handling system that is easy to operate, flexible in application and provides simplified real time reduction. ASCOP also produces a complete line of PW Data Systems and equipment, Telemetering sets and High and Low Speed Rotary Sampling Switches. Contact ASCOP regarding your present program *today*.

FEATURES

- Operation from Standard Transducers and Pickups.
- Operation from Low-level Transducers.
- Recording and transmission of up to 88 data channels.
- Ease of data reduction.
- Pressurized for very high altitudes

SPECIFICATIONS

- **Input Sensitivity:** 0-15 mv or 0-30 mv
- **Input Circuit:** Differential balanced to ground
- **Data Channels:** 43 or 88
- **Sampling Rate:** 20 or 10 samples per second per channel
- **Output:** Standard pulse width
- **Power Requirements:** 115V, 400 cycles

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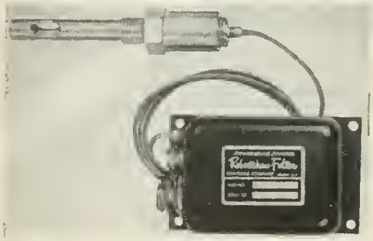
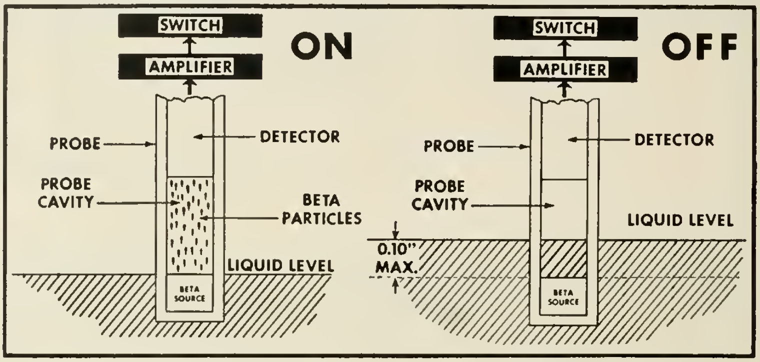
NEW MISSILE PRODUCTS

Robertshaw-Fulton Unveils Liquid Level Switch





A 9-ounce liquid level switch which utilizes radioactive means to sense and control fuel levels in supersonic aircraft and missiles has been unveiled by Robertshaw-Fulton Controls Co. The system consists of a 2-oz. ½ x 4¼ in. probe and a 7-oz. 3¾ x 2 5/16 x 1¼ in. transistorized amplifier of rugged construction to meet aircraft and missile needs.

The sensing probe contains a hermetically-sealed beta source and a beta detector (geiger mueller tube) mounted inside the fuel tank or cell. These are separated by a small cavity into which the liquid flows.

When no liquid is present, radioactive particles pass from the source to the detector; when liquid enters the cavity, the radioactive particles are absorbed and the radiation level is reduced.

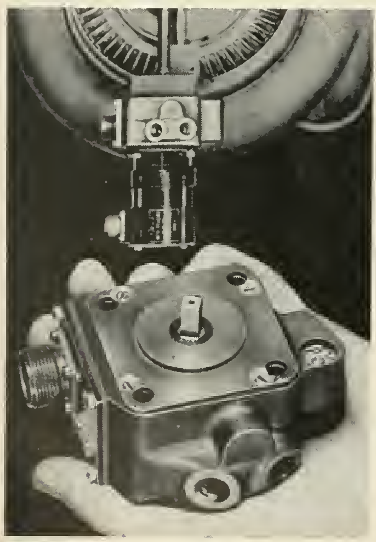
The R-S system converts this change in radiation to an electrical signal, amplifies it by a transistorized circuit, then actuates a relay that is used to energize warning lamps, valves or servo motors to correct the fuel distribution on the aircraft or missile.

Company officials place the signal response time at about 1/20th of a second and its accuracy at —1/10 in. whether liquid level is rising or falling. Switch works on 28 volts d-c at 0.05 amps.

Circle No. 225 on Subscriber Service Card.

SPEED GOVERNOR

A new speed governor and tachometer switch proposed for a variety of



applications in aircraft, drones and missiles has been introduced by The Lee Co.

Essentially a "droop" type governor with a 7% permanent droop, the Lee development has been designed for direct throttling of a propellant to a gas generator and has been used for throttling of JP-4 fuels on small jet engines.

Company officials, however, visualize its potential as a speed regulator on auxiliary power units, overspeed protection device for turbo pump sets, and for sequencing and control of remotely operated engines as on drones or air-launched missiles.

The governor weighs about 1 lb. and measures 3.18" x 4.31" x 1.71" overall.

Circle No. 204 on Subscriber Service Card

ROCKET TEST STAND

Aerophysics Development Corp. subsidiary of Curtiss-Wright Corp. has developed a vertical balancing machine capable of dynamic balancing of rocket motors, rotating launchers, and turbo machines weighing up to 5,000 lbs. in weight.

It is said to handle rocket motors with thrust ratings up to 20,000 lbs. and diameters up to 36 in. Turbo machines or components, such as flywheels, can be accommodated at dimensions up to 10 ft. in length and speeds of 10,000 rpm.

According to ADC, rotating units weighing several hundred pounds have been balanced to an accuracy of about 1,000,000th of a radian. Experience showed that test and correction cycle could be completed in about one hour.

The new balancer will also measure dynamic unbalance of a spinning rocket motor when shut down or firing. In addition, with slight changes in suspension system, it can be adapted for measuring jet misalignment of rocket motors ranging in capacity from 100 to 20,000 lbs. thrust.

Circle No. 206 on Subscriber Service Card

LOW-NOISE BLOWER

Turbo Research Corp. has developed the Model 101 centrifugal blower intended to fill the gap in pressure range between previous centrifugal and axial types used in aircraft and missiles.

The Model 101, featuring a drastic reduction in noise levels, is rated to deliver 1300 cu. ft. of air per minute at 8,000 rpm against a discharge head of 4 psig. Literature available.

Circle No. 208 on Subscriber Service Card

CARTRIDGE-ACTUATED CUTTER

Aerojet-General Corp. has introduced a new cartridge-actuated cutting device that weighs only one pound and occupies 7.5 cu. in. of space for airborne use in severing aircraft and missile system lines.

The Model AGX-1800 Aerocutter, as a typical example, is designed to sever four stainless steel tubes of ¼ in. diameter and .035 in. wall thickness while they are pressurized to 150 psi with corrosive fumes.

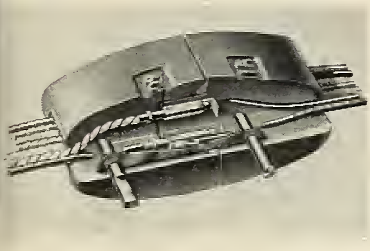
As an added feature, the unit will

cut the tubes so that one end may vent to ambient pressure and swage the other against an anvil to seal it and prevent further flow. It is fired by an electrical impulse which actuates a non-corrosive propellant and may be reloaded for repeated use.

In addition to airborne applications, the company proposed use of the Aerocutter in safety systems for nuclear reactors, as well as for hydraulic or pneumatic devices and mobile ground equipment.

Circle No. 207 on Subscriber Service Card

MISSILE CONNECTORS



New series of electrical connectors which feature the molding of insulation directly onto contacts and leads has been introduced by Alden Products Co.

The new design, intended for use in fool-proof, tamper-proof cables for critical aircraft and missile operations, calls for molding of contacts and leads with one hot shot of connector insulation into connector bodies arranged integrally within their cables.

Among special IMI (integral molded insulation) connectors unveiled by Alden is an umbilical disconnect for missile use.

Circle No. 214 on Subscriber Service Card

PROPELLANT PUMP

A new ball-piston type missile fuel pump designed for handling low viscosity, low-lubricity, highly corrosive propellants such as normal propyl nitrate has been announced by General Electric Co.'s Aircraft Products Dept.

At 260°F, the GE pump is rated to deliver 0.50 gallons of propyl nitrate per minute. In addition, GE states, use of corrosion resistant materials in its construction makes the pump suitable for high-temperature operation with many other exotic missile fuels.

Circle No. 205 on Subscriber Service Card

MISSILE RECORDER

A miniature magnetic tape recorder, already used to secure skin temperature data in high-speed, high-altitude flights of Aerophysics Development Corp.'s HTV (hypersonic test vehicle) has been introduced by North American Instruments, Inc.

The new units—weigh 2¼ lbs. and measure 4 in. in diameter by 5 in. high making them ideal for use in collecting aerodynamic data from missiles too small for conventional telemetering equipment.

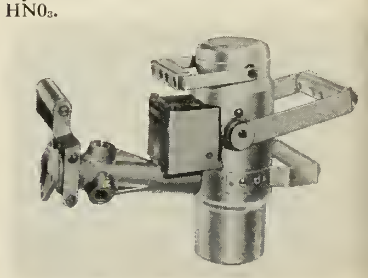
According to E. Bollay, NAI president, a single recorder has been recovered and reused eight times in missile tests to date at Holloman AFB, N. Mex. In all, company officials say some 12 different firms are using the units in rocket and missile testing.

Circle No. 213 on Subscriber Service Card

ACID TRANSFER NOZZLE

A missile oxidizer transfer nozzle developed by Lear, Inc., Lear-Romec Division, is designed especially for handling fuming nitric acid and is rated for operation at temperatures extending from —65° to +140°F.

The Romec nozzle, designated Model RR13110, meets requirements of Spec. MIL-N-25556 and uses only the purer aluminums and special stainless steel alloys to resist the corrosive action of HNO_3.



Normally, two nozzles are needed to transfer liquid propellants or oxidizers from the supply tank to the missile—one for filling and the other for venting the tank. The Lear nozzle provides a teflon gasket flange to which the vent or fill hoses are attached.

The Model RR13110, which is rated to handle a flow of 100 gallons per minute, incorporates two safety interlocks in its construction. The first prevents inadvertent opening of the flow control valve before the nozzle is attached and locked to the adapter on the missile tank; the second prevents unlocking nozzle from adapter while the flow valve is open.

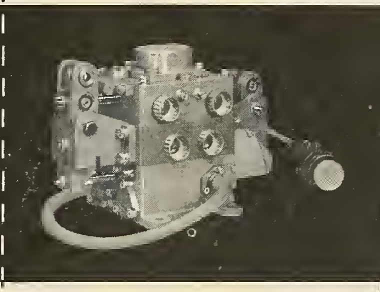
Lear-Romec also produces Model RD13040 adapters used on the missile tank and servicing trailer in conformance to Spec. MIL-A-25555. Literature available.

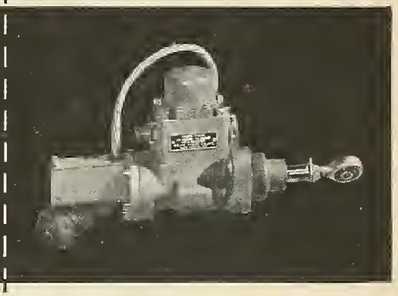
Circle No. 209 on Subscriber Service Card

From MOOG . . . Advanced Electro-Hydraulic Servo Components

Moog is the industry's leading producer of electro-hydraulic servo valves. This leadership has been achieved by advanced valve design resulting in high performance, high quality, reliability and efficient manufacture. The same creative approach applied to industry's newer problems has resulted in the introduction of Moog Dual Input and Servo Actuator units.

These recent achievements in the creation of advanced custom designed electro-hydraulic servo components are evidence of Moog's continuing progress.





SERVO VALVE

• These proportional "dry motor" electro-hydraulic servo valves feature high dynamic response, sensitivity, linearity and reliability. Light-weight and compact, they are also available in custom designed versions for special or advanced applications.

DUAL INPUT SERVO VALVE

• This new component provides for positioning of aircraft control surfaces by summing mechanical and electrical inputs without external use of mechanical linkages. Use of an entirely new concept offers improved performance, system simplification and saving of space and weight.

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• Custom designed integrated assemblies include actuating cylinder, electro-hydraulic servo valve and feedback sensing device. In a closed loop, actuator displacement is a function of input signal.

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4. Automatic ac ranging from 30 to 10,000 cycles!
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2. No modifications required for operating printers, IBM Punches, etc., or for combining with auxiliary E-I input modules or instruments.
3. All contacts readily accessible at rear panel on connectors.
4. With auxiliary plug-in modules, digitized data is provided in printed form, punched cards or tape with **no** modification to basic measuring instruments.

Circle No. 44 on Subscriber Service Card.

BASIC MODULES

Universal Power Module, Models DXA-000 or DXB-000

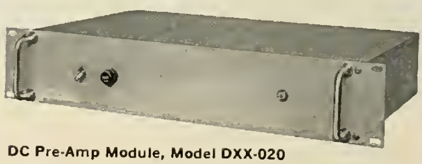
Supplies *all* power and reference voltages for other E-1 modules. Power and reference supplies and stepper drive amplifier are transistorized. Powers one or more modules.

Calibration: Automatic
Reference Stability: 0.01% from 40° to 125° F.
Input Power: 115 volts, 50 to 400 cycles.
Write for Bulletin 175-1

DC Switch Module
Model DVX-400: 4 digits; **Model DVX-500:** 5 digits

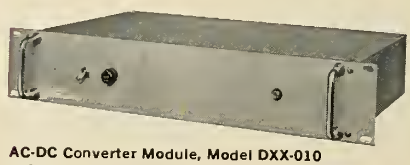
Contains Digital Potentiometer. Provides visual in-line read-out of digits, polarity, decimal point. All contacts accessible at rear panel connector. Front and rear panel input connectors. Power supplied by Universal Power Module.

Write for Bulletin 175-2



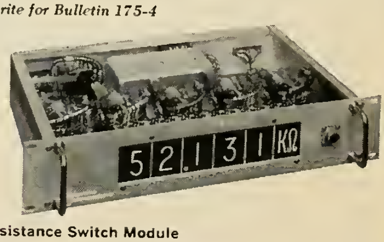
DC Pre-Amp Module, Model DXX-020

Input: 1 range scale, gain of 10.
Output: 0.0001 to .9999 volts. **Linearity:** 0.01%.
Gain Multiplication Accuracy: 0.01%.
Input Power: 115 volt, 50 to 400 cycles.
Drift: 10 microvolts per hour.
Write for Bulletin 175-5



AC-DC Converter Module, Model DXX-010
A fully transistorized AC-DC converter.

Accuracy: 0.1% of reading, or 2 mv.
Frequency Response: 30 to 10,000 cycles.
Range: .0001 to 999.9 volts.
Zin, AC: 1 meg. on the 1 volt scale, 10 megs. on other scales; 20 mmf.
Ranging: Automatic. **Reading time:** 3 seconds, average.
Write for Bulletin 175-4

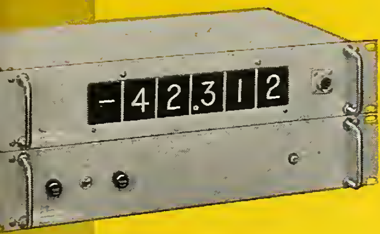


Resistance Switch Module
Model DOX-400: 4 digits; **Model DOX-500:** 5 digits

Contains balance circuit, bridge ratio arms. Provides visual in-line read-out of digits, range. All contacts accessible at rear panel connector. Power supplied by Universal Power Module.

Write for Bulletin 175-3

Using E-I's new, transistorized, modular design, any precision instrument for measuring DC, AC-DC, Ohms, DC and AC ratios can be constructed from basic units!



DC Digital Voltmeters

specifications	Model DVA-400 (Combines Universal Power Supply, Model DXA-000, and Model DVX-400 Modules.)	Model DVA-500 (Combines Universal Power Supply, Model DXA-000, and Model DVX-500 Modules.)
Display:	4 digits, plus or minus, decimal point.	5 digits, plus or minus, decimal point.
Accuracy:	±1 digit.	±0.01%, plus or minus 1 digit.
Range:	.0001 to 999.9.	0.0001 to 999.99.
Automatic Features:	Ranging, polarity.	Ranging, polarity.

(Adding the E-I Pre-Amp Module, Model DXX-020, increases sensitivity to 10 microvolts.)

DC RATIOMETER – Same modules as Voltmeter except uses external reference. Ratio range: 0.0000 to 1.0999.

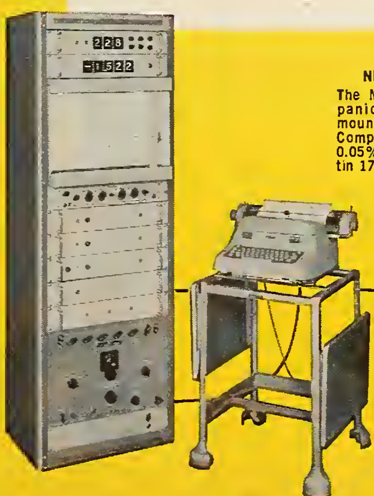
AC-DC Digital Voltmeters

specifications	Model DVA-410	Model DVA-510
DC Specifications:	Same as Model DVA-400.	Same as Model DVA-500.
AC Specifications:	Same as Model DXX-010.	Same as Model DXX-010.

(AC RATIOMETER combines Model DVA-400, with two Model DDX-040 or Model DXX-050 Modules. Ratio range is 0.0000 to 1.0999.)

Digital Ohmmeter

specifications	Model DOA-400 (Combines Model DXA-000 and DDX-400 Modules.)	Model DOA-500 (Combines Model DXA-000 and DOX-500 Modules.)
Display:	4 digits.	5 digits.
Range:	Automatic, 0.01 ohms to 10 megohms.	Automatic, 0.01 ohms to 10 megohms.
Accuracy:	0.01 to 0.1%.	0.01 to 0.1%.



OPERATING MACHINE READ-OUTS
Pictured here is a typical Automation System constructed with standard E-I modules. This system automatically scans and measures 400 channels of AC and DC voltages with punched tape read-out. E-I Model 200 X-Y Recorder provides plotted data. With auxiliary plug-in input and output modules, complete custom data handling systems may be set up. Write for Bulletin 175-6.

NEW HAND-CARRY MODEL
The Mark IV is the ideal companion to the new E-I rack-mounted modular equipment. Compact, weighs only 25 lbs.; 0.05% accuracy. Write for Bulletin 170.

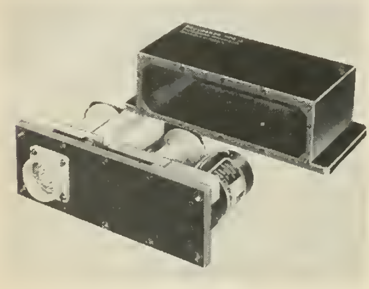
SEE THIS EQUIPMENT AT THE IRE SHOW, BOOTH #3614.

ELECTRO INSTRUMENTS
INC. 3794 Rosecrans, San Diego, California

NEW LITERATURE AVAILABLE—Write for new short form Bulletin 175 containing information about the new Electro Instruments modular design.

MULTI-CHANNEL PROGRAMMER

A small programming device, the MPR-13, provides up to 13 channels for electrical programming of either repeat or random cycling. Weight is 3 lbs. 10 oz. and size is 2 x 3 x 6 inches. The device uses a moving insulating tape marked lengthwise in time and divided into 13 channels through punched holes and slots in the tape.



As the tape is advanced contactors close for a period equal to hole size or slot length. A magnesium casting is used for low weight and high resistance to shock and vibration. The Photographic Products, Inc.

Circle No. 217 on Subscriber Service Card

MICROWAVE DIODE

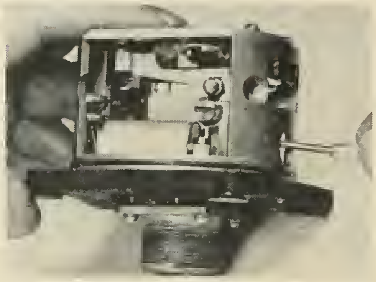
A silicon diode for use as a low-level detector in missile guidance, beaconing and telemetry has a theoretical tangential sensitivity of —53 dbm at 9000 mc for a receiver bandwidth of 10 mc.

Use of the MA-408B is said to give an improvement of 4-5 db when it replaces IN23C mixer crystals in low-level circuitry. For highest sensitivity a dc bias of +50 microamperes is recommended. The Microwave Associates, Inc.

Circle No. 216 on Subscriber Service Card

ACCELEROMETER

An accelerometer which has a caging mechanism to prevent wear when the unit is not in use offers accuracy to ½% and an operating temperature range from —50°C to 100°C. The caging mechanism of the new Series LA07-0100-1 is electrically released when it is in use.



Vibration from 10 to 2000 cps to 10g can be withstood and the device is shock-resistant to 40g or to 100g on special order. Rated linearity is 0.5 to 1.0%. Potentiometer pickoff is 500 to 20,000 ohms, and resolution to 0.15% is obtained. Humphrey, Inc.

Circle No. 218 on Subscriber Service Card

TRANSISTORIZED INVERTER

A dc to ac inverter with no moving parts has been designed to provide 300 va using transistors. Weighing 5.5 lbs. and occupying a volume of 96 cu. in. the new CW-1029 will withstand vibrations of 10g between 10 and 2000 cps.

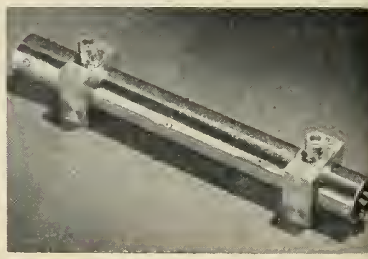
Use of the inverter is planned in the second stage of the Vanguard vehicle as a power supply for servos. Efficiency is rated as 60-70% with a harmonic content of less than 5%. Cooling is through the mounting base of the unit. Stability is within 0.2 cycles. The Electrosolids Corp.

Circle No. 215 on Subscriber Service Card

TRAVELING-WAVE TUBES

A new line of lightweight traveling wave tubes cover the range of 8-12 kmc and weigh 5-7 lbs. Weight includes a combined capsule and solenoid that reduces overall size and weight as well as minimizing power requirements for the solenoid.

Two of the eight tubes in the new



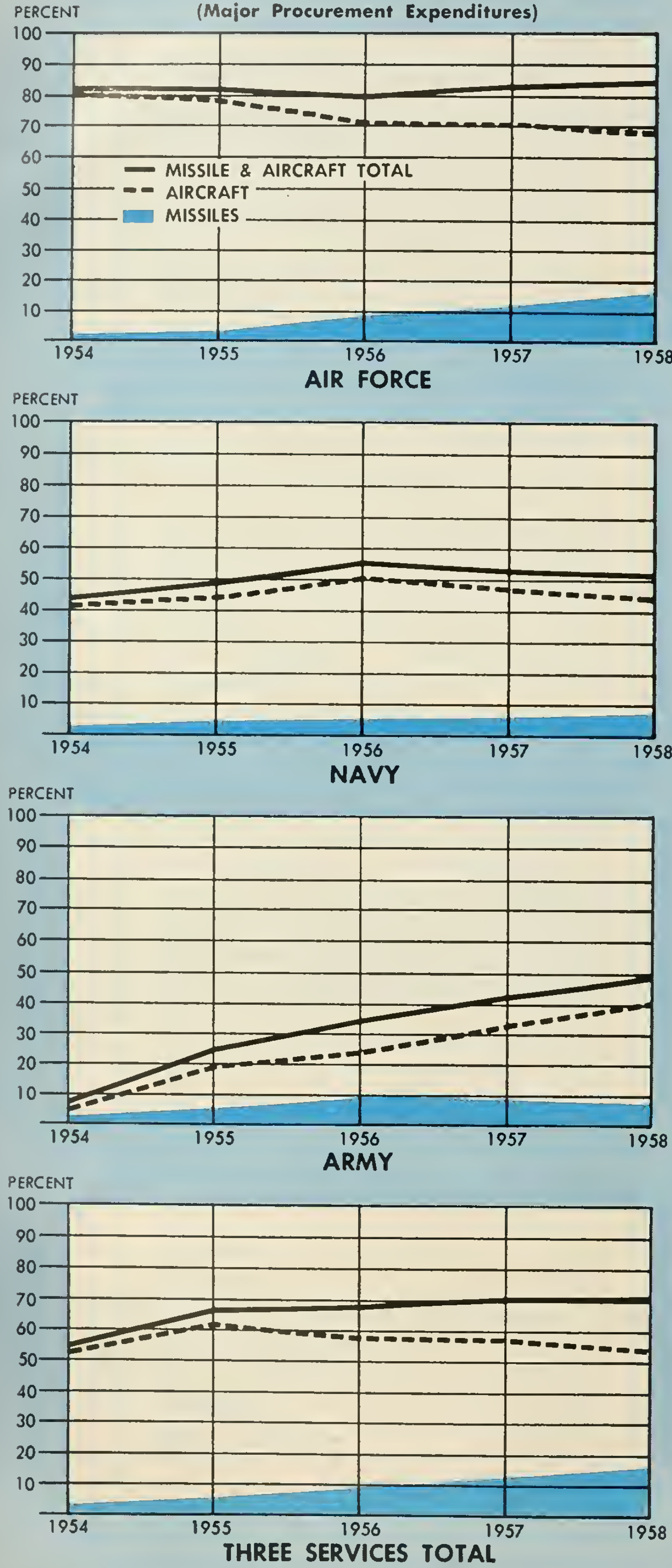
line cover 2-4 kmc with power outputs from 10 to 30 dbm and small-signal gains from 28-34. Two other tubes cover 4-8 kmc with 10-30 dbm outputs and signal gains of 30-32. Two others cover 8.2-12.4 kmc with outputs of 20-30 dbm and gains of 25-30. A similar series of tubes without the encapsulated solenoid have weights from 10¾ lb. to 20¾ lb. Geisler Laboratories.

Circle No. 221 on Subscriber Service Card

INDUSTRY BAROMETER

MISSILE-AIRCRAFT PERCENTAGES

(Major Procurement Expenditures)



An analysis of Defense Department expenditure estimates reveals that in fiscal 1958 about 17 per cent of major procurement and production funds will be spent for guided missiles. Thirteen per cent will go for missiles during fiscal 1957.

During FY 1956, approximately $10 out of every $100 spent by the three services for major procurement and production was for guided missiles. In 1951, the rate was only $.50 out of every $100.

Of the three services Army has had the greatest growth in missile expenditures. Spending for missiles equalled 25 per cent of major procurement expenditures in 1956, and in 1958 missiles will account for 41 per cent. The 1956 missile expenditure percentages for the Navy and Air Force were 5 and 9 per cent, respectively; and in 1958 they will be up to 7 per cent and 17 per cent, according to DOD estimates.

Major procurement and production expenditures include, in addition to guided missiles and aircraft and related procurement, money paid out for ships and harbor craft; combat vehicles such as tanks, infantry assault and armored vehicles; support vehicles—trucks, ambulances, busses; artillery, including anti-aircraft; weapons; ammunition; electronics and communications equipment such as radar, radiac and infrared, and meteorological equipment; and production equipment and facilities. Other items not classified elsewhere, but whose size, unit value, or procurement and production problems indicate inclusion under the general category of major procurement and production, are also accounted for in this category. Such items are railroad equipment, major materials handling equipment, construction equipment and special training devices.

Guided missiles, as a part of the major procurement category, include, in addition to the complete missile with integral armament components, expenditures for the following: launching, guidance and control devices, boosters and sustainers; propellants (other than standard petroleum fuels); special tools and ground handling equipment peculiar to the handling of missiles; unmanned aerial targets, excluding target drones used primarily for training. The missiles category excludes standard aircraft engines not procured for use on guided missiles, and missiles and components for research and development or still in the research and development stage.

Bell Applies New Microwave Power Find

First successful application of a recently discovered new source of microwave power has been achieved by Bell Telephone Laboratories.

Using what is known as the "maser" principle, a new electronic device using solid-state materials for radio energy generation and amplification was operated at Bell's Murray Hill Laboratories.

The "maser" was first demonstrated in molecular beams of gases in 1954 by Prof. C. H. Townes at Columbia University.

It means "microwave amplification by stimulated emission of radiation." The principle makes use of spinning electrons in a solid cyrstalline substance in the field of a strong electro-magnet.

Equipment used by Bell included a waveguide cavity containing the crystal. The whole assembly was immersed in liquid helium. The cavity has two resonant frequencies.

One was equal to the frequency of oscillation and the other to the energizing source. The crystal, paramagnetic salt diluted with a diamagnetic substance to reduce electron interaction, was located at the point of maximum field intensity—2,800 oersteds.

When a 17,500-mc energizing signal at about 100 milliwatts was brought into the cavity, the spinning electrons underwent a transition from one energy state to another and self-sustained oscillations occurred at 9,000 mc. Power output was 20 microwatts.

Bell scientists say the new oscillator has an attainable noise figure hundreds of times lower than presently available devices. This could result in development of new long distance communication systems.

In such uses the device could be easily tuned by varying the applied magnetic field and bandwidth would be around 100 mc.

AIA Hits Congress' Report On Recruitment

Aircraft Industries Assn., in a sharp rebuttal to Congressional criticism of costs in aircraft and missile engineering procurement, has charged that Navy Department figures were erroneously interpretated by a House group in arriving at its statistics.

Directing its comments at a report issued by the House Subcommittee on Manpower Utilization and Departmental Personnel Management, AIA officials explained that the fault rested with subcommittee calculations which based recruiting costs on net hires rather than on the Navy's system of gross hires.

Proper adjustment of figures cited by subcommittee chairman, Rep. James C. Davis (D-Ga.), would scale Davis' average cost of $1,317 per new employe down to the Navy figure of $808, AIA pointed out.

Citing an extreme example of the inconsistency of Congress approach, AIA asked what cost per new employe would be used if a firm spent $10,000 to recruit 10 new employes and in the same period lost 10.

The industry association also took issue with a comparison by chairman Davis of defense contractors and commercial business firms leading to a conclusion that the former spent more than 10 times as much for recruiting. AIA simply noted that the Congressman unfairly balanced the recruiting costs of 37 defense contract firms against similar costs of only 17 commercial firms.

Concluding its criticism, AIA noted that Congress took no testimony from industry in its investigation and urged that it confer with industry before launching any "corrective" program, as such action could have serious effects on the overall defense program.

Student Engineer Program Launched At Fairchild

Fairchild Engine Division, Fairchild Engine and Airplane Corp. has launched a cooperative student engineer program involving six major engineering schools to help alleviate the shortage of trained engineers.

The program is arranged to combine, in a five year span, four years of college education and two years of actual experience in aircraft powerplant design and development. Schools associated with the Fairchild program are Univ. of Cincinnati; Univ. of Detroit; Antioch College; Georgia Tech; Drexel Institute and Northeastern University. Project at Fairchild is being coordinated by T. F. Hammen, Jr.

Acme Gets AMC Award

Acme Precision Products, Inc. of Dayton, O. has received a $5,888,851 contract from Air Materiel Command for a new liquid oxygen plant.

An Announcement

OF FIRST IMPORTANCE TO EXPERIENCED ROCKET ENGINEERS AND SCIENTISTS

- *Reaction Motors initiating big new Research and Development Program*
- *Key spots offered to men who have already made a name for themselves in Rockets*

If you're one of the relatively few trained rocket men in America, your experience will pay off handsomely at Reaction Motors. The first rocket company in America, RMI is now entering its period of greatest expansion, a period that will see far-reaching developments in America's fastest-growing industry. Your participation in RMI's program during this crucial period is your best guarantee of leadership in the industry. In a job like one of those listed below you'll be strategically placed for both achievement and advancement.

1. Senior Design Engineer

Prefer ME or AE degree and a minimum of 6 years experience in aircraft engines or airframes. You should have extensive design experience, including plenty of board time, shop contact, structural design, stress analysis. You will be working directly with design engineers and layout draftsmen on design of light weight, complex structures.

2. Instrumentation Engineer

BS minimum in mechanical, aeronautical or electrical engineering; 3-5 years experience on aircraft engines. Must be familiar with the application of instrumentation to testing of rocket or other aircraft engines, the utilization of currently available instrumentation, or the modification and adaptation of such instrumentation for particular requirements and wide limits of flow temperatures, pressure, thrust, etc.

3. Stress Engineer

Degree in engineering or applied mechanics. Required experience in mechanical design with emphasis on stress analysis: 3 years for an engineer, to 6 years for the senior engineer. Must be able to handle and/or supervise involved analyses—including the effects of dynamic forces, high temperature gradients and high pressure differentials—under conditions where light weight is vital.

4. Project Engineer

BS or MS in ME, AE, or ChE—with at least 5 years experience in the design, fabrication and test of rocket thrust chambers, gas generators and ignitors. Project engineers also needed with background which includes knowledge of principles and problems associated with design, development and analysis of hydraulic or pneumatic power plant controls and systems.

RMI'S 6 MAIN PROJECT AREAS INCLUDE:

MISSILES • PILOTED AIRCRAFT • LAUNCHING DEVICES • GROUND SUPPORT EQUIPMENT • LIQUID AND SOLID PROPELLANT CHEMISTRY • NUCLEAR ROCKETS

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REACTION MOTORS, INC.

A MEMBER OF THE OMAR TEAM

50 FORD ROAD • DENVILLE, N. J.

Missile School Marks 4th Year

HUNTSVILLE, Ala.—One of the nation's most important but least appreciated defense agencies is observing its fourth anniversary here this month by getting a new name and putting the Army's new *Lacrosse* surface-to-surface and *Dart* anti-tank missiles on public view for the first time. In fact, it exhibited the Army's whole family of missiles, except the late models of the IRBM and ICBM.

The Ordnance Guided Missile School—now the U.S. Army Ordnance Guided Missile School, by official decree—held an open house, showed movies, displayed its sleek weapons, served cake and coffee—and even allowed cameras.

The School has been somewhat overshadowed in this area by the presence of its more spectacular sister installations, Redstone Arsenal and Army Ballistic Missile Agency.

Yet in four years it has provided the nation with the nucleus of its new missile defense units. More than 5,000 key officer and civilian personnel have been "graduated" from its courses in the use and maintenance of the *Nike Ajax, Corporal* and *Redstone* missiles and are now on duty with missile units in the field and at key headquarters.

They are the beginning of a vastly expanded program that will see thousands of men—and some women—trained to handle the increasingly potent and varied arsenal of missiles available to the Army and other branches of the service. A $7 million building program is under way to provide training in *Nike-Hercules, Dart, Sergeant* and *Lacrosse* missiles.

Navaho Cutback at NAA Forces Layoffs

Reduction by the Air Force of a portion of the second-stage test vehicle (X-10) in the *Navaho* missile program has resulted in a reduction in force at North American Aviation's Downey and Los Angeles *Navaho* activities.

However, a portion of the layoff will be absorbed by attrition (not hiring replacements), and NAA said it will also attempt to re-assign employees who can qualify for job openings in other divisions.

The remaining layoffs, of undisclosed number, will be made by NAA in accordance with existing union agreements. The force reduction became necessary when the Air Force

rdered the company to divert ma-
rials from X-10 test vehicles to more dvanced stages in *Navaho* missile de-elopment, essentially introducing a stretch-out" in the *Navaho* program.

Iarquardt Aircraft ;rants General Pay Hike

Marquardt Aircraft Co., producer f the ramjet powerplant for the Boe-ig *Bomarc*, announced a general wage icrease of 4% for salaried employes fective on February 18. Hourly em-loyes also received a 7 to 12¢ per our pay hike.

The new increase, which affects bout 2,680 personnel, increases Mar-uardt's top technical and office hourly ale to $3.12 an hour and top factory ade to $2.93.

ulver City Quarters 'or Douglas Engineers

Douglas-Santa Monica division as shifted about 160 missile engineer-g personnel to new quarters at Doug-s A2 location in Culver City, Calif. ; a result of the growth of missile igineering work at Santa Monica.

Company is now constructing a ant balcony that will add 45,000 sq. . of office space for the division's issiles engineering department.

Iew GE Contract For J79s Iay Be For Regulus II

General Electric Co. has an-ounced receipt of a $53,414,557 Air orce contract for additional J79 jet igines but did not identify the air-aft for which they are slated.

The J79 is presently used in the ockheed F-104A and Convair B-58 personic bomber, but is also known power the supersonic Chance ought Regulus II missile, a possible planation for the omission of air-aft mention in the announcement.

'ouglas, Northrop et Missile Contracts

Northrop Aircraft, Inc. has re-ived a $3,366,647 contract from Air ateriel Command covering flight sting of "undisclosed equipment" pre-med to be a missile.

Douglas Aircraft Co. at Sacra-ento, Calif. received a $1,305,528 MC award for guided missile (*Thor*) velopment work.

Chrysler Transfers Personnel to ABMA

HUNTSVILLE, Ala. — Chrysler Corporation, which has been manufacturing limited quantities of the Army's Redstone short-range missile in its Detroit plants, is transferring 21 employes and their families to Huntsville, Alabama. Purpose of the move is said to bring specialized missile engineers into closer contact with the Redstone Arsenal and Army Ballistic Missile Agency here.

Local representatives of Chrysler would not comment on reports that the transfer of the group portends increased production here of the Redstone and other missiles. Heretofore, production of the Redstone missile has been equally divided between Detroit and Huntsville.

RMC Organizes Subsidiary Plant On West Coast

Rochester Manufacturing Co. of Rochester, N. Y. has set up an engineering and production subsidiary at Pasadena, Calif. to produce aircraft and missile high pressure gauges.

New firm, to be called Rochester Manufacturing Co. of California, will produce gauge equipment developed by Lindsay Engineering Co. of Pasadena. J. E. Lindsay, former research scientist at California Institute of Technology and inventor of the new gauge, will be manager of engineering for the RMC subsidiary.

A. H. Ottman, RMC president, said the west coast firm probably will be geared to assemble and store products manufactured in its three Rochester plants, including weapons fire control components.

New Missile Gear Firm Formed in Massachusetts

Geartronics Corp., new precision instrument gear firm located at 30 Nashau St.. Woburn, Mass. has been formed as an outgrowth of the merger of Massachusetts Gear & Tool Co. and Gear Systems, Inc.

According to John H. Lyman, the firm's president, the consolidation will provide facilities for production of both precision and commercial gears, complete gear systems and gear research and development for industrial and military applications.

Prior to the merger, Gear Systems, Inc. played a major role in R&D activity for radar, aircraft, missile, computer and atomic energy applications. Heading research for the new firm is Prof. Earle Buckingham, ɔrmerly of the mechanical engineer-ıg department at Massachusetts In-ıtute of Technology.

ɪartin Begins Shift ɪnto Denver Plant

The Martin Co. during February ıoved a starting group of 63 employes ıto its new Denver plant that is slated ı build the *Titan* ICBM. Over the ɛxt several months, the company ex-ɛcts to install about 600 tools and ıajor pieces of equipment into the ıcility and to vacate a temporary ıanufacturing plant in Denver.

To date, Martin contracts from ıe Air Force on the Titan project ɔtal $385 million.

ɜeckman Computers ɔrdered For *Thor, Titan*

Two new orders for computer and ata processing equipment have been nnounced by Beckman Instruments, ıc. for major missile programs.

Douglas Aircraft Co. has an or-ɛr with the Fullerton, Calif. firm for 200-channel, Beckman 112 transis-ɔrized data-processing system to speed ɛsearch on Air Force's *Thor* interme-iate range ballistic missile.

Baldwin-Lima-Hamilton Corp. also ɔok delivery of the first of a new ɛries of transistorized special purpose nalog computers designated the Beck-ıan 101. Baldwin-Lima-Hamilton will se a total of 10 Model 101 computers s part of the instrumentation on test ɛands it is developing for Martin-Den-ɛr for the *Titan* ICBM project.

Both devices are being produced y Scientific Instruments Division of ɛeckman.

ɜell To Expand ʀ&D Program

Bell Aircraft Corp. is planning a 15 million expansion of its research nd delevopment facilities including ıe construction of The Lawrence D. ɛell Research Center on a 100-acre ɛact in Cheektowaga, N.Y.

Bell president Leston Faneuf, in recent talk in Buffalo, said the center ɪll include a hypersonic windtunnel nd other facilities for thermal barrier ɛsearch.

Expansion program at Bell also ɪll include a new electronic computer nd data processing center, a large en-ineering research building and a de-ɛlopment manufacturing shop. These ıcilities will occupy 619,000 sq. ft.

Columbia U is Commended By GE for Defense Efforts

Columbia University's Electronics Research Laboratories have been commended by General Electric as a leading contributor to the nation's air defense capability. J. J. Farrell, General Manager of the G-E Heavy Military Electronic Equipment Department at Syracuse, said that certain basic computing, storage and display components used in a new ground control intercept system produced by his department for the Air Force were developed at Columbia's Research Laboratories under the initial direction of Dr. John R. Ragazzini, who is now Executive Officer of the University's Department of Electrical Engineering. Professor L. H. O'Neill, currently Director of the Electronics Research Laboratories, completed the development.

Mr. Farrell termed the development of the intercept system an outstanding example of "university-industry cooperation" aimed at the primary goal of promoting national security. Nomenclature for the overall system which includes the Columbia developed "Ragazzini Computer" is the AN/GPA-37 Radar Course Directing Group. The system is designed to receive data from long range radars, track the potential enemy aircraft and subsequently direct our interceptors to the target for the kill.

$2.4 Million Missile Awards By AMC

Largest of three new missile contracts awarded by USAF's Air Materiel Command went to Goodyear Aircraft Corp. and totaled $1,279,496 for *Matador* (TM-61B) missile guidance system facilities. GAC is prime contractor for both *Matador* guidance and ground handling equipment.

Other AMC contracts were awarded Aerojet-General Corp. ($266,882) for rocket boosters and igniters, and to Hughes Aircraft Corp. ($920,000) for *Falcon* missile facilities.

Ryan Gets New Contract For *Firebee* Drones

Ryan Aeronautical Co. has received two Air Force and one Navy contract totaling $5,350,000 to produce more than 100 additional *Firebee* jet target drones. The *Firebee* is now in use at USAF's Vincent AFB, Ariz.

Ryan officials said that other contracts expected soon will extend *Firebee* production to mid-1958. Company is also developing an advanced version of the drone for USAF to enable it to reach higher speeds and altitudes.

Continental Aviation & Engineering Corp., producer of the J69 jet engine for the *Firebee*, disclosed that a Ryan XQ-2B drone has achieved an altitude of 53,500 ft. during tests at Holloman AFB, N. Mex. Drone was recovered by parachute after 97 minutes of powered flight.

Positions Available in U.S. IGY Satellite Tracking

The Astrophysical Observatory of the Smithsonian Institution, 60 Garden Street, Cambridge 38, Massachusetts, is accepting applications from scientists and technicians for positions in the Optical Satellite Tracking Program of the IGY. Qualified personnel will be assigned as observers to IGY stations in the United States, and in foreign countries for periods from one to two years. Prior experience in physics, astronomy, or electronics is mandatory and an academic degree in one of these fields is desirable.

Interested persons should write to the Associate Director, Satellite Tracking Program, at the address mentioned above.

Elgin Gets $360,000 In New Nike Contracts

Recent $360,000 contract award to Elgin National Watch Co. for safety and arming mechanisms for Nike missiles has increased by more than 200% its production in that program, the company reports.

Elgin is presently working on three contracts for the electro-mechanical fuzing device which it recently redesigned under assignment from Diamond Ordnance Fuze Laboratories.

Republic To Build New Wind Tunnel

Republic Aviation Corp. has let a $200,000 contract with Burns and Roe, Inc., New York engineering and construction firm, to design and supervise construction of a new windtunnel facility for advanced aircraft and missile testing.

Project will involve two tunnels—a transonic facility covering speed ranges from Mach 85 to 1.4, and a supersonic tunnel for testing up to Mach 4)3,000 mph).

Tunnel facility will be housed in a 72 by 82 ft. building at Republic's Farmingdale, L. I. location. Total project will run about $1 million.

Firm of Burns and Roe previously was responsible for design of ground equipment for both the Bendix *Talos* and Boeing *Bomarc* missiles as well as the Naval Aero Turbine Test Station, Trenton, N. J.

missile literature

ANALOG COMPUTERS. New booklet entitled "High-Speed Analog Computers, Key to Rapid System Development," presents question-and-answer type description of a number of computer types and their application in development of control systems for military weapons, by GPS Instrument Co., Inc.

Circle No. 107 on Subscriber Service Cord

MICRO SWITCHES. New 32-page catalog available from Micro Switch, a Division of Minneapolis-Honeywell Regulator Co. describes more than 140 switches, switch actuators and terminal enclosures it produces for airborne applications.

Circle No. 108 on Subscriber Service Cord

SERVO MOTORS. Bulletin No. 385 issued by Norden-Ketay Corp. contains complete data on its standard and custom servo motors.

Circle No. 109 on Subscriber Service Cord

BALANCING MACHINE. A 16-page booklet published by Stewart-Warner Corp. gives details on its electronic dynamic balancing equipment used for aircraft and missile jet engine rotors, impellers, gears and flywheels, etc.

Circle No. 110 on Subscriber Service Cord

D-C MOTORS. Fractional Horsepower d-c motors built to Spec. MIL-M-8609 are illustrated in 8-page booklet by Lundy Manufacturing Corp.

Circle No. 111 on Subscriber Service Cord

NICAD BATTERIES. Nickel cadmium batteries for aircraft and missile use are described in 8-page technical report prepared by Nickel Cadmium Battery Corp.

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SHOCK TUBES. Avco Manufacturing Corp. has published a 10-page brochure describing new services it offers in the design and manufacture of special shock tubes for aircraft and missile research. To date Avco has developed units capable of simulated speeds of Mach 25 at altitudes exceeding 100,000 ft.

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ROCKET FACILITIES. Four-page brochure describing facilities and past activities in solid-propellant rocket development is available from Grand Central Rocket Co.

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PROPELLANT-POWERED CUTTERS. New leaflet distributed by Propellex Chemical Corp. announced availability of its electrically-initiated, propellant-powered cutters for parachute risers and reefing cords.

Circle No. 102 on Subscriber Service Cord

MINIATURE BEARINGS. New 16-page catalog lists RMB miniature ball and roller bearings produced in Switzerland and marketed in U.S. by Landis & Gyr, Inc.

Circle No. 103 on Subscriber Service Cord

METALLURGICAL TESTS. Complete scope of metallurgical testing services available from Crippen & Erlich Laboratories, Inc., subsidiary of Foster D. Snell, Inc. are described in four page folder. Price list included.

Circle No. 104 on Subscriber Service Cord

SILICONE REPORT. Laboratory report on its new fluorinated silicone compound for aircraft and missile fuel systems is available from Acushnet Process Co.

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MAGNESIUM/TITANIUM DATA. New 44-page booklet published by Brooks & Perkins, Inc. describes in detail the physical and mechanical properties of magnesium and titanium, including forming, welding, machining, heat treatment and stress relief characteristics.

Circle No. 106 on Subscriber Service Cord

INFRARED SYSTEMS. New 8-page brochure issued by Servo Corporation of America described company's infrared applications and research activities in producing and delivering some 21 such weapons systems to date.

Circle No. 120 on Subscriber Service Cord

LOW TEMPERATURE APPARATUS. Hofman Laboratories, Inc. has published a 16-page catalog illustrating low temperature equipment it produces, including capacity and performance data on specific liquid oxygen and nitrogen handling units.

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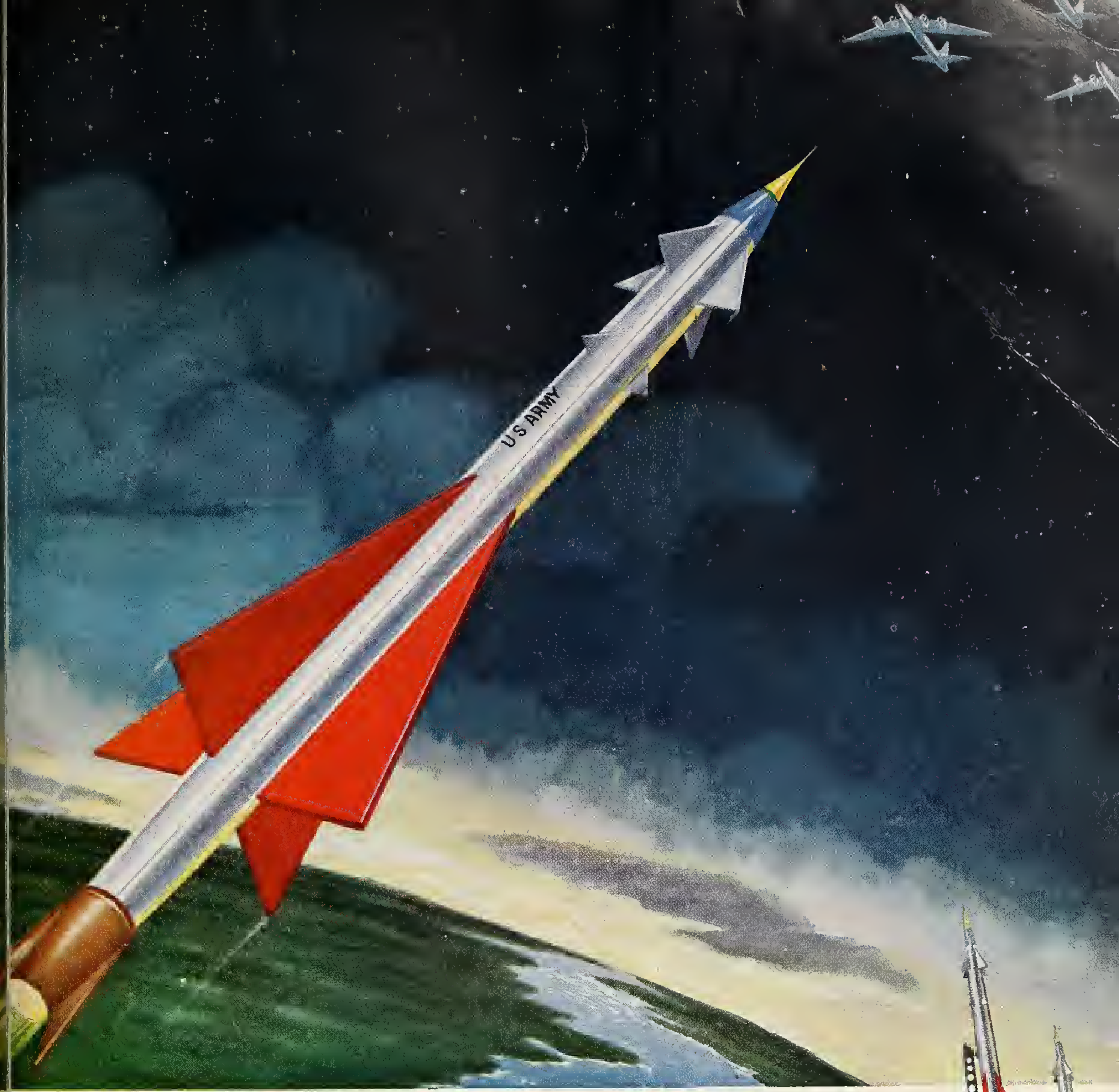

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