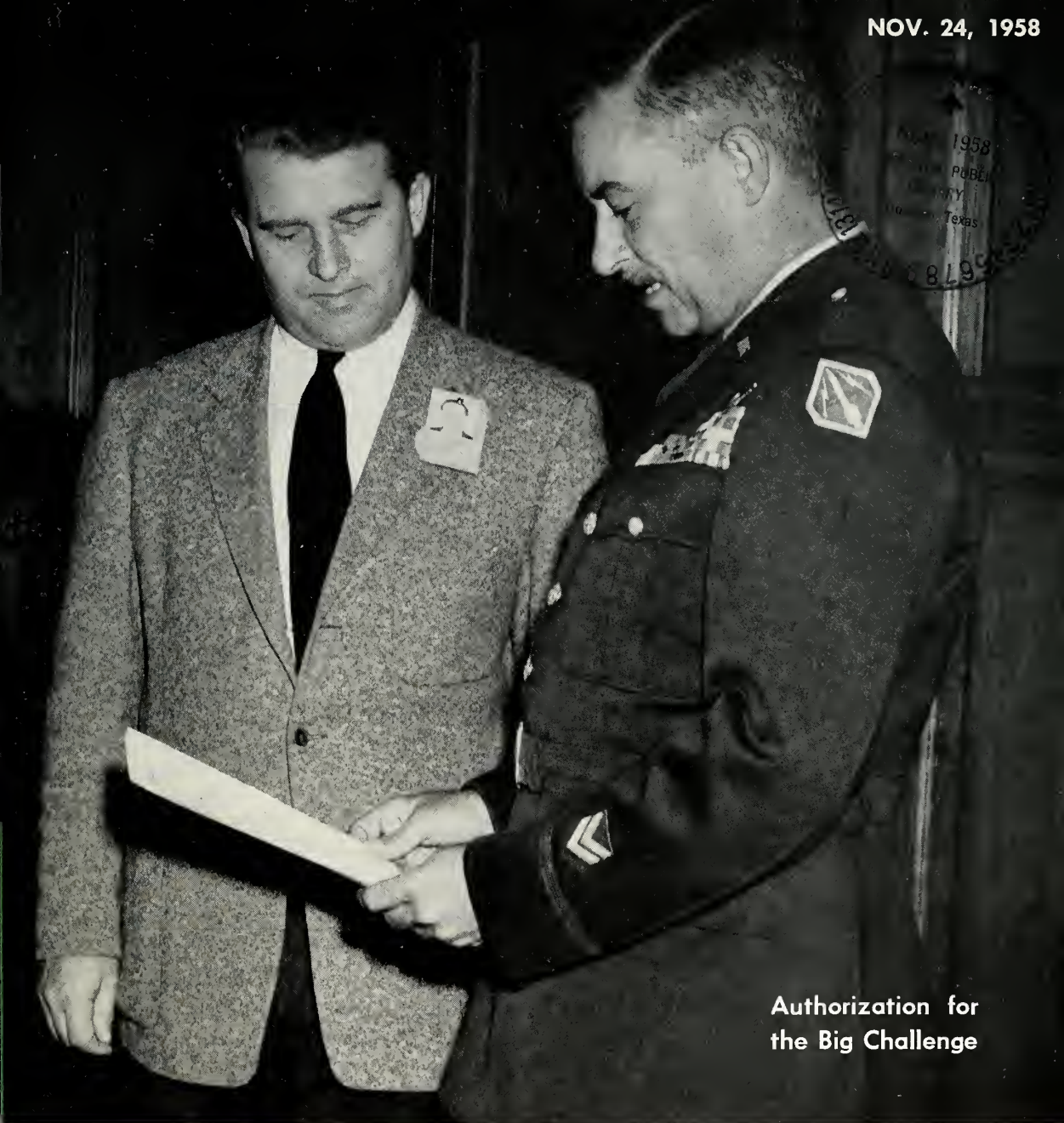
CONRAD LAU

Conrad Albert Lau, aeronautical engineer, inventor, executive, known to his friends and business associates as "Connie", was born on February 8, 1921 in Port of Spain, Trinidad, British West Indies to Mr. and Mrs. Egbert Lau. He was one of a family of four, all boys. His brothers were Neil, Roy and John. He and his wife Nancy Page Lau had three children, Conrad, Jr., Sally and Michael.

Conrad attended school in Trinidad through his sophomore year at Queen's Royal College. He entered Massachusetts Institute of Technology in his junior year. He received his B.S. Degree in 1942 and his Masters Degree in Aeronautical Engineering in 1943. While at MIT he was on the Dean's List for high scholastic achievement, and he was elected to membership in TAU BETA PHI, National Honorary Engineering Fraternity. Also, at MIT, in recognition of his Christian leadership, he was elected Secretary of the Technical Christian Association, a student organization of all Christian denominations dedicated to practicing and encouraging the Christian life.

Conrad joined Chance Vought Aircraft, Division of United Aircraft Corporation, upon graduation from MIT in 1943. He devoted his entire professional career to the Company that had become Ling-Temco-Vought, Inc. at the time of his untimely death, April 18, 1964. Through his initiative, superb intelligence, and human warmth, he had advanced rapidly from the position of Junior Aerodynamics Engineer to Director of the U. S. Navy VAL Light Attack Aircraft program for LTV.

NOV. 24, 1958



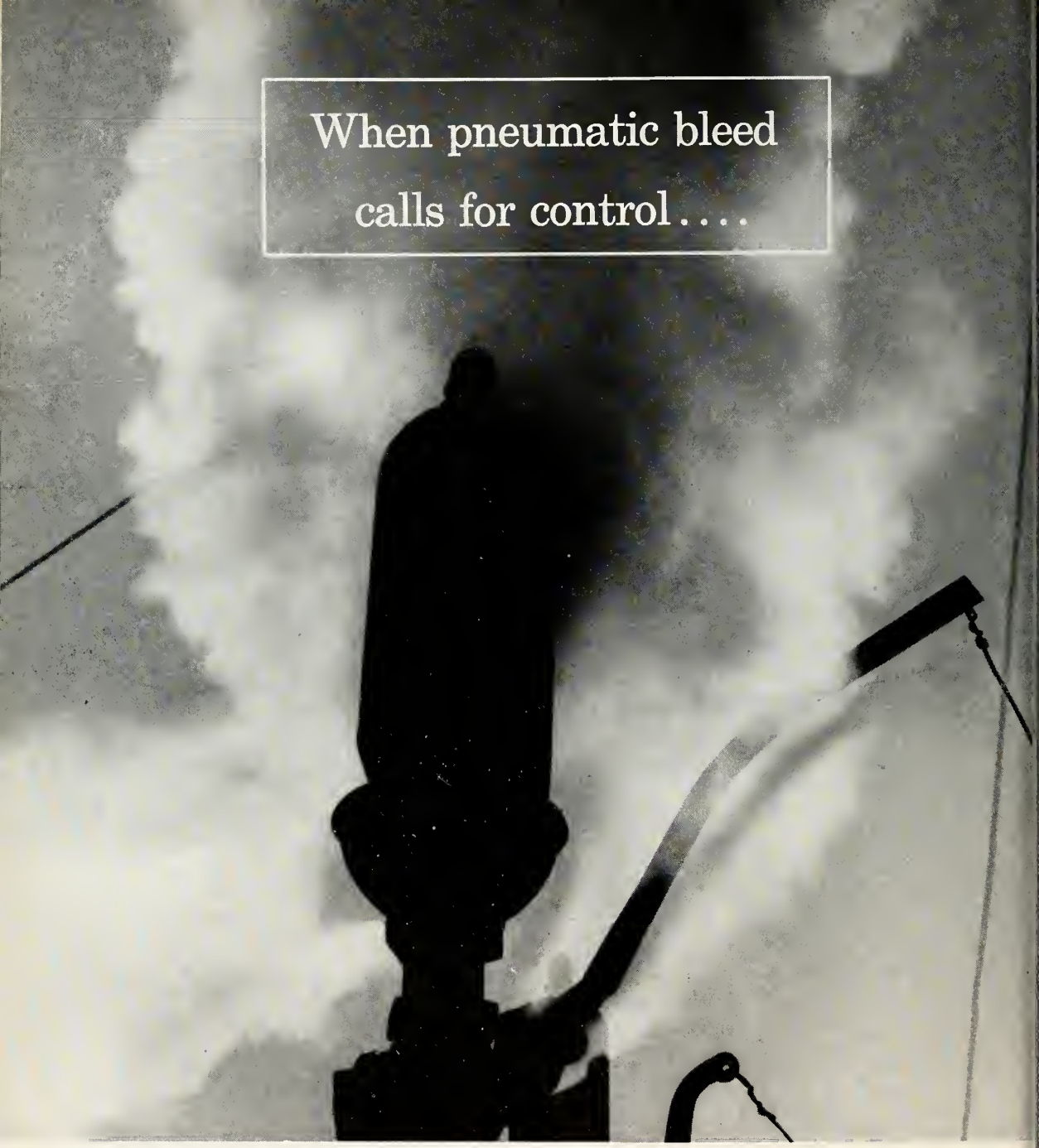
Authorization for the Big Challenge

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

News and Business Edition

AN AMERICAN AVIATION PUBLICATION



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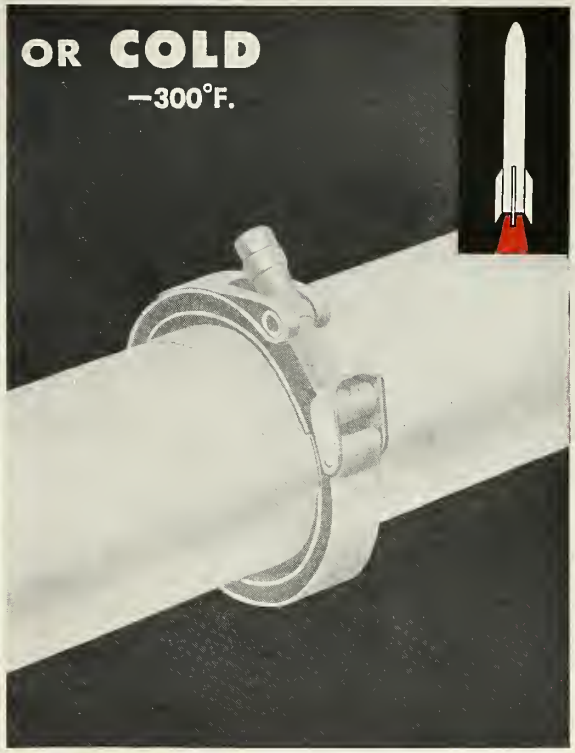

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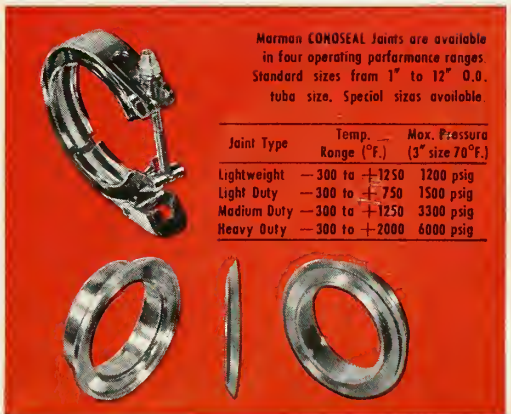

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COVER: *Dr. Wernher von Braun and Maj. Gen. John B. Medaris. With Air Force lunar probes past, Army team readies for possible December 5 Juno II firing which will by-pass, rather than orbit the lunar body. (Story on p. 25.)*

missiles and rockets Vol. 4, No. 21, Nov. 24, 1958

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in this issue

NOV. 24 HEADLINES

ASTRONAUTICS ENGINEERING

MISSILE ELECTRONICS

DEPARTMENTS

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FROM NOSE TO NOZZLE, FROM FIN TO FIN, CONTOUR TURNED PARTS—WITH PRECISION BUILT IN

In My Opinion . . .

. . . there's no doubt the missile and rocket industry is here to stay and that it will continue to grow. As a matter of fact, it now represents one seventh of our total defense expenditure. Yet, some conservatives say the missile industry is nothing but a fading myth! In the past two years—since missilery has become a major part of the defense expenditure pattern of this country—there's been a lot of bitter and probably needless infighting over that one single word "industry."

Understandably, perhaps, the tendency to call missilery an "industry" has brought violent argument from those who have felt that their previous experience and service in aircraft work made this term a misnomer, and somehow put them outside the pale of a new field.

Equally bitter have been many inspired proponents of the new art—some of them manufacturers who never had any interest in aircraft, but who certainly have a large stake in missiles.

The "missile industry"—just like the "aircraft industry"—doesn't control its raw materials or subcontractors; it calls on many other industries to serve it and supply materials and skill. What's more, who really cares very much what it is called, or who does the work?

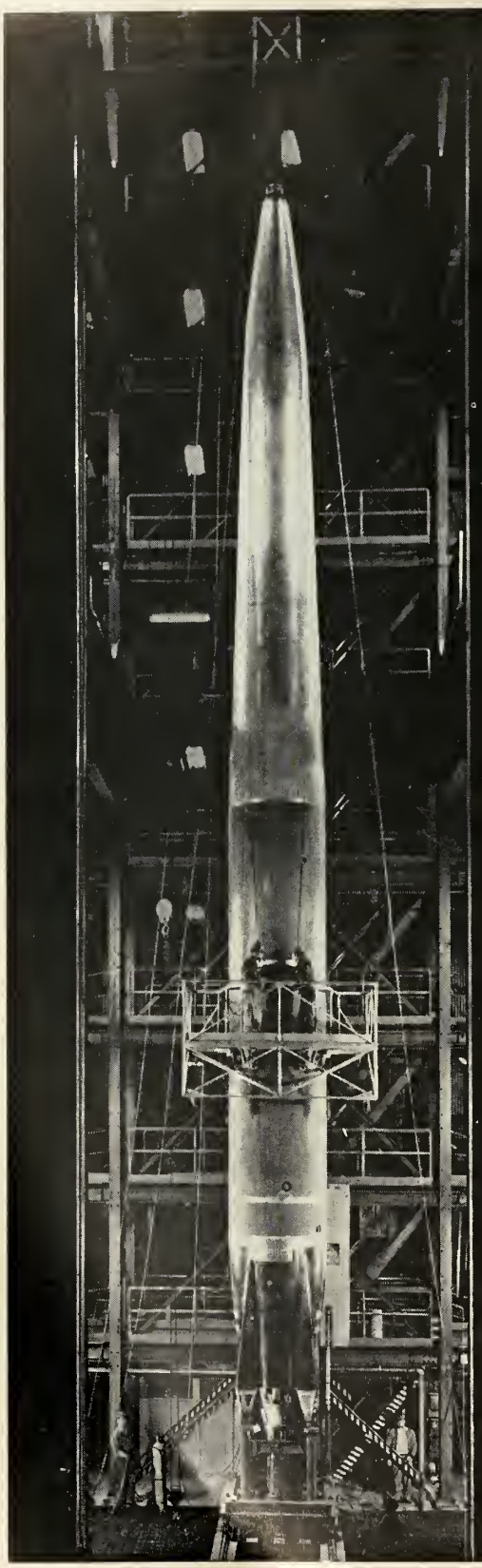
The fact remains that missilery is a new business—and that it is a big business. A $6.5 billion business, to be exact.

It is a new market for old skills and old products. And a brand new market for a lot of brand new skills and new products. It is making work—and money—for a lot of service groups, such as the construction industry, watchmakers, piano builders, chemical companies, and others, which must come into the missile picture to keep the birds flying. It is a brand new employment market for something like 400,000 people. (See m/r, Nov. 10, p. 11.)

And out of it will come many things other than the missiles themselves. Out of it will come new scientific worlds to conquer, new engineering frontiers to attack. And more prosaic things that will contribute much to everyday living.

Transistorization, miniaturization, new metals and materials, new uses for standard things—these cannot but contribute to human comfort and ability, beyond the immediate uses in missiles and engines of warfare. Many refinements of the present-day motor cars and airplanes are ready examples of what can be developed out of what started out to be war machines only.

So it doesn't matter very much if we call this new field a new industry or a new business or what. And it gets us absolutely nowhere to argue about who has a right to be in it. This is everybody's business.



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MISSILE DEVELOPMENT DIVISION

North American Aviation, Inc.

washington countdown

Navy takes comfort . . .

that the Lockheed *Polaris* was not specifically mentioned in Secretary McElroy's discussion of down-grading importance of land-based IRBM's. This adds steam to Navy's argument "to get the missiles to sea" rather than basing retaliatory hardware in continental U.S. which the Navy says puts bull's eye right on this country.

Russian submarines . . .

are operating off Cape Canaveral despite a statement to the contrary made by Maj. Gen. Donald Yates. Can reported instances of jamming of missile telemetering channels be explained? Or, the case of a diver retrieving a missile 14 miles away in 100 ft. of water, having seen a submarine and the air hose of another diver? The other diver left his boot mark on the missile's (probably a *Redstone*) tail assembly, and whereabouts of some parts of this particular missile apparently are in doubt.

Navy's top priority . . .

interest in underseas exploration has a boost from Sen. Henry M. Jackson who termed the vast underseas spaces as a "full new area of development which has not been tapped." He said the Russians are far ahead in this field. Jackson also advocated that NATO nations cooperate to send up a satellite for peaceful outer space research by 1960.

Weapon systems management . . .

probe will begin this month by Armed Services Subcommittee. "High costs" of weapons and "team approach" will be explored.

Peace is the word . . .

when it comes to space. Senate majority leader Lyndon Johnson said so at a San Antonio meeting on space medicine. ARPA Director Roy Johnson said it in New York and Ambassador Lodge said it at the United Nations. Johnson said the U.S. "has no military offensive objectives in space," but must develop a defensive posture in space. Lodge introduced a resolution co-sponsored by 19 other countries for development of a peaceful outer space policy. Russians countered with demand that foreign bases be relinquished as part of price for ban on use of space for military purposes. Johnson, speaking before the UN, said this nation has no differences "within our government, between our parties or among our people," on the goal of dedicating outer space to peaceful purposes.

Germany and Italy . . .

have held informal talks on mutual cooperation in the field of missiles for non-military use, possibly for research or as future transport carriers. Since the Germans are still not permitted to conduct any work on military missiles, this might be a device to lay basic groundwork so that Germany may get back into the military missile field as quickly as possible when they are officially authorized to do so.

Rough trail ahead for Texans . . .

Sam Rayburn and Lyndon Johnson. The Senate and House majority leaders will have their hands full riding herd on fellow Democrats when Congress convenes in January. Freer-spending members will force them to find a safety valve somewhere between expediency and caution. Leaders will have to tread narrow path to avoid an insurrection on one hand and responsibility for too much spending on the other. An old, an unhappy position, but new for Rayburn and Johnson.

First standing committees . . .

will be named in both House and Senate to deal with matters of space and science. In the past session, House had a select committee and the Senate a special committee. New committees assume jurisdiction no other standing committee has—joint responsibility in both military and civilian areas. Astronautics committees will cover both. House committee will have 25 members, Senate committee will have 15. Johnson will be chairman of Senate group. Good bet for House chairman is Paul J. Kilday of Texas or possibly Overton Brooks of Louisiana. Committee's jurisdiction covers complete field of astronautics, standardization, NASA and other matters including science scholarships. Members will be appointed by committees with division in keeping with ratio of the parties in the House.

industry countdown

Chemicals for missiles . . .

are expected to corner a large portion of the defense market in the forthcoming months. Reliable forecasts of estimated expenditures for missile chemicals and related products (fuels, oxidizers, lubricants, sealants and plastic coatings) indicate a climb from $700,000 in fiscal 1959 to $1 billion in fiscal 1961.

Navy strategic dispersal policy . . .

of ship construction for achieving faster delivery of missile carriers has been advanced by the latest award of $182.5 million to four firms for construction of seven frigates. All contracts were awarded on a fixed price basis, as a result of competitive negotiations, to six yards submitting the lowest proposals from a total of eight invited firms. Bath Iron Works will build three of the frigates; New York Shipbuilding Corp., two; Dodd Shipyards Corp., and Puget Sound Bridge & Dredging Co., one each.

ARPA's recent research award . . .

of about $8 million to a number of chemical firms for long range studies of new chemicals for solid rocket propellants (m/r, Nov. 10, p. 11) has generated some bitterness among longtime rocket firms. The awards have been described by these companies as "neither intelligent nor fair" they have put their own resources and funds into similar research. For example, Olin Mathieson said it has spent about $2 million and utilized some 50 engineers and scientists for advanced studies on solid propellant combinations.

Tow trucks in space . . .

has been forecast by Norman V. Petersen of Lockheed Aircraft Corp. as a necessity for the not too distant future. He predicted that space traffic will be so heavy that it will be necessary to have fleets of rocket-powered tow trucks for rescue of space travelers in flights between earth and the planets.

Architects of space . . .

will be an appropriate title for Daniel, Mann, Johnson, & Mendenhall, Los Angeles architectural and engineering firm, when construction dollars for missile bases are summed up at the end of fiscal 1959. The firm was in third place in 1957, having completed projects with a construction value in excess of $150 million.

Ballistic missile facilities . . .

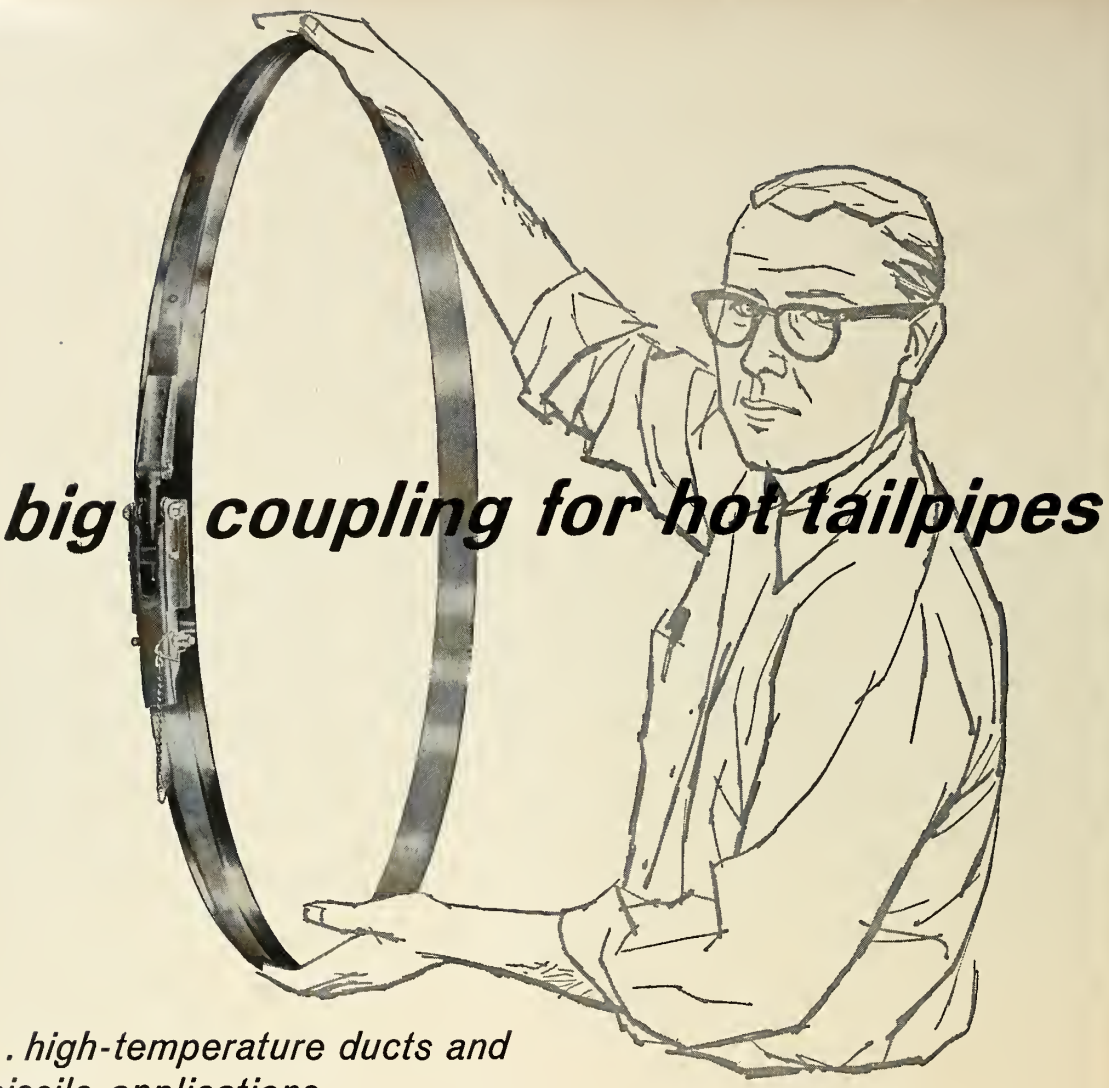
designed by DMJM include the Santa Susana hot test acceptance facility for North American; *Atlas* test facilities at Cape Canaveral and Sycamore Canyon: ICBM/IRBM training facilities throughout the U.S.; and *Thor* testing and launching facilities at Vandenberg AFB. The firm is proposing to design the Air Force's *Titan* facilities.

Underground missile factories . . .

are receiving more attention from military and industrial planners. Convair's next missile plant reportedly will be built underground as a precaution against nuclear attack. Moorehead Patterson, head of American Machine and Foundry has long advocated underground plant construction recently proposed using Green Mountain at Huntsville, Ala. for such a plant. The Germans in World War II found that plants underground were the only solution to continued production of the *V-2* rocket.

Army is evaluating . . .

Aerojet-General's Aerotrac (Target Recognition Artillery Concept) designed to fit into the fluid battlefield planning. The system would employ target "illumination" for attacking infra-red guided missiles. Concept is similar to the Project *Mauler* program now under study by ABMA, Martin-Orlando and Convair. Briefings by Aerojet were recently held with the Army Rocket & Guided Missile Agency (ARGMA) and the Continental Army Command.



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. . . high-temperature ducts and missile applications

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Test data: Model illustrated is tested to 15G's with tail pipe attached, and at temperatures to 900°F. Vibration requirements of MIL-E-5272A are met.

Janitrol couplings are supplied in stainless steel, with flanges of titanium, aluminum, or steel, in a wide range of sizes down to 1″ in diameter.

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schematic cross-section of standard coupling

schematic cross-section of flush coupling

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NOVEMBER 24, 1958
VOL. 4, NO. 21

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

March 1 May Be Mars Probe Date

Heliocentric force field of sun would be used rather than complex guidance so that probe would rendezvous with planet eight months later. Probable Venus launch date is January 1960, using present 'on the shelf' hardware.

by William O. Miller

WASHINGTON—The United States will make the first attempt to launch a space probe to the vicinity of Mars late in February or early March, if such an attempt is to be made any time within the next year.

While no official go-ahead has been announced, a National Space and Aeronautics Administration scientist agrees that a launch date about March 1 "could be right on the button," for a rendezvous with the planet a little over eight months later.

Two factors make such an attempt a strong probability: first, the heliocentric movement of the planets Mars and Venus in reference to the earth will make the effort feasible; and second, NASA scientists say that both the Air Force and the Army now have on the shelf the launching vehicles which, with boosters, could provide the escape velocity for either a Mars or Venus probe.

• **Minimum energy**—this first attempt, by necessity, will employ a minimum energy ellipse. Present hardware, with boosters, can supply the 25,000 mph required to escape the earth's gravitational field for a probe of Venus, or the 25,900 mph required for Mars, according to Newell Sanders, NASA assistant director of advanced technology. The big problems, he said, are communications and guidance. The simplest way, but longest time-wise, is to utilize the heliocentric force field of the sun so that the vehicle's path flight is cotangential to the orbit of the planet. This is more easily accomplished when the planets are on opposite sides of the sun, but in a straight line. This occurs only on certain dates. The next time Mars will be in this superior conjunction with the earth will be October 30, 1959. It will not occur again until December 14, 1961.

Thrust for escape from the earth would be used up a few minutes after launch. On its 350-million mile trip it would coast most of the way, circle Mars and continue in an elliptical orbit to return to the vicinity of the earth.

Dr. Newell said the time for such a trip to Mars would take about 247 days. This would place the launch date some time during late February or early March.

• **Venus too?**—Such an ellipse could be utilized in probing the vicinity of Venus, taking into consideration the dates when Venus is in superior conjunction. As Venus circles the sun in an orbit between the earth and the sun (Mars' orbit is beyond the earth's) the flight time is only about 151 days.

Venus was in superior conjunction with the earth on November 11. The next date will be June 22, 1960. Considering the flight time required, a probable launch date for a Venus probe would be in the latter part of January 1960, little more than a year from now.

• **Moon probe first?**—The Advanced Research Projects Agency, before NASA came into existence, asked the military to come up with plans for Mars and Venus probes. In the excitement over the lunar probes, sight has been lost of these projects. The Air Force, however, has been agitating for revival of the projects.

Another NASA scientist admitted he was part of a team presently working on the planetary probes. Although they are separate projects, for political reasons and in the interest of world-wide public relations, the probes could be held up until a successful probe of the moon has been accomplished.

• **Have vehicles**—The Air Force presently has two *Thor*s on the shelf, ordered by ARPA. The Army has *Jupiter*s which also could be used.

The thrust for the moon probe is slightly under 24,000 mph. With a little boost this could be raised to the 25,000 mph for a Venus probe or the 25,900 mph for the Mars shoot.

The payload of the last Air Force moon probe was about 85 pounds. By removing the retro rocket and reducing the payload by about one-half, the extra speed required undoubtedly could be attained.

Thrust is not a problem. The big question is instrumentation, guidance and communication. NASA scientists point out that when guidance and control is attained which will permit correction in flight, probes of Mars and other planets could be carried out at almost any time, but especially when they are nearest the earth (inferior conjunction) rather than at the greatest distance, as in the case of superior conjunction.

• **Communications**—Even with the vehicle coasting most of the way, the distance and time of flight pose numerous communications problems.

Since path loss over the distance to Mars has been estimated at about 263 db., a transmitting frequency of more than 2000 mc is indicated. This would have a receiver noise figure of 6 db. and a band width of no more than 1 kc. because of the great range and the necessity for keeping the receiver noise figure as low as possible.

Somewhat sophisticated circuitry will be required to handle the doppler shift as the radial velocity between the transmitter and receiver varies. A transmitter with about 10 watts of power into the antenna would seem necessary although this might be less if it is worked into the huge Jodrell bank radio telescope in England.

PACKHORSE OF SPACE. *Only means to put stores or people out beyond atmosphere is the big, high-thrust rocket.*

COUNT DOWN

for the conquest of space

IS THE ROCKET ENGINE MAN'S ONLY WAY TO OUTER SPACE?

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He is in Outer Space.

The only power that can put him there today is the large rocket engine. No matter how far and how fast space travel develops, these high-thrust engines provide one basic essential — the sheer brute force that can lift a payload from the surface of the planet to the airless void outside.

Endurance for vast distances

Once space is reached, a wealth of intriguing possibilities beckons. Entirely new aspects of propulsion are being developed to maneuver ships between the moving gravitational fields of Earth's neighbours in the solar system.

One advanced propulsion system that may be built soon is an ion rocket. This ultra-high-specific-impulse power plant provides low thrust for extended periods.

OUTWARD BOUND, *man's robot reporter heads off to a rendezvous with planet Mars.*

An endurance of months, or even years, is possible. Mounted in a suitable unmanned vehicle, such an interplanetary "private eye" would make the cislunar region seem like our own front yard. It could be sent off to reconnoiter the mysteries of Mars, Venus, or the Asteroid Belt.

Rockets ready today

To date, the vast bulk of successful missile and space projects in America have used Rocketdyne engines — Atlas and Thor for the Air Force, Jupiter and Redstone for the Army, the historic Explorer satellites, and the all-important first stage of the lunar probes. And Rocketdyne continues to improve the techniques of rocket engineering. High-energy fuels — storability — a full range of proven engine designs: these are some of the contributions Rocketdyne has made to weapon system operation for our nation's defense.

Million pounds of thrust

Rocketdyne is now at work on two approaches to propulsion systems that will deliver thrusts up to 1,500,000 pounds. One is a single-chambered engine, the other a grouping of engines adapted from the Thor-Jupiter engine family. From these will stem the multi-million-pound-thrust systems that are essential to launch the manned exploration of interplanetary Space.

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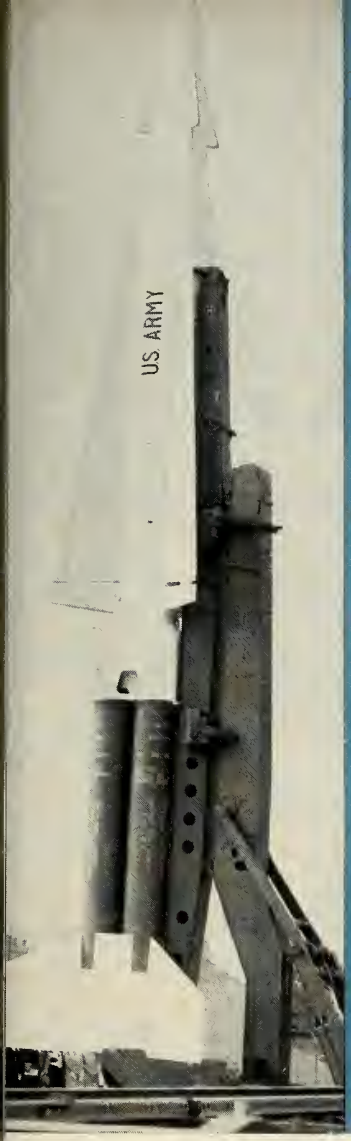

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Dyna-Soar Brings Out New Martin Team Idea

Prime-subcontractor relations change as Space Flight Division assembles top personnel in design competition stage

by Donald E. Perry

BALTIMORE—These are crucial days for a new concept in space project management that is decidely odd from an industrial standpoint—but could well be the "writing on the wall" for management to revise its approach in dealing with future complex space systems.

It is the Company Team Concept as opposed to the Prime-Subcontractor System. Eight months from now—about July 1—and perhaps sooner depending on priority assigned, the National Aeronautics and Space Administration and the Air Force will make a decision. The outcome will not necessarily make or break the Company Team Concept because it is in the ticklish area of design competition. And as all industry should know, the best design should win the competition, although many firms will argue this point at the drop of a contract.

But the stakes in this competition are high and worth all the effort, even though money to be realized through production is a secondary factor. The primary factor is prestige and a chance to build company technical capability at government expense. The battle is of more than routine interest because it pits two industrial giants—the Martin Company and the Boeing Airplane Company—against each other.

The competition is for the romanticized boost-glide *Dyna-Soar*, either the last of a long line of airplanes or the first truly space ship.

• **R&D contract**—Outcome will be an R&D cost-plus fixed fee contract. But the management method of bringing *Dyna-Soar* to reality brings the occupied airplane vs. the automated vehicle approach to the forefront again.

But what is the Martin Company's approach to *Dyna-Soar?* You're visibly impressed from the moment you park your car in a special lot at the Middle River, Md., facility. As you enter a special door marked "Space Flight Division," you feel you're separated from the Martin Company. That's the intended impression. For it is a separate, autonomous division, although it will not manufacture hardware.

In the Space Flight Division—unless you ask—you can't find out who signs whose pay check, because side-by-side are individuals working from Martin and Bell Aircraft. It gets further "chummy" with daily representatives from Bendix Aircraft Corp., Minneapolis-Honeywell Regulator Co., Goodyear Aircraft, and American Machine and Foundry Co., other *Dyna-Soar* team companies.

George S. Trimble, Jr., Martin vice-president and general manager of the division, and Roy J. Sandstrom, Bell vice-president and assistant general manager of the division, occupy the same office. They term the situation as "a family marching down the same road." And it has to be that way for Air Force does not want to deal with a multiplicity of companies, only one—in this case—Martin.

But the chiefs march in unison with the Indians. For if the *Dyna-Soar* team members get off the path, a management advisory board steps in. It is not staffed by representatives of the presidents of the six member companies, but by the presidents themselves. This is conducive for the best efforts.

• **Unity on team**—"We have decided unity," comments Trimble, "because at the beginning we laid some good ground rules." The rules make the Team Concept odd. First, the companies are not really subcontractors to Martin. Each firm has a copy of the work statements of all the others. Each knows how much money the other is getting, and everyone agrees in the sharing before it's made. So far there is little to share—about $5 million has been programmed. As one example, team thinking is that Bell, a pioneer investigator in the boost-glide field, should get a larger slice at this stage of the competition. Reason: previous advanced study efforts.

This is in strange contrast to the general prime-sub relationship, where the prime can tell his subs to keep their mouths shut. However, Martin wants each company to be in a position to tell the whole *Dyna-Soar* story, but it still will retain total systems management responsibility to the Air Force.

Martin which gained managerial know-how in team efforts by being one of the pioneers of the weapons system approach many years ago, admits that its *Dyna-Soar* management concept was "a shock to some of the team members at first," but all apparently have adjusted to this unusual way of doing business.

"Togetherness" may be an appropriate word in light of this philosophy of the "captain" treating all alike. Most assuredly it will have to be used more extensively in complex space programs beyond the capabilities of one single company.

Dyna-Soar, visioned in Eugen Sanger's 1935 proposal, ultimately will mean men in space performing military objectives. Whether they get there under the traditional aircraft method of development—man flying higher and faster—or whether an automated

(Continued on page 18)

George S. Trimble, Jr.—Martin vice-president and Space Flight Division general manager. Holder of design patent for B-51; Martin vice-president for Advanced Design and Engineering; B.S. MIT; Tau Beta Pi; member NASA Committee for Aerodynamics, DOD Technical Advisory Panel for Aerodynamics.

Roy J. Sandstrom—Bell vice-president and Space Flight Division assistant general manager. Holder of design patent for *X-2;* Bell vice-president of engineering and general manager of Weapons System Division; B.S. University of Michigan; Tau Beta Pi, IAS, ARS.

William L. Hadley—Director of Reliability and Safety. Hadley was Chief, Reliability Control Section, Bell Aircraft Corporation; B.A. degree at University of Buffalo; member, American Rocket Society; will have charge of escape system in the *Dyna-Soar* boost glide vehicle.

Norris Elliott Felt, Jr.—Program Manager. Felt was operations manager for *Vanguard;* B.S., University of Maryland; M.S. Georgia Institute of Technology; Tau Beta Pi, Phi Kappa Phi, Eta Kappa Nu; member, ARS, AIEE, president of Maryland ARS Chapter.

Hans Multhopp—System Technical Director. Multhopp was research scientist for German Air Ministry, chief of Aero & Advanced Design—Focke Wolf; principal scientist for Martin Company; University of Gottengen graduate; member, Lilienthal Gessellschaft, IAS, Deutsche Akademic for Luftfahrtforschung.

John DeNike—Director of Configuration Design. DeNike was project engineer for Martin Company's Advanced Design; B.S. New York State College for Teachers, Rensselaer Polytechnic Institute, Tau Beta Pi, Sigma Xi; member, ARS, IAS.

Wallace A. Helmuth—Director, Military Operations Analysis. Helmuth was Chief Advanced Design Military Operations Analysis Section for Martin; B.S. New York University, attended Johns Hopkins University; Tau Beta Pi; member, Operations Research Society of America.

Robert Glen Demaree—Director Crew Factors. Demaree was assistant professor at University of Illinois and Tulane; chief of Performance Branch, Lowry AFB; full-time consultant to Army Air Defense Human Research Unit; B.S., M.A., PhD., University of Illinois; member, American Psychological Assn.

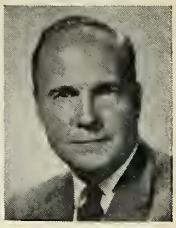
Charles J. Koch—Director Systems Dynamics and Controls. Koch was director of research and development and principal engineer for Martin; B.S. Case Institute of Technology; Tau Beta Pi, Sigma Xi; member of the Institute for the Aeronautical Sciences.

Donald W. Chrisman—Director Electronics and Electrical. Chrisman was Engineering Field Test Supervisor, principal staff engineer, and chief engineer electronic equipment design for Martin; B.S. Purdue University; Tau Beta Pi, Eta Kappa Nu; senior member of Institute of Radio Engineers.

Dr. Peter Friedrich Jordan—Director Structures. Jordan was a German Air Ministry Group Leader; principal scientific officer, Royal Aircraft Establishment, Farnborough; chief dynamics engineer for Martin; University of Gottingen, University of Breslau, Dr. rerun naturarum.

Dr. Julius Friedrich Vandrey—Director Aero and Space Physics. Vandrey was Group Leader in German Air Ministry; scientific advisor to Admiralty Research Lab, Teddington, England; principal engineer for Martin; Dr. rerun naturarum (Magna Cum Laude), University of Gottingen, Technical University of Hanover; member, Gesellschaft Fur Angewandt Mathematick & Mechanik, IAS.


Trimble


Sandstrom


Hadley

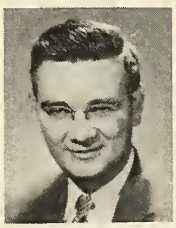

Felt

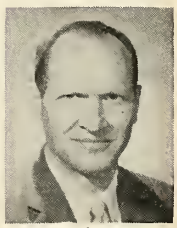

Multhopp


DeNike


Helmuth


Demaree


Koch


Chrisman


Jordan

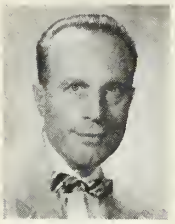

Vandrey

Guy

Marstiller

Walter G. Guy—Director Plans and Programs. Guy was Project Engineer, Manufacturing Manager and Operations Manager for The Martin Company. He is a graduate of the Academy of Aeronautics in New York and holds membership in many U.S. professional and technical societies.

James K. Marstiller—Contract Director, Bell Aircraft Sub-Contract. Marstiller was chief project test engineer for Chance Vought; deputy chief for B-36, YB-60 and B-58 projects; Bombardment Branch, Air Materiel Command; S.M., MIT; technical member of Institute of the Aeronautical Sciences.



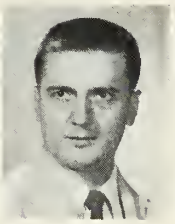
Gravenhorst

Hooker

Gordon P. Gravenhorst—Contractor Director—AMF Sub-Contract. Gravenhorst was a project engineer and the P5M Operations Manager for Martin; M.E. from Stevens Institute of Technology; member of Institute of Aeronautical Sciences and other technical and professional organizations.

Ross B. Hooker—Director Facilities Department. Hooker was an industrial engineer for Brown & Sharpe Mfg. Co., Conservation Director, Director of Procurement and Facilities, and assistant to vice president for manufacturing of Martin; attended Brant College, Parks Air College.

Schantz



Poletti

Joseph D. Schantz—Contract Director—Bendix and Minneapolis-Honeywell Sub-Contract. Schantz was assistant manager of research, manager of government projects for Farnsworth Television and Radio Corp.; chief electronics engineer for Bell Aircraft; M.S.E. from University of Michigan.

Peter J. Poletti—Director Documentation Department. Poletti was assistant project engineer for *Matador*/B-57; field test manager for *Matador*/*Mace*; B.S. from MIT, MBA from George Washington University; member, Institute of the Aeronautical Sciences.

Singer

Moore

Nathan Singer—Contract Director—Goodyear Sub-Contract. Singer previously was assistant project engineer for Martin; B.S. and M.A.E. from New York University; associate fellow of the Institute of the Aeronautical Sciences; member of American Rocket Society.

Wendell F. Moore—Contract Director—The Martin Company. Moore was chief propulsion engineer on *X-1*, *X-2* series aircraft for Bell; B.S. from Kent State University, attended Indiana Technical College; member, Institute of the Aeronautical Sciences.

(*Continued from page* 16)

machine precedes them as in the case of rocketry developments, may decide the competition between Martin and Boeing.

• **Automated vehicle**—Trimble does not see that the first *Dyna-Soar* vehicle will have a man in it. "He cannot contribute heavily to the first one because there is the question of what man can actually do. I personally do not believe he can do much more than if he were on the ground. When you get into what can he do with military equipment in the vehicle, it's a different matter," he said.

This can be interpreted that Martin is thinking of *Dyna-Soar* as initially an automated rocket development in contrast to Boeing which has already assigned two "pilots" to its project. In other words, the Martin vehicle would be sent up "X" number of times unmanned until reliability is proven.

Then man will enter the picture. These two different approaches could spell a successful vehicle measured in many years of development time rather than several.

But most important will depend on whom is sitting at the NASA—AF design competition decision table—the rocket cycle proponent or the aircraft cycle proponent. Then *Dyna-Soar* will either be the last airplane or the first truly space vehicle.

Rome Research Center and Holloman will give technical advice in cooperation with the Research Vehicles and Advanced Systems section of Wright Air Development Command. Lt. Col. (Russ) Harrington is *Dyna-Soar* project officer.

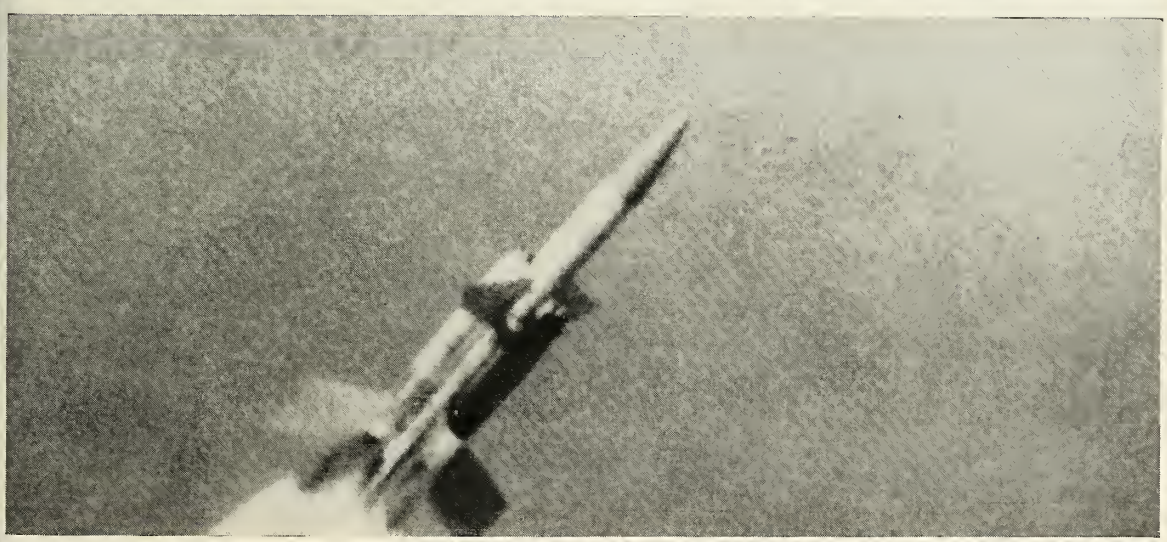
NASA—whose primary Congressional mandate is the scientific exploration of space—may have a changing role. In the original *Dyna-Soar* proposal, the old NACA was named as a technical consultant for instrumentation. Will it continue to so serve when the Air Force is looking as *Dyna-Soar* essentially as a military requirement?

• **Vital to inventory**—Not just a fish jumping momentarily out of its natural environment, such as the *X-15*, *Dyna-Soar* is considered by the Air Force as a vital addition to its inventory. It will be used in reconnaissance missions at extreme altitudes and bombing missions at closer range.

Sources other than Martin say *Dyna-Soar* with a range of 12,000 to 25,000 miles, will be rocket-boosted to a 100-150 mile altitude and then would glide (assisted by small sustainer rockets) over its target and then on to

(Continued on page 20)

Is your future with the team that developed BLOODHOUND?



Adoption of Bloodhound by the RAF and now Sweden confirms Bristol's missile development team as the most successful in Europe.

This team has consistently expanded until it is now one of the largest in the world—but the responsibilities it is shouldering for the future call for an even greater number of first-class minds.

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In joining us, you will, above all, achieve satisfaction —the satisfaction of working within an enlightened chain of command; with engineers whose knowledge and ability you can respect. If you prove yourself the right man, that respect will be mutual.

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a landing. It is in decided competition with Russia's dynamic soaring vehicle which apparently will use an 820,000 pound thrust engine developed for the T-4 missile.

This alone may dictate approval of the rocket-cycle development rather than the aircraft cycle, and the project conceivably could be given a priority close to anti-missile defense.

But no one can get excited over money potentials. Just like the *X-15* and existing ballistic missiles—which will provide *Dyna-Soar* with vital information—it will not be a quantity production item. Six to a dozen vehicles could be a maxium, but here lies a golden opportunity for participating firms on either the Martin or Boeing team: the chance to develop space technology know-how with a minimum of company sustained fund loss. Prestige thus is an overwhelming factor.

Then too, the qualifications of Bell: if Martin is planning an automated system, they cannot be discounted. Bell is experienced in free-flight and automation as witnessed by the *X-1*, the *X-2*, proportional radio controls for missiles and its completely automatic all-weather landing system. All are musts for an automated *Dyna-Soar* vehicle.

Bendix—which will work on communication systems, telemetry hydraulics, electrical power conversion, cabling, and electrical connectors, can be remembered as teaming with Bell for highly accurate navigation and landing systems. Bendix, too, is known particularly for instrumentation and its integrated instrument cockpit display program and airborne data processing.

Minneapolis-Honeywell came to the limelight with work on the *Titan* inertial guidance system, and this coupled with its low-altitude bombing system used by many current aircraft, is a formidable contender to the Boeing concept.

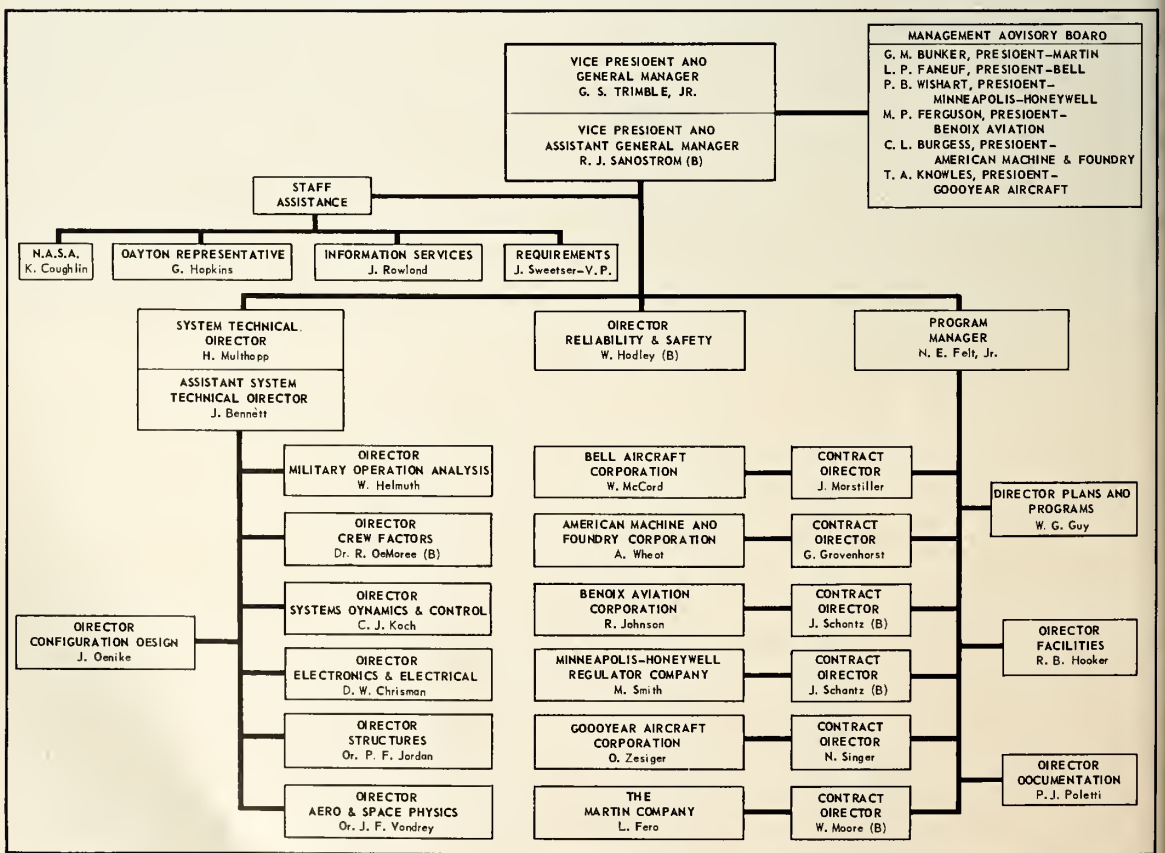
• **On two teams**—Goodyear, by a strange paradox, is on both the Martin and Boeing squads. For Martin, Goodyear will develop the crew escape capsule system, necessary radome materials and high resolution radar. For Boeing it will be guidance.

This should not affect Goodyear's efforts. Air Force is reserving the right to change team members in an effort to come up with the best equipment possible. Team organization, as practiced by Martin, is an effort to reduce the cost, and substitutes can be allowed. But according to Trimble, it is not anticipated that other companies will be needed unless the present ones fail to give Martin the "broadness" needed.

American Machine and Foundry's role in the program will concern the design and manufacture of ground handling and launching equipment. AMF has developed support equipment for the *Talos*, *Bomarc*, *Titan* and *Atlas*. In addition, AMF has done developmental and production work in the radar and ordnance fields.

The Space Flight Division now has 30 Bell representatives and 70 from Martin. It probably will have 80-90 as a maximum during the design competition phase. If Martin gets the R&D contract, total division employment will be 300-400.

Martin Space Flight Division Organization



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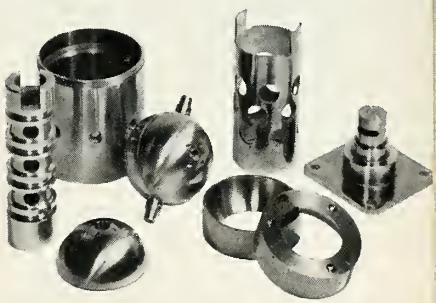

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...NEWS IS HAPPENING AT NORTHROP

Northrop's supersonic twin-jet N-156F counterair fighter is designed to meet the need of NATO and SEATO nations... a high-performance weapon system that delivers more fighting power at less cost.

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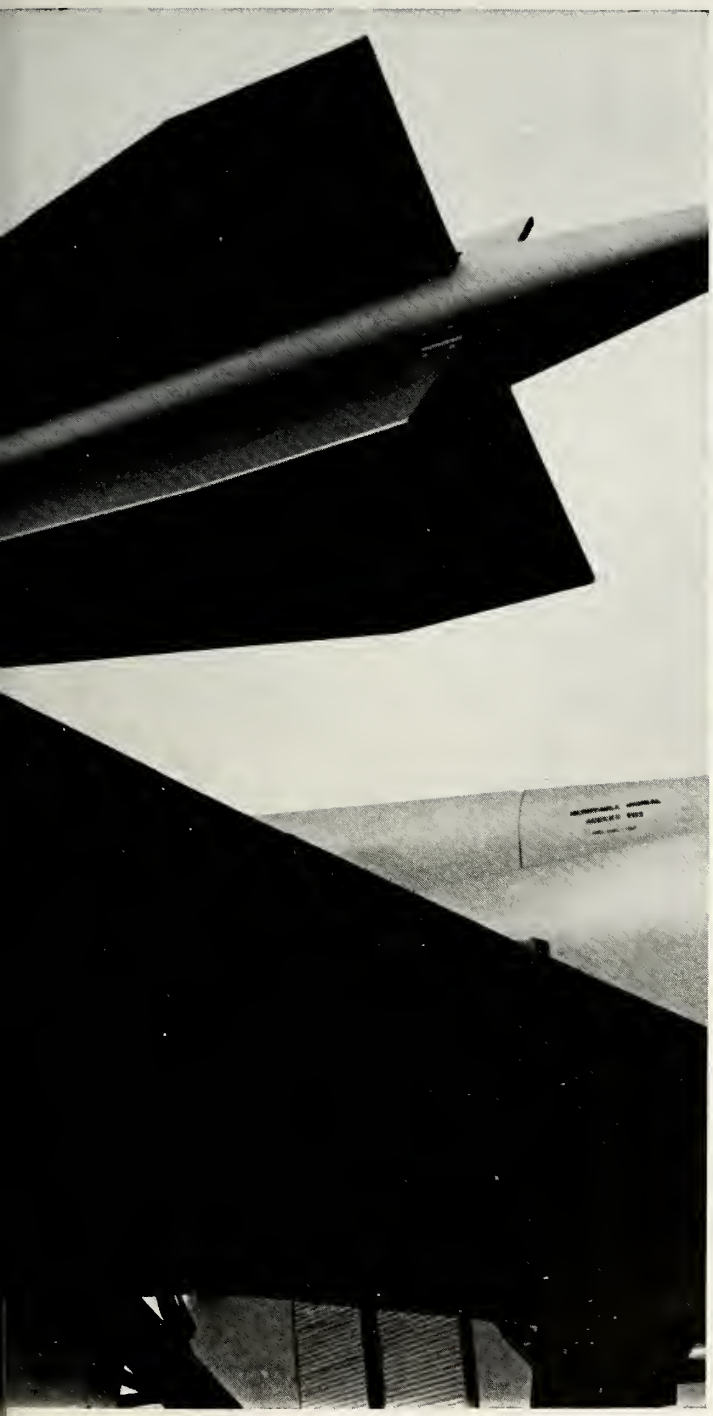
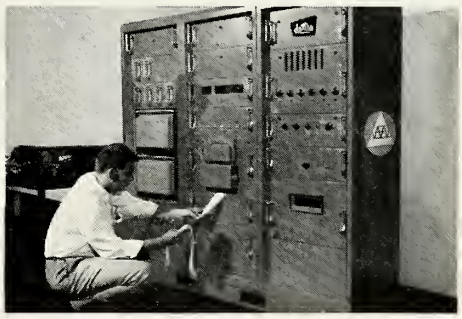


RADIOPLANE

Supersonic XQ-4 target: another advancement in a 20-year record of drone design and production for all of the U.S. Armed Forces.

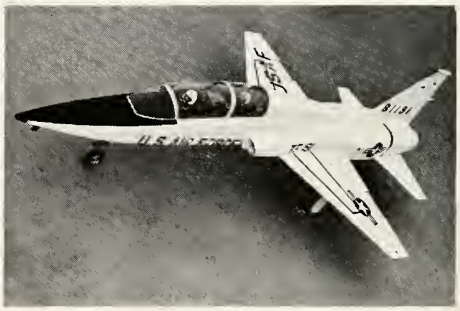
NORTRONICS

Datico gives kill assurance, spares men and man-hours in speeding the vital pre-mission checkout of six proven U.S. missile systems.



NORTHROP DIVISION

Supersonic USAF T-38, first of Northrop's new N-156 aircraft family, will train space age airmen at minimum cost; is twin-jet safe



INTERNATIONAL

The new N-156F counterair fighter, now being built at Hawthorne, Calif., is proof of Northrop Aircraft's ability to create higher quality weapon systems at lower cost. This and other Northrop contributions to national and international defense are products of the Company's cost-minded management team and of Northrop-developed, years-ahead production techniques.

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'Unsophisticated' *Juno II* May Orbit Sun

'Souped-up' *Jupiter* will fire all 4 stages in sequence for 220-seconds to reach lunar vicinity in 34 hours after Dec. 5 lift-off

by Norman L. Baker

WASHINGTON—With the spotlight now on the ABMA/JPL team, the Army is taking steps to assure at least one close proximity approach to the moon's surface during the two forthcoming attempts in December and January.

Sophistication of launching systems, when compared with the Air Force *Pioneer* attempts, has been reduced to a minimum in an effort to improve the chances of a successful shot to one-in-two. During the Air Force attempts chances of success were reported at 1-in-25.

The Army technique will employ excess power for an additional margin of velocity and reduction of flight time in addition to ground-monitored guidance for minimizing directional error. The excess velocity is expected to send the payload past the moon into an orbit about the sun. No attempt will be made to orbit the lunar body, therefore eliminating another critical maneuver designed into the *Pioneer* lunar probes.

The *Juno II* launching vehicle will be an extensively modified *Jupiter* IRBM with the standard *Jupiter-C* upper stages. The *Jupiter* first stage will have an elongated RP-1 fuel tank for increasing the rocket's burning time. The upper three stages, in clusters of eleven, three, and one, will be positioned on top of the instrumentation and guidance section, replacing the warhead nose cone.

• **Fire in sequence**—All four stages are expected to be fired in sequence to provide continuous burning, eliminating the coasting phase of the last three stages required with the *Explorer* satellite launchings. First stage will fire for approximately 200 seconds with final stages firing for 6½ seconds each—a total burning time of about 220 seconds.

Burnout velocity will be 24,300 mph or above, placing the payload in the vicinity of the moon in 34 hours. The upper stages will be fired near enough to the earth's surface to present a large buildup in aerodynamic heating. For that reason a special protective cover made with ablative materials will cover the final stages during its trip through the atmosphere.

Juno II will be "aimed" in a direction calculated to either shoot the payload past the moon 10,000 to 50,000 miles from the surface or make an impact with it. Dr. Wernher von Braun stated the chances are one-in-two the payload will miss the moon and wind up in the sun's gravitational field.

• **LEV-3 guidance**—Guidance within the vehicle will probably utilize the proven LEV-3 gyro stable platform for control of roll and yaw with an air-bearing gyro for control of pitch. Deviations from the planned flight path due to internal guidance errors will be corrected by a ground station using a doppler radio link.

The 15-pound instrument payload (10 pounds less than the *Pioneer* payloads) will be comprised mainly of radiation equipment and associated radio system. Lifetime of radio batteries is expected to be reduced due to anticipated short operational period. Major difference in the payload weights of the Army and *Pioneer* probes is the elimination of the retro-rocket and TV scanner systems for the Army attempts. Von Braun stated further that the chance of the payload transmitting useful data is one-in-three.

Continued reception of payload data is anticipated for several hours after the payload passes beyond the moon. The arrival of the payload in the vicinity of the moon will be timed so the moon is directly above the JPL tracking station at Goldstone in the Mojave Desert.

• **Relaxed schedule**—The additional velocity increment plus the elimination of the moon-orbiting maneuvers will provide the Army with a relaxed launching schedule. The moon will be at its closest approach to the earth December 5, the date the launching is expected to be attempted, but the Army lunar probe technique should provide a launching timetable through December 12. Beyond that date, the increasing distance of the moon from the earth, will offset the advantage supplied by the additional velocity and steadily increase the probability of directional error.

Two days, December 8 and 9, of

A MODEL OF THE ARMY'S *Juno II* lunar vehicle is shown in this photograph of NASA officials conferring with Dr. Wernher von Braun at ABMA. The *Juno II*, at right, utilizes the same upper stages as the *Jupiter-C*, a model of which is shown at left. Major difference is use of a *Jupiter* IRBM instead of a *Redstone* as first stage.

SPACE TECHNOLOGY LABORATORIES, INC.

Space Technology Laboratories, Inc., previously a division of The Ramo-Wooldridge Corporation, became a separate company on October 31, 1958. Space Technology Laboratories will be directed by Lieut. Gen. James H. Doolittle, Chairman of the Board (after January 1, 1959); Dr. Louis G. Dunn, President; and Dr. Ruben F. Mettler, Executive Vice President. The other members of the Board of Directors are Robert F. Bacher, Head of the Division of Physics, Mathematics and Astronomy at the California Institute of Technology; James T. Brown, Vice President of the Mellon National Bank, Pittsburgh, Pennsylvania; and Samuel E. Gates, Attorney with the New York firm of Debevoise, Plimpton and McLean.

Space Technology Laboratories has the largest professional scientific and engineering staff in the nation devoted exclusively to Ballistic Missile and Space programs. STL is responsible for the systems engineering and technical direction of the Air Force THOR, ATLAS, TITAN, and MINUTEMAN ballistic missile programs. While it does not engage in production, STL performs experimental and analytical research projects in advanced space technology, including the fabrication and assembly of special equipment and the conduct of test programs. A recent example is the lunar probe project assigned to STL by the Air Force and the National Aeronautics and Space Administration.

Space Technology Laboratories, Inc., plans to maintain a combination of technical competence and organizational strength appropriate to its special and continuing role in the important national program of space weapons development.

SPACE TECHNOLOGY LABORATORIES, INC.

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Thompson Ramo Wooldridge Inc.

On October 31, 1958, **Thompson Ramo Wooldridge Inc.** was formed by the merger of *Thompson Products, Inc.*, and *The Ramo-Wooldridge Corporation.*

Thompson Ramo Wooldridge will be directed by J. D. Wright, Chairman of the Board; Dean E. Wooldridge, President; Simon Ramo, Executive Vice President; and F. C. Crawford, Chairman of the Executive Committee. The other members of the Board of Directors are B. W. Chidlaw, A. T. Colwell, J. H. Coolidge, H. L. George, R. P. Johnson, and H. A. Shepard. Each is a Vice President of the merged company.

Thompson Products, Inc., has been for many years a large manufacturer of components and accessories for the automotive and aircraft industries. In recent years, it has also been active in the fields of Missiles, Electronics, and Nuclear Energy. Thompson has concentrated on products which require a high level of competence in engineering and precision manufacturing.

The Ramo-Wooldridge Corporation was organized five years ago to conduct research, development, and manufacturing operations in the field of electronic and missile systems having a high content of scientific and engineering newness. In addition to the work performed by Space Technology Laboratories, Inc., Ramo-Wooldridge has been engaged in major systems work in such areas as digital computers and control systems, communications and navigation systems, infrared systems, and electronic countermeasures.

The merger of the two companies into Thompson Ramo Wooldridge Inc. is intended to provide an integrated team having strong capabilities for scientific research, engineering development, and precision manufacturing.

Thompson Ramo Wooldridge Inc.

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the above timetable are considered unfavorable for launch. The moon will be in conjunction (between the earth and sun or New Moon) on December 10. Therefore if the payload were launched on those dates (8th or 9th) it would arrive in the vicinity of the moon at the conjunction and if it passed the moon it would proceed on into the sun instead of an orbit around it.

Furthermore, the tracking stations have requested that no launches be made when the moon is in conjunction. Radio signals from the sun could almost black-out the payload's transmitted data when traveling in the direction of the sun. The three *Pioneer* probes were all fired at or near the time of new moon.

• **More sophisticated detector**—Although the Air Force project, had it been successful, would have been a greater feat and provided more data, the Army probe will have a more sophisticated detector system to measure both cosmic and solar radiation. The Army rocket will have two counters. The Air Force probes had only one.

Each counter will pick up different ranges of energy, at a different counting rate (particles per second). The low counter will measure in more detail. The high counter will give a better picture of the intensity.

If the December shot fails, Army probably will not fire again until February. It takes about two weeks to prepare the rocket and a January attempt would cut deeply into Christmas and New Year holidays.

The instrument package will also contain an optical device incorporating a photoelectric cell from which the scientists hope to get measurements to guide them in deciding on a "picture-taking device" for use on future probes.

Two Symposiums Tackle Space Medicine Problems

SAN ANTONIO—Scientists at two space medicine symposiums recently exchanged ideas on how to keep future space explorers in top shape—mentally, physically and emotionally. Their views came out of the Second International Symposium on the Physics and Medicine of the Atmosphere of Space at San Antonio and the British Interplanetary Society's Symposium on Space Medicine in London.

It was generally agreed that man is emotionally equipped and can be physically equipped to handle a few weeks' run in outer space but interplanetary travel poses new problems, such as: How do you keep a space crewman well fed if he turns up his nose at algae puddings? How do you shield him from known and unknown radiation dangers? How would a space "lifeboat" work best? How do you keep him from getting bored? How do you provide an "umbilical cord" to Mother Earth so he doesn't feel completely detached from his fellow beings?

• **Outcome**—Suggested answers: Convert the algae to more appetizing form by feeding it to slugs, snails or water fleas. (There was some question whether the spaceman would find water-flea steak more tasty than the algae soup which space doctors have been advocating as a rich source of protein.)

Protect him from high and low-energy radiation particles with layers of various metals plus hydrocarbons. Make the escape capsule self-sufficient and an integral part of the vehicle, allowing it to eject the damaged or non-functioning part of the ship.

Give him at least one companion and give him enough jobs to do which he believes important to the mission. No suggestions were forthcoming on an ersatz umbilical cord, except that the matter requires extensive study.

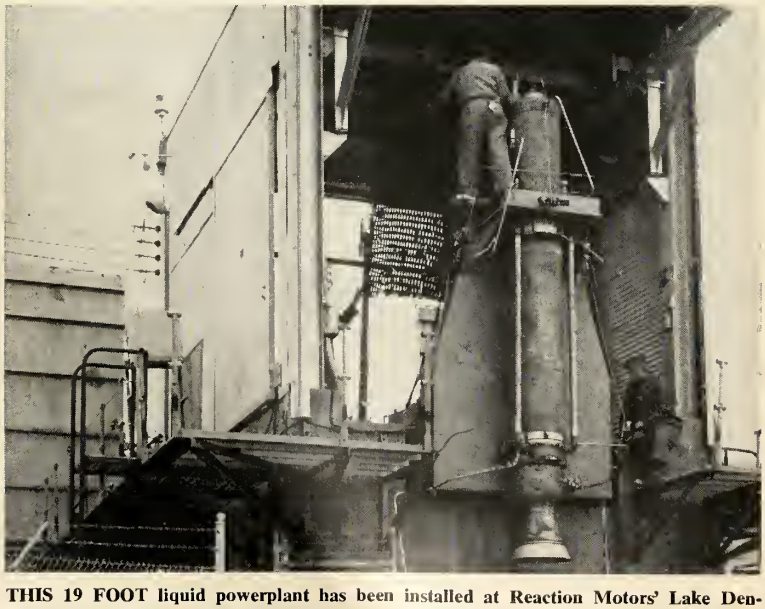
• **Food**—Bacteriologist Robert G. Tischer of Mississippi State University made the algae suggestion. Tischer said if the space crew is not likely to eat algae directly, then the interposition of an animal that would eat algae would yield animal protein food for the space crew. He also suggested microbial protoplasm "perhaps with modifications and the addition of flavors," as another bill of fare. But the consensus is that there still is no practical solution for palatable nutrition in the closed ecological system required in long space trips.

• **Radiation**—Dr. S. Fred Singer of the University of Maryland proposed a complex radiation shield composed of an outer layer of lead, a layer of tin, a layer of aluminum, magnesium or titanium, and finally a thin layer of plastic or other hydrocarbons to stop a substantial percentage of the high-energy radiations.

Consensus of several scientists is that radiation is a hazard that needs more study, that it can be dealt with, and that reaction to it is a question of individual response as well as dosage.

• **Escape**—Al Mayo of Douglas Aircraft—El Segundo suggested that instead of an escape vehicle, the nucleus of a space craft, housing the controls, should be complete in itself and would function as a spatial life raft while the malfunctioning or damaged portions "escape" through ejection.

Reaction's 'Packaged Liquid' Stand



THIS 19 FOOT liquid powerplant has been installed at Reaction Motors' Lake Denmark, N.J. for test and evaluation. As an example of the short development time involved in building packaged powerplants in different sizes, this large unit was first tested within three months of the time work was begun on the *Guardian* engine project.

What's new in TITANIUM welding:

Resistance and fusion welding as fabrication procedures have become increasingly important with the advent of missiles and aircraft designed for sustained operation at Mach 3 and better.

Titanium alloys are available which provide fusion-weld efficiencies of 100 percent, and spot-welded joints with excellent load carrying capacities.

Through its new Toronto, Ohio, rolling mills —designed specifically for titanium operations —Titanium Metals Corporation of America can provide light-gage flat-roll weldable products of consistently highest quality, on the fastest delivery schedules, at the lowest possible price in the industry today.

Q. What are the leading welding grades?

A. Ti-75A, a single-phase unalloyed grade which is readily formable; Ti-5Al-2.5Sn, a single-phase alloy grade which provides excellent resistance to oxidation up to 1200°F; and Ti-6Al-4V, a duplex-phase alloy grade with guaranteed minimum tensile strengths to 130,000 psi. Guaranteed minimum mechanical properties of these grades are:

GRADE	DENSITY lb/cu in	Guaranteed Room Temperature Properties		
		0.2% YS	UTS	Elong, % in 2"
Ti-75A	0.163	70,000	80,000	20
Ti-5Al-2.5Sn	0.162	110,000	115,000	10
Ti-6Al-4V	0.161	120,000	130,000	10

Q. Are special precautions required for welding these grades?

A. Titanium is spot-welded more readily than aluminum and many of the carbon and low alloy steels, and requires no special precautions. Spot-weld machine settings used for titanium and stainless steel are very similar.

Titanium is fusion-welded with inert-gas-shielded arc welding techniques and joint designs which are also similar to those used for other metals. Two fundamental principles must be considered:

1. Coated electrodes and other fluxing compounds cannot be used.
2. Titanium weld joints must be shielded from the normal atmosphere with an inert blanket of argon or helium during welding.

Q. Does that mean chambers are mandatory for fusion weldng?

A. No. Open air welding is adaptable to production operations when both root and face of the weld are protected from the air. Small parts and complex shaped weldments which are difficult to shield adequately may still be welded more easily and economically inside a chamber. This is described in detail in TMCA's publication, *Titanium Welding Techniques*, Engineering Bulletin #6.

Successful titanium welding techniques have enabled fabricatars to praduce missile prapellant starage battles which resist internal pressures af 8000 psi at —300°F. This all-titanium battle, praduced by Rheem Manufacturing Campany, Dawney, Calif., is Ti-6Al-4V, fusian-welded in an argan atmasphere. Designers say use af titanium battles can add up ta 700 miles ta the range af an IRBM.

Q. Are titanium welds more susceptible to corrosion attack than the base metal?

A. Titanium welds offer the same excellent corrosion resistance as the base metal. Stabilizing heat-treatments, employed with many other materials, are *not* required.

Successful welding is a key factor in today's designs. It enables designers to draw upon titanium's unique combination of properties: light weight, corrosion resistance, and ability to withstand operating temperatures from –300°F to 1000°F — for the added performance vital to these uniquely critical times.

Titanium Metals Corporation of America has just completed the first comprehensive study of welding techniques yet published by the industry. This 32-page publication draws upon metallurgical considerations to recommend and explain techniques required for quality titanium weldments.

Titanium Welding Techniques, as well as other publications, in the most extensive data library in the industry, is available from Titanium Metals Corporation of America, 233 Broadway, New York 7, New York. This important literature is yours for the asking.

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- ☐ Bulletin 2 Heat-Treatability of Ti-6Al-4V
- ☐ Bulletin 3 Analytical Chemistry of Titanium
- ☐ Bulletin 4 Mechanical Testing of Titanium
- ☐ Bulletin 5 Properties of Ti-155A
- ☐ Bulletin 6 Titanium Welding Techniques
- ☐ Other .....

military electronics

ASW AND UNDERSEA WARFARE

- SE Submarine communications and detection.
- SE ASW data processing and display aids.
- PP ASW listening and retransmitting devices.

SPECIAL DEVICES

- SE Proximity warning.
- SE Long range electronic surveying equipment with airborne repeater.
- DS Electronic fusing.
- DS Electronic surveying equipment.
- DS Pulsed light range measurement equipments.
- PP Radiosonde transmitter and preamplifier.

MISSILE AND DRONE CONTROL

- SE Precision inertial-guidance system for short range air-to-surface missile.
- SE Bomber defense missile system.
- DS Homing guidance system for attack and reconnaissance drones.
- DS Air-to-air radar guidance system.
- DS Surface-to-surface radio inertial guidance system.
- DS Drone command guidance system.
- PP Data transmission and processing for surface-to-air missile guidance.
- PP Surface-to-air radar guidance system.

SENSORS

- SE Precision location of radars.
- SE High precision and high resolution forward-looking radar.
- DS VHF homing beacon for supply-drop aircraft.
- DS Anti-jam radar transmitter and receiver.
- DS Radar anti-clutter receiver.
- PP Beacons, C-band and X-band.
- PP Strategic bombing radars.

COMMUNICATIONS AND DATA TRANSFER

- SE Obstacle-gain data transmission.
- SE 18-Channel teletype.
- SE Noise-modulated data links.
- DS Integrated battlefield air mobile radio communication system.
- PP High-density FM voice multiplex.
- PP Integrated battlefield ground mobile radio communications system.
- PP High density UHF communication system for air defense.
- PP Coded secure communications.
- PP Pulse code modulated communication equipment.
- PP Multitone and digital selective calling equipment.
- PP Transportable and fixed-station microwave wide-band relay equipment.
- PP AM, FM and SSB voice and data communications equipment.
- PP I.F.F. equipment.
- PP Data link and logic for ground-to-air command guidance of aircraft and missiles.
- PP Miniaturized Transceivers.

Here is an unclassified look at representative Motorola militar electronics programs...past and current. Necessarily incomplete the listing includes only enough projects to demonstrate th breadth of experience at Motorola's Military Electronics Divisior For detailed information on how Motorola's capabilities can b applied to your problem...or for data on engineering caree opportunities...please write: Motorola, Inc., Military Electronic Division, 8201 East McDowell Road, Phoenix, Arizon

KEY:

Program Status Coding (Reference MIL-E-5400B)

- SE *Study programs or programs resulting in experimental models.*
- DS *Programs resulting in developmental and/or service test models.*
- PP *Programs resulting in pre-production prototypes and/or production models.*

A-811-1

experience on file at Motorola

COMPONENTS

- Quartz crystal resonators and filters.
- Electrical wave filters.
- Electromechanical filters.
- Precision V.F.O.'s and B.F.O.'s
- Electromechanical reed filters and tone generators.
- Transistorized power converters.
- Transistorized voltage and current regulators.

NAVIGATION

- SE Doppler personnel navigator.
- SE Inertial sensors.
- SE Supersonic intercontinental bombing-navigation system.
- SE Hyperbolic battlefield navigation system for aircraft, land vehicles and man pack.
- DS Hyperbolic amphibious navigation system.
- PP Aircraft rendezvous and station-keeping systems.

DATA PROCESSING AND DISPLAY

- SE Automatic data processing for electronic countermeasures.
- SE Data processor for electromagnetic intercept.
- SE Threat evaluator for air defense.
- PP Shipborne electronic data system for air defense.
- PP Large-scope bombing radar indicator.

ELECTRONIC WARFARE

- DS Battlefield electronic warfare.
- DS False target generation system.
- DS Tracking jammer.
- PP Subminiature passive radar illumination detector.

GROUND SUPPORT AND TEST EQUIPMENT

- PP Phase-lock telemetry.
- PP Command destruct receivers.
- PP Guided missile test equipment.
- PP Programmed automatic test system.
- PP Aircraft test equipment.
- PP Militarized precision pulse circuit testers.

SOLID STATE MATERIALS AND DEVICES

- SE Ferro-electrics.
- SE Ceramics.
- SE Solid state devices.
- PP Ferrites.

COMBAT SURVEILLANCE

- SE Drone guidance, data sensor, and data transmission integrated reconnaissance system.
- SE Aircraft data sensor, and data transmission reconnaissance system.
- PP High resolution side-looking radars for aircraft and drones.

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Fusion 'Pinch Effect' Is Called Unpromising

Researcher Believes Controlled Thermonuclear Power Can Be Achieved by Revolutionary Microwave Heat Containment

by Raymond M. Nolan

WASHINGTON—The "pinch effect" for controlled thermonuclear fusion, as known now, does not offer much promise for the future.

That is the opinion of RCA's E. W. Herold, who devoted himself to the subject of controlled fusion at this year's Electron Devices meeting in Washington. In his paper titled, "Controlled Thermonuclear Fusion," Herold said that the U.S. is undoubtedly the world leader in research aimed at harnessing thermonuclear fusion for the production of power. At the same time, he warned that "it would be dangerous to predict the long-range future trends, since a single new idea, in the hands of even a small competent group in any country, could change the rate of progress markedly."

Herold is Associate Project Manager of C. Stellerator Associates, an RCA-Allis Chalmers engineering staff organization that is designing and building a major fusion research facility for Princeton University and the Atomic Energy Commission.

• **Maintaining controlled fusion**—One intriguing theory of Herold's is that fusion power may some day be achieved by revolutionary all-electronic techniques, instead of by the combined electronic and electrical methods envisioned on the basis of present research programs.

As an example, he mentioned new microwave techniques to contain the 100-million degree heat needed to produce and maintain a controlled fusion reaction. Since no known material can contain more than a few thousand degrees of heat, present research is in the area of magnetic fields using the pinch effect for greater heating.

However, Herold feels that a definite breakthrough is needed to reduce the power needed to maintain a steady magnetic field over a volume of many cubic feet. Even better, he said, would be a containment method using radio frequencies to react upon the superheated deuterium gas that serves as the fusion fuel. He feels that it might be possible to set up containing microwave fields around the superheated plasma in somewhat the manner that super-high frequency waves are guided along solids in certain communications techniques. This would somewhat resemble a dielectric wave guide, reduced in magnitude with distance, so that wall losses could be cut down.

As Herold sees that problem, it would not have any immediate application to missiles or space craft since another part of the problem would be the megawatts of C-W power at microwave frequency needed to maintain the containment. However, he challenged his audience to discover a way to find the necessary power. When someone does, the near-ultimate generation of missiles, the electronically-propelled ones, will be much closer to reality.

• **Power direct from neutron**—Or perhaps the required energy will come from new ideas suggested by Herold, such as a method to produce power directly from the neutron without going through the heat cycle. He cited the analogy that a radio engineer uses the motion of charged particles to achieve power and said that this effect may someday be part of fusion reactors also.

But containment is not the only area where Herold sees a need for application of electronics. In a paper published this summer, he stated that in his opinion, the greatest contribution to thermonuclear fusion can be made by the radio-electronic engineer paying attention to the problem of ignition and heating.

He outlines the problem by mentioning some of the difficulties incurred in heating by the passage of direct current through a plasma. Because electrons travel 60 times as fast as deuterium ions, they carry most of the current, and this form of heating is effective mainly on electrons, tending to raise their temperature but not that of the ions, except after many thermalizing collisions. In addition, as the temperature rises, the resistance goes down and the I^2R loss decreases, since induced currents are normally limited by the plasma inductance. Thus, such heating appears to be self-limiting. On the other hand, if some way is found to heat the ions without heating the electrons, the cooling effect of the electrons will be a problem.

• **Hopeful of high power radio**—In radio-frequency heating, there are some peculiar skin effects in a plasma to consider. These are long mean-free-paths and magnetic constraints on the particle paths. The cyclotron frequencies of charged particles in a magnetic field are, quantitatively: (in cps)

Electron cyclotron frequency= 2.9×10^6B,

Deutron cyclotron frequency= 770B,

Triton cyclotron frequency=510B,

Alpha particle cyclotron frequency =770B.

Since B equals 26,000 gausses, these correspond to 75,000 mc for electrons, 20 mc for deutrons and alpha particles, and 13 mc for tritons.

Herold feels that high-power radio frequencies, which are adapted to the plasma characteristics, and to the ion and electron dynamics, offer great hope, both for containment and the ignition problem. If containment time is very short, he says, very high power radio frequency may supply the rapid heating necessary to achieve useful results.

• **Plasma problem more complex**—In his paper, Herold cited the case of electronics engineers understanding containment of low-density electric charges by magnetic fields because this

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For more information, write to: Vice President, Defense Products Marketing, Crosley Division, Avco Manufacturing Corporation, Cincinnati 25, Ohio.

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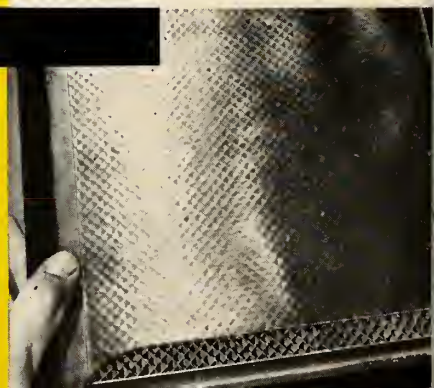
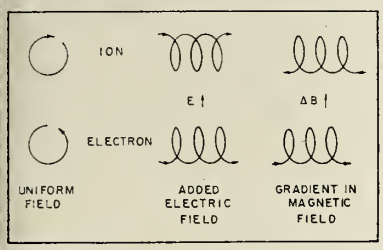


occurs in every magnetically focused electron tube, and in magnetrons when they are beyond cutoff. These simple concepts provide a start to understanding high-density plasma containment.



The diagram shows the simple case of an isolated ion or electron in a magnetic field. Such charges experience force at right angles to the magnetic field and to the perpendicular component of their own velocity. Only velocity components parallel to the field are unaffected. Thus, the particles, whether they be electrons or ions, are held to the magnetic field lines, rotating in circles, as shown at the left of the figure, and free to move back and forth along field lines. When there are other fields present such as the electric fields or there is a gradient of a magnetic field, the particles drift across field lines and are no longer contained. This is a phenomemon of containment since no way is known of establishing a uniform magnetic field with no gradients or magnetic forces.

With a plasma, the problem becomes more complex since the plasma is a good conductor and the current in it tends to set up its own field and disturbing force.

It is Herold's contention that the electron physicist, the electron tube engineer, and the radio engineer can all contribute new concepts to this field of gas discharge technology.

New Resistors Depend On Magnetic Field

The phenomenon of magneto-resistance is now being applied to resistor-type devices.

The new components operate on the theory of the magneto-resistive effect where solid state units exhibit an electrical resistance which is a function of an applied magnetic field.

Major advantage of the devices, called Magnetoresistors by their developer, Ohio Semiconductors Inc., is that they can be used to provide a low-noise variable resistance having no moving parts. Their most valuable application will probably be in the feedback and control systems area where fast response may be quite a bit superior to existing electromechanical systems.

Magneto-resistance is not a newly discovered phenomenon, but practical applications are recent. The reason for magneto-resistive practicality now is the use of highly purified and specially prepared high mobility intermetallic compounds such as indium antimonide and indium arsenide. With these compounds, the magnetoresistive effect becomes great enough for extensive practical applications.

In the resistor-type device, ratios of high-to-zero field resistance of more than 40 to 1 have been attained. The company anticipates that units with power dissipations of up to 100 watts will be available when production is underway.

High Temperature Research Described in OTS Reports

Three publications currently available from the Office of Technical Services, Department of Commerce, describe Air Force-sponsored research in the high temperature field. Two reports describe capacitors, one operating up to 250 C and the other to 500 C. The third report discusses research on aluminum antimonide for use in semiconductors operating up to 500 C.

Title of the first report is "250 C Ceramic Capacitor With Wide Temperature Range." It describes the development of titanate-based ceramic capacitors with high dielectric constants, small temperature coefficients and low loss factors with a temperature range from minus 65 C to plus 250 C at up to 1000 volts.

The final products in the research program were composed of 80.1% barium titanate, 16.99% lead titanate and 2.91% tantalum oxide. The processing methods are claimed to have resulted in higher degrees of mixing and greater reproducibility than was previously possible.

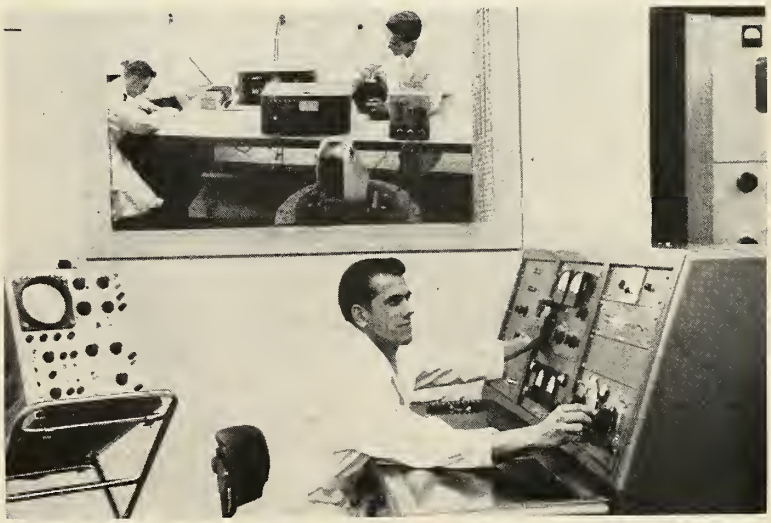
The other capacitor report is titled, "Research and Development on Ultra-Thermic 500 C Capacitors." These units were fabricated using successive layers of platinum and dielectric materials deposited by vacuum thermal evaporation.

Investigated during the program were the dielectric properties of oxides of such materials as aluminum, magnesium, zirconium and boron nitride to measure their resistivity throughout the required temperature range of the capacitors. The document reports that alumina and boron nitride yield satisfactory dielectric qualities in thin film form at high temperatures. Information is also included on techniques and processes involved in depositing thin dielectric layers.

The third report, "Research on Aluminum Antimonide for Semiconductor Devices," discusses research in the development of purification and crystal growing techniques for obtaining suitable aluminum antimonide material.

The study was conducted because aluminum antimonide was found to have the optimum potential for meeting the 500 C objectives.

Reliability Center for Missiles

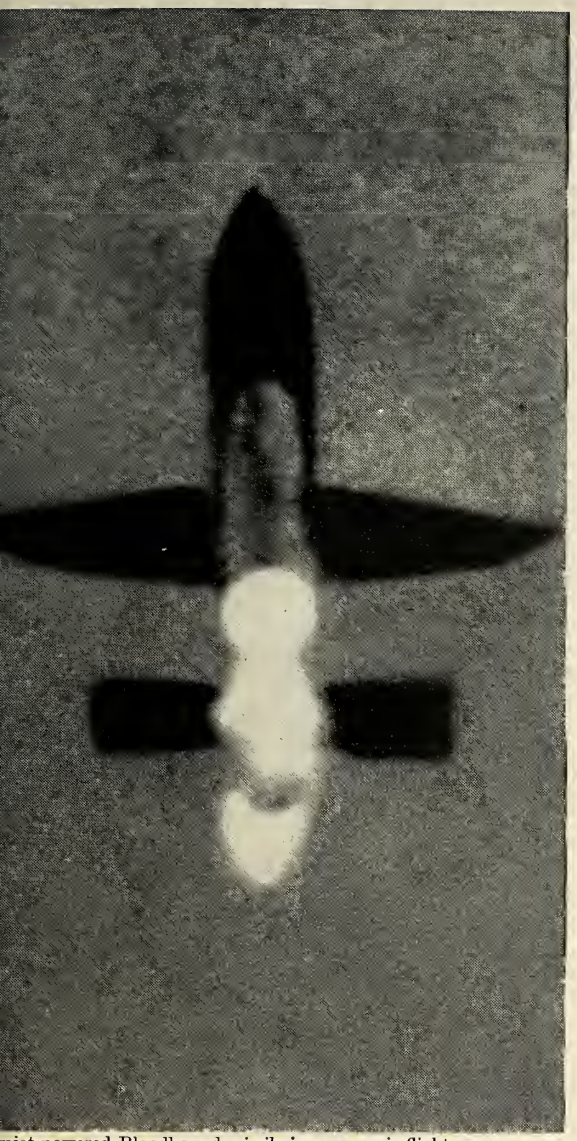


NEW PRODUCTION reliability center built by Leach Corporation will help to insure the more than 99.99% reliability required for missile components. Components undergo vibration in triple-walled silence chamber.

BRISTOL RAMJETS POWER

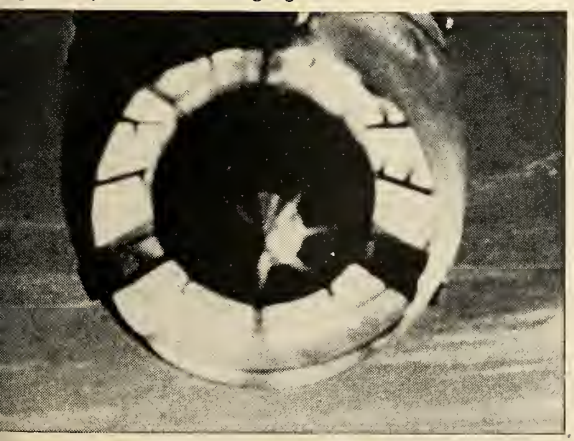
BLOODHOUND DEFENCE SYSTEM

—now ordered by Sweden



mjet-powered Bloodhound missile in supersonic flight

-up of ramjet air-intake during flight



Choice by European neutral confirms operational effectiveness of Bristol/Ferranti's surface-to-air guided missile system and its ramjet engines.

Adoption of the Bloodhound—already approaching full operational status with the RAF as mainstay of Britain's air defence—was made by a Swedish assessment team after exhaustive evaluation of the merits of surface-to-air guided missile systems available throughout the world.

Bristol ramjets—ensuring long range, flexibility, simplicity of handling—play a large part in making Bloodhound the most effective defence system of its kind in the world—*now and for many years to come.*

Bristol Siddeley

ENGINES LIMITED

Hawk May Be Built By NATO Countries

Five European companies, three Dutch, one French and one Italian, are understood to be very interested in manufacture of the Raytheon *Hawk* under license. The French firm of Sud Aviation is reportedly seeking to produce the missile in association with Italy's Fiat. The three Dutch firms believed to be interested are Philips, Fokker and Hollandse Signal-apparaten.

Raytheon declined confirmation of the reports, saying only that negotiations are in an exploratory stage and no details have been decided. If any agreements are reached, it is presumed that Raytheon will provide technical assistance in the form of "know-how," proprietary information, while actual production would be under control of the NATO countries involved.

The United States is now awaiting proposals from a number of European countries on the subject of licensing agreements. Several Dutch firms are also seeking to produce *Sidewinder*, providing it would not be obsolete by the time it comes off the production line.

Industrial Park Under Development for Research

WASHINGTON—Newest evidence of the impact of missile work on the general U.S. economy is the establishment of a new industrial park development—to be devoted entirely to scientific research and development activities—on a 365-acre plot just north of Washington's city limits.

In Montgomery County, about eight miles northwest of the District line, the development is known as Washington-Rockville Industrial Park. It is said by its developers to be the first in the United States to be devoted entirely to organizations doing scientific and research work, largely connected with missiles and space flight.

Some 10 specially designed office and plant structures—each set in a park-like atmosphere—are under construction on the former farmland. It is expected that some 500 companies may locate on the site, for an initial construction and land expenditure alone of more than $50 million.

Soviets Release *Sputnik* Cosmic Ray Measurements

The Academy of Sciences of the USSR has published a report of some of the cosmic ray findings of *Sputnik* II, months after the satellite's demise.

The satellite had two similar instruments for the recording of cosmic radiation, each independent of the other. Each consisted of a charged particle counter with an operating length of 100 millimeters and a diameter of 18 millimeters. The average amount of matter surrounding the counter was 10 gram/cm^2. Operating voltage of the counter (400v) was provided with the aid of a semiconductor converter fed from a 6½ v battery.

Both instruments contained scaler devices made of semiconductor transistors requiring 0.1 watts of power each. Weight of the instruments and power supply was 5.5 pounds.

The noted change in the intensity of cosmic rays in relationship to altitude beyond the limits of the atmosphere could be due to three effects: the increase of intensity at the expense of decrease in the screening action of the earth; increases in intensity because the lessening of the earth's magnetic field leads to a decrease in the generation of the energy of particles which can penetrate through the earth's magnetic field; and the change of the albedo of cosmic radiation.

G. F. Metcalf Named To AIA Missiles Group

George F. Metcalf, Regional Vice President—Washington Defense Activities for the General Electric Co., is the new chairman of the Aircraft Industries Association's Guided Missile Committee. He succeeds C. R. Irvine of Convair who resigned.

The committee is composed of representatives of leading U.S. manufacturers of guided missiles. It is the focal point for the views of missile manufacturers on non-competitive matters dealing with the design, development and production of missiles.

when and where

NOVEMBER

The Convertible Aircraft Congress, designing and operating missiles from unprepared sites, Franklin Institute, Philadelphia, Penna., Nov. 28.

First Electronic Computer Exhibition and Symposium, Olympia, London, England, Nov. 28-Dec. 4.

DECEMBER

National Resources Conference, Industrial College of the Armed Forces, Departmental Auditorium, Washington, D.C., Dec. 1-12.

Third EIA Conference, Reliable Electrical Connections, Dallas, Texas, Dec. 2-4.

IRE and AIEE, Second National Symposium on Global Communications, Colonel Inn, St. Petersburg, Fla., Dec. 3-5.

Eastern Joint Computer Conference and Exhibit, Bellevue-Stratford Hotel, Philadelphia, Penna., Dec. 3-5.

Professional Group on Vehicular Communications, Ninth National Conference, Institute of Radio Engineers, Hotel Sherman, Chicago, Ill., Dec. 4-5.

Mid-American Electronics Convention, sponsored by Kansas City Section, Institute of Radio Engineers, Municipal Auditorium Arena, Kansas City, Mo., Dec. 9-11.

American Astronautical Society, Fifth Annual Meeting, Hotel Statler, Washington, D.C., Meeting will be held in conjunction with the 125th Annual Meeting of the American Assn. for the Advancement of Science, Dec. 27-30.

JANUARY

Fifth National Symposium on Reliability and Quality Control in Electronics, Bellevue-Stratford Hotel, Philadelphia, Penna., Jan. 12-14.

Southwest Electronic Exhibit, Arizona State Fairgrounds, Phoenix, Ariz., Jan. 21-23.

Fifth Annual Radar Symposium (classified), Rackham Bldg., University of Michigan, Ann Arbor, Mich., Jan. 27-29.

Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, N.Y., Jan. 27-30.

FEBRUARY

14th Annual Technical and Management Conference, Reinforced Plastics Div., Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Ill., Feb. 3-5.

IRE, AIEE 1959 Solid State Circuits Conference, University of Pennsylvania, Philadelphia, Pa., Feb. 12-13.

MARCH

IRE, AIEE and Association for Computing Machinery, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco, Calif., March 3-5.

Gas Turbine Division of the American Society of Mechanical Engineers, turbine in action, Cincinnati, Ohio, March 8-11.

The American Rocket Society, 1959 Annual Meeting, Daytona Plaza Hotel, Daytona Beach, Fla., March 23-25.

Ryan has built every production rocket motor for America's first operational guided missile—the Army's Corporal—for over five years.

It takes tremendous power to boost the 10-ton Corporal to Mach 3 flight speeds ... to drop its atomic blast on a target 100 miles away. And this power must be controlled with pinpoint precision.

Ryan achieves this fine precision by forming, welding, and machining Corporal rocket motors to laboratory-like tolerances. Ryan has over twenty years' experience in this exacting type of work, which merges high-temperature metallurgy with manufacturing skills.

Designed by the Cal-Tech Jet Propulsion Laboratories, the Corporal motor is built by Ryan for the Firestone Tire and Rubber Company, prime contractors for the Corporal missile.

The Army relies on the Corporal's rocket motors for unerring performance—shot after shot. America's aircraft, engine, and missile manufacturers can rely on Ryan, too—for building complete propulsion systems ... for building single components for rocket motors, ramjets, or turbojet engines.

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In the February 9th, 1959, Special Issue, MISSILES AND ROCKETS gives a complete analysis of all satellite instrumentation—including Russian instrumentation! Plus articles on Missile Electronics that review the past . . . examine the present . . . and predict the future of the $2 billion missile electronics market. Plan now to be represented with a sales story that will enable the decision makers in the electronics field to learn the latest details about your capabilities—your products. Closing date: January 19, 1959.

■ Beginning January 5, 1959, MISSILES AND ROCKETS will move to a full technical-news weekly. There no longer will be a distinction between "Engineering and Electronics" and "News and Business" editions. Reader Service cards will be included in the 4th cycle and in the February 9th and July 20th Special Issues as well as the mid-May "Missile Market and Product Guide".

MISSILES AND ROCKETS

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AF Wins First Round With GAO

by Clarke Newlon

WASHINGTON—The Air Force has won the first round, at least, in its battle with the General Accounting Office and Congress that its detailed Inspector General investigation reports are privileged matters. But Air Force was left with the clear threat that future legislation may drastically alter the situation.

In testifying before the Moss committee, Air Force Secretary James Douglas strongly defended the right of the Air Force (and implicitly all the services) to withhold certain details of an IG investigation into alleged delays and excessive costs of the long range missile development program.

He was given a last minute assist from the White House by way of a letter from the President to Rep. Clare Hoffman, a Republican committee member, upholding the AF position. This was, in effect, that the summary and some 35 pages of the report (of a total of 61) in detail, were really all the GAO needed to know.

• **Several possibilities**—Next move is up to the legislative branch and Congressman Moss and the GAO are mulling over several possibilities:

1. To continue an independent investigation by the GAO of "deficiencies" the Inspector General found in the AF missile development program.

2. Agreements between Moss, Carl Vinson, chairman of the House Armed Services Committee; William Dawson, chairman of the House Government Operations Committee; Clarence Cannon, chairman of the House Appropriations Committee and Sub-Committee Chairmen George Mahon and Edward Hebert—to introduce a rider on the next Defense Department appropriation bill making it mandatory to turn such IG reports over to the GAO in toto on request.

3. To reintroduce a bill originated at the last session by Rep. Porter Hardy to strengthen the GAO position. This bill specified that any official failing to comply with Section 313 of the Budget and Accounting Act of 1920 (making it mandatory upon the services to turn over any requested material to the GAO) would not only forfeit his salary during the period of such refusal but would be subject to a $5,000 penalty.

• **Areas criticized**—In the summary of the Air Force report as released by the Moss committee, the IG was critical of:

Contractors using overtime as a subterfuge to get around salary and work week limitations, thus increasing program costs.

Purchases by some contractors which do not meet AF standards, resulting in delays and excessive costs.

Leasing of equipment when similar equipment was available in the industrial reserves.

Some contractors failing to get approval for cost-plus-fixed-fee contracts, a violation of military regulations.

Some operations of Ramo-Wooldridge Corp, which directs much of the AF missile program.

Lack of follow-through on contract supervision.

DOD Taking Good Look at Cutting out Missiles

WASHINGTON—There are too many different missiles in the U.S. arsenal and the Department of Defense is taking a long look at the whole field to decide what and where to cut, according to Secretary McElroy.

"We have a proliferation far beyond what is wise," McElroy said, "and some of the marginal programs in the missile field will be cut out."

Important among these is the *Thor-Jupiter* IRBM decision, and the official answer will be announced before the end of the year. Anti-aircraft missiles presently can't replace interceptor aircraft, he continued, but they reduce the requirements.

"We would not eliminate those *Thor*'s and *Jupiters* already ordered," McElroy said, "but the farther we go in making ICBM's operational, the less interesting it is to deploy IRBMs."

The four *Thor* squadrons for Britain are firm, McElroy said. He said he considered both *Thor* and *Jupiter* operational missiles, notwithstanding recent test failures.

Budget discussions are in full swing, but the Secretary would give no indications as to what increase might be expected, or how the money would be split up between the services. He did say that a recent five per cent increase over the 1959 budget attributed to Deputy Secretary Quarles was hedging. He did say he expected no difficulties stemming from the Congress as the issues were so great as to override any partisan considerations.

contract awards

AIR FORCE

By the Air Research Development Command, Baltimore, Md.:

The **Data Tape Division, Consolidated Electrodynamics Corp.,** has received a $216,900-contract for magnetic-tape recorder/reproducer equipment that will be used with range instrumentation previously supplied to the Air Force Missile Test Center, Patrick Air Force Base, Fla.

By AMC, Wright-Patterson Air Force Base, Ohio:

Northrop Aircraft Inc., Northrop Division, Hawthorne, Calif. received $150,000 for augmentation of ground equipment for launch crew training for SM-62A program.

McDonnell Aircraft Corp., St. Louis, Mo. received $500,000 for development of quick-loading capability for GAM-72.

By San Antonio R&D Procurement Office, Wright Air Development Center, Air Research and Development Command, U.S. Air Force, Lackland AFB, Texas:

Minneapolis-Honeywell Regulator Co., Aeronautical Div., Minneapolis, Minn. received $179,928 for design, development, fabrication and installation of a space cabin simulator.

Burroughs Corp. received a $22.8 million-contract for additional 32 data processing systems in the SAGE (Semi-Automatic Ground Environment) continental air defense program.

ARMY

By the Department of the Army.

J. W. Bateson Co., Inc., Dallas, Texas, received a $1,273,000-contract for construction of a guidance building, antenna foundation and transmitter building at White Sands Missile Range, New Mexico.

By District Engineer, U.S. Army Engineer District, Fort Worth Corps of Engineers, Fort Worth, Texas:

King Construction Co. and Associates, Texarkana, Texas received $4,142,564 for *Nike-Hercules* facilities, Alvarado, Denton, Mineral Wells and Terrell sites, Dallas-Fort Worth defense area.

By Corps of Engineers, Office of the Dist. Eng., Tullahoma, Tenn.:

Blount Bros. Construction Co. received $1,797,395 for construction of second increment, plenum evacuation system, propulsion wind tunnel, and Arnold eng. development center, Tullahoma, Tenn.

By Purchasing and Contracting Div. White Sands Missile Range, New Mex.:

Ampex Corp., Los Angeles, received $28,650 for one recorder/reproducer.

By U.S. Army Engineer Dist., Corps of Engineers, Mobile, Ala.:

Warren, Knight & Davis, Birmingham, Ala., received $99,800 for architect-engineer services in connection with Redstone Arsenal, Ala.

propulsion engineering

by Alfred J. Zaehringer

Working fluids for an atomic rocket are being studied by Bell Aircraft Corp. engineers. Hydrogen is best if there is a temperature limitation. However, helium is superior where power is limiting. At 2,000°K and 20 atm pressure, for example, hydrogen produces an I_{sp} of 664 sec for a pile power of 21 kw/lb thrust. For helium, under the same conditions, a power of 12 kw/lb thrust would produce 389 sec.

Two new boron fuel processes might reduce present costs. Utilizing a Linde-type process, an alkylated borane could be produced by direct reaction of diborane with acetylene. Ziegler process, using triethyl aluminum, reacts boron fluoride and borax to form the boron alkyl.

Propulsion for torpedoes or underwater rockets utilizes alkylaluminum hydrides. Aluminum alkyls are also claimed in a new patent issued to duPont. The compounds bridge the gap between the straight metal alkyls and the boron hydrides.

Temperature is important when testing the sensitivity of monopropellant materials. Los Alamos Scientific Laboratory found this to be true when testing nitromethane. The effect of sample size and effective diameter are also important.

Solid propellant performance data is becoming more available. Ammonium perchlorate with polybutadiene acrylic acid plus aluminum powder gives an I_{sp} of 250 sec. Ammonium nitrate with cellulose acetate yields 171 sec. Ammonium perchlorate and polyurethane offers 238 sec. A mixture of ammonium perchlorate and potassium perchlorate produces 236 sec. Potassium perchlorate with a polyester (styrene) resin has a 178 sec. potential. All data are theoretical figures calculated at 1,000 psi pressure. The figures may not be representative of classified combinations. which may be higher or lower in performance when obtained in actual rocket systems.

Polysulfides out for solid propellant fuel-binders? Claim is that Thiokol may switch over to the chloroacetals. Other possibilities are ethyleneketal or thioketals. Other companies are working on urethanes, butadienestyrene, and acrylated butadienes.

Solids south of the border: Wolff & Co., of Buenos Aires, Argentina, has been very active in the field of solid propellants. The firm recently acquired German patents for propellants which are blends of nitrocellulose, nitrated polyalcohols, and a molten nitro compound.

Propellants for atomic rockets have been screened by AEC. Liquids are preferred working fluids. Water, though good, would have a molecular weight of about 18 at high pressures and temperatures inside a pile. Nitrogen compounds (such as ammonia or hydrazine) would be at 8½-10½; alcohols would be decomposed to 9-10 while hydrocarbons would be 5½-8. Helium is near 4 while hydrogen would be 2. Hydrogen thus appears as best bet (performance wise) for high I_{sp}, while the hydrocarbons would be suitable for medium performance.

More performance data on plasma jets: Giannini Plasmadyne Corp. reports that they have achieved thrusts of ½-2 lb with argon at a power input of 40-60 kw on 1-4 gr/sec mass flow; I_{sp} is 140-214 sec. With helium, thrusts of ½-1½ lb have been attained on mass flows of 0.7-1.3 gr/sec with inputs of 80 kw. Performance of He is higher—amounting to 530-590 seconds.

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advertisers' index

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