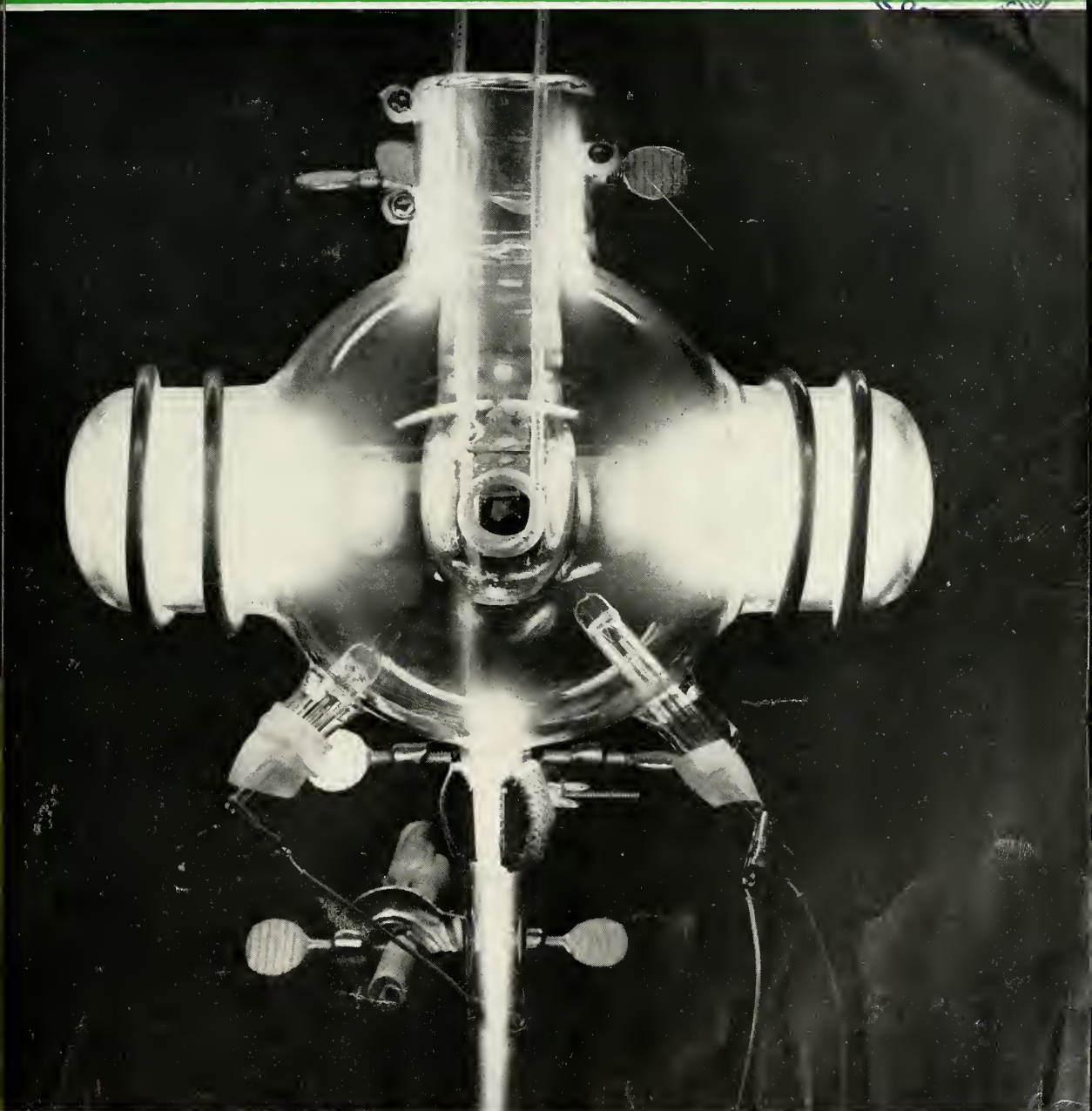
SEPTEMBER 12, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY



Melpar Studies Plasma Modulation

AN AMERICAN AVIATION PUBLICATION

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20 Reasons

for using Hadley cryogenic fluid controls in new hydrogen super-thrust missiles

Nineteen of the reasons are the proven performance of Hadley valves and regulators—many of which operate under cryogenic conditions—at nineteen key control points on the Atlas ICBM. It's as tough a task of pressure regulation as has yet come along.

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openings exist for qualified engineers

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Immediate openings on Dyna Soar and Minuteman for Electrical/Electronic Engineers

Two of the advanced projects on which Boeing is a major contractor are the Dyna Soar boost-glide vehicle and the Minuteman solid-fuel ICBM. The steady expansion of these long-range programs at Boeing has created openings for six electrical/electronic engineers. Salaries are $10,000 and up depending upon background.

Electrical/Electronic Materials and Processes Engineers

Four assignments available, entailing the preparation of electrical/electronic manufacturing process specifications which describe engineering requirements for shop manufacture of electric wiring installations and electronic packaging. Preparation of material and component specifications for electrical materials such as insulated wire and cable, connectors, and wiring devices. Development of improved electrical installation techniques to suit new applications in missiles and aircraft, and prove suitability of new techniques, materials, and wiring components by laboratory test. Duties include coordination with design engineers, manufacturing, quality control, purchasing and vendors. Requirements are a B.S.E.E. degree, and two to six years of electrical/electronic equipment design or process experience, with ability to write electrical requirements.

Electric Component Evaluation Engineers

Two assignments available: to evaluate performance and reliability of electric/electronic equipment and components by analysis and test. Make critical reviews of design and manufacturing quality of equipment and components procured or proposed for missile and aircraft application. Consult with and advise system design and application engineers on selection of equipment and components. Maintain contacts with equipment and component manufacturers to be familiar with new developments and to advise on Boeing requirements. Requirements are a B.S.E.E. degree, and two to ten years of electrical equipment design/test experience.

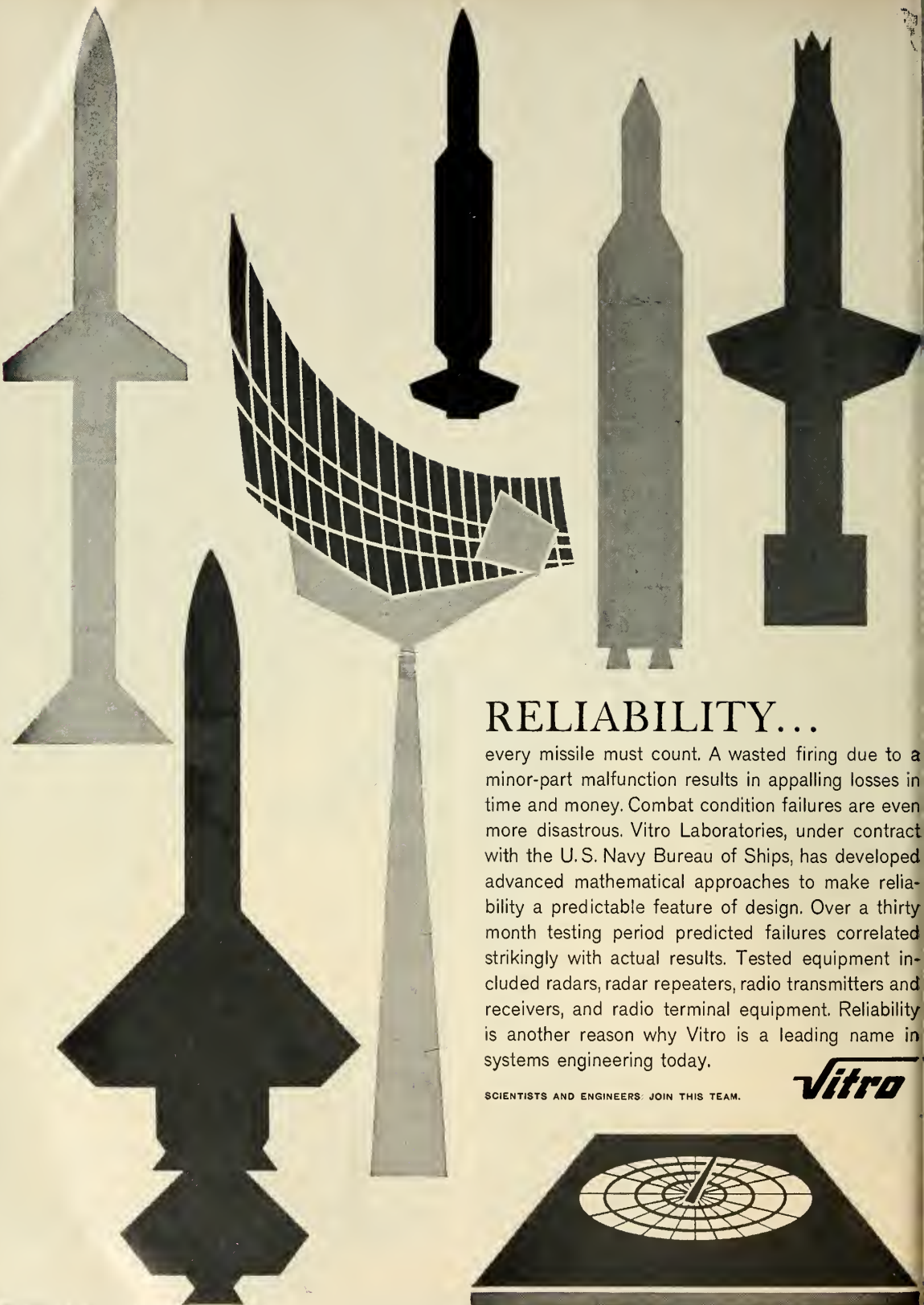
* * * *

At Boeing you'll enjoy the advantages of the uncongested Pacific Northwest area, famous for mild year-round climate, unexcelled recreational facilities, fine schools and outdoor Western living for the whole family. Boeing pays moving and travel allowances.

* * * *

Write today, outlining your educational and experience background, to: Mr. W. B. Evans, Boeing Airplane Company, P. O. Box 3707 - MRF, Seattle 24, Washington.

BOEING



RELIABILITY...

every missile must count. A wasted firing due to a minor-part malfunction results in appalling losses in time and money. Combat condition failures are even more disastrous. Vitro Laboratories, under contract with the U. S. Navy Bureau of Ships, has developed advanced mathematical approaches to make reliability a predictable feature of design. Over a thirty month testing period predicted failures correlated strikingly with actual results. Tested equipment included radars, radar repeaters, radio transmitters and receivers, and radio terminal equipment. Reliability is another reason why Vitro is a leading name in systems engineering today.

Vitro

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THE MISSILE / SPACE WEEKLY

missiles and rockets

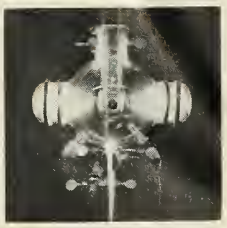
September 12, 1960 Volume 7, No. 11

blished each Monday with the exception of the st Monday in December by American Aviation blications, Inc., 1001 Vermont Ave., N.W., Washgton 5, D.C.

Wayne W. Parrish
President
Leonard A. Eiserer
Exec. Vice President and General Manager
Fred S. Hunter
Vice Pres. and Editorial Director

inted at the Telegraph Press, Harrisburg, Pa. cond Class postage paid at Washington, D.C. d at additional mailing offices.

bscription rates: U.S., Canada and Postal Union ations—1 year, $5.00; 2 years, $8.00; 3 years, 0.00. Foreign—1 year, $10.00; 2 years, $18.00; 3 ars, $26.00. Single Copy rate—$.50. Subscriptions e solicited only from persons with identifiable mmercial or professional interests in the missile/ ace industry. Subscription orders and changes address should be referred to Circulation Fulfillent Mgr. M/R, 1001 Vermont Ave., N.W., Washgton 5, D.C. Please allow 4 weeks for change to come effective and enclose recent address label possible.



THE COVER

Plasma modulation tube designed by Melpar for experiments in connection with its theory of information transfer via a re-entry plasma sheath. See p. 17.

SEPTEMBER 12 HEADLINES

ADVANCED MATERIALS

SPECIAL SECTION

GROUND SUPPORT EQUIPMENT

SPACE MEDICINE

ASW ENGINEERING

ELECTRONICS

INTERNATIONAL

DEPARTMENTS

31,026 copies this issue

letters

German Rocket Groups

To the Editor:

In your article on "IAF Congress Finds No Agreement on Space Control" (M/R, Aug. 29, p. 43), a mistake slipped your attention:

The Deutsche Astronautische Gesellschaft admitted to IAF membership is the *East* German aeronautical society that applied for membership under the name "Astronautische Gesellschaft der Deutschen Demokratischen Republik."

As the East German puppet state is not recognized by Western governments the society would have had little chance of being accepted and therefore changed the name in the course of the IAF Congress to "Deutsche Astronautische Gesellschaft." It is not correct that only one society will have the full voting rights. Two West German societies, the DRG and the DGRR are members of the IAF while the latter has the full rights. The DGRR tried in vain to prevent the East German society becoming a member with voting rights, but was overruled by all other voting members. The procedure caused bitter comments in the German press.

Erhard Heckmann
Editor
Flugwelt
Köln

Through an error in processing of the story, M/R incorrectly identified the group admitted to membership as West German. We are grateful to Herr Heckmann for the correction.—Ed.

Radioplane and Mercury

To the Editor:

Your very excellent article in the Aug. 1 M/R ("Parachute Recovery System Being Refined") carries the implication that Cook Electric Research Laboratories is in some way responsible for NASA's Project *Mercury* landing system. The facts are that the Radioplane Division of Northrop Corporation was selected by NASA and McDonnell Aircraft (prime contractor for the *Mercury* capsule) to develop and produce the *Mercury* landing system.

Radioplane has successfully landed the *Mercury* capsule 53 times in tests from aircraft at launch altitudes from 2000 to 30,000 feet. In addition, Radioplane landing equipment has been used in many capsule system tests by NASA, including *Little Joe, Big Joe,* Capsule No. 1 escape rocket test and several aircraft drops.

We are intensely proud of our part in this most vital project to place the first American in orbital space flight. In fact, the Ringsail parachute which will bring the astronauts safely to earth was

vented by one of our engineers who has been tackling tough recovery problems requiring super reliability here at Radioplane for many years.

We feel certain that CRL is probably as anxious as we are to have this misconception corrected so as to avoid embarrassment or confusion on other space recovery projects in which both Radioplane and CRL are engaged.

W. H. Freeman
Director, Paradynamics Group
Radioplane Div., Northrop Corp.
Van Nuys, Calif.

M/R of course did not intend to misplace the credit which rightfully belongs to Radioplane. Actually, we did not say that Cook was responsible for the Mercury landing system; we did report that Cook contributed much of its past experience to assisting NASA in developing the system. The first drogue chute used on Mercury was produced by Cook; Radioplane's chute is now being used.—Ed.

Optics Coverage Cited

To the Editor:

I congratulate you on your excellent report on optics in the Aug. 22 issue. You have really covered the waterfront. I was especially pleased to note your references to the materials needs, since we have some interest in this field.

I liked your "no nonsense" approach —perhaps best illustrated by the statement, "This bias is well grounded in ignorance," referring to the arguments of those who believe that optics is obsolescent.

James Balog
Manager, Market Planning
Electronic Chemicals Div.
Merck & Co., Inc.
Rahway, N.J.

To the Editor:

We were pleased to note the fine coverage of K & E specifically, and the breadth of your entire optical report in general. The Optical Industry needs more editorial emphasis than it has received in the past.

Albert W. Chapple
Marketing Manager
Optics and Metrology Div.
Keuffel & Esser Co.
Hoboken, N.J.

To the Editor:

Congratulations on the excellent optics roundup. Somehow our numbers were garbled in transmission. The ballistic camera Nortronics is developing for the Air Force (M/R, Aug. 22, pp. 26, 27) is a 500-mm (not 60-mm) camera. It will be the largest camera of its type ever built in this country.

Marc Nault, Public Relations
Nortronics Div.
Northrop Corp.
Hawthorne, Calif.

Development of nuclear power, utilized in space ships like this Douglas concept, will speed the day when man will travel in outer space and use its resources.

Air Force space studies aimed at cracking military problems also reveal potential civilian benefits

Progress in space research is so rapid that consideration must now be given to projects you'd have scoffed at a few years ago. For instance, development of a nuclear rocket could drop payload costs so low that it would be economically worthwhile to import rare materials from other planets.

Projects such as this are the daily fare of engineers at Douglas. Right now they are studying the many problems related to interplanetary exploration: Can humans survive? What about temperature, gravity, water, food . . . and fuel for the return trip?

Douglas has been finding answers to such problems since 1941. These answers are seen in action every time a Douglas-built Thor boosts another payload into space.

DOUGLAS

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The Countdown

WASHINGTON

To The Bitter End

The Eisenhower Administration apparently hopes to hold the line on defense spending—even after it passes from office. It has directed the military services to draft FY '62 budgets based for the most part on either modest increases or reductions. COUNTDOWN hears that Pentagon budgeteers are now in the process of drafting four budget models for the outgoing administration. Model A is 5% under FY '61. Model B is identical with FY '61. Model C is 5% more. And Model D includes a list of items that the services feel they ought to have in case the country might have to fight a war.

Mercury Investigation Still Pending

Some congressmen went home talking about the possibility of investigating NASA's *Mercury* man-in-space program immediately after the presidential election, rather than wait until January. But, whether they will hold it early apparently still depends upon what Russia does in the space race in the next few months.

More Mercury Slippage

NASA has just about given up hope for a downrange manned *Mercury* capsule shot aboard a *Redstone* until the end of 1960. The first unmanned *Mercury-Redstone* is scheduled to go in a few weeks. If all goes well, it will be followed by one with a monkey in the capsule and the manned shot.

CINCPAC Goes Hard

An abandoned World War II underground airplane factory—reportedly 200 ft. underground on the Island of Oahu—is being converted into a command post for CINCPAC (Commander in Chief of the Pacific). The facility, with a cafeteria to feed 30,000 persons, is being made chemical-biological-radiological warfare-proof.

Second Round

The Army is now expected to award study contracts for a mobile battlefield anti-missile system in about a month. Several dozen contractors are in the competition. On the first time around, the Army turned down all the proposals submitted by more than 40 companies —apparently on grounds that their concepts for such a system were not revolutionary enough.

Courier Launch Date Set

Latest date set for the launching of the Signal Corps' *Courier* delayed repeater communications satellite is now Oct. 2 from the Cape.

INDUSTRY

Troubles for Aerospace Corp.

COUNTDOWN is told the Air Force's new Aerospace Corp. has run into organizational troubles so serious that Space Technology Laboratories is quietly working on some of the contracts intended for the non-profit agency. Aerospace Corp. presently has only 500 of the 1400 personnel it was scheduled to have by now. STL, incidentally, is suffering from recruiting raids on its engineering staff.

Contributor to Base Slippage?

One industry source believes that insurance companies may be contributing to the lag in ICBM base construction—by being too easy in bonding sub contractors. The contention is made that the bonding companies feel there is practically no risk on their part, no matter who the contractor, since payment by the government is guaranteed even if the bonding company has to fulfill the contract. Thus, unqualified subs get in the program.

Bogies on the Board

ICBM base building "czar"—Maj. Gen. Thomas P. Gerrity—has set up a 24-hr. command post in the AMC's Ballistic Missile Center to trouble shoot construction delays. Using a system akin to the Air Defense Command, duty officers post problems arising at any of the bases on a chart as "bogies." Special teams are given 24 hrs. to "shoot down" the bogies before the problems are referred to the direct attention of Gerrity or his deputy.

BuShips Adds Space Office

The Bureau of Ships has just created an Astronautics branch within its R&D office. The new group will be handling shipboard support work for such systems as *Transit, Advent* and a seagoing mobile satellite launcher.

Skybolt Test Equipment High

J. W. Fecker Division of American Optical has just picked up two contracts (over $1 million each) for electro-mechanical turntables to test all-inertial gyro packages. One is with Nortronics for the Douglas *Skybolt* and the other for Convair's *Atlas*.

INTERNATIONAL

Space Communications Network

Sweden's Ericsson Group soon will firm up plans for a "spacewide" satellite communications center through their U.S. manufacturing subsidiary-North Electric Co. The latter already holds contracts in the *Thor, Jupiter* and BMEWS programs.

Italy's New Electronics Giant

With its new agreement to use the facilities of Microlambda, missile guidance subsidiary of Finmeccanica, Selenia, S.p.A. probably will be rated as Italy's largest single electronics firm. Raytheon holds a 40% interest in Selenia, Finmeccanica 40% and Italian Societa Edison the remaining 20%.

Nord is Humming

Backlog at Nord Aviation shows 37,500 *SS 11* and 26,200 *SS 10* antitank missiles on order. *SS 10*'s are rolling off the production line at 1000-per-month rate. At the start of next year, *SS 11* production will hit 2000 per month. Total French missile exports (mostly Nord products) are expected to total $30 million in 1960.

The Overseas Pipeline

A new German rocket test site will be built near Soltau not far from Hannover . . . Meteor, S.p.A. has just revealed two new drones built by their plants at Trieste and Gorizia . . . Revue Militaire Suisse says the U-2 pinpointed 40 Soviet ICBM sites of which 20 had anti-aircraft missiles.

Up to $100 Million . . .

NASA Picking Prime for OGO

The National Aeronautics and Space Administration is asking for bids by Sept. 26 on the prime contract for the Orbiting Geophysical Observatory, which could amount to $50 to $100 million over the next eight years.

The initial contract will call for R&D and delivery of three flight spacecraft within three years after authorization to proceed. NASA's Goddard Space Flight Center also asked for estimates of cost of delivery of one or two spacecraft a year for the subsequent five years.

The OGO is to weigh about 1000 lbs., of which at least 150 lbs. will be assigned to as many as 50 scientific experiments. It must have a potential of growth to 1500 lbs., of which at least 500 lbs. must be assigned to experiments.

The satellite must be mountable on *Agena-B* or *Centaur* upper stages. The first launch (EGO) will be on an *Atlas-Agena B* down the Atlantic Missile Range, aiming at an eccentric orbit (perigee 150 naut. mi., apogee 60,000 naut. mi.) of 31° inclination. The second launch (POGO) will be on a *Thor-Agena B* down the Pacific Missile Range, aiming at polar orbit (perigee 150 naut. mi., apogee 600 naut. mi.)

First launching is to be 27 months after authorization to proceed.

Scientific experiments carried aboard the OGO satellites will include measurements of:

–Magnetic fields—magnitude, direction and variation.

–Energetic particles—composition, flux and energy spectrum.

–Dust—composition, flux and energy spectrum.

–Atmospheric structure—pressure, temperature, composition and density.

–Ionosphere—electron and ion densities and temperatures.

–Solar physics — ultraviolet, X-ray and gamma region monitoring.

–Astronomy—Stellar emissions in the ultraviolet, X-ray, gamma and very low frequency regions.

–Meteorology—earth weather parameters.

–Planetary parameters — properties of planetary surfaces and environment.

–Technology—tests of power supply, thermal control, structural systems and the like.

–Biology—behavior of various life forms in space conditions.

–Miscellaneous—night airglow radiation, auroral radiation, vehicle charge, electrical fields, etc.

The spacecraft is to be stabilized so that the same axis constantly points toward the earth, with a 2° permissible error during an active life of one year. At least 20 lbs. of experiments are to be oriented along an axis stabilized in the plane of the satellite's orbit, with a 5° permissible error. Another 20 lbs. of experiment must be oriented along an axis pointing at the sun, with a permissible error of 20°. Both gas jets and reaction wheels will be used as torque generators.

The experiments will be installed in modular compartments. Some modules, however, may carry more than one experiment while some experiments may occupy the space for more than one module.

The satellite must have a minimum of 30 sq. ft. of exposed surface area. Of this 10 sq. ft. must point toward the earth, 10 sq. ft. away from the earth, 4 sq. ft. forward in the plane of the orbit, 2 sq. ft. toward the sun, 1 sq. ft. away from the sun and 1 sq. ft. aft in the plane of the orbit.

The spacecraft will have two beams capable of in-flight extension to 15 ft. or longer at 180° opposition to one another. Each beam will carry 5 lbs. of experiments in the volume of 0.25 cu. ft.

NASA suggested a maximum diameter of 56 in. to allow enclosure during launch in a 5-ft.-diameter shroud to match with the diameter of *Agena-B* and *Centaur*. However, projection beyond 5 ft. is allowed if the additional aerodynamic drag is taken into account.

Power supply will be solar cells and storage batteries providing an average 40 watts at a nominal 18 volts and up to 80 watts intermittently. The satellite will have three telemetry systems: a wideband system operating either at 400-800 mc or 136-7 mc for the bulk of data, with a bit rate up to 200,000 bits a second; a narrow-band system on 136-7 mc to telemeter up to 10 experiments, with a bit rate up to 50 a second; and a special purpose telemeter at 300-400 mc with a sinusoidal signal that varies with the range from 5 cps to 270 kc. with maximum frequency at perigee.

Anderson Hits Rover Contracting

Sen. Clinton P. Anderson (D-N.M.) says the possibility of a ground launching as a first test of the project *Rover* nuclear rocket probably will be ignored now that a National Aeronautics and Space Administration official controls the project.

Anderson, Chairman of the Joint Committee on Atomic Energy, recalled that some NASA officials have said that the first test of *Rover* should be as an upper stage of a *Saturn* booster and that Lockheed Aircraft Co. and The Martin Co. are to make six-month studies of program requirements.

"Will their contractors see it differently?" Anderson asked. "I suspect not."

The senator questioned what he called a device of "policymaking by contract" and added:

"A council headed by the President was established to set overall space policy. This year the Administration proposed the elimination of the Space Council and—interestingly enough—any participation by the Chairman of the Atomic Energy Commission, who sits on the Council."

The bill to eliminate the Council, passed earlier by the House, died in the Senate. Majority Leader Lyndon B. Johnson, Chairman of the Senate Space Committee, said in a memorandum that a new President in 1961 might hold different views about NASA organization.

The bill also would have changed the law to give NASA more flexibility in waiving claim to patents developed under its contracts, squaring its policy with that of the Department of Defense.

Johnson said the patent law changes are not urgent and should be deferred until completion of a study of overall reform of patent rules by the Senate Judiciary Subcommittee on Patents.

Zeus Operational Prototype Fired

irst tactical configuration of the Nike-Zeus AICBM launched ecently at White Sands, N.M. Missile was ninth fired in devel- ment program. Small grille-like part visible below missile is launching shoe, normally airborne to about 200 ft.

The Missile/Space Week

Texaco Picks up Big Fuel Contract

One of the largest research contracts ever made by the U.S. Air Force for the development of new high energy liquid propellants has been awarded to Texaco, Inc.

The $1.3 million contract calls for a comprehensive study of the whole liquid propellant program and the development of advanced fuels that will solve many of the problems now surrounding the handling and storage of high energy liquids. Basic aim of the contract is the development of propellants that have all the advantages and performance capabilities of liquids combined with some of the handling simplicity and compactness of solid fuels.

Space Flight Hit by Radiation Limit

Radiation shielding problems for manned spaceflight will be further complicated by an AEC ruling which goes into effect Jan. 1. Lifetime exposure limits will be slashed from 15 rems per year to five, with not more than three rems in any one quarter. This undoubtedly will affect NASA's Project *Apollo* and possibly the Air Force *Dyna-Soar,* as well as handlers of radioactive materials in industry.

Echo's Skin Develops Wrinkle

A slight wrinkle has apparently developed in the skin of the *Echo I* balloon satellite. NASA said this accounts for the apparent variation in *Echo's* brilliance. Slight fluctuations in the intensity of signals bounced off the balloon support the theory.

However, the 100-ft. sphere still is an excellent reflector. Radar measurements show the surface area to be about the same as on Aug. 12, the day of launch.

Bidding Starts on Minuteman Silos

The 150 *Minuteman* hardened launching sites at Malmstrom AFB, Mont., are to be completed by 1962. Each 10-bird "flight" will function under a single launch control facility. The $40-million complex will have an oxygen generator system and a 5500-gallon water tank at each of the 15 spring-supported underground control centers.

The Army Engineers will open bids about Nov. 3 in Seattle. Completion dates will be issued in the specifications around Sept. 3. A pre-bid conference is scheduled for Oct. 6 in Seattle. Invitations will be circulated only among those contractors whose records of performance guarantee timely completion.

SP Upgraded by Raborn Promotion

Importance of the Navy's *Polaris* program is being raised by the Administration in elevating Special Projects Director William F. Raborn to vice admiral. Upgrading of the billet will not affect SP's organizational setup for contractors.

Satellite Weather Forecasts Now Su

Daily worldwide service expected in 4-5 years, depending on funds and rate of technical progress; Tiros II data to be widely distributed

by Jay Holmes

Daily worldwide weather forecasts by satellite now appear certain to become a reality within four to five years. Just how soon is largely a question of money and the rate of experimental progress.

Satellite forecasting—the first practical application to result from man's exploration of space—has already begun. Some data from *Tiros I*, the first weather satellite, was fed into regular weather channels and was available to U.S. meteorologists for 78 days this last spring.

Wider distribution and use will be made of information from *Tiros II*, to be fired later this year.

If R&D progress continues as expected, and if money is forthcoming continually, an operational system of weather satellites may be established in four or five years. The total cost, exclusive of launch vehicles, will be about $60 million.

The great advantage of satellite weather observation is the possibility of complete coverage. At present, weather predictions are based on information from a world network of reporting stations concentrated in the densely populated regions, which make up about a fifth of the earth's surface. Data from the remaining four-fifths of the earth's 6 x 10^{15} tons of atmosphere is sparse or non-existent.

The weatherman is called on to answer many questions, of importance to aviation, shipping, agriculture and a host of industries. Accurate, detailed weather forecasts are obviously vital to national defense. But the question of greatest interest to most people is, "Will it rain or shine tomorrow?"

• **Cloud cover pictures**—To give a reliable answer, the meteorologist must know first where it is raining and shining today. He collects observations—samples describing weather conditions near each of his widely distributed stations. Using these bits of information, he must make up a picture of the weather, relying on experience and inference to fill in the gaps.

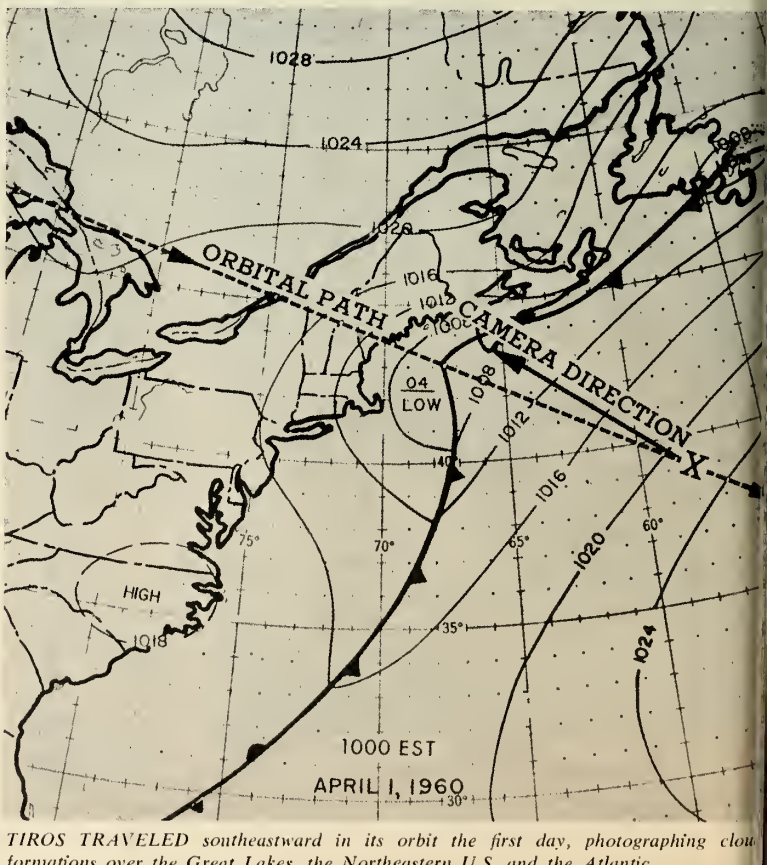
The forecast is a projection of this picture into the future.

But no matter how experienced the weatherman, the picture is still largely guesswork. Weather systems affecting populated areas develop over tremendous stretches of ocean for which there are few reporting stations. The weatherman's only knowledge about what is happening there comes from ships and planes passing through. For great areas off the world shipping lanes, there is no information at all for long periods of time.

This situation is not limited to the oceans. Several years ago, a midsummer deluge of rain poured on parts of New York State, Pennsylvania and lower New England—a highly populated area—causing widespread floods, many deaths and property damage in the millions. There was no warning from the Weather Bureau. The storm originated in an area between reporting stations.

Tiros I showed it was possible to photograph the cloud cover and make maps that show where it is cloudy and where the sun is shining all over the earth. With this information alone, the Weather Bureau and military weather services were able to make detailed analyses for many ocean areas where the scanty amount of conventional surface information made accurate depiction of existing weather next to impossible.

• **High performance**—*Tiros* was a test craft. Its primary purpose to demonstrate the feasibility of a weather satellite. But in doing so, it turned in a series of spectacular accomplishments, some of which were of immediate



TIROS TRAVELED southeastward in its orbit the first day, photographing clou formations over the Great Lakes, the Northeastern U.S. and the Atlantic.

be Reality

alue. The accomplishments included:

–Man's first view of a fully developed tropical storm in one paragraph. A South Pacific typhoon, 800 miles in iameter, was observed on *Tiros'* 125th rbit.

–A collection of 22,952 cloud-cover ictures transmitted over a period of 8 days, more than 60% of good uality.

–Special cloud maps supplementing urface-gathered weather data, distributed within three to six hours after the ictures were taken from space.

–Identification from the pictures of n area containing cumulonimbus louds on May 19 that two hours later awned a series of tornadoes and hail-orms on the Oklahoma-Texas line.

When the National Aeronautics and pace Administration launches its second *Tiros* in the last quarter of this alendar year, the information will be d at a greatly increased pace into erational weather channels—even hough the primary function of the satllite will again be experimentation. he operational use of the information ill still be considered an experiment—o further test and document the operanal value of satellite data.

In the area of theory, observations om *Tiros* have already changed some leas meteorologists held about weather rocesses. Beyond this, many questions ve been raised, which will require ngthy study to settle.

• **Money needed**—Strangely, theotical meteorologists are far from oded by the thousands of pictures ailable. For even among the thouands, there may be only a few of a rticular type of weather situation. obtain proper statistical samplings, searchers hope to have the opportuty to study many more such pictures.

The most important of the new leas is the extent and frequency of rge spiral cloud and storm systems. was well known previously that opical hurricanes consist of bands iraling about a quiet center.

Tiros pictures showed that the spiral oud bands occur frequently, over uch larger areas than those of tropil storms, and over oceans outside of e tropics.

Another attractive idea is that clouds often are lined up in the direction of the wind—a fact that, if true, would greatly increase the value of cloud-cover photos. Evidence is mixed on this question.

The application of cloud-cover information was so obviously successful that the Weather Bureau immediately began to make plans to exploit it. A short time after the launching, the bureau sought an emergency $5 million appropriation—half for research and development on its use and half for additional communication facilities.

The Budget Bureau turned down the request on the ground that the Weather Bureau should get its funds from NASA, which supports the Weather Bureau work out of its meteorological satellite budget. That fund now has risen to $20.7 million in the current fiscal year.

NASA said it could not supply the communications money because its function is research, not operational weather forecasting. Now, however, the space agency is rethinking the entire question. A top-level study, to be completed by fall, will seek to determine the proper organization of government agencies to coordinate and control all practical uses of space exploration.

Meanwhile, plans are progressing for future weather satellites. *Tiros I*, launched April 1, carried two television cameras. The letters in the name stand for Television and Infrared Observation Satellite. But the first one carried only the TV cameras, since the infrared equipment could not be perfected on time.

The second *Tiros* will carry infrared instrumentation that will scan the earth's heat radiation, mapping it by area. The first attempt at measurement of heat radiation was aboard *Explorer VII*, which measured total heat flux from the earth.

The second-generation weather satellite, *Nimbus*, will be stabilized so that the TV cameras always point toward the earth. *Tiros* is spin-stabilized; thus the camera is always in motion with respect to earth and pointed away from the earth much of the time. Also, *Nimbus* will be a polar orbiter, which will look at all of the earth. *Tiros I*, with an orbital inclination of 48°, observed only that part of the earth between the two 48th parallels.

NASA expects to let a contract this fall for development of the *Nimbus* spacecraft. The first one is due to be launched by a *Thor-Agena B* vehicle in the first half of calendar 1962.

Still farther in the future is *Aeros*, a 24-hour satellite, which has not yet been approved. If approved, the project could begin in 1962 and launchings might take place by 1964.

Aeros would provide stationary platforms from which cloud cover and the earth's heat radiation could be measured. In addition, weather scientists are at work on plans for measurement of temperature structure and composition of the atmosphere, the sun's radiation spectrum and precipitation and cloud structure as shown by radar.

• **History**—No one is certain of the exact origin of the idea of using satellites to improve weather forecasting. One of the first to put it forward seriously was Harry Wexler, the Weather Bureau's director of meteorological research, in a talk in 1954.

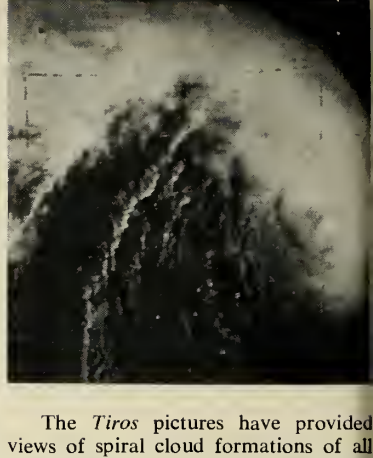
Wexler made the suggestion a short time after an *Aerobee* rocket, launched from White Sands, N.M., saw a well developed storm center that was responsible for widespread flash floods in the southwestern United States. The continental network of surface reporting stations, a reasonably dense network

Weather Satellites, Present and Future

Satellite	Launch Date	Vehicle	Orbit	Stabilization	Instrumentation
Tiros I	April 1, 1960	Thor-Able	50	Spin	2 TV cameras
Tiros II	4th quarter 1960	Thor-Delta	50	Spin	TV cameras, Earth IR scanning
Tiros III	1961	Thor-Delta	50	Spin	TV cameras, Earth IR scanning
Nimbus I	1st half 1962	Thor-Agenda B	Polar	Earth-oriented	TV cameras, Earth IR direct Solar measurements
Later Numbus, operational versions	1963 or 1964	Thor-Agenda B	Polar	Earth-oriented	TV cameras, Earth IR direct, Solar measurements, Infrared spectrometer Radar
Aeros I	1964 or 1965	Centaur or Saturn	Polar	Earth-oriented	TV cameras, Earth IR direct, IR spectrometer, Solar measurements, Radar

LEFT: Square white patch is cloud mass that spawned tornadoes over Texas May 19.

RIGHT: Typhoon 1000 miles east of Australia, snapped April 19.



in comparison with the ocean areas, gave no indication of the impending storm.

The *Tiros* project began in the Advanced Research Projects Agency of the Department of Defense and was transferred to NASA in the spring of 1959. All three services, however, still are participating. The Army Signal Research and Development Laboratories at Ft. Monmouth, N.J., supervised development of the payload and some ground equipment by RCA's Astro-Electronic Products Division. The Air Force and its contractors supplied the launch vehicle and facilities, data acquisition and help in data analysis and interpretation. The Navy helped process and analyze the photographs.

The Weather Bureau had the responsibility for data analysis, interpretation and dissemination.

The 270-lb. *Tiros I*, a stubby cylinder 19 in. high and 42 in. in diameter, carried beacon transmitters, attitude sensors, telemetry circuits and a 19-watt power pack of nickel-cadmium batteries charged by solar cells, in addition to the TV cameras and related equipment.

A wide-angle TV camera covered an area of about 1000 miles on a side at the satellite's average altitude of 450 miles. A narrow-angle camera covered an area of 100 miles on a side within the wide-angle camera's view. The cameras each consist of a lens, a focal-plane shutter and a ½-in. Vidicon tube especially designed for satellite use.

An electron beam converted the stored picture into an electronic signal that was transmitted directly to ground receivers or stored in a magnetic tape recorder for later transmission. When out of ground station range, the tape recorders attached to the two cameras could store up to 32 pictures.

• **Identification tough**—The satellite, spinning at a rate of between 9 and 12 rpm, could be programed to take pictures at 10-second or 30-second intervals. The wide angle camera had an f/1.5 lens and the narrow angle lens was f/1.8. Each had a shutter speed of 1.5 milliseconds.

Two primary ground stations commanded the satellite and received photo data. They were at Ft. Monmouth and Kaena Pt., Hawaii. Backup receiving stations were at Cape Canaveral and Princeton, N.J.

A 2-watt FM transmitter, operating at 235 megacycles, transmitted the stored photographs, from one camera at a time. Tape readout from both cameras took about 3½ minutes. Since *Tiros* was in transmission range of a station up to 12 minutes on a pass, it could send 8 minutes of direct data.

Identification of the pictures was a tricky job. Crude approximations were made by identifying landmarks on the wide-angle lens. Next, a process of "boot-strapping" was followed, in which cloud elements were matched in successive pictures, until another recognizable landmark provided a second reference point.

Many problems had to be solved to match each picture with the latitude and longitude grid. The wide-angle lens gives a barreling effect. The images were distorted by imperfections in the electrical signal. The image was foreshortened whenever the lens was not pointed exactly perpendicular to the earth's surface—nearly all the time on a spinning satellite.

The first few matching grids took weeks to draw. However, an IBM 7090 computer and a high-speed curve drawer supplied by Electronic Associates, both at the Weather Bureau's National Meteorological Center in Suitland, Md., are helping to produce the remaining grids at a rapid rate.

Cloud-cover maps, produced from the *Tiros* photos as a supplement to weather maps, are being put together in animated form by Navy weathermen as an aid to studying the dynamics of the atmosphere.

• **Meteorological gains**—The pictures showed a tremendous degree of organization of the cloud patterns over the earth.

The *Tiros* pictures have provided views of spiral cloud formations of all sizes—large, small and middle-sized—and of all ages—from a storm just developing to one gradually breaking up. They will provide objects of study for researchers for years to come.

The Weather Bureau is building up a staff of about 80 to make theoretical analyses of the pictures and other data to be gathered by future weather satellites. Present employment in the bureau's Meteorological Satellite Section totals about 45.

Jobs are open for synoptic meteorologists, theoretical meteorologists physicists and electronic physicists at the National Meteorological Center in Suitland. Starting salaries range from $5880 for recent recipients of bachelor's degrees to $10,635 (G. S. 13) for Ph D.'s or others with appropriate research experience. A few higher-salaried posts are open to persons with heavy experience.

• **Future plans**—On *Tiros II*, local radiation intensity will be mapped out with the aid of the satellite's spin. As it moves in orbit, *Tiros* will point its IR detector toward the earth. The spin will create a scan, like a single line traced by the scanner in a TV picture tube. The spin will point the detector out to space for a moment. When it returns to earth, the orbital motion will have carried the satellite to a new location. Thus the series of lines will trace out a television-type picture of the earth's relative heat radiation.

Heat mapping will fill an important role in operational weather forecasting through theoretical study of weather processes. The atmosphere is a great heat engine. More exact knowledge of what happens will fill gaping holes in the weatherman's understanding of what happens.

If *Tiros II* proves the heat-mapping system feasible, it and cloud-cover photography will be incorporated into the earth-stabilized, polar-orbiting *Nimbus*. Although several other weather experiments are in the study stage, probabl

none will be ready by the time the first *Nimbus* is launched. The big assignment for *Nimbus I* will be to prove out technique for the difficult job of keeping cameras and detectors always pointed straight down.

Nimbus has slipped a little. Until recently, it was scheduled to be launched in the fourth quarter of 1961. Now, the target date is the first half of 1962.

A 650-lb. satellite, *Nimbus* is to be fired into a retrograde orbit of 80° inclination at an altitude of about 1000 kilometers (621 miles). It will have three subsystems: an electrostatic tape camera, high and medium resolution infrared equipment and a number of earth-sun experiments.

On Sept. 2, NASA's Goddard Space Flight Center received industry bids on design, development, construction and testing of a command interrogation device for *Nimbus*. The contract, which is expected to be awarded in a month or two, will call for a one-month design study, delivery of one prototype eight months after start of work, a second prototype two months later, and a flight model 13 months after the start of work. Three more flight models are to be delivered in the next three months.

The flight model thus could not be delivered sooner than November 1961. This factor alone might have pushed the launch date back to 1962.

Another factor is that the prime contract on *Nimbus* has not been awarded. NASA expects to request bids on the system shortly.

A pair of *Nimbus*-type satellites could provide data for a single global weather data and forecasting center, astronautical scientists were told last month in Stockholm.

• **Global system**—In a paper given at the Eleventh Annual Congress of the International Astronautical Federation, R. P. Haviland of General Electric said global coverage could be obtained with two mutually perpendicular polar orbits at altitudes of 2000 to 4000 miles. The single data and forecasting center could be located almost anywhere. However, a polar site where readout could be obtained on every passage would be best, he said.

Later versions of *Nimbus* will have several more advanced forms of instrumentation. It is hard to predict which will come first. Some scientists think radar may develop swiftly. The aviation industry is tremendously enthusiastic about the success of airborne radar in spotting weather disturbances and helping pilots steer around stormy areas.

Radar sees bad weather by observing reflections from the falling raindrops. The same equipment in a satellite could spot and follow storms long before they came within range of airborne radar. It would operate night and day, unlike cloud-cover photography. Also, the cloud photo does not say whether rain is actually falling.

The satellite-borne radar might be used in conjunction with a network of ground radar beacons connected to automatic weather stations.

Another form of future instrumentation is an infrared spectrometer. The Weather Bureau has seized with considerable enthusiasm a suggestion by L. D. Kaplan of Massachusetts Institute of Technology that radiation by carbon dioxide in the 15-micron IR band might make it possible to measure temperatures at various levels of the atmosphere.

Kaplan assumed that CO_2 is uniformly mixed through the atmosphere and that the mixing rate is known. From 10 measurements of radiation at different wavelengths in the 15-micron bands, he suggested setting up a set of simultaneous equations that would yield 10 temperatures.

By selecting wavelength intervals according to the absorption of CO_2, he argued, it might be possible to obtain a vertical temperature sounding that would have nearly the accuracy of those obtained with radiosonde balloons.

The Weather Bureau is using a simplified form of the Kaplan scheme in which three layers instead of 10, all in the stratosphere, are used. This will avoid the problem of interference from clouds lower down.

• **IR experiments**—A second similar experiment would measure the temperature at the surface of the earth at any given point, where clouds are absent. This would be done by measuring IR radiation in the 11.1 micron region, a "window" through which at least 70% of the IR radiation gets through the entire atmosphere.

In June, the Weather Bureau awarded an $80,000 contract to Barnes Engineering for a nine-month design study of feasibility and instrumentation for the two IR spectrometer experiments. Specifications called for limitation of instrument size to 6 cu. ft. and total weight to 300 lbs. Power requirements must be held to 10 watts.

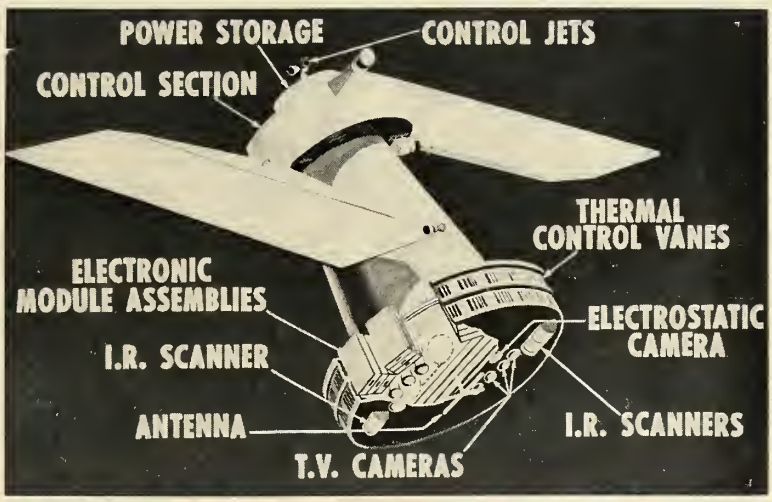
The specifications described flight conditions that indicated the spectrometer experiments are contemplated for use in later versions of *Nimbus*. The conditions are: stabilization, so that one axis is perpendicular to the earth's surface, and a speed of about 4 miles a second in a circular, quasi-polar orbit at 600 miles altitude.

Besides getting accurate, detailed measurement of the heat given off by the earth, the weatherman must also know in detail the amount of energy the earth receives from the sun. A number of the earth satellites have made measurements of the sun's radiation. Eventually, however, a permanent monitor of solar activity will be needed.

The later versions of *Nimbus* probably will put all the measurements together on a permanent basis.

Beyond *Nimbus*, NASA and the Weather Bureau are now considering the possibility of a big 24-hour satellite called *Aeros*, which would provide the advantage of weather observation from a platform that would be completely stationary with respect to the earth. The time period projected for the first launching, about 1964, would indicate that *Atlas-Centaur* is contemplated as the launch vehicle.

Centaur, however, is limited in the weight of payload it could deliver and guide precisely to a 23,000-mile orbit over the equator. If *Aeros* is approved, it may have to wait a year or so and become the first major assignment for *Saturn*.



NASA artist's conception of the second-generation Nimbus weather satellite.

Pacific Fleet Must Wait for Polaris

FBM submarines are several years from deployment there; Mace and Regulus I are biggest missiles now in Far East arsenal

by Frank G. McGuire

PEARL HARBOR, HAWAII—Deployment of *Polaris* submarines as part of the U.S. Pacific Fleet appears to be about three or more years away under present plans.

However, this would not mean that Atlantic-based *Polaris* subs would necessarily avoid Pacific waters while on station—particularly as the size of the *Polaris* fleet increases.

Polaris submarines operating out of East Coast ports are capable of cruising anywhere off the coasts of the Sino-Soviet Bloc.

But officially the biggest U.S. missiles deployed in the Pacific under the Pacific unified command are *Regulus I* and *Mace*.

Missiles in the CINCPAC (Commander in Chief, Pacific Unified Command) arsenal are based on Okinawa and Taiwan and in Korea.

Nuclear-armed *Honest John* surface-to-surface missiles are in use by the 4th Army Missile Command in Korea. *Nike-Hercules* antiaircraft missiles with nuclear warheads are on Taiwan and Okinawa, with deployment in Korea expected soon.

Hawk antiaircraft missiles are expected to be deployed with several battalions on Okinawa and in Korea by the End of this year. Nuclear-tipped *Mace* missiles are now located at Tainan on Taiwan and at Kunsan in Korea.

• **Seagoing missiles**—At sea, the Pacific fleet's 425 ships include five missile-launching submarines—USS Halibut, Tunny, Grayback, Growler and Barbero—armed with *Regulus I* air-breathing surface-to-surface missiles. In addition, four missile-armed cruisers are in the fleet—USS Helena and Los Angeles, both with *Regulus I*, and the USS Topeka and Providence with *Terrier* antiaircraft missiles.

Three more cruisers, the USS Galveston, Chicago and Oklahoma City, will soon report to the Pacific fleet with *Talos* antiaircraft missiles. A frigate, the USS Preble, with *Terrier*, is now with the fleet and will soon be joined by the frigates Coontz, King and Mahan, now under construction.

Four nuclear submarines—USS Sargo, Swordfish, Halibut and Sea Dragon are with the fleet, and believed armed with nuclear torpedos, presumably *Astor*, an antisubmarine weapon. A fire aboard the Sargo some months back brought out a report that nuclear warheads were on its torpedoes. Navy spokesmen here confirmed the report initially, then an official headquarters denial was issued. Navy has since refused comment.

With fleet air units are *Bullpup*, *Sparrow* and *Sidewinder* missiles, as well as Lulu nuclear depth charges. Aircraft operational currently are the A3D, A4D, F3H, F8U, and WF2.

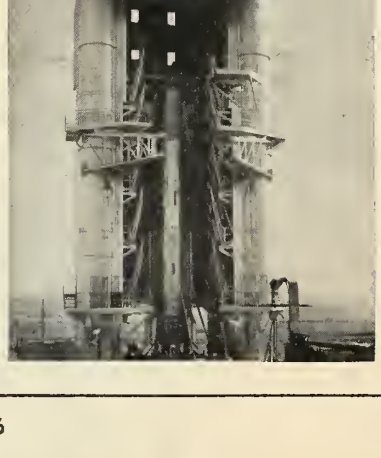
• **Growing opposition**—On the opposing side of the Bamboo Curtain, CINCPAC spokesmen disclaim any knowledge of either missiles or nuclear weapons in Korea, but carefully point out that such capability may be there. In the remainder of Communist-controlled Asia, missiles are coming into operational arsenals in increasing numbers.

Giving an estimate of Communist air strength throughout Asia, Maj. Gen. C. W. Cecil, Deputy Chief of Staff for Pacific Air Forces (PACAF) said a total of 6300 operational combat aircraft face the Western Powers in the Pacific area, in addition to support aircraft. Of this total, 3200 are Soviet, 2600 are Chinese Communist, and the remainder are North Korean.

PACAF intelligence believes that the Soviets have one of their three long-range air armies in Far Eastern Russia with major bases at Vladivostok, Irkutsk and west of Komsomolsk. Bear and Bison aircraft make up this force. Additionally, tactical aircraft of the I1-1 Beagle type are based in the Soviet Maritime provinces, as well as Naval Air Forces, which utilize the I1-18 also but are land based units.

The I1-18 (of which there are 1000) can cover all of Southeast Asia, Japan, Okinawa and Philippines from bases in China. The estimated 200 Bison and Bear bombers can cover all of the Pacific area from home bases with one aerial refueling.

Besides the Bear, Bison and Beagle, Russia is credited with the deployment of about 3260 day fighters and 240 all-weather interceptors in its air defense setup.

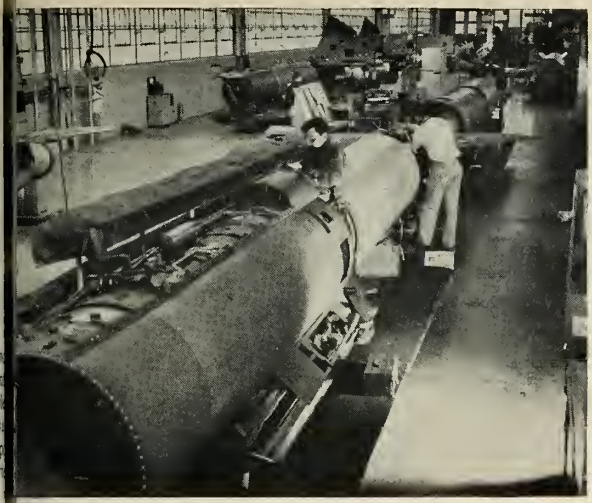


Next Week . . .
Third Annual GSE Issue

The era of big missile mobility is at hand.

For next week's special issue, M/R editors have compiled a provocative report on the impact of mobility upon ground support equipment; what it means in terms of strategy and the immediate and future requirements of the military services.

Among the many special features in this latest GSE issue will be an inspection of Spadeadam Rocket Establishment (see photo), Britain's most important missile center, whose future hangs on whether the British decide to proceed with a space program.



Bomarc B Production Line

IRST PHOTOS of Boeing's Bomarc B final assembly at attle. Moving along line at rear are now-operational Bomarc 's. Mating of nose radomes (right) is included in final assembly. Almost scrapped by Congress this year, Bomarc B experimental models recently have hit targets at up to 270 miles. The supersonic interceptor will be deployed in U.S. and Canada.

cout Shot Soon

Second Four-Stage Launch Due in a Month

WALLOPS ISLAND, VA.—A second ring of the full four-stage *Scout* satelte launcher will take place in about a onth from the National Aeronautics id Space Administration station here.

Engineers are making changes in e bird and in ground support equipent to take account of weaknesses otlighted by the aborted first flight ily 1.

Thrust of the hydrogen peroxide ts used for roll control of the third age was more than doubled. On July excessive torque overpowered the ntrol jets just at third-stage burnout.

The heat shield on the third stage as restructured. The shield came off the first flight as the vehicle passed rough the transonic region during st-stage burning. Normally, the shield jettisoned at third-stage ignition.

The launching will be controlled om a new blockhouse just completed tween the *Scout* and *Little Joe* unching pads here. Workmen now are stalling control and tracking equipent.

• **Tracking insurance**—The *Scout* ill be tracked optically as well as by dar. John C. Palmer, chief of flight st operations, said it is hoped that tical tracking will prevent an erroneus radar reading, which was responble for the abort on July 1. The radar ave a signal that appeared to indicate e vehicle was veering off course dur- g third-stage burning.

Actually, it was on course. How- er, the ignition of the fourth stage was prevented by command signal. As a result, the *Scout* reached an altitude of only 860 miles and traveled only 1500 miles downrange. The four-stage flight program had called for reaching 2300 miles altitude traveling 4700 miles downrange.

NASA's contract with Chance Vought calls for firing of three more *Scout* vehicles before next July 1.

AF Hunts More Space For West Coast Work

INGLEWOOD, CALIF.—Employment at the USAF missile division and allied space programs will jump 600% in the next 4-5 years—reaching a total of 12,000 employees.

In the next 24 months alone, the present employment figure of 2000 persons is expected to increase to nearly 8000.

Air Force officials now term the search for additional working space "urgent." Already overflowing their present facility at Inglewood, Calif., the Ballistic Missile Division and Ballistic Missile Center are looking for a several-hundred-acre plot in Southern California.

Plans formulated in June for the purchase of Space Technology Laboratories quarters are already being tabbed "inadequate." Studies show that the STL facility would be too small.

Although the STL plant could house 3000 persons, preliminary plans call for BMD, BMC, STL and the new Aerospace Corp. to share it jointly. Projected 24 month growth rates for these groups are: BMC, from 600 to 2400 persons; BMD, 1000 to 2000; Aerospace Corp., 100 to 3000.

Plasma Modulation Study (Cover Story)

It is possible to transfer information through the plasma sheath enveloping a re-entry vehicle, according to preliminary results of tests currently being performed by Melpar, Inc., Falls Church, Va.

Under certain conditions, a portion of the plasma can be modulated in density. Since a variation in cross-section occurs, the company says that even a modest radar system can detect the change and record the modulation waveform.

If the plasma is over-dense for a particular radar frequency, and if the wavelength and plasma scale height are related properly, reflectivity is very high.

Melpar is investigating the combined plasma physics-electromagnetic boundary value problem in detail. In its experiments, a plasma modulation tube (see cover picture) is being used to help verify the Melpar theory of data transfer through a plasma sheath.

Coils on the tube "ears" produce the main plasma. The central Vycor coil modulates plasma density. A focused-microwave plasma-diagnostic system is employed to measure reflected power variations. The two double probes shown in the picture are used to measure electron density and temperature at different radial points within the plasma.

Neon is used in the tests to expedite the theoretical and experimental correlation of results, largely because of the well-behaved cross-section of the gas as a function of electron energy.

SAC FLEXES A NEW MUSCLE

Beneath the wings of its B-52 intercontinental bombers SAC now packs a formidable new weapon—the GAM-77 HOUND DOG air-to-surface missile. The first operational unit to carry the supersonic HOUND DOG is the 4135th Strategic Wing, based at Eglin Air Force Base, Florida.

This B-52/GAM-77 union greatly extends the useful life and striking power of SAC's long range bombers and adds to the command's operational flexibility.

The HOUND DOG's versatile capabilities have been demonstrated in a number of free flights over the Atlantic Missile Range and the Eglin Gulf Test Range. In addition, it has withstood many extreme environmental tests including a 10,800 mile flight over the North Pole ending with a successful firing over AMR.

In just 30 months, the HOUND DOG air-to-surface missile progressed from the drawing board to its first flights with SAC crews. Combined with the B-52 bomber, the HOUND DOG gives SAC a powerful new deterrent for preserving world peace.

THE MISSILE DIVISION OF NORTH AMERICAN AVIATION, INC.

Downey, California

Technical Countdown

PROPULSION

Answer to Solid-Propellant Mystery?

An explanation of why erratic variations in temperatures and pressures result from acoustic resonance during burning may soon be at hand. According to Dr. Frank McClure of Applied Physics Laboratory, pressure transducers able to live in the 5000°F combustion temperatures are just becoming available and can be expected to help shed some light on the problem—one of the most critical in solid-propellant technology.

Propellant Design Ups Minuteman Mass-Fraction

Secret of the *Minuteman* booster's mass-fraction of 0.89 —best for any big solid rocket—is a combination internal configuration that eliminates tail-off burning of residual silver. The boundary between slow-burning and fast-burning propellant is designed so that the flame reaches all sections of the outer case simultaneously.

New Saturn Booster Tests Slated

The next series of *Saturn* static tests, beginning at Huntsville late this month or next, will simulate the actual flight configuration of the giant booster. The tail section will be completely enclosed so that eventual leakages will show up. A tail shroud, tail flame shield, and tail heat shield will be added to the SAT prototype tested in last spring's series. Last tests demonstrated that each of the eight engines behaves as if it were operating completely on its own.

ELECTRONICS

Space Surveillance Improvement Drive

There's widespread feeling that the U.S. must develop a more effective space surveillance system. ARPA—which is getting out of management side—will continue to pursue R&D. Primary needs are methods for identifying detected satellites and longer range (over 1000 miles) capability.

Project PRESS Gets Under Way

ARPA has started work on Project *PRESS* (Pacific Range Electromagnetic Signature Study) aimed at detection and identification of ballistic missile warheads. Part of Project *Defender*, *PRESS* is a more sophisticated version of the current DAMP study being conducted at Atlantic Missile Range.

Pyrogyro Powered by Tiny Charge

A pryotechnic gyroscope developed by Giannini Controls uses a three-gram explosive charge in the hermetically sealed unit to drive its rotors. The propellant is ignited electrically. Gases escape through tiny holes to provide a jet-like impulse which drives rotor up to 36,000 rpm within one-tenth second after ignition. Running time for the half-pound gyro is four minutes.

New Cryogenic Phenomena Observed

Scientists at Varian Associates are attempting to predict and measure plasma effects under conditions which apply in a solid-state material. Most work is done at liquid-helium temperatures. Varian is believed to be first to attempt a thorough exploration of plasma effects in semiconductors.

EIA Hits Lower Electronic Tariffs

Electronic Industries Association has gone on record against tariff negotiations aimed at cutting duties on any electronic products. In support of its opposition, EIA declared that lowering import bars would cause "deterioration, rather than technological progress, in our military programs."

Radio Signal Super-Detector Developed

A new adaptive waveform recognition system for detecting and classifying unknown or concealed radio signals has been developed by General Electric Research Laboratory. The system has reportedly detected signals buried in random noise that defied detection by trained observers. According to GE, the system's operation is limited to narrow-band signals and would not be a counter to a noise communication system such as GE's recently announced "Phantom" (M/R, Sept. 5, 1960).

ADVANCED MATERIALS

Meteoroid Protection by Bumpers

Spacecraft weight reductions up to 50% in outer-wall construction can be achieved through meteroid bumpers or multi-wall configurations. Tests at GE's MSVD show that a large part of a meteoroid's kinetic energy can be dissipated, resulting in only a mild pitting of a vehicle's skin. Test pellets reached velocities of 18,800 ft/sec.

Research in Rolled Beryllium

In an effort to reduce the cost of end parts, the Air Force is spending about $300,000 on an R&D program for rolled beryllium structural shapes. Beryllium Corp. will perform the basic studies, while certain phases of the program will be carried out by Allegheny Ludlum, The Budd Co., and Nuclear Metals.

Ceramic-like Resins Still in Early Development

Latest word from the British firm, Artrite Resins, is that their ceramic-like resins (TECHNICAL COUNTDOWN, June 6, 1960) have not yet been developed sufficiently to warrant announcing availability, price, or even a trade name.

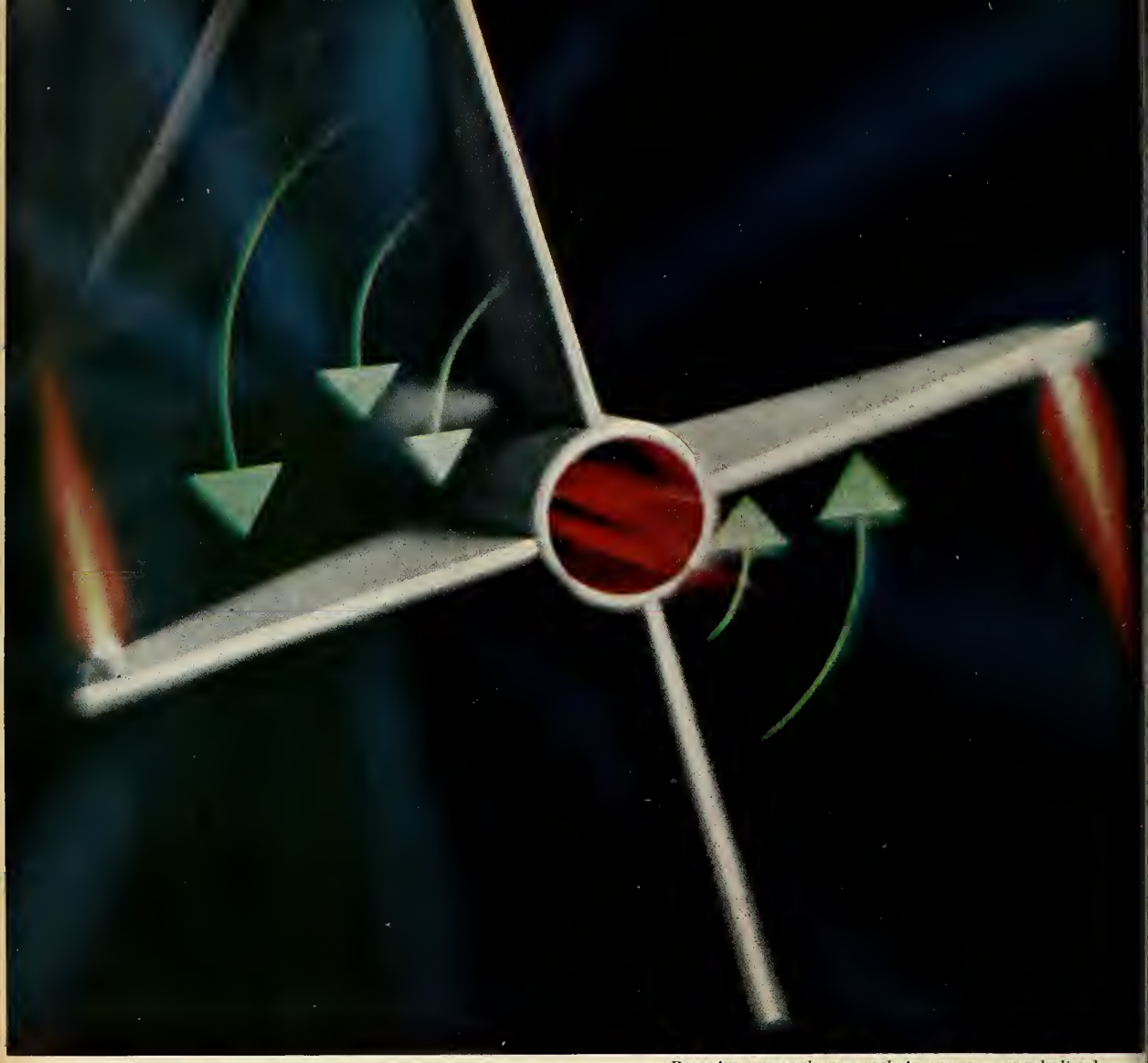
Latest on Boron

Decaborane and pentaborane are available in lab quantities from Olin Mathieson's Energy Division . . . Callery Chemical reached an agreement with Imperial Chemical Industries Ltd. for an exchange of assessment information in certain aspects of the field of boron compounds. Acquisition by either party of non-exclusive royalty-bearing licenses under the other's patents is one aim of the pact.

ASW ENGINEERING

ASW Almost Limitless Area

A Naval Ordnance Laboratory study shows that there are about 1500 different ASW operational situations—based on the wide variety of vehicles, locations, threats, types of war, and tactics.



Reaction controls at work in space — symbolized.

STEERING GEAR FOR ASTRONAUTS

Conventional aircraft control surfaces will not guide space ships and capsules. Rudders, ailerons and elevators find no resistance and hence produce no reaction to their movements where there is no atmosphere. Even at altitudes only half way up, they are sluggishly ineffective.

The accepted answer to a dependable steering mechanism for astronauts is a system of jet reaction controls developed and produced by Bell Aerosystems Company. First used on Bell's own supersonic X-1B several years ago, the system has been greatly improved and adopted for the X-15, the Mercury man-in-space project and other space vehicles.

Through strategically located, low and high thrust (1 to 1500 pound) rocket engines, Bell's reaction controls not only position and guide the ship by controlling the roll, pitch and yaw, but they also provide for orbit changes and retro-thrust. Some of the jets are throttleable while others can be operated in combination to provide the astronaut positive and flexible control.

This revolutionary steering gear for space, available using monopropellants or high energy bipropellants, is just one of many advanced projects which are currently engaging the diversified talents of Bell Aerosystems Company in the fields of rocketry, avionics and space techniques. Engineers and scientists seeking challenging, long-range career opportunities can find them at Bell.

BELL AEROSYSTEMS COMPANY

BUFFALO 5, N. Y.

DIVISION OF BELL AEROSPACE CORPORATION

Successor to the Defense Group of Bell Aircraft Corporation

Tungsten Nozzles by Vapor Deposit

NBS develops method using hexafluoride which makes complex parts easily and cheaply; missile company in the act

by William Beller

TUNGSTEN NOZZLES can now be made easily and cheaply through a process recently disclosed by the National Bureau of Standards.

The vapor deposition method is used.

This means that the excellent high-temperature strength of tungsten can at last be exploited for making highly complex parts.

Although the process is still in its early developmental stage, at least one large missile company is hastening to try it for major work.

Here is the way the job is done: A mold of the part to be made is first preheated inductively to about 1200°F in a hydrogen atmosphere. Then the gases tungsten hexafluoride (WF_6) and hydrogen are passed over the mold. The result is a tungsten coating deposited on the heated surface while hydrogen fluoride passes off as a waste gas.

The hexafluoride is commercially available and costs only about $25 per pound. The tungsten coating formed by it has a density of 19.3 gm/sq cm —the theoretical density of the pure metal.

This density is higher than that of tungsten compacts made by powder metallurgy or flame spraying methods. Reason is that pores are introduced by these two methods but not by the gas deposition one.

Deposits up to 1/8-in. thick have already been obtained. A 1/16-in. coating was made in one hour—a speedy job, especially when compared with conventional electroplating.

• **An unruly metal**—Tungsten has only recently been put to high-temperature use in forms other than wire and strip. Unhappily, the metal's brittleness and hardness have prevented its being machined by conventional means. Only during the past two years have forging and skull casting techniques been successful. Thus, strong efforts have been going on to get a practical way to deposit tungsten coatings.

TUNGSTEN-PLATING PROCESS takes place in ceramic cylinder shown at left. Waste gases are absorbed in center vessel. NBS chemist Jean Connor monitors process.

Tungsten deposition from aqueous or organic solutions was tried unsuccessfully. An effort was made to release the metal from fused electrolytes. The rate of plating was too slow, the deposit too rough, and the coatings could not be built up to the desired thickness.

Vapor phase deposition was then tried. An early chemical used, and one that is still being experimented with, is tungsten hexachloride (WCl_6).

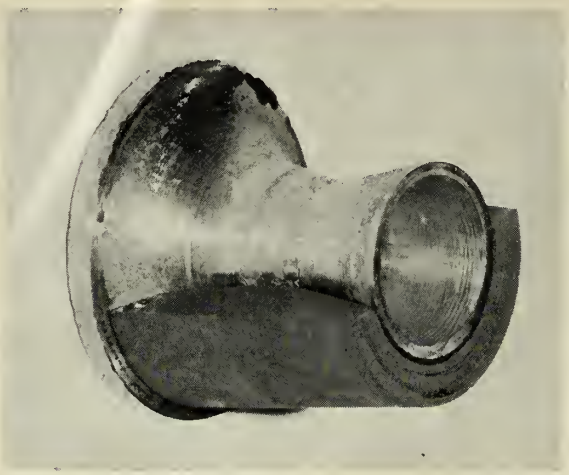
The hexachloride is a solid and therefore has to be vaporized—an unwelcome complication. Also, the plating process is highly sensitive to the rate of WCl_6 flow and requires a mold heated to 1740°F. This temperature is above the service point of most steels.

Bureau scientists turned to the hexafluoride for two reasons: (1) The compound is a gas at room temperature. (2) Tungsten readily forms only one compound with fluorine, the hexafluoride. Thus the chemical reaction during deposition is straightforward, uncomplicated by side reactions, and makes highly efficient use of the metallic gas.

W. E. Reid and Dr. A. Brenner of NBS's electrodeposition group devised the present method. The work is being sponsored by the Navy. Coincidentally, a similar method has been developed by the Bureau of Mines.

An industrial organization, still secretive about its pilot plant process of depositing tungsten, is also believed to be using the hexafluoride method.

• **Technique can be crude**—The process is simple enough to be done in most laboratories. The object to be plated is put inside a ceramic cylinder, the air is pumped out and replaced by hydrogen. A controlled temperature induction furnace heats the object to



TUNGSTEN ELZZON (nozzle insert) made by vapor deposition process is shown full-scale. High - temperature problems are lessened by housing in loosely fitting graphite blocks.

1200°F. Then two gases, tungsten hexafluoride and hydrogen, are passed through ordinary flow meters into the reaction chamber.

When the gas mixture contacts the heated object, the reaction leaves a tungsten coating on its surface. At the same time, hydrogen fluoride gas is formed and subsequently absorbed in a metal cylinder containing sodium fluoride.

Reid and Brenner report that although the theoretical ratio of three moles of hydrogen to one mole of hexafluoride is needed for complete reduction, satisfactory coatings are obtained when the ratio is lower. In practice, smooth coatings are insured by using a hydrogen-to-hexafluoride ratio greater than six.

Wide variations in the system have no major effects either on the process' efficiency or on the coating's quality. Although the optimum temperature range for rapid formation of smooth deposits is between 1200° and 1300°F, temperatures in the range from 700° to nearly 1650°F are all effective. At 1650°F, definite crystal growth is observed.

• **Made-to-order thicknesses**—Bonding of tungsten to various materials was studied. Adhesion to molybdenum and to nickel shows up good; to copper, somewhat weaker; and to iron, rather poor. The tungsten-graphite bond is about as strong as the graphite itself. Tungsten deposited on ceramics also displays good bonding characteristics.

To obtain a stronger bond to graphite, Reid and Brenner decided to siliconize the surface. Here in effect, a silicon carbide film was first formed on the graphite. Improvement in the adhesion of the subsequent tungsten coating resulted.

One such tungsten-plated graphite nozzle has withstood a 35-sec. firing test. More rigorous tests are being planned. In addition, preliminary experiments with vapor deposition of the metal rhenium have begun at NBS.

Under good conditions, tungsten can be deposited up to a mil a minute. Thus the process lends itself to continuous production of tungsten-coated strips and wires.

Although plating a metal strip or wire is simple, the uniform distribution of tungsten over an irregularly shaped object is a problem that must be individually solved.

Experiments show that a more uniform thickness of coating is obtained if the plating chamber is much larger than the object. Furthermore, the metal is deposited in greatest thickness where the gas mixture first contacts the object. Hence, coating thicknesses can be appropriately distributed by passing one gas, say WF_6, through the main opening in the chamber; and at the same time, by directing the other gas by means of a system of injector tubes and spouts to the desired places on the object.

The maximum thickness of deposit that can be obtained by this vapor deposition method has yet to be determined. If there is a limitation, it is probably brought about by the maximum allowable roughness of the plated surface.

• **'Elzzons' held by graphite**—Sometimes a pure tungsten part is wanted. In this event, the metal shape that took the initial deposition is dissolved in a suitable acid.

This process is used for making nozzle inserts, which are subsequently housed in loosely fitting graphite blocks. It is believed that this technique for engaging the inserts cuts down on thermal shock problems; it also eliminates the differential expansion trouble that could exist between the tungsten and its substrate metal or graphite under high-temperature conditions.

Probably influenced by Samuel Butler's book *Erewhon*, the NBS scientists have dubbed such an insert an "elzzon," which is "nozzle" spelled backwards.

The high value of tungsten as a structural material for high-temperature use and the simplicity and cheapness of the hexafluoride process will probably bring a number of companies into the tungsten plating field. Meanwhile, the NBS group is studying the crystal structure of the deposited tungsten and the means for altering it to get increased strength and less stress.

SPECIMENS OF simple and complex forms and coated objects produced at NBS. Note plated rocket nozzle (right bottom) and thick solid-tungsten cap (right center).

LiH Studied as Hydrogen Generator

FEASIBILITY STUDIES on the production of hydrogen from lithium hydride for a number of space uses are under way at Tapco Group's Test Center, Roanoke, Va.

The lithium hydride work was started because of its potential as a hydrogen producer—one pound of pure hydrogen for every four pounds of lithium hydride. This capability has been demonstrated experimentally.

There are a number of applications for such a generator. Underwater propulsion devices, deep space probes and portable power supplies for ground use are among those being considered.

According to Tapco, the hydrogen would be used with an oxidizer which could be either compressed or liquid oxygen. The energy conversion mode would be either a turbine or a fuel cell.

• **High thermal energy**—The main advantage of such a system is in the large quantity of heat released in the reaction—25,590 cal/gm-mole if all of the hydride is converted to hydrogen. If an adequate supply of water is available and the hydride is converted only to the oxide, the amount of H_2 produced is not affected but the heat quantity drops to 15,600 cal/gm-mole.

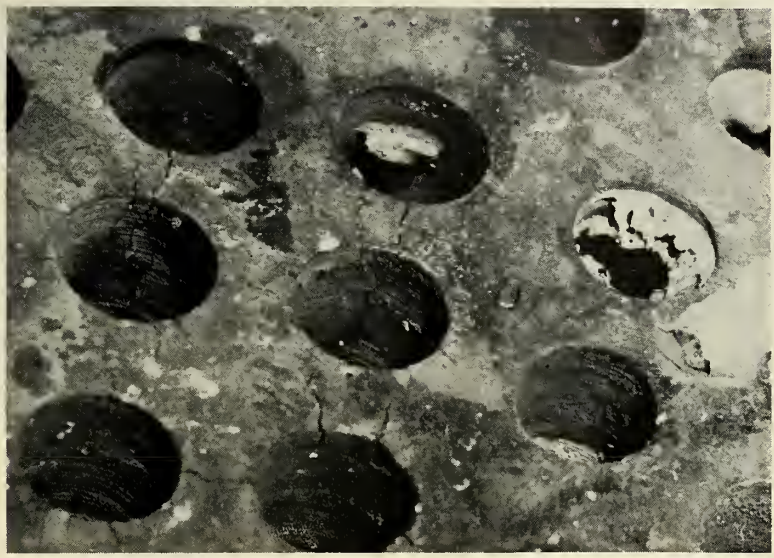
In order to utilize the LiH most effectively, it is necessary to re-circulate the water—which results in combustion of hydrogen with oxygen. In a system this means that the steam generated in passing through the system must be pumped back up to the pressure encountered in the hydrogen generator inlet.

With hydrogen-oxygen fuel cells, removal of the water from the cell with a pump would require an electric motor drive. Reuse of the water to generate more hydrogen greatly reduces the water of the overall system.

Tapco points out that this hydrogen production method is not to be regarded as a panacea for the problems in either carrying bottled pressurized hydrogen or in cryogenic storage. As in most applications, there are certain systems in which the use of LiH is attractive.

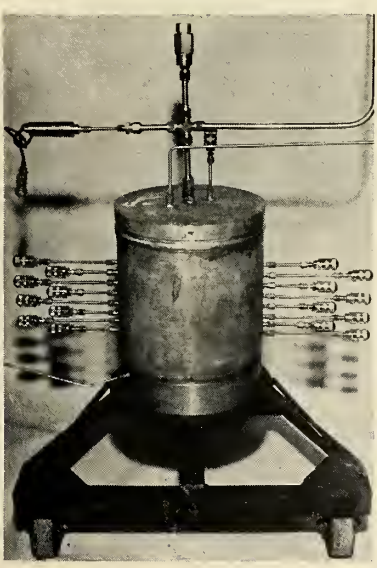
The use of LiH with water is not a new application. Balloons have been filled through this means for years. The major hurdle is the generation of H_2 in large volume at high pressure.

Generators have been built at Tapco-Roanoke which produce hydrogen at pressures from 500 to 1500 psi. One large feasibility generator has been successfully operated with a hydrogen production rate of 12 lbs. per hour.



ACCUMULATED OPERATING time of one hour resulted in these cracks in a plate of type 304 stainless steel contained in the lithium hydride system.

Techniques of control have been worked out and methods of restricting the maximum temperatures within the generator have been devised. Such temperatures may vary from 1700°F to around 3200°F.



LARGE LITHIUM HYDRIDE HYDROGEN generator can turn out 12 pounds of pure hydrogen per hour. The feasibility device is 12 in. in diameter.

The method of starting the generator is probably the most difficult aspect of the operation and Tapco considers this proprietary.

Particle size, chamber configuration, response times and a large number of other items have been investigated by the researchers.

Twin Coach Machine Folds Metal Into Corrugations

Metal can be folded into corrugated shapes with a unique machine developed by Twin Coach Co., Buffalo, N.Y.

In contrast to the usual method of drawing such configurations, the device makes possible simultaneous perforating, off-setting, slotting or lancing. Thus an infinite variety of patterns is possible.

The key element in the process is a cam-controlled action, which moves the forming dies in both horizontal and vertical planes. Die costs range from $800 for a simple design to $3500 for complex ones. But each die gives about 1000 hours of use.

At present, folded metal is available in gauges from 0.002 to 0.030 in. at a tolerance of 0.001 in.

RESEARCH AND DEVELOPMENT AT LOCKHEED

...is setting the pace in space for years ahead

Lockheed Missiles and Space Division's progress transcends even that of an era marked by phenomenal scientific growth. To an important degree, the Division's research and development activities are considered to be the basis of its success.

As systems manager for the Navy POLARIS Missile and the Air Force AGENA Satellite in the DISCOVERER, MIDAS and SAMOS programs, the Division is engaged in extensive research in many diverse engineering and scientific fields. Some highlights of current research and development activities include: Operations research and preliminary design; nuclear and space physics; physical electronics; chemistry; materials; mathematics; engineering mechanics; electronic communications and instrumentation; and computer research and development.

Research is a concept which holds many different meanings to those concerned with science and technology. At Lockheed, a distinction is made between the *nature* of the work and its *objectives*. Consequently, such terms as basic research, applied research, systems or operations analysis, engineering and development are used. A given individual might find that his personal inclination often leads him quite naturally from one type of research to another. Recognition of this desire is reflected in the scope of work conducted in the Research Branch at Lockheed Missiles and Space Division. Principal research activities are: Pure and applied research; advanced design; engineering analysis; electronic prototype development; and machine computation.

Organization is determined by the *technical field* rather than by the *type of research*. For example, a structural dynamicist, as a member of the Structures Department, may, on one occasion, work on future space vehicle configurations, at another time be associated with current projects such as the POLARIS or Satellite programs, or he may be engaged in basic research at the research laboratory. In each case, the individual has the opportunity to maintain as much or as little contact as he wishes with others in his field of interest.

Important staff positions at Lockheed's Research and Development Branch in Palo Alto are available. Those scientists and engineers with experience related to the above areas are invited to write to: Research and Development Staff, Dept. I-29A, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance is required.

Lockheed / **MISSILES AND SPACE DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
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Missiles and Rockets

ASTROLOG

A status report on U.S. missiles and rockets and all space vehicles presently in orbit

★ *Indicates change since July 4 edition*

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SPACE VEHICLES			
ADVENT (ARPA-Air Force)	GE-Bendix prime for polar-orbiting phase	New overall name for advanced communications satellites STEER, TACKLE and 24-hour instantaneous repeater called DECREE	R&D
★AEROS (NASA)	No contract announced	24-hour weather satellite to be boosted by CENTAUR or SATURN	Planning. First flights would be i 1964 or 1965
★AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout; AGENA B stop-start engine will have about double fuel capacity of AGENA A	Used in DISCOVERER program larger AGENA B also to be use with ATLAS and THOR. NASA als will use to take place of cancelle VEGA
★APOLLO (NASA)	No contract announced	Three-man spacecraft capable of orbiting moon or becoming space station; probably winged for lunar flights; boosted by SATURN	Competition on for 6-month stud contract to be awarded Nov. 1 R&D prime to be chosen in FY '6
ATLAS-ABLE (NASA)	STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion	Orbit 200-lb. vehicle around moon or send into deep space	Two lunar orbit attempts beginnin this summer
CENTAUR (NASA)	Convair, prime; Pratt & Whitney/-JPL, propulsion	Pair of LOX-liquid hydrogen engines, 30,000 lbs. total thrust, atop ATLAS booster, capable of orbiting 8000 lbs. or accelerating almost 3000 lbs. to escape velocity	First test flight in 1961; first engin delivered
★COURIER (ARPA-Army)	Army Signal Corps, prime	Delayed repeater communications satellite	COURIER 1A launching failed i August because of booster blow-up Next shot expected in October
★DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA launchings of early stabilized satellites; main purpose is to test techniques for SAMOS	14 launchings; capsule recovere from orbit on No. 13 & 14. No. 1 to carry small primate. Total 35 shot planned
DYNA-SOAR I (Air Force)	Boeing, space craft and systems integrator; Martin, propulsion	Boost-glide orbital space craft; first space bomber; TITAN I booster; TITAN II probably to be used later	R&D; first glider flights from Ed wards AFB by 1962; intensive ma terial studies underway
★ECHO (NASA)	Langley Research Center, prime	Puts 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite	Second launching attempt successfi Aug. 12
★FIREFLY (NASA)	No contract announced	Geodetic survey satellite	No funding
JUNO II (NASA)	ABMA/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, prop.	Early deep space booster; small payload	Five more shots planned
★MARINER (NASA)	JPL, prime	600-1200 lb. unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B	Seven shots planned beginning ne year
★MERCURY (NASA)	NASA, prime; McDonnell, capsule	First manned satellite	Program slipping about one yea First manned capsule launching b REDSTONE down Altantic Range st scheduled for Dec. but probably w slip to 1961. First manned orbit sh still scheduled for 1961
MIDAS (Air Force)	Lockheed, prime	Early-warning satellite; detect ICBM launchings by infrared before birds leave pad; R&D models weigh 2 tons; operational system to have 12-15 satellites	R&D; second launching May 24 pa tial success
★NIMBUS (NASA)	Contract to be let shortly	Follow on to TIROS weather satellite	First launching scheduled for ear 1962

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
OVA (NASA)	No prime announced; Rocketdyne, propulsion	Clustered 6-9 million lb. booster plus upper stages	Early R&D on 1.5 million lb. F-1 engines
OAO (NASA)	No contract announced	3500-lb. orbiting astronomical satellite observatory equipped with telescope; boosted by ATLAS-AGENA B	Contract to be awarded soon; 11 firms or teams competing
OGO (NASA)	No contract announced	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B booster	Procurement planned in early 1961
RION (ARPA-Air Force)	General Atomic	Space station launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted; program shifted to Air Force alone
PROJECT 3059	Aerojet-General, Grand Central, propulsion	Solid motor in 1 million to 2 million lb. thrust class	Research determining feasibility; NASA contracting for complementary studies with United Technology Corp.
PROSPECTOR (NASA)	No contract announced	Soft-landed, remote control, unmanned moon exploring spacecraft. SATURN booster	Planning. First flight planned by 1965
RANGER (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. rough landed instrumented capsule on moon; ATLAS-AGENA B booster	R&D; first flight planned 1961 or 1962
REBOUND (NASA)	No contract announced	System of 12 or more passive communications satellites launched several at a time	Study
SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY	R&D; stabilization already achieved in DISCOVERER series; first test launching scheduled this year; scheduled to be operational late 1962, early 1963 under new, bigger program
ATURN (NASA)	NASA Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines	Series of multistage vehicles based on 1.5-million-lb. clustered booster and upper stages using combinations of LOX-liquid hydrogen engines. Earliest model will orbit 20,000-lb. payload	Static firings of clustered booster in progress successfully since April; first flight test spring of 1961; flight with live upper stages scheduled 1963
SCOUT (NASA-Air Force)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Allegany/Thiokol, propulsion	Solid four-stage satellite launcher; 200 lb. payload in orbit	Air Force and probably Navy also to use for research; first test in April and July partially successful; AF version called HETS
SURVEYOR (NASA)	No contract announced; STL, McDonnell, North American, Hughes competing	Soft-landed 100-300 lb. instrumented spacecraft on moon; ATLAS-CENTAUR booster	Competing studies to be completed in November; R&D contract to be awarded 1961; first moon flights '63-'64
THOR-ABLE-STAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle with orbital capability of 200 lbs. New ABLE-STAR upper stage has restart engine, boosts heavier payload	THOR-ABLE phased out. THOR-ABLE-STAR operational in TRANSIT and COURIER
THOR-AGENA (Air Force)	Lockheed, prime; Bell, propulsion	Two-stage vehicle capable of orbiting more than 300 lbs. AGENA-B restartable upper stage boosts payload capacity to 1250 lbs.	Operational in DISCOVERER program. AGENA-B first used May 24 to launch MIDAS II. NASA to use extensively beginning late '61
THOR-DELTA (NASA)	STL, prime; IT&T, guidance; Rocketdyne / Aerojet-General / Allegany, prop.	Improved THOR-ABLE with 480-lb. payload capability	To be used in ECHO and TIROS programs. Used successfully in ECHO I shot
TIROS (NASA-AF-Army-Navy-Wea. Bu.)	RCA-Army Signal Corps, prime	Meteorological satellite; TV pictures of cloud cover	R&D; first launching in April a success; two more scheduled; one late this year
TRANSIT (ARPA-Navy)	Johns Hopkins Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50 lbs.	TRANSIT 1B R&D satellite put in orbit April 13; IIA plus piggyback satellite successfully in orbit June 22, four satellite TRANSIT systems scheduled operational 1962; next R&D launching late fall
TRIBE (ARPA)		Family of space launching vehicles	Planning
VOYAGER (NASA)	No contract announced	Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster	Study; first flight planned by 1965
YO YO (Navy)	No contract announced	Tactical sea-launched one-pass reconnaissance satelloid	R&D

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
X-15 (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 3600 mph; flight at edge of space; on AF model each XLR-11 rocket engines develop 16,000 lbs. of thrust; later XLR-99 engines to develop 50,000 lbs. Three planes delivered	Powered flights in progress; plane #1 has hit Mach 3 and more than 80,000 ft. with XLR-11 engine; plane #2 out of operation for installation of more powerful XLR-99 engine for fall flight; plane #3 heavily damaged by fire June 8 in test prior to flight with XLR-99
MISSILES & ROCKETS			
ALFA (Navy)	Avco, prime	ASW surface-to-underwater; 500 lb. solid; conventional; formerly called ABLE	Deployed on destroyer escorts
ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, Sonar; Torpedo, GE; depth charge, M-H.	Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range about 8 miles	R&D; operational on Destroyers Norfolk & Peary; plans call for deploying on 150 destroyers and cruisers
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater; rocket torpedo; nuclear	R&D
★ATLAS (Air Force)	Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	ICBM; more than 5500-to-7500 mile range; liquid; nuclear; Atlas "E" series has inertial guidance; earlier Atlas "D" has radio inertial	60 military launchings: 39 successes, 8 partial, 13 failures; 6 scientific launchings: 4 successes, 1 partial, 1 failure. 11 scheduled sites for 13 squadrons named; partial squadrons operational at Vandenberg A
★ARM (Air Force)	No contract announced	Anti-radar missile	Studies; plan for separate missile shelved at least temporarily
BOMARC-A (Air Force)	Boeing, prime; Westinghouse, guidance; Marquardt/Aerojet, propulsion	Ramjet surface-to-air interceptor; liquid booster; 200 m. range; Mach 2.7; nuclear	First squadron operational at McGuire AFB, N.J.
BOMARC-B (Air Force)	Boeing, prime; Westinghouse, guidance; Thiokol, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 500 m. range; nuclear	Ten launchings: 2 successes, 8 failures; first successful flight April 14. Production program sharply cut back by Air Force
BULLPUP (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol (Reaction motors), propulsion	Air-to-surface; 4-8 mile range; conventional 250-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model under development	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; Air Force buying modified version; Marines launching BULLPUP from helicopters
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime; Daystrom, U.S. distributor	24.6-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant	Marines planning to purchase; Army considering them; already operational with West German troops
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CORVUS (Navy)	Temco, prime; W. L. Maxson guidance; Reaction Motors, propulsion	Air-to-surface; pre-packaged liquid; radar homing; about 100-miles range	First successful test July 18, 1959
CLAYMORE (Army)	No contract announced	Anti-personnel missile	R&D
CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
DAVY CROCKETT (Army)	In-house project at Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men	R&D; operational in FY '61; first NATO deliveries also FY '61
★EAGLE (Navy)	Bendix, prime; Bendix, guidance; Aerojet propulsion; Grumman, airframe	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow Douglas Missileers now under development; Eagle is 15 ft. long; wt., about 2000 lbs., Mach 4; solid	R&D; Missileer production run reported to be 120 in next few years
★FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead	GAR-1 through GAR-4 operational; GAR-9 & 11 R&D
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D
HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 20-mile range; solid; conventional; designed to hit low-flying planes	Operational; units training for early deployment to Europe and Far East; advanced Hawk under development; Jan. 29 successfully intercepted Honest John, first known intercept of one tactical missile by another

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
HONEST JOHN (Army)	Douglas, prime; Hercules, propulsion	Surface-to-surface; unguided; 16.5-mile range; nuclear	Operational; deployed in Europe
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400; training fully underway
JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear, re-entry vehicle	IRBM; liquid; nuclear	To be deployed with Italian troops in Italy and may be used as AICBM target drone; 29 military launchings: 22 successes; 5 partials; 2 failures. One 15-bird squadron to be deployed in Turkey. Last R&D test shot launched Feb. 4
LACROSSE (Army)	Martin, prime; Federal Telecommunications Laboratories, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; 4 units being trained; 3 more planned for 1960; being deployed in Europe and Far East; advanced LACROSSE R&D program dropped at least temporarily
LITTLE JOHN (Army)	Emerson Electric, prime; ABL, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	Operational this year; units training with it
LOBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BALLISTA	Studies
LULU (Navy)	General Mills/Naval Ordnance Lab, prime	Small nuclear depth charge air-dropped or launched by ASROC	Operational
MACE (Air Force)	Martin, prime; AC Spark Plug, guidance; Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has 1000-m. range	Being deployed with U.S. troops in West Germany; now all mobile but hard-base version in R&D; first launched from prototype hard site in July
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650-mile range	Being turned over to West Germans; also deployed in Far East
MAULER (Army)	Convair, prime	Surface-to-air; IR guidance; highly mobile antiaircraft and antimissile missile for field use; to be on tracked vehicle; 12 missiles in each launcher	R&D; NATO may buy
MINUTEMAN (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF rail launcher	2nd generation ICBM; solid; fixed or mobile aboard railroad trains; nuclear; 3 stages	R&D; scheduled to be operational mid-1962 at Malmstrom AFB; launching of eight tethered birds from silos successfully completed in May; first full R&D launching from Cape in Dec.; tactical rail system tests completed
M-55 (Army)	Norris Thermodor, prime	Four-inch diameter, small, short-range poison gas rocket; to be fired from 45-tube launchers	Operational
MISSILE A (Army)	ARGMA to act as prime; six R&D contracts for components scheduled to be let soon	Surface-to-surface; 65-70 mile range; solid	Design studies
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Hercules Powder, propulsion	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; about 170 batteries in U.S.
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion	Surface-to-air; 80-mile range; Mach 3+; nuclear; effective against tactical missiles as well as aircraft; mobile or fixed installation	Rapidly replacing NIKE-AJAX; more than 80 batteries deployed in U.S.
NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol and Grand Central, propulsion	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands. 9 R&D launchings: 6 successful, 2 partial, 1 failure. Test shots in the Pacific planned in mid-1961. Earlier shots from Pt. Mugu, Calif., into PMR. Administration has refused to okay Army recommendation to begin major production
PERSHING (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; two-stage solid; approx. 500-mile range; nuclear; transported on tracked FMC XM474 tracked vehicle	R&D; to replace REDSTONE; 6 R&D launchings (live first stage; dummy second): 6 successes. Expected operational late 1962
POLARIS (Navy)	Lockheed, prime; GE, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear	67 launchings of test vehicles: 46 successes; 18 partial; 3 failures; launched from surface ship Aug. 27, 1959; expected on station late in 1960; 1100-mile plus range vehicles under test at Cape Canaveral; first sub launchings this summer; 14 subs built, building or authorized; 5 long-lead items authorized by DOD, 2 more by Congress

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
REDEYE (Army)	Convair, prime; Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable	R&D; Marines also will use; NATO may buy
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe to be replaced by Pershing
REGULUS II (Navy)	Chance Vought, prime; Stavid, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines used as target drone
SERGEANT (Army)	JPL/Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	Production. To replace CORPORA this year
SHILLELAGH (Army)	Aeronutronic, prime	Surface-to-surface; lightweight; can be vehicle-mounted	Early R&D
SIDEWINDER (Navy)	GE-Philco, prime; Avion, guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; 6-7-mile range; conventional; new I-C models to have switchable IR and radar-guided warheads	Deployed with Navy and Air Force all-weather type under developmen
SKY BOLT (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	Air-launched ballistic missile; more than 1000-mile range; solid; nuclear	R&D; to be purchased by British; op erational 1964-65; both U.S. an British planes to test-launch fro Eglin AFB, Fla.
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear-powered ramjet; nuclear	Study-R&D
SNARK (Air Force)	Norair, prime; Northrop, guidance; Aerojet-General, propulsion	Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear	Deployed at Presque Isle, Maine
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft earlier SPARROW I obsolete; ne contract aimed at extending rang and altitude
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion	Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear	Estimated operational date: 196 To be installed first on Threshe nuclear-powered attack submarine
SS-10 (Army)	Nord Aviation, prime	Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French an other NATO and Western unit battle-tested in North Africa
SS-11 (Army)	Nord Aviation, prime	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional	Operational. Under evaluation b Army
TALOS (Navy)	Bendix, prime; Farnsworth/Sperry, guidance; Bendix/McDonnell, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galve ton
TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Many test firings in Pacific; e pected deployment 1960 as prima armament of guided missile d stroyers; production
★TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs.; 102 in. long; 105-lb. warhead	The Navy is buying the Norwegi missiles to equip two destroyer e corts
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional	Operational with fleet
TERRIER-ADVANCED (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	About 100% performance improvement over TERRIER	Operational Advanced TERRIERS be deployed about mid-1960
★THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases set up in En land. 63 military launchings: 42 s cesses; 11 partial; 10 failures; 35 s entific launchings: 29 successful, partial; 4 failures; R&D and "T rod" advanced tests complet Feb. 29
★TITAN (Air Force)	Martin, prime; Bell/Western Electric, Remington Rand, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, re-entry vehicle	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range	21 launchings test vehicles: 14 s cesses; 2 partial; 5 failures. 8 s for 12 squadrons named; 14 squ rons planned; TITAN I operatio fall 1961; first Vandenberg laun ings scheduled this Oct.; TITAN scheduled to be operational e 1963
TYPHON (Navy)	Westinghouse, prime; Bendix propulsion	Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Early R&D; may be used on hydro destroyers

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
VAGTAIL (Air Force)	Minneapolis-Honeywill, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
VILLOW (Army)	Chrysler, prime	Highly-classified missile	R&D
UNI (Navy)	Naval Ordnance Test Station, prime	Air-to-air, air-to-surface; solid; unguided rocket; 5-mile range; conventional	Operational

SATELLITES

SATELLITE	COUNTRY	STATUS
EXPLORER I (30.8 lbs.)	U.S.	Launched 1/31/58, est. life 3-5 years. Orbits earth, perigee: 213.9 m., apogee: 1192.9 m., period: 107.8 min. (Discovered Van Allen Belt); not transmitting.
VANGUARD I (3.25 lbs.)	U.S.	Launched 3/17/58, est. life 200-1000 years. Orbits earth, perigee: 406 m., apogee: 2450.7 mi.; period: 133.9; still transmitting.
LUNIK I "MECHTA" (3245 lbs.)	RUSSIA	Launched 1/2/59. Believed to be in orbit around sun on 15 mo. cycle; not transmitting.
VANGUARD II (20.7 lbs.)	U.S.	Launched 2/17/59, est. life 10 years +. Orbits earth but is "wobbling," perigee: 346.4 m., apogee: 2047.7, period: 125.4 min., inclination to equator: 32.88°; not transmitting.
IONEER IV (13.40 lbs.)	U.S.	Launched 3/3/59. Orbits sun, and achieved primary mission, an Earth-Moon trajectory; not transmitting.
EXPLORER VI "PADDLE-WHEEL" (142 lbs.)	U.S.	Launched 8/7/59, est. life: to Aug. 1961. Orbits earth, former perigee: 156 m., former apogee: 26,357 m., former period: 12½ hours, present orbit unknown; speed: at perigee 23,031, at apogee 3126 mph., inclination to equator: 46.9°; not transmitting.
VANGUARD III (about 100 lbs.)	U.S.	Launched 9/18/59, est. life 30-40 years. Orbits earth, perigee: 322.6 m., apogee: 2320 m.; period: 129.9; not transmitting.
UNIK III (about 614 lbs.)	RUSSIA	Launched 10/4/59, est. long life, orbits earth-moon; took first picture far side of moon; est. perigee: 30,000 m., apogee: 291,000 m.
EXPLORER VII (91.5 lbs.)	U.S.	Launched 10/13/59, est. life 20 years, orbits earth, perigee: 343.7, apogee: 673; period: 101.2; transmitter to cut off in October.
DISCOVERER V CAPSULE (less than 300 lbs.)	U.S.	Launched 8/13/59. Satellite burned up in atmosphere Sept. 28. Capsule also thought to have been destroyed, but it was later rediscovered and first thought to be an unidentified Soviet satellite. Est. life several months; period: 98.9; perigee: 119.6, apogee: 756.4.
PIONEER V (94.8 lbs.)	U.S.	Launched 3/11/60, est. life: forever; orbits sun, interplanetary radio communication satellite, passed 20 million miles June 20; not transmitting.
TIROS I (270 lbs.)	U.S.	Launched 4/1/60, est. useful life: 3 mos., perigee: 428.9 m.; apogee: 468.1; period: 99.2. Picture-taking weather satellite; still transmitting.
TRANSIT 1B (265 lbs.)	U.S.	Launched 4/13/60, est. life: 16 mos. minimum; perigee: 237.7; apogee: 442.9; period: 95.6. First R&D navigation satellite. Not transmitting.
SPUTNIK IV (10,008 lbs.)	RUSSIA	Launched 5/15/60; est. life: relatively brief; original perigee: 188; apogee: 229; changed to 191/429 on May 19. Last reported—Period: 94; perigee: 174.7; apogee: 406.2. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed because of poor orientation of retrorocket.
MIDAS II (5000 lbs.)	U.S.	Launched 5/24/60; est. life: 40 months; perigee: 300.1; apogee: 318.4; period: 94.4; Telemetry for IR scanning failed two days after launch; still transmitting.
TRANSIT II-A (223 lbs.)	U.S.	Launched 6/22/60; est. life: 50 years; period: 101.7; perigee: 389.2; apogee: 650.5; still transmitting.
NRLI "GREB" (40 lbs.)	U.S.	Launched 6/22/60 with TRANSIT II-A; period: 101.7; perigee: 657.8; apogee: 657.8. Solar radiation measuring satellite; still transmitting.
DISCOVERER XIII (1700 lbs.)	U.S.	Launched 8/10/60; period: 94; perigee: 156.6; apogee: 425.5; 300-lb. capsule successfully ejected from orbit and recovered from Pacific 8/11—the first satellite to be recovered from orbit.
ECHO I (132 lbs.)	U.S.	Launched 8/12/60; est. life: one year; period: 118.2; perigee: 957; apogee: 1038.4; first successful orbiting of a passive communications satellite.
DISCOVERER XIV (1700 lbs.)	U.S.	Launched 8/18/60; period: 94.5; perigee: 116; apogee: 502; 300 lb. capsule ejected from orbit and recovered for the first time in the air by a C-119 aircraft over Pacific.
SPUTNIK V (10,120 lbs.)	RUSSIA	Launched 8/19/60; period: 90.72; perigee: 190; apogee: 211. Capsule of undisclosed configuration and weight carrying two dogs and other living organisms successfully ejected from orbit and recovered in meadow—the first successful return of an animal from orbit.

ground support equipment

Army Gets Liquid Test Facilities in Navy Turnover

THE ARMY has expanded its liquid-propellant test facilities through the turnover to Picatinny Arsenal, the Army Ordnance ammunition development center, of the adjacent Naval Air Rocket Test Station at Lake Denmark, N.J.

The Ordnance Corps thus acquired 760 acres of land and 215 buildings, including 68 permanent warehouses, valued at approximately $12 million.

Picatinny Arsenal is located near Dover, N.J., about 30 miles northwest of New York City.

A new Liquid Rocket Propellants Laboratory has been activated in the Arsenal's Ammunition Group; it absorbed 81 civilians formerly employed by the Navy. Irving Forsten, former technical director of the NARTS Rocket Propulsion Laboratory, has been named Chief, LRPL, by Picatinny.

Dr. John D. Clark, chief chemist at NARTS since 1949, will be Chief, Propellant Section, while John J. Caravan, who had been at NARTS since 1952, becomes Chief, Rocket Engine Section.

• **Variety of test stands**—Among the testing facilities which now will be utilized in the Army's research and development program are:

–A liquid-propellant rocket engine test stand—capacity to 350,000 lbs. thrust. Instrumentation can measure 96 channels.

–A test stand equipped to test liquid-propellant rockets having their own tankage or high-thrust solid-propellant rockets—capacity 100,000 lbs. thrust. Equipped with remote control, closed-circuit TV.

–Two dual-mount test bays capable of testing liquid-propellant rocket engines up to 10,000 lbs. thrust, also equipped with closed-circuit TV.

–A test stand testing solid-propellant motors and JATO's up to 40,000 lbs. thrust, equipped with closed-circuit TV.

–A test stand capable of testing liquid- and solid-propellant engines up to 30,000 lbs. thrust.

–Eight stands accommodating liquid-propellant rocket engines up to 10,000 lbs. thrust.

–Two stands, one a double-bay stand and the other a variable attitude stand, for liquid-propellant rocket engine testing. The former can withstand 15,000 lbs. thrust, while the variable attitude stand is rated to 20,000 lb thrust.

–Three double-bay test stands whic can test liquid-propellant rocket e gines up to 15,000 lbs. thrust.

Among the other facilities t Arsenal acquired in the turnover a a components workshop for cold te ing and flow testing of components, instrumentation workshop, a temper ture conditioning pad, a JATO exhau temperature and blast pressure facilit a hazardous propellant-handling buil ing, a centrifuge, a shock tester, a dr test facility, an environmental t building, a physical chemistry labo tory, an analytical chemistry laborato and a shops branch.

The Reaction Motors Divisio Thiokol Chemical Corporation, lea 10 test stands and four double-b stands in three areas. Storage facilit capable of accommodating 13,000 g lons of ammonia and nitrogen gasifi tion equipment are included.

Other staff members for the n Liquid Rocket Propellants Laborato include William F. Lehman, specia in qualification test and evaluation p grams; Frederick R. Hickerson, auth ity on advanced liquid rocket eng concepts and Edward A. Jenkins, el tronics expert and technical consulta

Sperry Rand Enters Range Instrumentation Field

Eyeing what it foresees as a billi dollar market, Sperry Rand has inc porated a Missile Range Instrumen tion group to "design, develop, produce compatible missile range s tems." Divisions participating direc in the effort include Ford Instrume Remington Rand Univac, Sperry Gy scope, and Vickers, Inc.

The decision to enter this fi according to a company spokesm was based on a lengthy study wh revealed a need—and a market po tial—for complete, integrated range strumentation. They concluded t range instrumentation has not k pace with missile development and t an urgent need exists for compat and integrated systems.

The announcement said that Spe Rand is perhaps the only corporat having the built-in resources to p vide such extensive coordinated ins mentation.

Monkey Will 'Study' Weightlessness

Discoverer series' first orbit of primate—due next month—will carry elaborate instrumentation and highly trained animal

by Heather David

Much long awaited physiological data required for America's manned spaceflight program may be obtained by the Air Force next month when an attempt probably will be made to orbit a primate in a *Discoverer* capsule.

Now tentatively ticketed for *Discoverer XVI,* the first animal to be launched by the U.S. in an earth orbit will be a tiny 5-8-lb. American rhesus monkey—an animal which closely resembles man in physical arrangement and development of certain parts of his brain. The monkey previously had been expected to go aboard *Discoverer XV.*

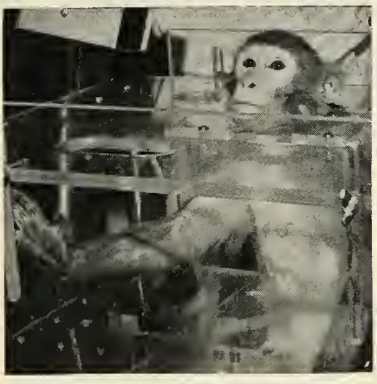
Major goal in the test, said Brig. Gen. Don D. Flickinger, Assistant for Bioastronautics, is to determine the ability of higher mammals to function during extended periods of weightlessness. Humans have experienced weightlessness as long as 90 seconds; the *Discoverer* trip will extend this knowledge to 17 or 18 hours.

More intelligent than dogs, the monkey can perform certain decision-making or reasoning tasks. This fact may forecast some of the effects of space travel on man's mental capabilities.

At various phases of the trip, psychomotor tests of the see-light, pull-lever variety will be given to the tiny subject. More complex tests and more detailed monitoring of brain activity will be programed for subsequent flights.

The *Discoverer* capsule will carry a lighter load of telemetry instrumentation than did the recent Russian flying menagerie, mostly because of sheer weight and power limitations. However, Air Force medical experts say that not all the Soviet devices were necessary to get an adequate description of the effects of the flight on the animals.

General Electric's Missile and Space Vehicle Department designed and manufactured the *Discoverer* capsule under a Ballistics Missiles Division contract. It will include sensors to measure respiration, pulse, blood pressure, EKG (electrocardiogram) and body temperature. Probable additional monitors would include a phonocardiogram (heart sounds) and an eye motion detector (to indicate motion sickness and other disturbances of equilibrium).



A 'TEEN-AGE' (16-18 months) rhesus much like this one is now getting flight instructions for Discoverer trip.

• **Banana pie in the sky**—Food will be administered to the astrosimian in the form of small dehydrated pellets. Not at all as unappetizing as they may sound, these are the same pellets used during training to reward him for completing psychomotor tasks.

Enough food, water and oxygen will be provided to sustain a two-hour countdown, approximately 27-hours mission time and several hours safety period.

Capsule environment will be maintained at a slightly rarified atmosphere of 8-10,000 ft., according to the Air Force. Temperature, under a monkey-comfort-index, will be kept at about 80°F, with humidity at less than 50%. Temperature variant is less than ±5°, pressure less than 1 lb. psi.

Although radiation-measuring devices will be carried aboard, no serious hazard is anticipated from radiation. The Air Force will aim for a near-circular orbit at about 160 m., well below the 600-mile limit medical experts set for dangerous radiation. Greatest apogee for a recent *Discoverer* orbit has been 502 miles, set by *XIV.*

Normal launch, acceleration and reentry should present no problems in the way of g forces, which will be slightly less than with *Atlas* vehicles. The animal will encounter forces of 7 g's during acceleration and a short duration of 12-15 g's during re-entry. Rate of descent before impact will be about 20-25 ft. per second—less than 1 g.

Throughout the trip the monkey will be esconced on a contour-fitting couch, much like those used in previous short flights. A lightweight nylon harness will permit him limited movement.

• **It's all in the mind**—Preconditioning plays an all-important part in the scientific validity of these tests. An animal's physiological reactions will depend to a great extent on its "nervous system." For instance, sheer fright during weightlessness would produce an abnormal electrocardiogram, but the weightless condition itself would not be responsible for unusual heart activity.

The five potential *Discoverer* passengers have undergone extensive training at the Balconnes Laboratory of the University of Texas, Austin, under a School of Aviation Medicine contract. Isolation, g-forces, high temperatures are all part of the course.

The monkey provides an excellent experiment subject not only because of his manlike qualities, but because long-term effects will appear five times as fast because of the shorter life span.

If unexpected radiation exposures should occur, high dosages would of course be immediately obvious. Breakdown of white blood cell mechanism would occur in a day or so; cancers, leukemia, etc., resulting from lower dosages would appear within months.

• **Tight scheduling**—Although it is very probable that the monkey shot will come in *Discoverer XVI,* the wedding of the biomedical package to the launch vehicle might cause a hitch, a high Air Force official told M/R. If some difficulty occurs in the lengthy process, a non-live shot might be substituted to keep on schedule.

The regular Air Force schedule (excluding the monkey shot moved up from next year) calls for the first *Thor-Agena B* on *Discoverer XVI.* The greater capability of the *B* vehicle over the *Thor-Agena A* will make it very possible that if all goes well with the monkey, a 30- or 40-lb. chimp might not be far back in line.

All-attitude Liquid Gage Developed

System made by Liquidometer Corp. can measure oxygen supply of astronaut or liquefied metals in propulsion

LOS ANGELES—Space flight presents unusual problems in accurate gaging of liquids, which might be forced to any part of a tank by varying g-forces or which might float in a tank in globules under zero-gravity conditions.

An all-attitude liquid-quantity gage to meet these problems has been developed by the Liquidometer Corp. The company says it is both simple and extremely accurate.

A typical application of the gage is in the measurement of an astronaut's breathing oxygen. Another application is the gaging of liquefied metals in advanced propulsion systems.

Space Simulation

STRESSES WHICH DYNA-SOAR flight will impose are being calculated by the Space Medicine section at Boeing Airplane Co. Depressurization, extreme heat and high level noise are simulated simultaneously in this sealed chamber.

The heart of the system is a capacitance liquid-measuring probe. This consists of a matrix structure of wires or tubes in cubical form, with a second, independent, structure enclosed by the first. The two electrically independent circuits form the two active terminals of a three-terminal capacitor. The vehicle shell forms the third terminal.

The structure is built to fill the entire volume of a tank and measures the liquid on a digital basis. Whenever one of the capacitor cubes is filled with liquid, a change in capacitance occurs. This is measured in a bridge circuit by an instrument-type servo system.

• **No up, no down**—The design has no top or bottom reference. It can sense liquid quantity within the tank in any attitude or while undergoing violent agitation.

Regardless of the shape or location of the liquid and foam throughout the tank, the capacitance added by the liquid will be essentially the same and thereby produce essentially the same indicator reading.

In addition to operating an indicator gage, the output of the system can be telemetered, used for control purposes or fed into a computer for overall performance information.

Due to the large gaps between wires, the tank unit elements present little interference with liquid flow and drainage. Liquidometer says even very viscous fluids can be gaged without introducing drainage problems in the tank.

The unit is insulated from the tank walls by Teflon spacers. These are sufficiently long to provide adequate leakage paths between active terminals and ground. These same basic insulators are used to separate and support the high- and low-impedance frameworks.

If the system is required to operate in a radioactive environment or at very high temperatures, the insulator material can be changed to ceramic, the company says.

The matrix-type all-attitude liquid-quantity gage is an outgrowth of a research program in capacitance-method fuel-quantity measurement which Liquidometer began at its home plant in Long Island City, N.Y., in 1940.

Space 'Corset'

Garment Designed to Prevent Pilot Injury

Pilots of orbital and re-entry craft who push the panic button in flight may find themselves suddenly grasped in a tight-fitting corset.

Comprising a restraining system of inflatable bladders, netting and straps, the garment is designed to draw a pilot up tight in his capsule to prevent his being injured. He will not be able to move a muscle within seconds after hitting the emergency escape button.

The new gear can be adapted to any of several advanced flight vehicles, such as the *Dyna-Soar*, the B-70 or craft coming in from above the atmosphere. The corset was developed by Goodyear Aircraft Corporation for Wright Air Development Division of USAF's Air Research and Development Command.

The moment the pilot activates the system, straps on his shoes draw his feet inside the escape capsule, bladders around his legs, arms, body and head inflate, and the netting encasing the pilot becomes taut. The capsule doors close, the capsule is pressurized, air-conditioned and ejected. As the unit descends, parachutes open.

The entire operation from button pushing to main chute billow takes only 10 seconds, according to the manufacturer.

Life Sciences Division Set Up at Little, Inc.

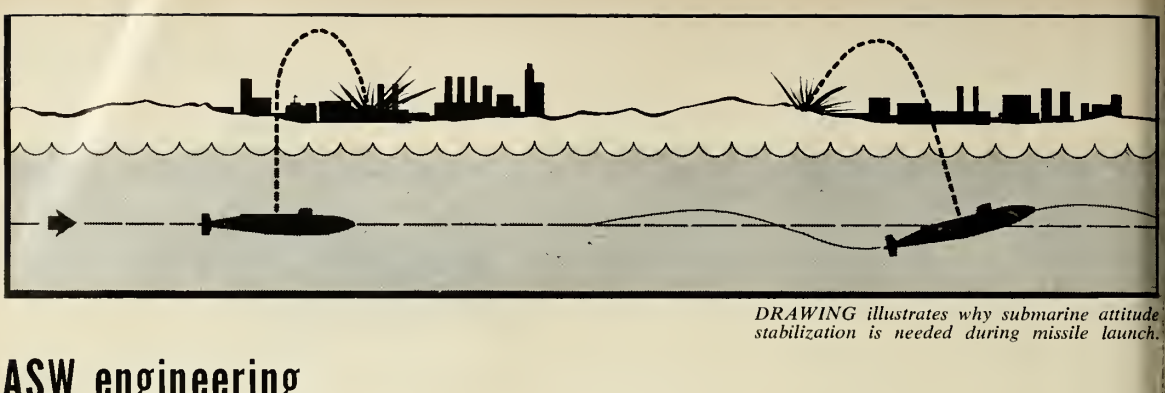
Human factors problems connected with man's survival in the Space Age will be investigated in a newly established Life Sciences division of Arthur D. Little, Inc.

The purpose of the effort is "to study intensively the physiological aspects of living in synthetic climates, wearing clothes of synthetic fibers, and eating chemically created foods," according to company president James M. Gavin.

He pointed out that it is also important that the company study the sociopsychological impact of these innovations.

Heading the Life Sciences division and now an ADL vice president is Dr. Charles J. Kensler, formerly chairman of the Department of Pharmacology and Experimental Therapeutics in Boston University's School of Medicine.

He sees his division's work extending from investigations of the direct use of micro-organisms in fermentation processes to the evaluation of exposure risks encountered in space travel.



DRAWING illustrates why submarine attitude stabilization is needed during missile launch.

ASW engineering

SAAVS Stabilizes Polaris Subs

Some newly released details of the Kearfott system which controls motion even during launching by salvos

by Donald E. Perry

THE NAVY HAS lifted somewhat the veil of secrecy surrounding the technology of controlling motion during missile firings of the *Polaris* fleet ballistic missile submarine.

The development, by Kearfott Division of General Precision, Inc., is called SAAVS—for Submarine Acceleration and Velocity (measuring) System. This control system can sense and supply corrective signals for misalignments from any source ranging from small deviations caused by sligbt changes in current to the severe misaligning force created by a missile launching.

• **Background**—The *Polaris* program has presented submarine control designers with unprecedented demands for accuracy and sensitivity. If a sub is to serve as a missile-launching platform, its motion at any time must be known precisely.

At land launching bases, stability is achieved quite simply, by sinking tons of steel and concrete into the earth. But the sea offers no such foundation for a submerged vessel, since constant changes in water currents and temperature, and activities within the submarine itself all interact continuously to change the ship's attitude. Hence the FBM boat requirement that these forces be countered by controls capable of special precision and rapid response.

For, in the moments during and immediately following a fleet ballistic missile launching, the problem of controlling tbe submarine motion is increased a thousandfold. Tons of matter are being ejected and term compensation affected—all in a few seconds.

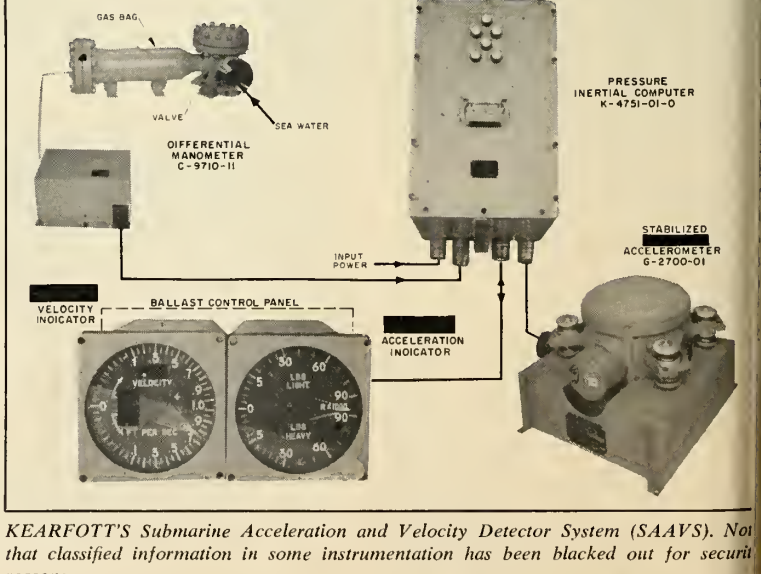
The violent forces caused by the firing set up tremendous disturbances that last for hours. Regular stabilizing controls prevent the vessel from lurching severely.

But the submarine must maintain a controllable attitude, even while launching missiles in salvos, in spite of the repeated concussive forces. Hence it is imperative to stabilize the ship with quick precision during each subsequent firing.

• **Stability with accuracy**—This is where SAAVS—already installed on the USS George Washington—comes in. It detects rate-of-attitude changes by comparing pressure-derived velocity information with inertially-derived velocity. The error signal thus generated is used to provide a long-term correction to the inertial information.

The system outputs are velocity and acceleration. It features the high resolution, response, and short-term accuracy of inertial systems. In addition, according to Kearfott, it has long-term stability and accuracy not ordinarily associated with a pure inertial system. Engineering details, however, are still classified.

The output of the SAAVS' differential pressure gage is differentiated with respect to time by means of an electromechanical gating circuit. The output of the gating circuit is applied to



KEARFOTT'S Submarine Acceleration and Velocity Detector System (SAAVS). Not that classified information in some instrumentation has been blacked out for securit reasons.

wo-channel division servo which com-
ares the two differential pressure read-
ngs taken at a discrete time increment.
Output of the pressure channel is, after
roper scale factoring, a shaft position
nalog of velocity.

Acceleration information is obtained
rom a pitch-and-roll-stabilized acceler-
meter. The output of the accelerome-
er is fed into a scaling amplifier which
rovides a direct acceleration read-out.
t is also fed into an electromechanical
ntegrator whose output is a shaft posi-
ion analog of inertial velocity.

The shaft position representing pres-
ure-derived velocity and the shaft po-
ition representing inertially derived
elocity are then fed into a mechanical
ifferential. The output of the differen-
ial is fed back into the electronic in-
egrator to accomplish the long-term
orrection. In addition, the output of
he differential is fed into a mechanical
ntegrator.

This integrated output is also fed
ack to the electronic integrator to
ompensate for bias shifts and drift.

Navy Streamlines Its Components Monitoring

The number of weapons systems
nder development by the Navy will
rop from 94 to 30 in Fiscal Year
962 budget with Navy laboratories
etting an even stronger role in their
echnical direction.

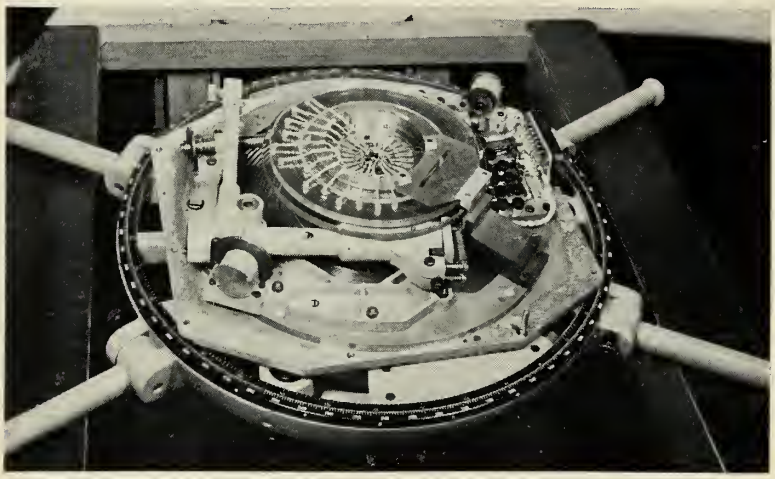
Actually the big drop doesn't
ecessarily mean the Navy is cancel-
ng more systems development. It's
n action by Vice Admiral J. T.
Hayward, Deputy Chief of Naval Op-
rations (Development) to strengthen
is shop by eliminating monitoring of
ardware previously classified as sys-
ems which in reality was only com-
onents development.

The reason is a redefinition of
ystems development by the Navy
hich says simply a system requires
wo or more major components which
re committed to become fleet issue
ardware. Previously such items as
adar, sonobuoys and sonar were classi-
ed as systems when actually they fell
nto a major components category.
uch components development in the
uture will be strictly monitored by
he bureaus with Hayward's shop step-
ing in only in exceptional situations.

Rear Adm. Leonidas D. Coates,
Hayward's director of development
lanning, explains that in the past no
ne had a good definition for a system
hich in turn resulted in such a large
umber. As part of the clean-up, Hay-
ard's office now has a three part pro-
ram: Part 1 deals with Weapons Sys-
ems, Part 2A is Exploratory Develop-
ent (actually miscellaneous is a better
ord) and Part 2B is Research.

Phasolver Promises Accuracy Plus Low Cost

Analog measuring device by Telecomputing Corp. will be used with big Army radio-telescope Antenna



DIGITIZED AZIMUTH CIRCLES have been developed by Askania-Werke for use with Telecomputing Corp.'s Phasolver. The system will be used with Askania cinetheodolite for instantaneous readout of angular values in azimuth as well as in elevation.

AN EXTREMELY ACCURATE analog measuring device for both linear and rotary application is nearing final development by Telecomputing Corporation, Los Angeles.

Called Phasolver, the unit converts very small mechanical motion to practical electrical phase shifts. For readout, these can be digitized for high accuracy and resolution.

For example, TC says the device is now capable of rotary measurements to within 3 seconds of arc (or 1/432,000 revolution), and with further development it is expected to achieve an accuracy of 1 sec. of arc.

• **First use with antenna**—Phasolver is being developed for use with the Army's 84-ft. radio-telescope antenna at Madkin Mt., Ala. Under a contract awarded by Redstone Arsenal, delivery of the system is scheduled for early 1961.

The TC device will be a principal unit of the digital control and data handling system of the large antenna.

The system was originally developed by TC, but the company says it is being refined through its application to the Redstone dish. It also has been married to an Askania-Werke Kth 58E automatic tracking cinetheodolite at Edwards AFB.

Under a subcontract to TC, Askania developed the digitized azimuth circles for use with Phasolver to provide real time readout of angular values in azimuth, as well as elevation. First prototype has been delivered and is now undergoing test and evaluation by the Air Force.

• **Single-axis rotary measurement**—Two main elements comprise the Phasolver system: a highly accurate electrostatic shifter (or transducer) and the associated electronics and digitizing equipment.

The transducer is attached to the rotating element to be measured. The sensing device is made up of two dimensionally stable non-conducting discs. One of these discs rotates with respect to the other.

Each carries a pattern of conducting metal film on the facing surface. The closely spaced patterns are called the driver and coupler.

There are no physical connections to the coupler disc, which is fixed to the rotating element to be measured. The driver disc is fixed to the supporting frame.

Input and output connections are made to the driver. Energy is coupled electrostatically from the driver to the other second patter producing an output signal. This in turn is directed to the load by output coupling rings in the driver pattern.

The output signal has a constant amplitude and a phase angle, referred to the input signal, that is proportional to the rotary position of the coupler disc. This is accomplished by the intricate configuration of the two disc patterns.

Operation of linear Phasolvers is the same as for rotary measurement—principal difference is in pattern configurations.

• **Many advantages offered**—Its developers say that results of tests so far indicate that the new system is superior to any comparable system existing today.

The company feels the system offers many significant advantages over other measurement methods for reading out mechanical motion:

–No gears are employed.

–Output is uniquely established; accumulators are not required.

–No rubbing parts eliminates wear and increases reliability.

–High speed doesn't hurt discs or readout accuracy.

–No degradation is caused by ferrous metal or stray magnetic fields.

–Concentricity of centers of measured rotary element and Phasolver is not critical.

Currently undergoing further simplification of its associated electronic equipment, the system shows promise of providing a practical, low-cost measuring device which will have no equal in the field, according to TC President W. R. Whittaker.

Using simplified electronics and 4.5-in-diameter discs, TC engineers recently have performed repeatable lab tests with the system showing a resolution of 0.32 second of arc.

RCA Thermionic Tube Works at Low Temperature

A new thermionic tube developed by RCA is said to be the first to operate efficiently from low-temperature sources. Previous types of such heat-to-electricity converters required temperatures in the range of 2000°C. The device operates from source temperatures of 1100°C—equivalent to burning common fuels such as gasoline and natural gas.

Laboratory results are reported to indicate an efficiency of 14% in converting heat energy directly to electricity.

"Why do we like Missiles and Rockets magazine? The answer is simple. Missiles and Rockets deals exclusively with astronautics. Missilery and outer space exploration today is an industry by itself, long divorced from aviation," R. R. Drummond, (left), Chief, Structures Research. He is shown here with Managing Editor Howard and E. L. Strauss, Supervisor of Non-Metals Research, examining extreme high temperature test examples of ceramics and plastics being developed for re-entry vehicles.

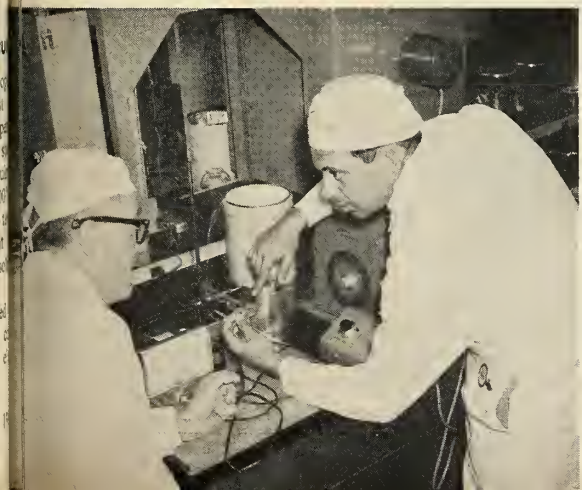
WHY DO SO MANY KEY PEOPLE AT THE MARTIN COMPANY READ MISSILES AND ROCKETS

1,087 Paid Subscriptions! In 1959, Martin ranked sixth among all military prime contractors. Its missile/space projects included Titan, Dyna-Soar, and Bullpup, among others. Therefore, it is not surprising to find 1,087 paid subscribers to M/R concentrated at Martin. And since many M/R subscriptions have high pass-along readership, M/R penetration involves many times that number of readers.

Some of the many reasons why M/R commands intense readership at Martin are given in the picture story. They were obtained as a result of a recent visit to the company by M/R Managing Editor, William Howard (insert).

These comments and those of other key readers in missile/space companies show again what M/R has known all along . . . that the missile/space industry is an industry by itself, complete and distinct from aviation . . . with rapidly changing requirements that demand *undiluted, weekly* technical/news reporting. Missiles and Rockets deals *exclusively* with this market—and the deep, penetrating readership and acceptance it has earned document its leadership in the missile/space field.

"News to the missile engineer must be news and must be technical . . . on a frequent basis—not a month old. From concept proven flight—it takes thousands of parts from hundreds of companies to put a bird in the air." J. Lennard, Scientist, Research and Development.



"Today's missile and astronautics engineer must know the products and capabilities of the other companies throughout the industry. Here's where Missiles and Rockets magazine fills the bill."—R. Allen, Scientist, Cryogenics, Research and Development.

British Show New Tactical Missiles

Over 20 guided weapons and drones viewed at Farnborough; Vickers displays Vigilant, new antitank weapon being offered to U.S.

FARNBOROUGH, ENGLAND — Latest entry in the international antitank missile sweepstakes is the Vickers-Armstrong *Vigilant*—a "lowest cost per kill" weapon.

The British War Office is ordering evaluation tests, probably to be held next spring, and the missile also is being offered to the United States. The U.S. Army is debating whether to buy the *SS-10, SS-11,* or the *Cobra* antitank weapon.

Shown off at the 1960 Society of British Aircraft Constructors Display and Exhibition, the *Vigilant* is wire-guided. Overall weight of the one-man-operated system, including launcher box and controller, is 45 lbs. The missile itself weighs 26 lbs. Range is about one mile.

Vigilant is somewhat comparable to Nord Aviation's *SS-10,* which has a launch weight of 33 lbs. and an effective range of 5250 ft.

Other entries in the antitank weapon market are the French *Entac,* Australian *Malkara,* Swedish *Bantam* and the Swiss *Mosquito.*

Missiles generally were more strongly represented at this year's Society of British Aircraft Constructor's at Farnborough Show, than at any previous SBAC Display. There were over 20 guided weapons and pilotless target aircraft of 12 types in the "Missile Park" (20% larger in area than in 1959), the Static Aircraft Park and Exhibition building.

An Avro *Blue Steel* stand-off, powered bomb (or air-to-ground missile) was shown for the first time. Two years ago, an early version of this weapon was flown over Farnborough fitted to a Vulcan, but this is the first time one has been seen on the ground. *Blue Steel* will equip the Royal Air Force's V-bombers and enable them to launch an attack on an enemy target without approaching too closely.

An unusual exhibit was a 60-ft. model of the stern of one of Britain's new County Class missile-carrying warships. On the deck is a complete twin-barrelled launcher containing a boosted *Seaslug,* a display of guidance equipment, a pictorial display of *Seaslug* in action and a sectioned missile. Visitors could operate *Seaslug's* fins by pressing a button. This ship model, built by the three principal *Seaslug* contractors—Armstrong Whitworth, Sperry and the General Electric Company—is the largest ever seen at Farnborough. The Bristol/Ferranti *Bloodhound,* now in service with the Royal Air Force and ordered by Australia and Sweden, is claimed to have the longest range of any semiactive homing missile in the world. Displayed with *Bloodhound* this year was its launcher, part of a launch control post and the target-illuminating radar, elements shown operating in a simulated engagement.

The British Army's 36th A.A. (G.W.) Regiment, Royal Artillery, which is equipped with English Electric *Thunderbirds,* was displayed in the Missile Park. The Regiment also showed a *Thunderbird* battery of four launchers and missiles in the Static Aircraft Park with two launcher control posts, battery command post and tactical control and target illuminating radars.

The Short *Seacat* naval antiaircraft missile has been ordered by the Royal Navy and Sweden and will be adopted by Australia and New Zealand. It is to be evaluated by West Germany, and other Commonwealth and NATO countries are showing considerable interest in this weapon.

De Havilland *Firestreak* air-to-air missiles were on view fitted to a Javelin, Lightning and Sea Vixen—for which aircraft it is standard operational equipment—in the Flying Display, on the Hawker Siddeley stand in the Exhibition building and in the Missile Park. *Firestreak* can be fired at subsonic or supersonic speeds and uses infrared detection to guide it onto its target.

Two pilotless, radio-controlled target drones were shown—the *Jindivik 2E* and *C.T.41.* Fairey Engineering is the European agent for the Australian designed and built *Jindivik,* which has been ordered by the British and Swedish Governments. This target aircraft is powered by a Bristol Siddeley Viper which gives it a speed of some 600 mph, an operational ceiling of more than 50,000 ft. and a radius of action of 100 miles. A *Mk 3 Jindivik* under development will have a more powerful Viper. The *C.T. 41* supersonic target drone is a Nord Aviation development for which Armstrong Whitworth has obtained a servicing and maintenance license from the French company.

VICKERS VIGILANT has been ordered for trials by the British Army. The wire guided antitank missile is controlled by hand-held sight-controller.

Malkara, the Australian-designed ntitank weapon of which there are ome 400 on order for the British rmy, was exhibited by Fairey Engineering, the company responsible for he weapon in the United Kingdom.

Space research was represented on he Ministry of Aviation stand by the econd stage of a two-stage *Black Knight* uilt to investigate re-entry problems. wo-stage *Black Knights* have reached height of more than 300 miles and he second stage on view has made a uccessful re-entry into the earth's tmosphere.

A modification of the Hercules owder Co. *Altair 248* solid rocket will rovide the retropropulsion for the *anger* rough-landing moon capsule nder development by Aeronutronic ivision of Ford Motor Co.

Under a subcontract awarded reently, Hercules will engineer, develop nd produce the retro rocket at its acchus, Utah, plant. The rocket will ave a double-base grain in a plastic-ber glass case.

Ryan Electronics, a division of yan Aeronautical Co., will provide the ltimeter that will give the 300-lb. unar capsule the signal to separate rom the *Ranger* spacecraft, a larger tructure. The altimeter, its antenna nd its support structure, will be ounted on the *Ranger* and remain ith it.

For Aeronutronic is building the unar capsule under contract to the Jet ropulsion Laboratory of the National eronautics and Space Administration, hich is building the *Ranger.*

NATO, Italian Academy Hold Propulsion Seminar

A Seminar on Astronautical Propulsion was held this week in Milan nd Varenna, Italy. The Seminar was ponsored by the Department of Natural and Physico-Mathematical Sciences of the Instituto Lombardo, Accademia di Scienze e Lettere, Politecnico di Milano, in collaboration with he NATO Advisory Group for Aeronautical Research and Development.

The following problems were discussed during the Seminar: Problems elating to space mission; physicohemical problems related to solid and quid propellant propulsion; design, evelopment and operation of solid and quid propellant missiles; problems reted to nuclear propulsion obtained by ssion; solar propulsion problems; nic and photonic propulsion probms; problems connected with the tilization of plantary atmospheres for he first stage of space missions; magetodynamic and hyperaerodynamic roblems related to space propulsion; future problems in the field of space propulsion.

Among the scientists delivering papers at the Seminar were: Prof. Theodore von Karman, Prof. Luigi Crocco, Dr. Hugh L. Dryden, Dr. Robert W. Bussard, Prof. S. S. Penner, Prof. Martin Summerfield, Prof. Antonio Ferri, Dr. Paul A. Libby, Dr. Adalbert O. Tischler, Jack Buchanan, Prof. E. Saenger, Alfred E. Kunen, Dr. A. E. Von Doenhoff, Prof. Manlio Abele, Prof. Luigi Broglio.

JAPAN'S Kappa 8 being prepared for firing at Akita Rocket Range. Vehicle has a launch weight of 1½ tons, top velocity of 4918 mph. In launching last March, Kappa 8 carried 55-lb. payload to altitude of 124.2 miles.

New DEW Line Station To Use Danish Personnel

Operational and maintenance personnel of a U.S. defense communications terminal at Thule AFB, Greenland, will be virtually all-Danish, according to Federal Electric Corp., service organization of International Telephone and Telegraph.

The new terminal at Thule AFB has been designated Project "Dew Drop." It will provide a new communications link between Thule and the Distant Early Warning (DEW) line rearward communications station at Cape Dyer on Baffin Island. Information from Thule will tie in at Cape Dyer with existing direct communications to North American Air Defense Command headquarters in Colorado Springs, Colo.

Federal Electric will operate the Thule end of the link under terms of a $196,490 Air Force contract.

Russia Reportedly Testing ASW Device in Barents Sea

Russia may be testing in the Barents Sea a new device linked to anti-submarine and underwater missile experiments.

Described in a recent Tass report as a steel, pear-shaped apparatus more than 10 feet high and weighing 5192 lbs., the vessel is supposed to have a submersion depth of nearly 2000 feet and sufficient room for one observer and scientific apparatus.

No explanation of the device's function was given, but the Soviet news agency referred to its ability to measure light at great depth and to remain submerged for six-hour stretches. It was described as having five portholes, a searchlight and photometers designed to measure the intensity of light.

First indications that a device of this type was being tested came earlier this year. But little significance was attached to Tass reports at the time which simply referred to "successful tests in Baltic shipyards."

soviet affairs

By DR. ALBERT PARRY

A unique way of welding titanium

with the aid of a smelting electrode is claimed by the Soviets. At the special Exhibition of Modern Welding Technology held recently in Moscow, a welding torch resembling a pistol and weighing only 900 grams was shown. It contained an electric motor and a mechanism to handle thin titanium or aluminum wire. Staff members of the All-Union Scientific-Research Institute of Electro-Welding Equipment, where the novel tool was designed, announced that it can be used to weld titanium, aluminum and their alloys anywhere at all—"even at places to which access is difficult." The instrument is described as semi-automatic. The first quantity of these torches was produced by the Leningrad plant "Electric."

Another praiseworthy machine

among the 1000 entries at the Exhibition was, according to the Soviets, the A-372 model for electro-slag welding of thick metal, together with its latest improvement, called A-535. This machine is not really new; its A-372 version has already been shown at the Soviet exhibitions in New York, Brussels, and Marseilles. The scientists and engineers of the Paton Electro-Welding Institute in the Ukraine, where the machine was designed, say that there is no such wonderful instrument anywhere else in the world; that it has been greatly admired by Western experts who allegedly marvel at its ability to weld metals from 15 millimeters to more than two meters thick.

D. A. Dudko, who represented the Ukrainian laboratory at the Moscow exhibition, declared that the A-372 or the A-535 "can weld even thicker constructions, but so far there is no need for this." The speed of welding, no matter how thick the metal, reaches three meters per hour. "Do you realize," Comrade Dudko asks, "what tremendous possibilities are promised by this method of welding?"

Welding by electronic rays in a vacuum

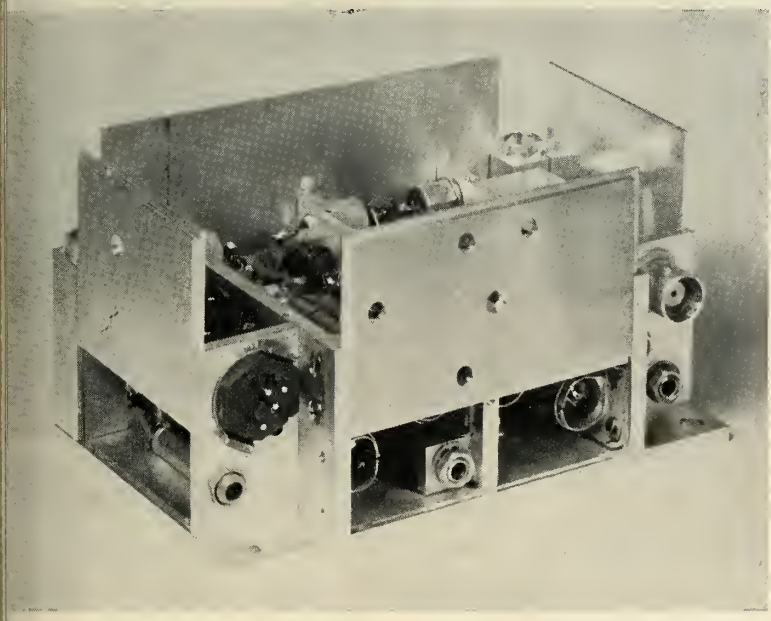
was also represented at the Moscow exhibition. So were cold welding, welding by friction, and other methods, including one piece of equipment capable of producing a new highly intensive source of heat—a stream of flame with temperatures of 15,000° and more. The Soviet directors of the exhibition were particularly proud of the fact that not a single one of the of the 1000 entries had come from outside Russia.

A 'birch-stick' method of steel-drilling

was recently demonstrated at a Soviet exhibition in Prague. This consists of using an ordinary birchwood stick in conjunction with an electric charge. A portion of the wooden stick is covered with a layer of material serving as a conductor of electricity. To the stick-holding instrument a barely visible wire brings an electric current of ordinary tension. A special apparatus makes it possible to concentrate this energy, then—at a necessary moment—to apply it with great force to the process of steel-drilling.

Lightning-like electric blows

punch out the needed holes in the metal with complete ease. Even super-strong slabs of steel cannot resist these blows, the Russians say. They point out that the new method proves one thing above all others: a drilling instrument does not have to be harder than the metal drilled. Boris and Natelia Lazarenko, (apparently a husband-and-wife team) were officially described as the instrument's inventors. They are on the staff of the Central Scientific-Research Laboratory of Electric Treatment of Materials, part of the network of the Soviet Academy of Sciences. Serial production of the new instrument has been entrusted to the Kuibyshev Carburetor Plant in Leningrad. The "birch-stick" method is declared to be especially useful when particularly tiny holes have to be drilled in metals.



High-Powered Tiny Transmitter

A small high-power transmitter, available from Telechrome Manufacturing Corp., produces 4 watts over the 215-260 mc telemetry band. Designed to withstand severe missile environment, the rugged unit is constructed of replaceable circuit modules for easy servicing and maintenance. The Model 1483 FM/FM Transmitter is 1-21/32 x 2-7/8 x 4-1/8 in. in size.

The unit meets applicable portions of Mil-E-5272C and has a frequency stability ±0.005% after normal warm-up.

Spurious radiation is 60 db below fundamental and its total weight is 1 lb.

Circle No. 225 on Subscriber Service Card.

Perceptive Polyolefins

The MIMX Corp. has developed a family of composite polyolefin plastic compounds bombarded with Gamma radiation which are demonstrating unusual physical properties far superior to similar compounds.

Called "MIMX 600," the new compounds possess outstanding resistance to high temperature, acids, solvents, and alkalies.

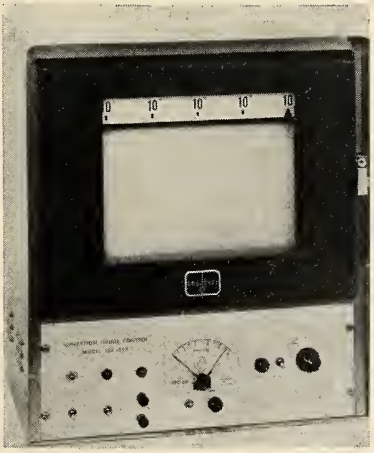
The main feature of the MIMX 600 compounds is a unique "memory" ability which allows them to resume original configurations even after they have been locked into other shapes temporarily.

Circle No. 226 on Subscriber Service Card.

Ionization Gauge Control

A Vacuum Products Ionization Gauge Control IGC-58 designed to meet the most rigid industrial requirements, yet represents the latest developments in the field is being marketed by F. J. Cook Inc. With the IGC-58 it is possible to measure pressures in the high vacuum region of 1 micron to 10^{-9} mm Hg. with automatic switching through five full-scale steps within the range.

The addition of a strip chart recorder coupled to the output of the IGC-58 provides for permanent, accurate and continuous records of vacuum pressures for immediate use or future reference. A design or the IGC-58 provides reference voltages to position the recorder pen, synchronized with the range switch and arranged to automatically subdivide the recorder chart into clearly identified pressure calibrated "bands".



Circle No. 227 on Subscriber Service Card.

Rechargeable Battery Cell

A silver-zinc secondary (rechargeable) battery cell, with high energy-to-weight ratio is being marketed by Cook Batteries.

The storage cell, SC-04, weighs only 0.5 lbs. and takes up less than one cubic inch, including terminals and vent plug. The cells may be interconnected to provide greater capacity.

The SC-04 features far higher energy-to-weight ratio than nickel-cadmium or lead-acid batteries. It has highly uniform performance with low heating and gassing, particularly at large current outputs. Each cell is designed for high shock and vibration resistance.

Circle No. 228 on Subscriber Service Card.

Flow Control Components

Orifices and porous metal restrictors are produced in external configurations conforming to the AN standards or engineered to special requirements by J. V. Houska & Assoc. Applications include accurate flow control at given pressures, damping elements used in control systems and instruments, filters for corrosive media and cryogenics, and ionization fuel cells operating at 1500°F.

These devices, made of metals throughout with the absence of moving parts, exhibit excellent stability and repeatability even under severe environmental conditions.

Circle No. 229 on Subscriber Service Card.

Tantalum Capacitors

Wet-anode tantalum capacitors (M-type), designed to serve in working temperatures up to 85°C, are available in three case sizes from ITT Components Division. The units provide capacitance range from 1.75 to 330 uf over a working-voltage range up to 125 v d-c and maximum surge voltages to 140 v d-c.

Meeting MIL specifications, these units are guaranteed to 80,000 ft. and accelerations of 20 g if limited to 0.1 in. in the range 50 to 2000 cps.

Circle No. 230 on Subscriber Service Card.

Solid-State Servo Drive

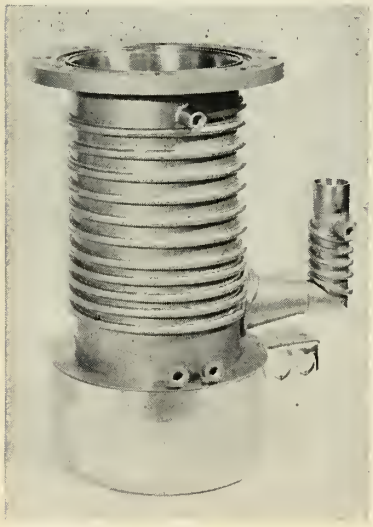
A solid-state, subminiature, servo drive system is available from Solidtronics Div., Electrosolids Corp.

The fast acting, accurate, compact and lightweight unit, consists of a solid-state servo amplifier, a precision gear train and a high-torque servo drive motor. The overall cubic volume of the entire system is but 1.75 in., and it delivers a torque of two (2) inch-pounds at the servo actuating arm from a voltage change of but 0.001 volt. The system's reaction time provides a servo actuator arm speed of 270° of rotation per second.

Circle No. 231 on Subscriber Service Card.

Oil Diffusion Pump

A 6-in. fractionating oil diffusion pump, which provides 70% more speed, 275% higher fore-pressure tolerance,



40% less backstreaming and lower ultimate pressures, is available from NRC Equipment Corp.

The H6-1500 incorporates an improved boiler and a simplified fractionating jet assembly which has three diffusion and one ejector stage. The speed peaks at 1500 liters per second between 6 x 10^{-5} and 5 x 10^{-4} mm Hg, and is more than 1400 liters per second from 1 x 10^{-5} to 1 x 10^{-3} mm Hg. Fore-pressure tolerance is 700 microns at blank-off and 600 microns at full load.

Circle No. 232 on Subscriber Service Card.

Million-Lb. Liquid Spring

A 1,000,000-Pound Liquid Spring using liquid compressibility is available from Taylor Devices, Inc.

This Liquid Spring is the highest force spring ever produced as a single, self-contained unit. An example of the capacity of this 1-ft.-diameter by 2-ft.-high spring is its capability of supporting three of the largest locomotives—if a way could be found to stand and balance them end to end on this Taylor Liquid Spring.

Circle No. 233 on Subscriber Service Card.

Transistor Commutator

Vector Manufacturing Co., Inc., has designed a Transistorized Commutator for simultaneous sampling of millivolt and volt signals and embodying a modular concept. This Commutator is available for sampling high-level or low-level inputs and is designed for synchronized and simultaneous sampling of intermixed high- and low-level inputs. A wide range of sampling speeds in excess of 25,000 pps, are available for PCM, PDM, and PAM commutation systems. Due to the absence of back current, no specialization of transducer loading effects is necessary.

Circle No. 234 on Subscriber Service Card.

new literature

SHRINK-FIT TUBES—Two brochures available from Raychem Corp. cover the properties and applications of Thermofit. Thermofit is an irradiated, modified polyolefin insulation sleeving which shrinks to a preselected diameter when exposed to heat. One brochure, Thermofit RNF (#203-4), lists all properties, test data, weights and sizes and various applications. The other brochure, Thermofit (RT-2000), describes the use of Thermofit in harnessing and gives some valuable information on harnessing techniques.

Circle No. 200 on Subscriber Service Card.

RECEIVING TUBES—An enlarged edition of the RCA Receiving Tube Manual is now available from the corporation's Electron Tube Division. The Manual has been updated, revised, and augmented. This edition contains technical data for more than 760 receiving tubes, including types for black-and-white and color television, series-string applications, ac/dc equipment, 12-volt car radio receivers, and high-fidelity audio applications (both monophonic and stereophonic). Data are also provided for more than 173 picture tubes, including color types.

Circle No. 201 on Subscriber Service Card.

CERAMIC PROPERTIES—A four-page brochure on precision technical ceramic products for the research frontier industries has been published by the Technical Ceramic Division, Gladding, McBean & Co. The two-color brochure contains suggestions to designers of ceramic products, and pictures and describes techniques of ceramic fabrication. It also features a properties chart and discusses general characteristics of ceramic materials which make them desirable for application to meeting industrial requirements.

Circle No. 202 on Subscriber Service Card.

ENVIRONMENTAL BROCHURE—The latest data on environmental testing and other applications for controlled atmospheric conditions is the subject of 32-page Brochure #600 offered by Webber Manufacturing Co., Inc. One feature is a pictorial color chart summarizing latest known data at altitudes from sea level up to two million feet. It shows specific weight, pressure, acceleration of gravity, and molecular weight at various altitudes. Other charts give technical information on atmosphere, temperature and humidity.

Circle No. 203 on Subscriber Service Card.

ALLOY DATA—A 44-page publication, Price and Technical Data Schedule No. 14, has just been released by Techalloy Co., Inc. The booklet offers complete data on chemical, physical and mechanical properties of all Techalloy alloys: Monel, Nickel, Nickel-Clad Copper, Inconel, Inconel "X", Incoloy, Nionel, Ni Span C, Stainless and Heat-Resisting Steels, Electrical Resistance Alloys, Glass Sealing Alloys and Iso-Elastic. Also included are the Federal, Military, ASME and ASTM specifications for these metals. For completeness, Price Schedule No. 14 lists the recently released ASM specs on Monel, Nickel, Inconel and Inconel "X" and ASM specification numbers.

Circle No. 204 on Subscriber Service Card.

PYROMETERS—A 6-page data sheet describing Leeds & Northrup Company's line of Pyrometers for temperature measurements up to 7600°F or 4200°C in plant or laboratory is available. The sheet describes and illustrates the construction and operation of the potentiometer-type L&N Optical Pyrometer, graphically showing the application of the "disappearing-filament" method of temperature measurement. It lists the standard Pyrometers and their ranges, together with accessory equipment for adapting a Pyrometer to a variety of specific measurements.

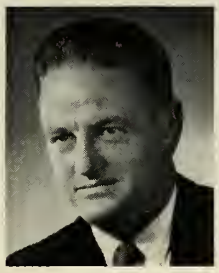
Circle No. 205 on Subscriber Service Card.

INSULATING MATERIALS TESTING—A manual on methods and equipment for testing insulating materials has been compiled by Associated Research, Inc. Sample subjects include determining resistance to arcing of insulating materials, testing insulating oils for high-voltage breakdown and detection of corona leakage in high-voltage equipment.

Circle No. 206 on Subscriber Service Card.

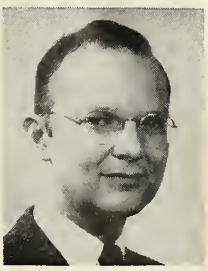
names in the news


RAUSCHENBACH


DUMAS


LOVENSTEIN


BARRY


KECK

G. J. Rauschenbach: Joins the Ford Motor Co.'s Defense Products Group as manager of the Huntsville, Ala., office, replacing **Leland C. Pleger,** now manager of marketing and planning for Tactical Weapon Systems Operations at Ford's Aeronutronic Division. Rauschenbach was formerly manager of The Martin Co.'s Orporate office in Huntsville.

Roger E. Dumas: Named director of research and Development for the Inductive Products Division of Statham Instruments, Inc. He has been with the company since 1957, most recently as a project engineer responsible for development of high-accuracy inductive-type linear accelerometers.

Allen J. Lovenstein: Former project engineer for the Crosley Division of Avco Corp., appointed manager of market planning and analysis for the Waltham Laboratories of Sylvania Electronic Systems.

Robert I. Barry, Jr.: Named assistant director of construction and installation for Technical Documentation at Page Communications Engineers, Inc.

Dr. James C. Keck: Elected a deputy director of Avco-Everett Research Laboratory, responsible for directing research programs in plasma propulsion, atomic physics, electronics and optics. Dr. Keck has been a senior staff member since 1955.

Milton F. Pravda: Joins The Martin Co.'s Nuclear Division as chief of system design. Was formerly with the Knolls Atomic Power Laboratories, where he was manager of reactor design for the Atomic Energy Commission's natural circulation reactor project.

Robert J. McCardle: Appointed field manager of the *Titan* launching system installation of American Machine & Foundry Co.'s *Titan* Installation and Activation Division, Lowry AFB, Colo. Prior to joining the firm he was chief field engineer and mechanical superintendent for the Ralph M. Parsons Construction Co.

John V. Sigford: Elected director of Minneapolis-Honeywell Regulator Co.'s Military Products Group. **David C. Gerrish** succeeds Sigford as manager of the firm's Aeronautical Division.

John R. Bodker: Named chief engineer for Avtron Manufacturing, Inc. Prior to joining the firm as a project manager three years ago, he was manager of the control section in Jack & Heintz engineering department.

Robert Pizzutiello: Promoted to the new post of head of sales for custom microwave components and systems at FXR, Inc.

Roland Louis Guerin, Jr.: Former sales manager for the Clearing and Western Design Divisions of U.S. Industries, appointed sales manager for BMW Manufacturing Co., Inc., responsible for marketing and sales.

Lewis G. Rogers: Named to the newly created position of sales manager for the Industrial & Military Products Division of Bulova Watch Co., Inc.

Dause L. Bibby: Vice president named president of the Remington Rand Division of Sperry Rand Corp., succeeding **Kenneth R. Herman,** who will devote his full time to the position of executive vice president in the Sperry Rand central office.

A. H. Sonnenschein: Appointed assistant to the president of Polarad Electronics Corp. He will also retain his former position as corporate director of planning.

William G. Carlson: Promoted to director of defense and aeronautical projects at Burns and Roe, Inc. He joined the firm in 1943 and was named assistant director of the division in 1956.

Edwin P. Berlin: Former advertising manager of the General Transistor Co., joins Sperry Semiconductor Division of Sperry Rand Corp., as marketing manager.

Howard A. Baxter: Joins Norma-Hoffmann Bearings Corp. as vice president in charge of engineering. He succeeds **Warren D. Anderson,** who will continue as engineering consultant to the president. Baxter was formerly director of technical services with American Machine & Foundry Co.'s Greenwich Engineering Division.

Dr. Kurt Berman: Manager of liquid-propellant rocket engines for General Electric's Rocket Engine Section, appointed to the Research Advisory Committee on Chemical Energy Systems of the National Aeronautics and Space Administration.

Duane C. Manning: Named marketing manager for the Electronics Division of the Elgin National Watch Co.

George P. Sutton: Returns to Rocketdyne as manager of the newly-created development planning organization of the research and engineering department. He left the firm in 1958 to serve for one year as the Hunsaker visiting professor of aeronautical engineering at the Massachusetts Institute of Technology, then as chief scientist for ARPA and division director of the Institute of Defense Analysis in the Department of Defense.

Dr. David S. Potter: Former assistant technical director of the University of Washington's Applied Physics Laboratory, joins General Motors Defense Systems Division as head of the sea operations department.

T. Singelis: Former vice president of advertising, named vice president of marketing services of the Clearing Division of U.S. Industries, Inc. He will be responsible for market research, sales analysis, order and customer service and advertising and sales promotion.

A. E. Schwerin: Named head of the newly organized *Skybolt* re-entry vehicle program office by General Electric's Missile and Space Vehicle Dept. Was formerly manager of the department's Flight Test Engineering operations at Cape Canaveral.

James R. Rowe: Appointed Washington engineering representative for Aerojet-General's Spacecraft Division. Was formerly head of the Advanced Systems department.

Jay B. Ford: Elected director of administration for United States Borax & Chemical Corp.

reviews

THE THEORY OF NEUTRAL AND IONIZED GASES, edited by C. De Witt and J. F. Detoeuf, John Wiley & Sons, New York, 469 pp., $17.50.

Here is a scientific volume of lectures delivered by outstanding physical scientists at the University of Grenoble's 1959 Summer School on Physical Theory. This series of summer schools began in 1951 and after each session a collection of the works has been issued, the first one being on Quantum Mechanics.

The present volume comprises Statistical Mechanics of Interacting Particles by E. W. Montroll; Statistical Mechanics of Non-Equilibrium Phenomena, by L. Van Hove; Theorie Microscopique des Gas Ionises, by J.-L. Delcroix; Plasma in a Strong Magnetic Field, M. Kruskal; Plasma Transport Theory, A. Kaufman; Etudes des Ondes Electromagneticques dans les Plasmas a Partirde l'Equation de Boltzmann, J.-F. Denisse; and Les Plasmas en Astrophysique, E. Schatzman.

This book is not intended for amateurs.

STUDY OF ULTRAHIGH TEMPERATURES, A. V. Grosse and C. S. Stokes. Order PB 161460 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 26 pp. $1.

This is the final report covering a four year study of various chemical and physical phenomena at temperatures up to 5000°K. The present report summarizes work reported in previous technical notes.

DICTIONARY OF AUTOMATIC CONTROL, Robert U. Bibbero, Chief Engineer, Applied Science, Bulova Research and Development Laboratories, Inc. Reinhold Publishing Corp. New York. 280 pp., $6.

The book covers control theory and basic concepts, computers and data processing, industrial machine and process control, aircraft and missile control and telemetering, and control components and design factors.

It also contains an index of major topics.

AN INVESTIGATION OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS, R. M. Paine and others. Order PB 161683 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 247 pp., $3.50.

Intermetallic compounds from 35 binary metallic systems were tested for oxidation resistance in dry air at 2300°F. Only high-melting (above 2550°F) compounds were evaluated.

Test samples included aluminides, beryllides, silicides, germanides, zirconides, and a number of miscellaneous compounds. Of the 35 compounds tested, 19 showed sufficient oxidation resistance to be potentially suitable for structural service in air temperature up to 2300°F. The report includes 31 tables and 603 references, plus discussions of the test samples and test results.

ORGANO-METALLIC AND ORGANO-METALLOIDAL HIGH-TEMPERATURE LUBRICANTS AND RELATED MATERIALS—Part 4, H. Gilman and R. D. Gorsich. Order PB 131176 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 63 pp., $1.75.

The synthesis and preliminary thermal screening for 36 compounds is described. This experiment was conducted to explore the possible application of new organometallic and organo-metalloidal substances as potential high-temperature lubricants and hydraulic fluids.

A table outlining the preliminary screening of 36 compounds for thermal stability is included in the report.

HIGH-TEMPERATURE EVALUATION PROCEDURES FOR LUBRICANTS—PART I: DESIGN DEVELOPMENT AND INSTRUMENTATION OF A 1000°F OXIDATION CORROSION BATH AND 400°F AND 700°F VISCOSITY BATHS, V. A. Lauer and D. C. Trop. Order PB 161506 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 23 pp., $.75.

An aluminum block bath for use in oxidation corrosion tests at temperatures up to 1000°F is described.

The report also reviews two high-temperature viscosity baths capable of maintaining temperatures of 400° and 700°F respectively. All three baths are designed to develop lubricants and hydraulic fluids for high-temperature service.

STABILIZATION OF FREE RADICALS AT LOW TEMPERATURES—SUMMARY OF THE NBS PROGRAM, Edited by A. M. Bass and H. P. Broida. Order from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. 110 pp., $1.50.

This monograph reviews the three-year program in free radicals research, initiated at the Bureau in 1956 under DOD sponsorship and terminated Oct. 1, 1959. Purpose of the program was the accumulation of data on the properties of the elusive molecular fragments known as free radicals.

Papers include: Qualitative comments on the physical and chemical processes in trapped radical systems; Experimental aspects of the NBS Free Radicals Program; A survey of theoretical work on trapped radicals at NBS; Low-Temperature chemistry; Methods of production of trapped radicals and properties of radical-trapping solids; Identity and concentrations of trapped radicals; and interactions between trapped species and the matrix.

contracts

AIR FORCE

$30,500,000—System Development Corp., for continued development and implementation of training programs for the Air Defense Command manual and SAGE system training.

$6,000,000—Sylvania Electric Products, Inc., Waltham, Mass., for intersite communications systems at two *Atlas* missile squadron bases; Francis E. Warren AFB and Schilling AFB.

$2,181,000—Sperry Gyroscope Co., Great Neck, N.Y., for development, fabrication and installation of the highly-classified AN/GSQ-44 system.

$1,200,000—Chance Vought Aircraft's Aeronautics Div., for production of 27 tail assemblies for the P2V-7 *Neptune*. Contract from Lockheed Aircraft Corp.

$800,000—Telecomputing Corp., Los Angeles, for airborne identification coding equipment.

$500,000—Aerojet-General Corp., Azusa, Calif.; Thiokol Chemical Corp.'s Nuclear Division, Denville, N.J.; General Motors Corp.'s Allison Division, Indianapolis, Ind., and Linde Co., for joint study work on a nuclear rocket propulsion system.

$41,657—Yale University, New Haven, Conn., for continuation of research and reports on radiobiological effects of simulated primary cosmic ray radiation.

MISCELLANEOUS

$1,900,000—American Electronics, Inc., for electro-mechanical components and subassemblies for missiles and a Radifio installation at a government testing facility.

$100,000—Astro-Science Corp., American Avionics, Inc., Div., for solid-state power supplies to be used in an airborne digital control system. (Contract from Temco Aircraft.)

ARMY

$3,000,000—Friden, Inc., San Leandro, Calif., for classified work.

$2,000,000—Bendix Corp., Baltimore, for classified work.

$1,800,000—Ryan Electronics Div. of Ryan Aeronautical Co., Los Angeles, for production of Doppler navigation systems.

$913,622—Martin K. Eby Construction Co., Inc., Wichita, for construction of missile assembly and technical buildings, Lincoln AFB.

$559,500—Western Electric Co., Inc., New York City, for *Nike Zeus* production equipment development program.

$349,483—Firestone Tire & Rubber Co., Los Angeles, for missile system field engineers.

$151,482—International Builders of Florida, Inc., Coral Gables, for construction of theodolite facilities, Cape Canaveral Missile Test Annex.

$54,782—Western Electric Co., Inc., New York City, for *Nike* replenishment spare parts. (Two contracts.)

$47,174—Sperry Utah Aircraft Co., Santa Monica, for missile system field engineering.

$23,250—H. S. Leigland and Sons, Seattle, for remodeling five buildings at Malmstrom AFB; for use as office to supervise construction of the *Minuteman* project.

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editorial . . .

The U.N. and Space Regulations

THE UNITED NATIONS, now undergoing its greatest test in the Congo, will inevitably face another, even greater one in the visibly approaching future—the establishment of space law and the regulation of certain space activities.

And, if the U.N. appears to be gaining stature and confidence in its world policing work—the U.N. will need every bit of that stature and confidence, and more, to form and enforce space regulations.

At the recent congress of the International Astronautical Federation in Stockholm, one panel made an attempt to come to grips with the problem of space law. The Russians promptly boycotted the meeting. There was no real agreement among those who did attend—apart from a consensus that it was too soon and too difficult to find a solution.

It may be difficult just now to find the solution. But it isn't hard to see the problem.

That can very easily be with us the moment the Air Force puts a *Samos* in orbit and the reconnaissance satellite makes its first pass over the USSR.

As of now, in light of the U.S. way of conducting space operations, there can be no secrecy when *Samos* is launched. Presumably we will all know the time of launch, the dimensions of the orbit and the ingredients of the payload.

Will *Samos* have a camera? Will it relay back pictures? That's what it is designed to have and to do.

Will our government then release the pictures? Pictures of Russia? With keys, perhaps to airfields, missile sites and submarine pens?

Or will everything be classified under a security veil? It will be a delicate situation. The Russians will know *Samos* is overhead. They will know what it is for.

Since they will know this, which takes *Samos* out of the clandestine area, and since they obviously know the location of their own military installations—then to what purpose security?

There are absolutely no international laws at the moment governing the use of space. There isn't even a good definition of space. The Russians seem to operate on the principle that anything they can hit is in their territory. That's pretty much the way it worked with the U-2.

Will they then remain passive about the *Samos* until they achieve the ability to knock it down?

This is now just an interesting subject for speculation, but when it actually happens it is likely to create a hairline balance between peace and war.

AGAIN, IT SEEMS apparent that international space laws must be established and that they must include certain enforceable regulations.

For there must come a time when nations will not be permitted to toss into orbit anything and any number of things they may wish. Nations will probably have to list their intentions for a year ahead and to abide by a program laid down for the world. Certain projects, inimical to the well-being of the majority of the world, may be outlawed.

This development may not come until long after the time when a reconnaissance satellite has any great significance. But there will be other eventualities—hydrogen bombs in orbit, perhaps.

Logical step-by-step progression would mean the promulgation of space law and agreement on enforcement. It would also mean an absolute requirement for inspection—and certain members won't like that any better then than they do now.

Since this is a world problem, it seems obvious that it must be handled by the United Nations, and faced in that forum very soon.

Clarke Newlon

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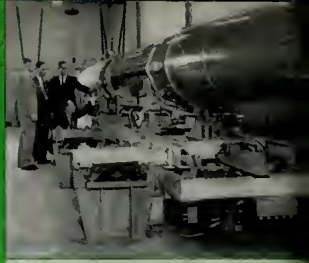

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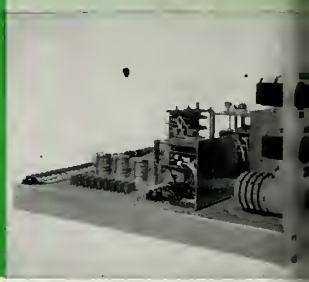

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