JUNE 20, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

X-15 No. 1 After Explosion

AN AMERICAN AVIATION PUBLICATION

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OVER 40,000 AIRBORNE INSTALLATIONS—including the latest missile and aircraft programs—have consistently proved the extreme reliability of Daystrom miniature and subminiature rate gyros.

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The Navy's Polaris will use

3/4 OF THE GLOBE FOR A LAUNCH PAD

A solid-propellant missile that will be launched from ocean depths. A nuclear-powered submarine that will cruise for months without surfacing. The Navy has combined them in the Fleet Ballistic Missile system. Each nuclear sub will be a mobile missile base, capable of patrolling 70% of the earth's surface, ready to launch 16 Polaris missiles in as many minutes. Aerojet-General furnishes the propulsion for the Polaris missile, General Electric the guidance. Lockheed is prime contractor and system manager.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

June 20, 1960 Volume 6, No. 25

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THE COVER

X-15 engine which suffered an explosion in its engine bay last week. The mishap may delay the program by as much as six weeks. See story on p. 18.

JUNE 20 HEADLINES

GROUND SUPPORT EQUIPMENT

PROPULSION ENGINEERING

ADVANCED MATERIALS

ELECTRONICS

ASW ENGINEERING

INTERNATIONAL

DEPARTMENTS

30,301 copies this issue

when and where

JUNE

American Institute of Chemical Engineers, Del Prado Hotel, Mexico City, Mexico, June 19-22.

American Institute of Electrical Engineers, Summer General Meeting, Atlantic City, N.J., June 19-24.

University of Connecticut, Institute for Practical Research on Operations, Storrs, June 19-25.

Atomic and Molecular Gas Beams Symposium, University of Denver, Denver, June 20-22.

ASME Applied Mechanics Conference, Pennsylvania State University, University Park, June 20-22.

Institute of Navigation, 16th Annual Meeting, Air Force Academy, Colorado Springs, Colo., June 23-25.

International Machine Tool Trades Exhibition, Machine Tool Trades Association, Brettanham House, London, June 24-July 8.

Fourth National Convention on Military Electronics, sponsored by IRE Professional Group on Military Electronics, Sheraton Park Hotel, Washington, D.C., June 27-29.

Institute of the Aeronautical Sciences, National summer meeting, Ambassador Hotel, Los Angeles, June 27-30.

JULY

Metallurgical Society of American Institute of Metallurgical Engineers, Conference on the Response of Materials to High Velocity Deformation, Estes Park, Colo., July 11-12.

Third International Conference on Medical Electronics, sponsored by Institution of Electrical Engineers, Olympia, London, July 21-27.

Pennsylvania State University, R&D Management Development Seminar, University Park, July 24-29.

Denver Research Institute, Seventh Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

AUGUST

Fourth Global Communications Symposium, co-sponsored by IRE, Prof. Group on Communications Systems and Army Signal Corps, Statler-Hilton Hotel, Washington, D.C., August 1-3.

Massachusetts Institute of Technology, Special Summer Program on Modulation Theory and Systems, Cambridge, August 1-12.

American Astronautical Society, Western National Meeting, Olympic Hotel, Seattle, August 8-11.

American Institute of Electrical Engineers, 1960 Pacific General Meeting, Cortez Hotel, San Diego, Calif., August 9-12.

ASME-AIChE Heat Transfer Conference and Exhibit, Statler-Hilton, Buffalo, N.Y., August 15-17.

XIth International Astronautical Congress, Stockholm, Sweden, August 15-20.

Cryogenic Engineering Conference, University of Colorado and NBS, Boulder, August 23-25.

NEW! 16 page guide to 3M products and capabilities in the aerospace industry

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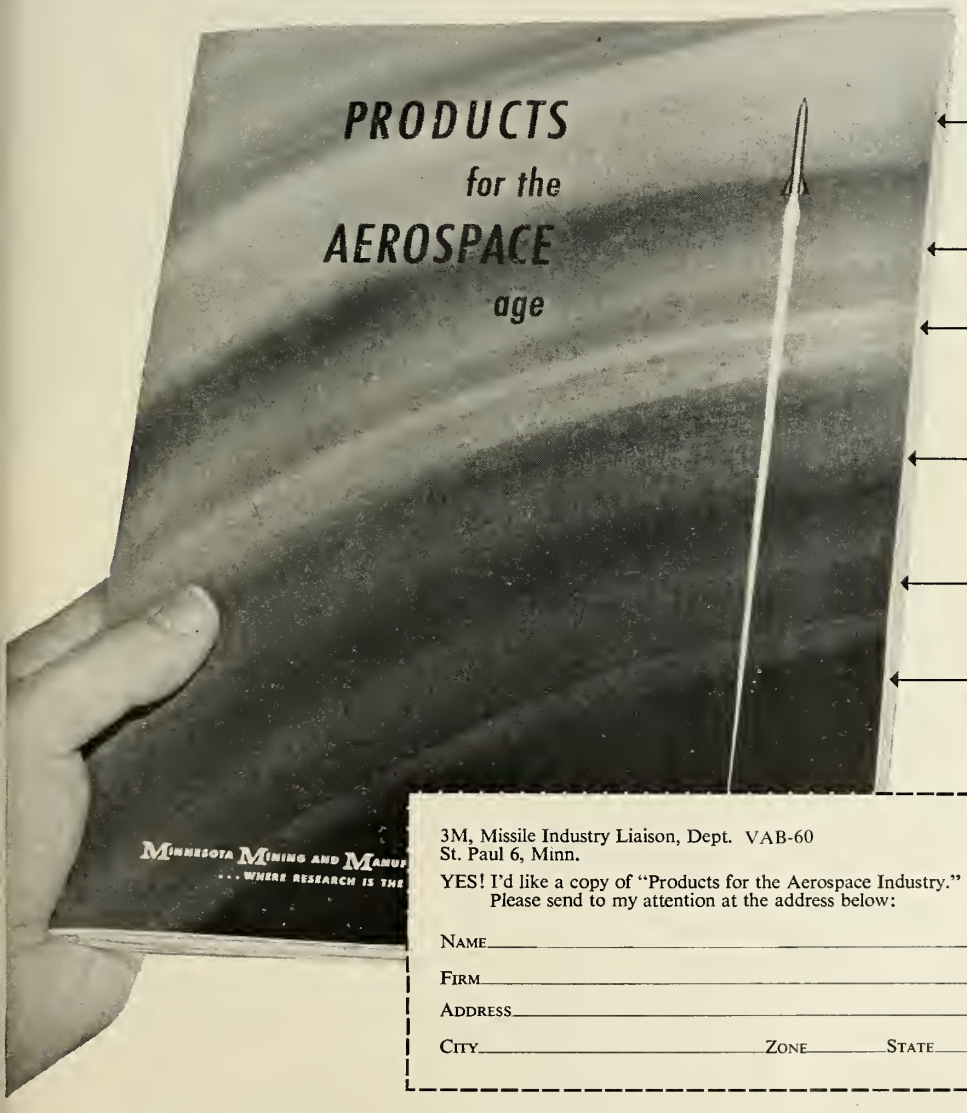
Write for your copy today! You'll find it a materials reference worth keeping and a source of new ideas, too!



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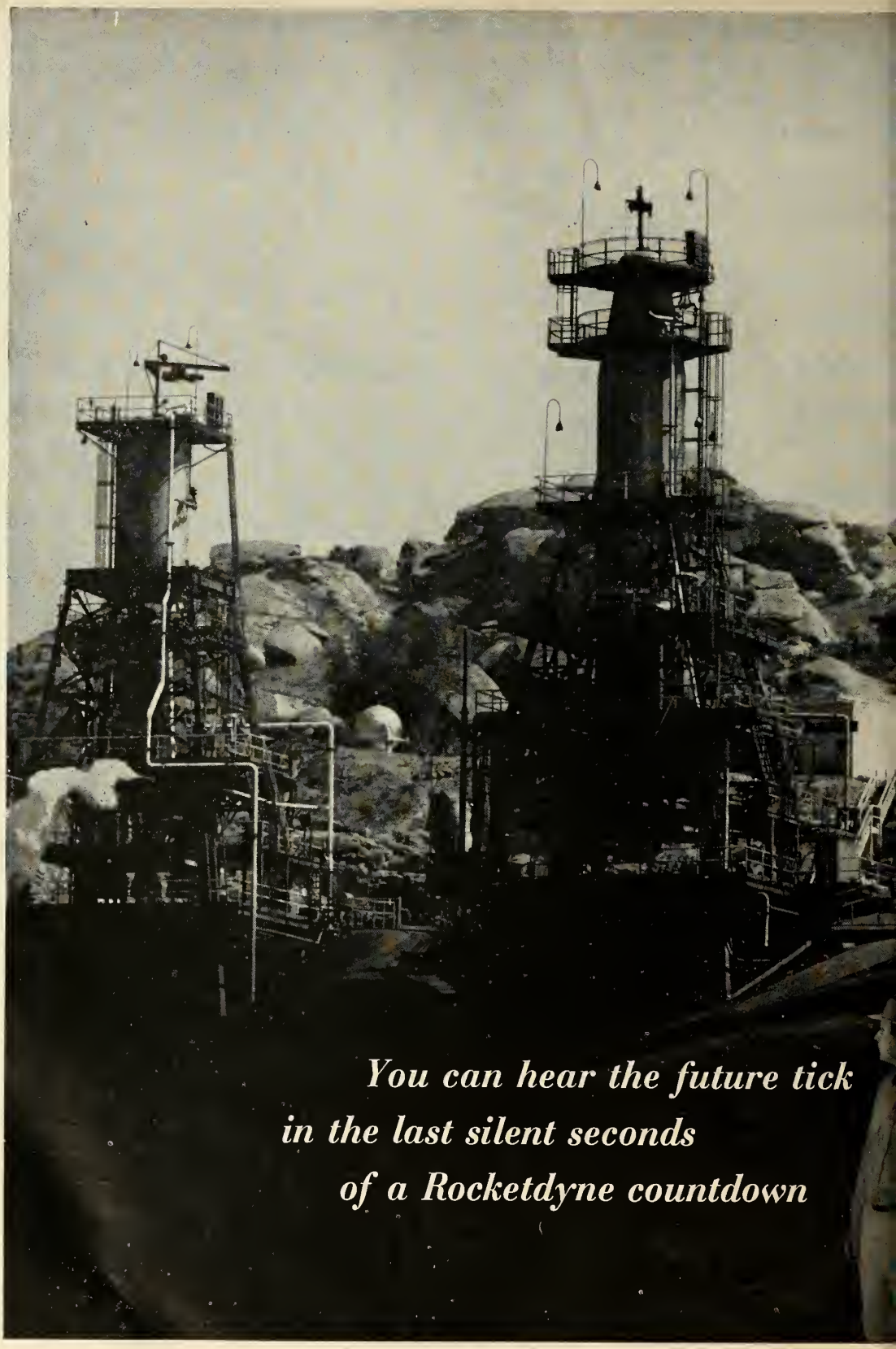
You can hear the future tick
in the last silent seconds
of a Rocketdyne countdown

FOUR...THREE...TWO...ONE... a moment of silence. Then a giant speaks—and a bolt of man-made lightning flashes.

Nearly every hour of every day, Rocketdyne technicians near that dramatic moment as they test and tune the space engines of today.

The best-equipped test facilities for high thrust rocket engines in the nation are at their command. Rocketdyne's finely instrumented test structures are located in California's Santa Susana Mountains; Neosho, Missouri, and McGregor, Texas.

Rocketdyne engines have powered most of the military and scientific projects conducted by the Air Force, Army, and NASA. Now huge boosters of one and a half million pounds of thrust are emerging from the technical heritage of Atlas, Thor, Jupiter, and Redstone.

And even while today's countdowns go on, plans for tomorrow's assault on space are being made. At Rocketdyne, engineers and scientists are investigating such advanced forms of propulsion as ion engines, nuclear engines, plasma jets, and magnetohydrodynamic engines. Meanwhile other groups are at work on high-energy liquid and solid propellants, and dramatic new devices for both liquid and solid propulsion systems.

Rocketdyne, a 12-year pioneer in rocket technology, was first with power for America's long-range ballistic missiles—first with power for Outer Space.

MEGABOOM—a giant solid propellant rocket motor produced at Rocketdyne's McGregor, Texas, solid fuel facility—delivers 100,000 pounds of thrust, boosts test sled to 1,200 mph.

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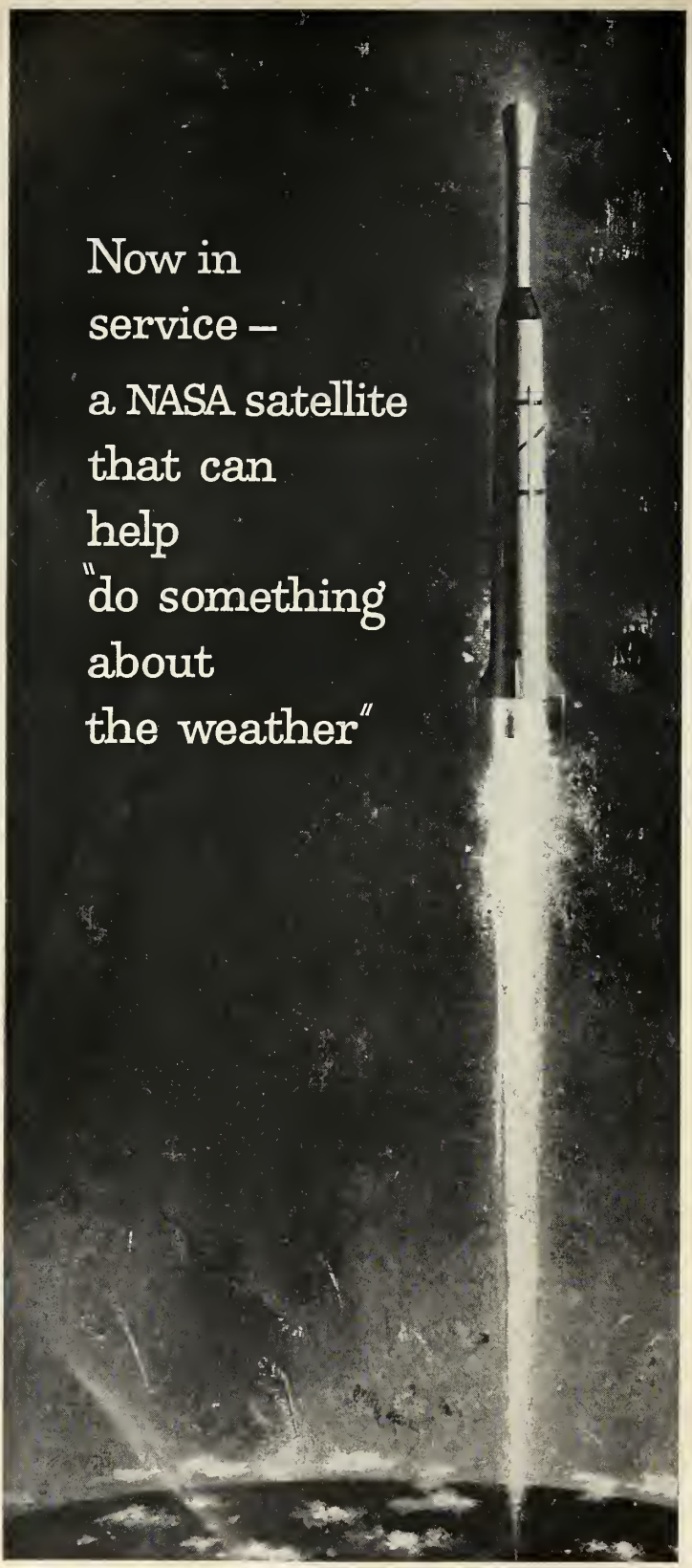

Out of Space Age achievements by Government and Industry will come better living for everyone

Someday soon the art of weather forecasting will become more precise as the result of a network of meteorological satellites. Even weather *control* may become possible.

The first of these satellites, *Tiros I*, is already transmitting pictures of weather around the world. The booster that helped put it in orbit was a modified version of the reliable Douglas *Thor* IRBM. *Thor* is prime booster in the scientific "Discoverer" firings . . . has worked perfectly in over 85% of its space missions.

Thus the knowledge gained through the development of missiles has a useful peaceful application through NASA projects.

Thor is one more proof that Douglas' extensive experience in missiles is a national asset, and that nothing can substitute for the imagination, experience and skills which Douglas has accumulated in nearly 20 years of missile development.

TIROS (Television Infrared Observation Satellites) would serve weather observers—relaying information on cloud cover, temperatures, solar radiation

DOUGLAS

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The Countdown

WASHINGTON

Jupiter on Attu?

Latest embellishment to a rumor that the U.S. may set up a missile base on Attu in the Aleutians is that the missiles may be 1500-mile *Jupiters*. Attu is about 500 miles from the Soviet Kamchatka Peninsula, where many long-range Russian missiles are believed to be based—including some at Petropavlovsk.

Memo to Moscow

Privately some presidential campaign engineers are complaining about the lack of Soviet cooperation in goading along the "space issue." They are finding it difficult to dramatize the issue in the pre-convention scramble in the absence of any new Soviet space accomplishments.

Academic Dollars

The furor over increasing the defense budget continues to appear academic to most Washington insiders. They contend the Eisenhower Administration is holding to its policy of maintaining a barely minimum deterrent. No matter how much more money Congress votes, it won't be spent in 1960.

Into the Van Allen Belt

First shots in Project *Nerv*—NASA's study of the lower Van Allen belts—will be fired from the Pacific Missile Range in August. NASA will use for the first time the new four-stage, solid-fueled *Journeyman*, assembled by Aerolab, to boost a scientific payload to about 1200 miles altitude. Recovery will be attempted about 1000 miles downrange.

Harvest Moon Shot

An *Altas-Able* moon-orbiter heads the list of NASA space shots being lined up for the third quarter of the year—probably September. Payload will be a duplicate of the one that failed last Thanksgiving Day. In the same time period, NASA also will attempt to orbit another *Echo* balloon and fire three ballistic shots in the *Mercury* program (a fifth *Little Joe*, an un-manned *Atlas-Mercury*, and an unmanned *Redstone-Mercury.)*

INDUSTRY

Rover Showdown Nears

Step toward settling the NASA-AEC dispute over how to test the *Rover* nuclear rocket will come this month with the award of a NASA study contract on the problem. Many NASA officials favor attempting to launch the rocket first from a stable orbit. But AEC experts prefer a straight ground-launch.

Slip at Cheyenne

Air Force officials are expressing dismay at lengthening delay in getting the first combat *Atlas* pads ready at Warren AFB outside of Cheyenne, Wyo. They were scheduled to be operational in May, but the timetable has now slipped to September.

Chopper Bullpup

Navy development officials have succeeded in firing a *Bullpup* from a Sikorsky HUS-1 helicopter—opening up the possibility of using the radio-guided air-to-surface missile for close-in support of ground troops.

Nike-Zeus Target Radar Tryout

First trial of the 78-ton target tracking radar for the *Nike-Zeus* using live missiles should come in a few months. The TTR made by Continental Can Co. has been shipped to Ascension Island in the Atlantic for tests against missiles fired from Cape Canaveral.

Minuteman Gets Rolling

This week the Air Force will start trial runs of 14-car *Minuteman* trains out of Hill AFB, Utah. The trains will be made up of DOD equipment, but no missile hardware or GSE will be carried in the early deployments scheduled to run through November. The Association of American Railroads is furnishing the engines, operating crews and rails.

INTERNATIONAL

Bosch Arma In British Purchase

In a joint ownership arrangement, American Bosch Arma and DeHavilland Holding Ltd. have acquired S. G. Brown Ltd., Watford, England. Brown is a major producer of precision navigation and gyroscopic equipment.

Crete Becomes Missile Stockpile

Word from Paris has NATO stockpiling missiles on the Island of Crete. Also in the Mediterranean, Britain is storing missiles on the Island of Malta.

First Spanish Rocket Test

Some Spanish scientists and astronautic "aficionados" expect to launch their first experimental rocket in July. Site of the firing and mission of the rocket has not been disclosed.

British Getting Improved Honest John

The British Army's 39th Heavy Regiment is in line to have its M31 *Honest John* tactical missiles replaced soon by improved versions of the same missile.

despite their claims . . .

Soviet Military Outlay Appear

The size of the Soviet military budget has been the subject of considerable discussion and speculation among U.S. officials, military men and experts on Soviet affairs.

Facts are hard to come by. The Soviet budget is misleading. And many attempts to determine the true value of the ruble border on the metaphysical.

The opinion generally held is that Soviet military spending today is about equal to U.S. military spending—and has been so for about five years. But where the United States has to spend only about 9% of its Gross National Product to maintain this level of spending, Russia must spend about 25% of its GNP.

The highly authoritative Stanford Research Institute last winter issued a comprehensive report on the Cold War, agreeing for the most part with this estimate. However, it pointed out that because of Russia's growing GNP new military increases would be possible in the coming decade.

Bernard W. Poirier, a foreign research analyst for MISSILES AND ROCKETS, *has sifted through much of the available material and arrived at the more ominous conclusion that the rise in Soviet military spending is already well under way. Here is his analysis.*

by Bernard W. Poirier

Pious Soviet claims—and figures—to the contrary, Russian military spending today is taking a sharp turn upward.

Indeed, an analysis of the Soviet budget shows:

- Hidden military expenditures not detailed in the published version of the budget have been steadily increasing since 1957.
- The rate of increase in the Red spending program for arms has more than tripled this year over the 1959 amount.
- At least six months before the U-2 incident, the Kremlin programed 8½% of the entire national budget for military intelligence, foreign subversion and espionage.

Significantly, the Soviets planned last fall to spend 178% more on military programs than they admitted publicly in their 1960 budget. This was two months after Premier Khrushchev's meeting with President Eisenhower at Camp David and seven months before what is now generally conceded by the west to be a deliberate Soviet scuttling of the Paris Summit Conference.

Gaining an insight into the financial manipulations of Soviet leaders is difficult. However, many highly regarded specialists have reported similar results in foreign publications after independently analyzing various portions of the Soviet economy and national budget.

The analysis presented here reflects a compilation of this information. Furthermore, the data has been correlated with comparable findings by the author and established Soviet economic trends.

- **Rubber ruble**—Except for property assets, the total actual Soviet budget closely resembles the country's Gross National Product. The Russians spend almost one-quarter of their national budget on the military portion, although their official figures show that percentagewise this share has declined for three successive years. (The United States annually spends less than 1/10th GNP on defense and the total U.S. budget, by comparison, represents less than 1/6th of the present GNP.)

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Table 1 illustrates the official Russian Budget as it is presented to the world. In recent years the Russians propagandized the smaller allocations for the Armed Forces and have attempted to justify this action by pointing to their reduction in military personnel.

Actually their military budget has forged upward at a faster rate than their expanding national budget despite the release of manpower to Russian industrial and agricultural needs.

Dollar comparability of the Russian budget to the U.S. budget gives an erroneous interpretation to the problem of clearly analyzing their economy. Theirs has no comparability to the economies of free nations.

They have no procurement of missiles, aircraft and ships. Their industrial facilities are all Government Furnished Equipment. They produce their own weapons and these are "sold or purchased" on paper only. The prices are adjusted to conform to the needs of the State.

The reduction in military personnel has not been sufficient to offset the greatly increased rate of military build-up.

The "Budget Ruble" is a strange animal. It is not the commercial ruble nor the tourist ruble. Whether it represents .222169 gram of fine gold is of no consequence. The rate of exchange of the Ruble for Dollars at tourist rates (4 for $1) or at black market rates (15 for $1) does not show the actual size of their budget. Consider simply that their budget more closely resembles their Gross National Product than our budget does. Remember that the Ruble is strictly controlled even to its circulation in the Soviet Union. Such a degree of control is never experienced in free nations.

The important consideration is, "What does their budget do?"

- It directly maintains the costs of 80% of a highly regarded but controversial educational system.
- It maintains heavy industry, chemical and consumer industries, utilities, transportation, scientific research in industrial methods, internal security, public works and public health.
- It maintains all the military might of 175 divisions; 30,000 aircraft and over 1,600,000 tons of naval seapower.

ɔ Climb

While the free nations exist and unction as the result of free economies, he Russian economy is the result of dictatorial direction by the State Administration. Russian deficit spending s wiped away like chalk off a blackɔoard.

Russian rulers use the state-controlled press to present a national ɔudget in a few generalized categories since they need not account underhanded financing to anyone, especially the Russian public.

The Budget category of National Economy includes agriculture, heavy industry, hydroelectric power, consumables, atomic energy, transportation, construction, etc.

The Science and Culture category includes education, sports, scientific research (Industrial and Rocket), information media, military infrastructure, etc.

According to outstanding authorities like *"Est & Ouest," "Europaische Wehr-Korrespondenz"* and others, the officially adopted "Unspecified Funds" category is administered by the KGB (Committee on State Security) for the support of espionage activities, compilation of intelligence, and foreign communist activities.

The actual Russian budget comes into sharper focus when the price supports for consumer goods and agricultural products are included (i.e. 1959 = 260.3). Transfer of weapons production costs (1959 = 26.7) and of rocket research (1959 = 28.3) is also necessary. Intelligence and espionage costs correctly belong in the military portion of the Budget, so does military infrastructure costs hidden from the public eye.

The Support of Weapons' Costs in the actual Military Portion (Table 2) is the best available computation of the difference between the true cost of weapons production and the amount credited to "procurement."

It is interesting to note that 28.3 billion rubles went to rocket research in 1959 and 39.5 in 1960. The costs of maintaining 80% of their educational system in 1959 was 94.3 billion rubles and 102.0 in 1960.

The Russians seem to make excellent use of their military funds. Their actual 1960 military funds (267.1) maintain 3,200,000 military personnel and 200,000 persons in rocket production. Moreover:

- They maintain up-to-date aircraft capable of airlifting 10% of their 100,000 airborne troops at a moment's notice.
- They maintain over 165 missile bases, missile production centers, and missile testing and evaluation sites; 20,000 first line tanks and 15,000 second line tanks; 37 cruisers; 230 destroyer types; about 475 submarines; over 20,000 military jet aircraft and about 30 types of missiles.
- They equip land forces with the latest equipment including 203mm atomic cannons; 12 tube 247mm, 4 tube 200mm, and 16 tube 140mm barrage rockets; 45mm and 57mm repeating anti-tank cannons tested in Antarctica; the new "Simonova" semi-automatic carbine; and new "lead uniforms" and portable atomic rockets.
- They produced enough nuclear bombs to test-explode at least 23 in 1958. (Reportedly the U.S. tested about 30 that year).

The increase over the official budget category is determined by computing the difference between the official budget amount and the actual budget amount. The difference is divided by the official amount. (i.e. 1960: $\frac{267.1 - 96.1}{96.1} = 177.9\%$).

The rate of annual increase or decrease of one budget amount over the former comparable budget amount is determined by dividing the larger amount of difference by the smaller amount of difference and subtracting the whole number 1. (i.e. 1959: $\frac{D^2}{D^1} = \frac{275.3}{244.2} - 1.00 = .127$ or 12.7%).

Table 1 OFFICIAL ANNUAL SOVIET BUDGET
(In Billions of Rubles)

Principal Categories	Actual 1957	Actual 1958	Actual 1959	Estimated 1960
National Economy	244.7	257.1	308.7	.....
Social and Culture	188.4	212.2	232.0	.....
Armed Forces	96.7	96.3	96.1	.....
State Administration	11.9	11.9	11.5	.....
Sub-Total	541.7	577.5	648.3	.....
Unspecified Funds	62.1	50.2	59.3	.....
BUDGET TOTAL	603.8	627.7	707.6	744.8

Table 2 ACTUAL RUSSIAN BUDGET
(In Billions of Rubles)

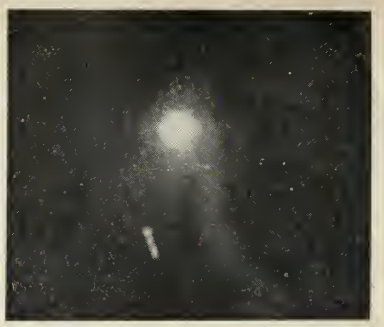
	1957	1958	1959	1960
National Economy	433.0	462.4	542.3	599.8
Budget Category	232.3	240.2	282.0	311.7
Price Supports	200.7	222.2	260.3	288.1
Social and Culture	160.8	184.1	203.7	242.9
Military Portion	209.8	213.5	225.4	267.1
Budget Category	96.7	96.3	96.1	96.1
Espionage, etc.	62.1	50.2	59.3	62.5
Transfers:				
—Production from N. E.	12.4	16.9	26.7	32.6
—Rocket Research (5 & C)	27.6	28.1	28.3	39.5
Support of Weapons' Costs	11.0	22.0	15.0	36.4
State Administration	11.9	11.9	11.5	11.6
GRAND TOTAL	815.5	871.9	982.9	1121.4

Table 3 COMPARATIVE TABLE

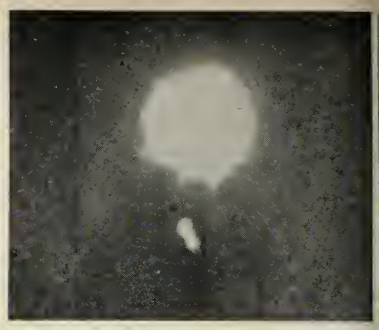
Whole Budget Comparison	1957	1958	1959	1960
Actual Russian Budget	815.5	871.9	982.9	1121.4
Officially adopted Russian Budget	603.8	627.7	707.6	744.8
Difference	211.7	244.2	275.3	376.6
Increase over Official Budget	35.0%	38.9%	38.9%	50.6%
Rate of ruble increase over prior	.....	15.4%	12.7%	36.8%
Military Budget Comparison				
Actual Military Funds	209.8	213.5	225.4	267.1
Officially adopted category	96.7	96.3	96.1	96.1
Difference	113.1	117.2	129.3	171.0
Increase over budget category	116.6%	121.7%	134.5%	177.9%
Rate of ruble increase over prior	.....	3.6%	10.3%	32.3%

Table 4 ACTUAL MILITARY BUDGET STATISTICS

	1957	1958	1959	1960
Military share of Total Budget	25.7%	24.5%	22.9%	23.8%
Increase over official Budget category	116.6%	121.7%	134.5%	177.9%
Rate of ruble increase over prior	.....	3.6%	10.3%	32.3%



GOING: *Nike* **explodes above prey.**



GOING: Its blast ignites *Corporal.*

Nike-Hercules Can Now

by James Baar

A highly-improved version of the Western Electric *Nike-Hercules* will soon become the Free World's first antimissile missile for use against tactical missiles.

It also is expected to be made mobile so that it can be swiftly deployed for use against tactical missiles launched against the rear areas of a battlefield.

• **Significant success**—Until now, the *Nike-Hercules* has been capable of knocking down only aircraft and air-breathing missiles. However, the new model of the air defense missile system proved it was capable of knocking down tactical ballistic missiles in a secret test over White Sands Missile Range earlier this month.

The Army has disclosed that on June 3 an improved *Nike-Hercules* destroyed an incoming Firestone *Corporal* high over the New Mexican desert.

Army spokesmen said the *Hercules* radar picked up and began tracking the liquid-propelled *Corporal* immediately after it was launched. The command-guided *Nike-Hercules* was directed to intercept the *Corporal* on the latter's downward leg.

As the *Corporal* streaked toward its target at a speed of more than Mach 3, the *Nike-Hercules* closed on it from above. The *Nike's* proximity fuse detonated the missile's high explosive warhead when the *Corporal* was still yards away.

Blazing *Nike* fragments riddled the *Corporal* and it exploded. Seconds later flaming *Corporal* parts tumbled toward the desert, trailing streamers of dirty smoke.

• **New radar is key**—Army spokesmen said all improvements in the *Nike-Hercules* system are in the radars. They said the improvements tripled the system's capability.

The principal improvement apparently is in a new General Electric radar that makes it possible to acquire and track much smaller and possibly faster targets at the same and greater distances than previously possible.

The Army said the improvement in *Hercules* is not directly connected with the development of the *Nike-Zeus* antimissile missile. However, a spokesman said information gained from work on the *Hercules* system would help *Zeus.*

The *Nike-Hercules* is designed to destroy incoming ICBM warheads streaking toward their targets at Mach 20.

Previously the *Nike-Hercules* has scored hits on Lockheed Q-5 drones at higher than 70,000 feet. The air-breathing drones were flying at nearly Mach 3.

The incoming *Corporal* destroyed by the *Hercules* was traveling at better than Mach 3. However, the Army indicated that capability of the new *Her-*

Nike-Hercules

Type	**Surface-to-air**
Range	**75 miles plus**
Length	**39 ft.**
Diameter	**31.5 in.**
Ceiling	**100,000 ft. plus**
Weight	**10,000 lbs.**
Stages	**Two**
Propellant	**Solid**
Warhead	**Nuclear/high explosive**

GOING: *Corporal* burns furiously.

GONE: *Nike* blast engulfs target.

Stop Tactical Missiles

cules system was not necessarily strained by the *Corporal's* challenge.

The Army said the June 3 anti-missile missile test was the first involving a *Nike-Hercules.* However, it was not the first time that one missile has destroyed another missile.

The Army has hit an *Honest John* with a *Hawk.* But this test was not considered a forerunner to an operational system.

• **Conversion kits ready**—Western Electric, prime contractor for *Nike-Hercules,* General Electric and other *Nike* contractors are already producing conversion kits incorporating the new improvements in the *Nike* system. Work was begun under a $20-million Army contract announced last February 29.

The conversion kits can be used to revamp present *Nike* sites with relative ease. The cost has not been disclosed.

The Army also has not disclosed how many of the more than 250 *Nike* batteries in the United States and the dozens scattered around the world will be converted. However, the *Nike* batteries that could make the best use of the improved feasibility would be those emplaced in NATO countries.

At present, about six *Nike* battalions each with four or more batteries have been deployed with U.S. troops in Europe. *Nike* batteries are also deployed with European troops in a number of countries including Italy, Norway and Denmark.

Finally, *Nike* batteries are deployed in Greenland, Alaska, Okinawa and Formosa and plans are under way to deploy them in Hawaii.

The majority of *Nike* battalions in the continental United States still are equipped with the less effective *Nike-Ajax.* However, the conversion to *Nike-Hercules* has been progressing rapidly.

More than 80 *Nike* batteries are reported to have been converted to *Hercules* to date.

The first *Nike-Ajax* were deployed in 1953. The 25-mile-range missile is considered effective against any manned Soviet bomber. *Ajax* is a completely mobile system, although it is deployed in fixed sites.

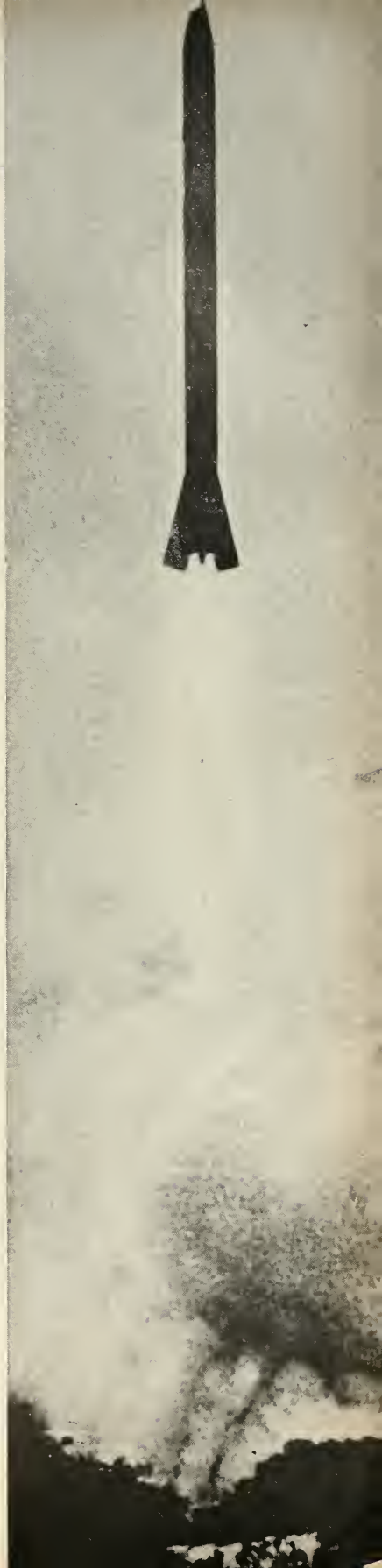
Little information has been available on Army plans to make the *Nike-Hercules* system mobile. But work on the mobile system has been going on for some time.

A principal argument used against the mobile system is that it was being designed for the disappearing threat of Soviet aircraft attack. Meantime, the Army has continued to look at other proposals for the development of anti-missile missiles for use on the battlefield.

Nike-Hercules' improved capabilities now make it more attractive as a mobile battlefield system. One of the most persuasive arguments being advanced in its favor is simple but forceful: It is here.

Corporal

Type	**Surface-to-surface**
Range	**75 miles**
Speed	**Mach 3 plus**
Length	**45 ft.**
Diameter	**30 in.**
Weight	**11,000 lbs.**
Stages	**One**
Propellant	**Liquid**
Warhead	**Nuclear/high explosive**



Boeing Wins Contract for Navy's First ASW Hydrofoil

Antisubmarine warfare took a historic step this last week with award of a $2-million contract to Boeing for construction of the Navy's first hydrofoil warship—a missile-packing patrol craft.

The ship is expected to be the forerunner of a fleet of hydrofoil patrol craft and much larger hydrofoil destroyers.

They would be used to combat enemy submarines lurking off U.S. coasts. The larger hydrofoil destroyers would be used to launch antimissile missiles at submarine-launched IRBM's (M/R May 23, p. 12).

The Navy awarded the much-coveted $2,082,215 contract for the first hydrofoil patrol craft—dubbed the PCH—to Boeing's Aerospace Division at Seattle. The Navy said Boeing's proposal was the lowest of 11 submitted. A total of 35 firms were invited to make bids.

Boeing announced that it has leased facilities from the J. M. Martinac Shipbuilding Corp. at Tacoma, Wash., for construction of the PCH and for conducting sea trials. Delivery is expected in early 1963.

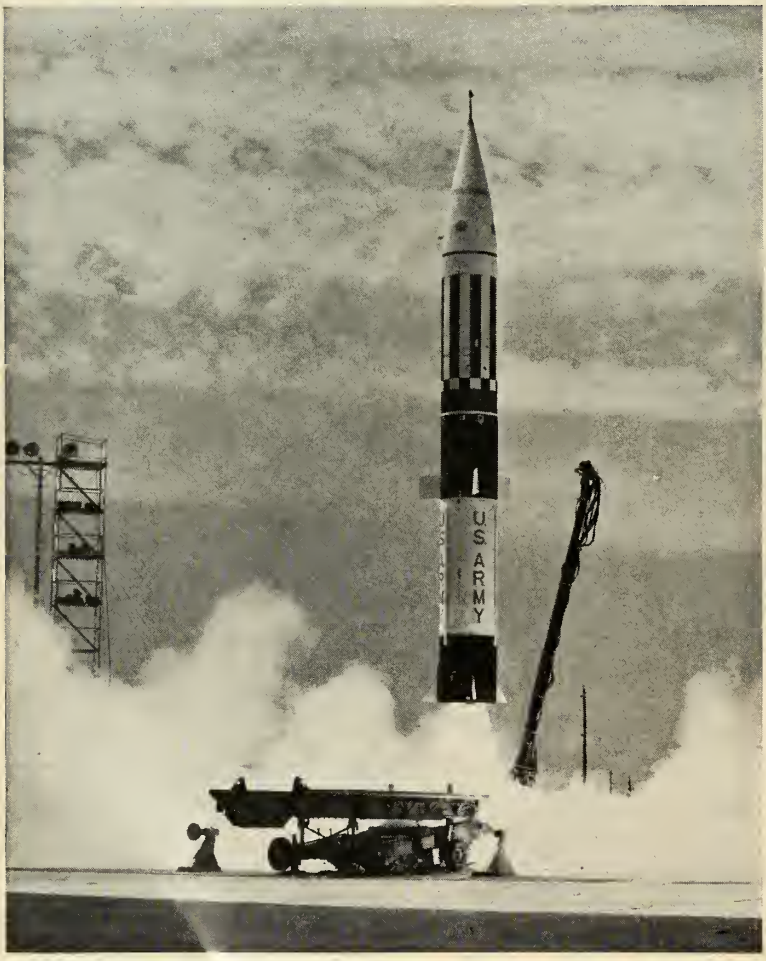
The first PCH will be 115 feet long and will displace 110 tons fully loaded. It is expected to rip over the surface of the sea at 50 knots.

The ship will be powered by two Bristol-Siddeley 3000-horsepower gas turbine engines. The British engine's name is the Proteus. The PCH also will be powered by an auxiliary 600 horsepower diesel for conventional sea travel.

The PCH is expected to be armed with such advanced ASW missiles as Minneapols-Honeywell's *Asroc* and the most advanced sonar equipment.

The hydrofoil destroyer would be armed with similar ASW weapons plus such antimissile missiles as the Westinghouse *Typhon* or a seagoing version of the Convair *Mauler*.

pershing passes fourth test



PERSHING RISES from transporter-erector-launcher in fourth successful test of Army's new solid-propelled battlefield missile June 9. Martin missile was preset to perform erratic movements in its short flight over the Atlantic from Cape Canaveral. Range safety officer was alerted to possibility the missile might have to be destroyed because of excessive conditions, but it wasn't necessary. As in previous flights, only first-stage Thiokol motor was live. Second stage was dummy.

Debus to Boss NASA Launch Activities at Both Ranges

Dr. Kurt H. Debus will be responsible for launch operations on the Atlantic and Pacific Missile Ranges, the National Aeronautics and Space Administration announced last week.

Debus, who has been head of missile firing for the Army Ballistic Missile Agency, has already taken charge of NASA launch activities at Cape Canaveral. When his ABMA group transfers to NASA on July 1, Debus will head a new Launch Operation Directorate, which will supervise NASA activities on both missile ranges (M/R, June 13, p. 20).

The NASA group will also take over completion of ABMA's obligations to the Army for launching *Pershing*, *Jupiter* and *Redstone* missiles at the Cape.

At the Pacific Missile Range, NASA activities will be confined to sounding rocket shots for more than a year. The first major NASA shot, a polar-orbiting *Nimbus* advanced weather satellite, is due to be launched down PMR by a *Thor-Agena B* vehicle in the fourth quarter of calendar 1961.

Dr. Hans Gruene will be Debus' deputy. Assistant directors will be Karl Sendler for instrumentation, Albert Zeiler for facilities and Clarence C. Parker for operations. Col. Asa M. Gibbs will have dual functions as chief of the NASA Office of Test Support and a member of the staff of the commander of the Atlantic Missile Range.

Debus' directorate will assume and expand the functions of the present NASA Atlantic Missile Range Operations Office. Melvin N. Gough, director of AMROO, will be transferred to NASA headquarters as flight operations coordinator for the assistant director of space flight operations.

Strike Threats Ease at Some Plants But Rise at Others

The labor-management dispute between machinists and the missile industry died down in certain areas last week and flared up in others.

Settlements were reached with the United Auto Workers at Douglas Aircraft, covering their plants at Long Beach, Calif., and Tulsa, Okla., and at North American's Rocketdyne Division. The proposed Douglas Contract for UAW workers at Charlotte, N.C., is still under discussion.

International Association of Machinists locals at Douglas are expected to agree with the UAW settlement.

But at Lockheed's Missile and Space Div., the IAM broke off negotiations last Tuesday, claiming that the company's latest offer was "unsatisfactory." Lockheed plants at Sunnyvale, Palo Alto, Santa Cruz, and Van Nuys were still being struck by the IAM at week's end.

A Federal Court decision last week prohibited Convair's IAM employees at Cape Canaveral from picketing other concerns at the Cape. NLRB Lawyers had complained that the IAM's Cape local had engaged in unfair labor practices by picketing and distributing handbills to induce workers other than those at Convair to leave their jobs.

First Standard IBM 7090 Computer in Action at ABMA

HUNTSVILLE—The first standard IBM 7090 transistorized computer went into operation at the Army Ballistic Missile Agency last week to process trajectory simulation data for the *Saturn* space booster.

A second 7090 will be installed in August. Ultimately the two systems will replace three existing large computers in the Computation Laboratory. They will almost triple the laboratory's capacity by performing in eight hours what was done previously in 20. Cost of each new system is 25% more than the standard IBM 709, yet each is six times faster—performing nearly 14 million logical decisions per minute. (By comparison the old card program calculator used in 1951 for *Redstone* missile development operated at 2174 decisions per minute.)

Typical early problems to be handled by the twin 7090's will include vibration effects and heat transfer caused by interaction of the eight *Saturn* engines in cluster, thrust alignment, multiplexing of fuel and oxidizing agent and guidance evaluation. Trajectory simulation will be an enormous cost saver, enabling study of a multitude of conditions during thousands of "paper" flights into space.

IBM officials said that a total of 82 of the 7090's will be delivered to industry and government by next May 1. These include two special purpose 7090's already in use at the Thule Ballistic Missile Early Warning station.

Aerospace Corp. hits snag In getting Board Members

Organization meetings at Secretary of Air Force levels are scheduled this week on the formation of the Aerospace Corp., successor to Space Technology Laboratories. The job of choosing a 10- or 12-member board is expected to last until the end of the month.

The biggest unsolved problem seems to be the selection of board members and obtaining their acceptances. Among those mentioned as possibilities are: Gen. James McCormac, former AF director of development; Roswell L. Gilpatric, AF under secretary from 1950 to 1953; Roger Lewis, Pan American World Airways executive vice president; Gen. Earl Partridge, former chief of the Air Defense Command; and Trevor Gardner, former AF assistant secretary for research.

Richard E. Horner, associate NASA administrator, has been reported to be a possibility but sources now report there is little indication Horner is interested. Several board memberships will be filled from academic ranks if present plans are followed, with men from California Institute of Technology and Massachusetts Institute of Technology in the lead.

Aerospace will operate on a cost-plus-fixed-fee basis as an Air Force contractor. Unlike STL Aerospace will not deal directly with contractors on a management basis. Instead, the new company will probably provide the recommended patterns and policy for research and development and leave administration to the Air Force.

STL would retain systems engineering and technical direction for the *Atlas, Titan* and *Minuteman* weapon systems until completion of the programs. Advanced planning, basic research and development now done by STL, plus some administrative services, would be transferred to the new corporation. The Air Force may ask STL to help draw a plan of operation for guiding the new non-profit corporation.

Grand Central Rocket Co. Names Brunetti President

Dr. Cledo Brunetti has been appointed president of the Grand Central Rocket Co.

He has been operating head of the company as vice president and general manager since September, 1958. At that time, Charles E. Bartley, founder and president of Grand Central, resigned. He now heads Rocket Power/Talco Division of the Gabriel Co.

Model of Momentum

This machined aluminum model, with 14 concave faces, serves as a physical representation of the hypothetical "Fermi surface" to illustrate the characteristics of electron motion in metal.

As electrons move through the latticework of atoms, their momenta vary according to their direction. The momenta also vary in different metals, depending upon the number of atoms per unit volume and the number of conduction electrons per atom. In the model—developed at the General Electric Research Laboratory—these variations are represented by the varying distances from the center to the surface.

The diagram illustrates how measurements of the momenta of conduction electrons are made as sound waves (q) are sent into a metal sample in

which their direction of movement is controlled by a magnetic field (H).

Payload for Moon

27 Companies Bid for NASA Study Contract

Twenty-seven companies are bidding for a study contract on a 2500-lb. space payload capable of delivering 150 to 300 lbs. of instruments to a soft landing on the moon. The project has no name as yet.

The National Aeronautics and Space Administration expects within a month to award the study contract, which could lead to business totaling $50 to $100 million for the winner. The six-month study itself will be worth $100,000 to $125,000, a NASA spokesman said.

The vehicle would be boosted to escape velocity by an *Atlas-Centaur* launching rocket and would be aided on its trip to the moon by mid-course and terminal guidance. NASA officials want the payload to fall to the moon at not more than 27 ft./sec. A man in a parachute falls to earth at about 30 ft./sec. By comparison, the *Ranger,* a rough-landing moon vehicle, is to hit the moon at more than 300 ft./sec.

The contractor will have to design the entire vehicle. Much of the 2500-lb. package will be the weight of small rockets required for mid-course and terminal guidance. The actual landing package is to weigh between 500 and 700 lbs.

The vehicle is expected to fly about 1963. First *Atlas-Centaur* flights are due in 1961, but, presumably NASA scientists will not want to entrust an expensive moon package to the launch system until it develops reliability.

A bidders' conference on the moon vehicle was held May 13 at Jet Propulsion Laboratory. Bids were received on June 6.

NASA has not stated whether it plans to award one or more study contracts. In the *Ranger* competition earlier this year, three companies, Ford Motor Co., North American and Hughes Aircraft, were chosen for relatively brief competitive follow-up studies before the contract was finally awarded to Ford's Aeronutronic Division.

The X-15 Explosion

Initial investigations into the explosion that severely damaged *X-15* No. 1 last week indicate that the blast did not occur in the engine chamber, but was probably caused by a fuel leak or a spark.

NASA *X-15* officials received this news with a sigh of relief. Had the explosion occurred because of structural fault of the space-plane's XLR 99 Reaction Motors engine, the program would have been set back many months.

A new engine was shipped to Edwards AFB last Monday, and will presumably be fitted into *X-15* No. 2. Delay from the explosion is expected to be about six weeks.

The explosion occurred when a hydrogen peroxide tank blew up in the plane's engine bay during engine tests. Shortly before the explosion, the engine had been shut down automatically due to an unidentified malfunction. The pilot, North American's Scott Crossfield, had pressed the recycle button just prior to the explosion.

Damage was extensive in the aft empennage and engine bay. Though ripped from the aft section, the forward portion including landing gear and wings did not appear to be seriously damaged.

'Spine' for Dolphin

BARREL LINERS from 16-in. battleship guns are being used as the capped "spine" of the *Dolphin* dummy-*Polaris* launch and training vehicle. The former gun liner holds compressed air that ejects several tons of water ballast after the *Dolphin* is launched from the submerged submarine and breaks through the surface of the sea. The dummy missiles are recovered and reused in crew training and launching system checkout.

GE Makes Turbodrives To Be Used in Centaur

General Electric Co. is producing turbodrives for propellant boost pumps that will be incorporated in the *Centaur* space vehicle, it was revealed last week.

Walter C. O'Donnell, general manager of GE's Aircraft Accessory Turbine Department in Lynn, Mass., said the new fuel system will result in weight savings of more than 350 lbs. GE will supply turbodrive units to Pesco Products Division, Borg-Warner Corp., which will mate them to boost pumps. Convair (Astronautics) Division of General Dynamics is developing the *Centaur* vehicle for the National Aeronautics and Space Administration. Pratt & Whitney Division, United Aircraft, is developing the engines.

The turbodrives, patterned after General Electric's AM-10 auxiliary power unit used in the *X-15* rocket aircraft, will power the liquid hydrogen and LOX boost pumps in the second-stage engine.

Most current liquid-fueled rocket engines depend on pressurized gas to deliver propellant to the engine's main pump. Warren A. Poole, GE project engineer, said the use of boost pump feeding—which does not require as much pressure and tank structure—makes possible the weight savings. Use of an intermediate boost pump will make it possible to design fuel and oxygen tanks to the structural requirements of the vehicle.

GAO review indicates . . .

Vega-Agena-B Mix-Up Cost Millions

Accounting office says AF refused to tell NASA of Agena-B plans and told of disinterest in Vega only after it was under way

by Paul Means

The Air Force's failure to communicate to NASA its plans to develop *Agena-B* caused a duplication of effort costing the nation $16 million in badly needed space money.

This conclusion can be drawn from the General Accounting Office's review of NASA's *Atlas-Vega* program, cancelled last December. (See M/R, Dec. 21, p. 15).

Why did the U.S. develop "two rocket vehicles with similar payload capabilities and about the same date of availability?" According to the review, it was because:

- The Air Force refused to tell NASA of the *Agena-B* project at a time when *Agena-B's* contracts had been let;
- The Air Force and ARPA informed NASA they would have no need for *Vega*, diminishing the need for the vehicle, only after it was under way;
- Lack of coordination between NASA's development of *Vega* and the availability of the Air Force's *Atlas* launch pads slowed down the project until NASA allegedly had little need for it.

To prevent this type of wasteful duplication, the Administration had held an interagency meeting between NASA and effected DOD organizations on Dec. 15, 1958, for the purpose of forming a National Space Vehicle Program.

At that time, according to the GAO report, NASA described *Vega* to the DOD representatives. But even though planning of the *Agena-B* "must have" preceded the meeting, "yet there was no evident communication of that planning by the Department of Defense . . ."

Out of this meeting came the report to the President entitled "A National Space Vehicle Program," dated Jan. 27, 1959. This document, presented "almost two weeks after the first contractual action" was taken "in the development of the *Agena-B* stage . . . makes no mention of the *Atlas-Agena-B*."

When NASA did finally learn about the competing program is not clear, the report states, but "we were told by officials of NASA that it was not until late in the summer of 1959."

Vega was developed as a general-purpose vehicle in the national Launch Vehicle Program to be used until the development of *Centaur*. NASA had expected that DOD would use the vehicle also. "However," according to the report, "it seems that DOD had no intention of using the vehicle."

"The most concrete evidence that DOD did not intend to use the *Atlas-Vega* was its decision to proceed with the development of the *Atlas-Agena-B* which was roughly comparable," the report states.

"A NASA official . . . told us that during the December 1958-January 1959 interagency discussions representatives of DOD stated they had no interest in *Atlas-Agena*."

Without DOD acceptance, "the sole prospect for extensive interim, general-purpose use of *Atlas-Vega* lay in NASA space activity. This prospect grew dim as the work got well underway and was extinguished by the time cancellation was announced," according to the report.

The slippage in *Vega's* schedule, the GAO report said, was principally because "satisfactory arrangements for launch facilities had not been made with the Air Force."

At the time *Vega* was initiated there were only two launch stands (numbers 12 and 14) which were capable of launching multistage, *Atlas*-boosted vehicles. "These stands . . . were then scheduled for full-time use until 1961 . . ." (One of these stands was damaged in Nov. 1959, by the explosion of an *Atlas-Able*.)

Vega's flight schedule couldn't have been carried out, according to the report, because "construction of additional launch facilities was approved . . . on May 15, 1959, and . . . the initial contract for these facilities was entered into on June 10, 1959. Construction of an *Atlas* launch stand requires 18 months," the report said.

The report adds, however, that "neither the *Atlas-Vega* nor the *Atlas-Agena-B* had an advantage over the other in availability as a general-purpose space vehicle."

The reason for this, according to the report, is that the *Atlas-Agena-B* program was also held up by nonavailability of launch facilities, and that the Air Force was more interested in using the *Agena-B* on top of the *Thor* IRBM's in the *Discoverer* series.

- **Which was better?**—Although the two were equally handicapped in terms of availability, GAO said, "the amount by which the payload capability of the *Atlas-Vega* exceeds that of *Atlas-Agena-B*, though minor, might be decisive in the choice of a "permanent" space vehicle or in the choice of a vehicle to perform some specific mission."

And slippage in *Vega's* schedule had "resulted in a NASA decision to change the missions of these vehicles from a satellite and a space probe, respectively, to 'lunar orbiters'."

Would *Vega* have made a better "lunar orbiter" vehicle than *Agena-B*? Many NASA spokesmen think so. (See M/R, May 2, 1960.) They think, however, that *Agena-B* can be modified with the proper three-axis guidance system (which *Vega* would have possessed) prior to its use (spring of 1961) as a lunar orbiting vehicle.

- **Why was Vega cancelled?**—The report states that "although pre-flight development (of *Vega*) was about on schedule through time of cancellation, it had become increasingly improbable that more than a few scientific payloads would be flown with *Atlas-Vega*."

Yet in May of this year, NASA let a contract with Lockheed to buy 16 of the competing *Agena-B* vehicles. (See, M/R, May 2, p. 15). Since the GAO report claims that the *Vega* had slightly

greater capabilities than the *Agena-B*, and 16 *Agena-B's* were purchased after *Vega's* cancellation, it would appear that *Vega* must still have had a mission at the time cancellation.

NASA insiders say that the President reacted with criticism of the Air Force when he discovered their development of *Agena-B*—a vehicle which had not been included in the National Space Vehicle Program. But since the Air Force's *Agena-B* program was a *fait accompli*, either the *Vega* or the *Agena-B* had to go.

The decision was in favor of the *Agena-B*. NASA sources say it was a political choice—based on the fact that Congressional criticism would be greater if an Air Force program were cancelled than it would be if the NASA program were cancelled.

How the Two Programs Progressed

Atlas-Agena B

Dec. 15, 1958—The *Agena B* stage was not named or described in the interagency meeting on U.S. launch vehicles. Representatives of AFBMD speaking for ARPA discussed their upper stage vehicles, classifying them as "existing," "under development," or "under study or in component development." One of the "existing" stages listed was the 117L which was the basis for the *Agena B* stage development. (The 117L stage has also been referred to as the *Agena A, Hustler, Sentry,* and *Discoverer.*)

No mention was made of any plans to develop the *Agena B* stage by giving the 117L engine restart capability and increased tank capacity and by making other modifications.

Missions were discussed for the *Thor-117L* and the *Atlas-117L.*

Jan. 16, 1959—AFBMD issued Contract Change No. 8 to Lockheed, the contractor for the reconnaissance satellite weapons system of which the *Agena* stage is one part, to initiate a "study and test program to investigate parameters and methods required to provide a restart capability" for the *Agena* engine. The contemplated program was to include preliminary design and an altitude test program. Restart capability, which did not exist in the *Agena A,* is a feature of the *Agena B.*

Jan. 27, 1959—The *Atlas-Agena B* was not mentioned in the document prepared by NASA describing the national space vehicle program. This document referred to the *Atlas-Hustler,* which was the same as the *Atlas-Agena A,* saying that it would have only about half the load-carrying capability of the *Atlas-Vega.*

April 10, 1959—ARPA issued amendment 4 to ARPA order No. 17-59 to the Commander, ARDC. Task No. 3 of this amendment provides as follows:

"Modify the *Bell-Hustler* stage to obtain dual burning capability, simplify guidance and control system, structual simplification such that payloads of arbitrary shapes may be carried, and increased propellant carrying capacity."

The *Bell-Hustler* stage referred to in this order is the *Agena* stage. The modifications cited are the principal differences between the then existing *Agena* stage and the *Agena B* stage.

We were informed by ARPA personnel that studies to determine the optimum tank size for the *Agena* stage were still in progress at the time amendment 4 to ARPA order No. 17-59 was issued. At that time a 60-percent increase was indicated.

April 24, 1959—AFBMD, in implementing amendment 4 to ARPA order No. 17-59, directed Lockheed to begin a design and development program to provide a restart capability for the *Agena* engine and to design and develop such other changes as were required to make other portions of the propulsion system compatible with the restart capability.

Because Lockheed objected to the broad wording of this statement, a clarifying revision was issued on June 3, 1959.

June 2, 1959—AFBMD and Lockheed agreed that the optimum tank capacity for the *Agena B* stage would be double that of the *Agena A.*

June 3, 1959—The contract change which had been issued to Lockheed on April 24, 1959, was revised to specify that Lockheed should (1) provide a single restart capability, (2) design and develop larger tankage, (3) design and develop a modified guidance system, and (4) design and develop such other changes as were necessary to make the vehicle subsystems and ground support equipment compatible with the specified changes.

June 4, 1959—ARPA concurred in the AFBMD/Lockheed decision concerning the optimum tank capacity for the *Agena B.*

Atlas-Vega

Dec. 15, 1958—*Atlas-Vega* was proposed by NASA in the interagency meeting on U.S. launch vehicles. Although not named as such, it was one of a group of vehicles described collectively by NASA as the type of program they would like to see established. The vehicle's first stage was identified as a modified *Atlas* ICBM; the second stage was to be powered by a 33,000-pound-thrust, liquid oxygen-kerosene engine; and the third stage was to be based on the 6000-pound-thrust, storable-propellant engine being developed by JPL.

Jan. 5, 1959—Beginning date for allowing costs under contract NASW-30 with the General Electric Company for *Atlas-Vega* second-stage engines.

Jan. 15, 1959—In consequence of informal requests by NASA, Convair submitted a proposal for development of a medium-energy upper stage for the *Atlas* booster, and GE submitted a proposal for modification of its model X 405 rocket engine. The upper stage vehicle proposed by Convair was essentially the *Vega* second stage. The major engine modifications proposed by GE were (a) provision of a capability for an initial altitude start and for restart of the engine and (b) an increase in nozzle expansion ratio from 5.5:1 to 25:1. These proposals eventually matured into contracts.

Jan. 27, 1959—The *Atlas-Vega* was listed as the first in a series of general-purpose space vehicles in a national space vehicle program described in a document prepared by NASA.

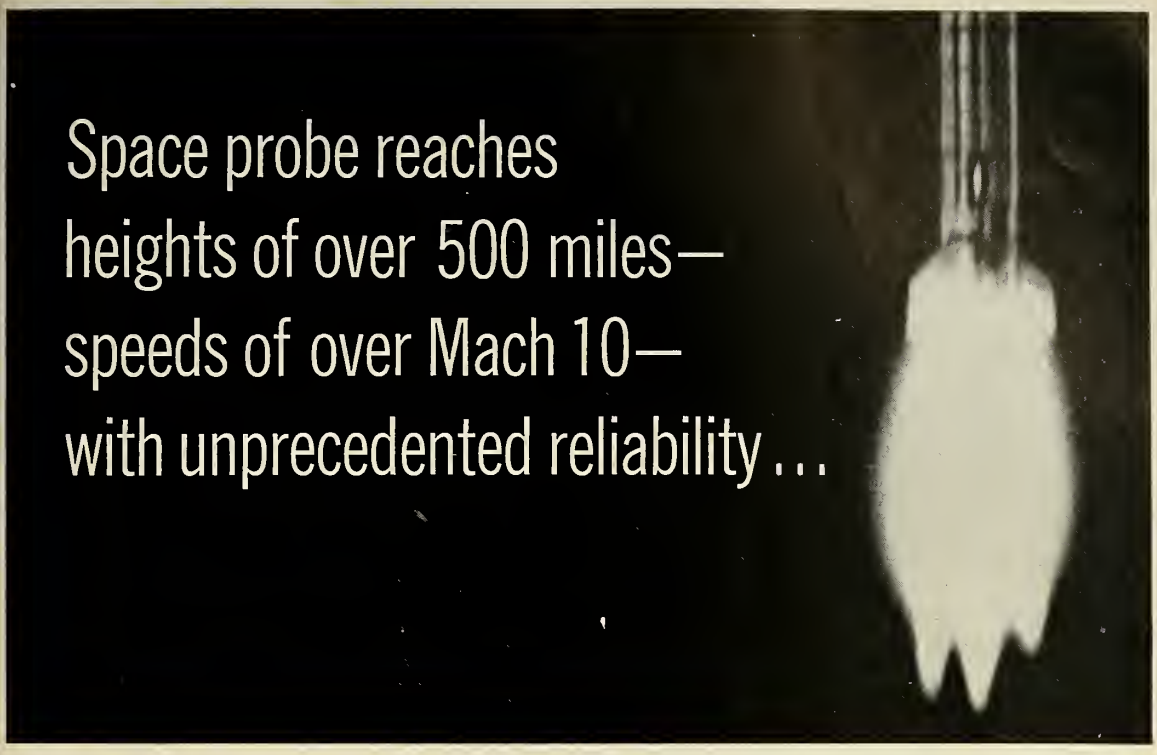
Jan. 30, 1959—NASA made funds available to JPL for development of the 6,000-pound-thrust, storable-propellant engine for use in the *Atlas-Vega* third stage.

Mar. 1, 1959—NASA contract NASW-45 entered into with Convair for (a) the design, development, manufacture, and test of eight *Vega* upper stage vehicles, (b) the design of modifications to the *Atlas* booster to make it compatible with the *Vega* upper stage, and (c) the launching of eight complete *Atlas-Vega* vehicles. However, the contract was not executed until May 21, 1959.

Mar. 18, 1959—NASA contract NASW-30 entered into with GE for modification of the model X 405 rocket engine and for delivery of 11 modified engines and spare parts. Contract NASW-30 provides for payment of costs "incurred in the performance of this contract starting on Jan. 5, 1959, through date of this definitive contract."

Mar. 26, 1959—NASA made funds available to JPL for development of the *Atlas-Vega* third stage.

May 21, 1959—Contract NASW-45 between NASA and Convair was signed.



...AND BRISTOL SIDDELEY SUPPLY THE POWER

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce the Gamma. A liquid propellent rocket engine, the Gamma powers the Saunders-Roe Black Knight, Britain's highly successful space research vehicle. An extremely reliable powerplant, the Gamma produces a total sea-level thrust of 16,400 lb (7,438 kg) and nearly 19,000 lb (8,618 kg) outside the earth's atmosphere, for a total powerplant weight of only 700 lb.

At the Woomera rocket range in Australia, the Gamma has sent Black Knight over 500 miles into space at speeds in excess of Mach 10 with a reliability that is unprecedented.

Since Bristol Siddeley's rocket division began work in 1946, it has developed a wide range of components. *By combining these components in single or multi-chamber layouts, thrust requirements from 500 lb up to 100,000 lb can be met.*

BRISTOL SIDDELEY ENGINES LIMITED

Bristol Aero-Industries Limited, 200 International Aviation Building, Montreal 3, Canada. Telephone: University 6-5471

Bristol Siddeley Maybach diesel engines power Britain's fastest express train.

The Bristol Siddeley Orpheus powers the Fiat G 91, NATO'S light fighter.

The Bristol Siddeley Proteus powers the Britannia airliner.

Circle No. 6 on Subscriber Service Card.

Boeing Science Lab Gets New Home

SEATTLE—Boeing Scientific Research Laboratories moved last week into a new $2,250,000 home, a university-like building across the Duwamish River from Boeing Airplane Co.'s home plant.

The move marked a major step forward in the growth of the research organization which Boeing established slightly more than two years ago to provide a strong link with the nation's scientific community.

Of the slightly more than 100 persons on the BSRL staff, some 50 are scientists. Main floor of the new building contains 24 laboratories with immediately adjacent offices for the scientific staff members. A library and seminar room are on the second floor, with a calibration laboratory and metalworking shop in the basement. The building is planned so that additional wings can be added as needed.

Boeing established BSRL with these purposes in mind:

- To provide a channel of communication with the scientific world and create an "awareness" within the company of scientific progress.
- To provide special help for the engineering department in an atmosphere which might aid in the conversion of basic scientific development into practical engineering applications.
- To discover something useful.

The laboratory will not take on any classified work. This will permit free collaboration between Boeing scientists and those of other countries. For a similar reason, it will do very little proprietary work, according to BSRL director Guilford Hollingsworth.

To promote contact between the BSRL scientists and the Boeing engineering departments, there will be no cross-charging to other departments for work done by BSRL. This, it is felt, will encourage the engineers to bring their problems to the BSRL group. The company anticipates that the research laboratory staff members may spend up to one-third of their time assisting others in the company. The remainder of the time they will be free to work on projects of their own in surroundings strongly reminiscent of a university campus.

At present, BSRL work is going on in such fields as flight sciences, gas dynamics, plasma physics, geoastrophysics, solid state physics and mathematics research.

Emphasis is on the theoretical. In plasma physics, for example, BSRL staff members are not concentrating primarily on transport properties but are more interested in such things as the characteristics of static plasma and the radiation characteristics of hot plasma. In the solid state laboratory, the scientists are not delving into ways to build a better transistor but are researching the mechanics of solids.

BSRL at present does not plan to take on outside contract work although this policy may be modified in the future.

mergers and expansions

LOCKHEED's California Division has opened a $3-million plastics center in Burbank. The 100,000-sq.-ft. facility will be used for development and manufacture of aerospace and consumer plastic products. Lockheed has over 400 technicians and engineers currently engaged in plastics products, with 22 manufacturing and research engineers working exclusively on development of new products and production techniques.

THOMPSON RAMO WOOLDRIDGE INC. dedicated its Colwell Engineering Center in Euclid, Ohio. The Tapco Group Materials Dept. engineering and technical staff will be the first occupants of the 32,000-sq.-ft. center. The facility is named after Arch T. Colwell, vice president-engineering, research and development since 1937 and head of these activities for 30 years.

MOTOROLA INC. plans to sink $1.2 million into the commercial aviation electronics business it acquired from Lear, Inc. Some 400 employees will move into a recently purchased plant in Culver City, Calif., and the division's present facilities in Santa Monica will be increased by 37,000 sq. ft.

LYTLE CORP. has acquired the Allied Research & Engineering Division of Allied Record Manufacturing Co. The Hollywood facility will be operated as a division of Lytle, and continue in the production of electroformed parts, especially for missile components. Nicholas Sannella, Jr., has been named manager.

INTERNATIONAL RESISTANCE CO.'s Burlington, Iowa, division will add 30,000 sq. ft. to its present 56,000-sq.-ft. facility. A 25% boost in employment is expected to accompany the expansion.

POLARAD ELECTRONICS CORP. has made its first diversification out of the field of microwave test equipment with the establishment of the Scientific Instruments Division. It will go into development and production of precision instruments for research in chemical, biological and medical fields.

CONTINENTAL-DIAMOND FIBRE is spending over $1 million for additional treating and press equipment for its laminated plastics products at its Newark, Del., plant.

EPSCO-WEST has established a West Coast branch of its components division to handle its line of transistor digital circuit cards, modules and magnetics.

Added Space for Packard Bell

PACKARD BELL ELECTRONICS $750,000 plant covers 53,000 sq. ft. of proposed 350,000-sq.-ft. electronics complex at Newbury Park, Conejo Valley, Calif. Its Technical Products Div., advanced electronics equipment manufacturers, will be housed here.

AEROJET-GENERAL CORP. has bought Firestone Tire and Rubber Co.'s Missile Engineering Laboratory at Monterey, Calif., for an undisclosed amount. Although Firestone will retain an unimproved 10 acres at Monterey, it is moving its missile work to its Los Angeles facilities. The 10 acres purchased by Aerojet includes a 12,000-sq.-ft. building and is adjacent to the Monterey Peninsula Airport.

BELL AIRCRAFT CO.'s sale of its defense business to Textron, Inc., has been approved by stockholders. Textron will pay $22 million for the business, which it will call Bell Aerospace Corp. Bell Aircraft will be renamed Bell Intercontinental Corp. Top Bell management will go with the subsidiary. Bell Intercontinental will retain land and buildings used by the defense group, but rent them to Bell Aerospace for $1.3 million under a 10-year lease.

In another transaction, Textron acquired Dorsett Plastics Corp., fiberglass boat manufacturers in Santa Clara.

MICROLAB has begun construction on a 15,000-sq.-ft. addition which will double its manufacturing area. The Livingston, N.J., firm manufactures precision coaxial components for the electronics industry.

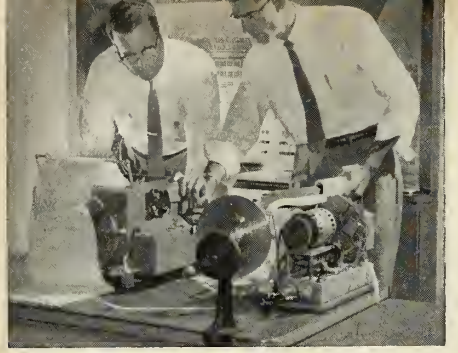
KAWECKI CHEMICAL CO., Boyertown, Pa., has purchased 50% of Penn Rare Metals common stock in a recent cash transaction . . . NEMS Clarke Co. has opened a sales and service office in Los Angeles . . . Vitramon Inc., capacitors manufacturers, has moved to a new plant in Monroe, Conn.

ULTRASONIC INDUSTRIES INC. has formed a Canadian subsidiary to market its diSontegrator ultrasonic cleaning equipment and other devices . . . Electronic Specialty Co. has established a European sales, maintenance and distribution center . . . Cain and Company has acquired Memo, Inc., a group of electronics sales engineers.

financial

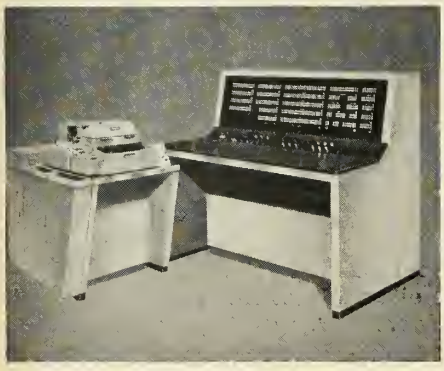
Ryan Aeronautical—A 37% increase in sales brought totals up to $51 million for the first half of the 1960 year, from $37.2 for the same period last year. Net six months income was $881,010.

Electronic Communications, Inc.—Net sales of $11.5 million were down from $18 million for the first half of 1959. Net income went down to $89,282 from $496,203. Backlog of orders was slightly up, reaching over $16 million compared to a backlog at the end of the first half of 1959 of $15.8 million.



The Univac Scientific computer is used to simulate and prove the projected design of new systems. This concept of mechanized design, which may be described as the use of one computer to build another, eliminates prototype building and attains a degree of reliability once regarded as only theoretically possible.

A technician follows the wiring diagram produced by the Univac Scientific. This application of mechanized design greatly facilitates the production of reliable automatic data processing equipment.



A significant achievement of mechanized design is the BOGART computer, produced by Remington Rand Univac, for the U.S. Navy. Intensive preliminary testing of the projected system made it possible to reduce the size of the computer while materially increasing its reliability through the use of transistors and printed circutry.

From the REMINGTON RAND UNIVAC

Military Division

Mechanized Design Dramatically Speeds Development and Increases the Reliability of New Data Processing Systems

Remington Rand Univac was the first to apply the concept of mechanized design to computer development. By using the Univac Scientific computer, the design of a projected system can be fully simulated and proved—thus avoiding the expensive, time-consuming process of prototype building.

This important technique has already made indispensable contributions to the development of such systems as the Univac LARC and Athena and the Univac Advanced Navy computer. Mechanized design has significantly aided Univac scientists and engineers in attaining the farthest limits of reliability, even under the most demanding environmental conditions.

The Military Division's tradition of excellence is firmly established by a distinguished series of defense systems. Mechanized design is another example of the outstanding capabilities which Remington Rand Univac can bring to bear on the development and production of complex computer equipment for military applications.

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Univac Park, St. Paul 16, Minnesota

Control and data systems developed by the Remington Rand Univac Military Division include:

ATHENA, the Ground Guidance Computer for the U.S. Air Force ICBM TITAN.

TACS AN/TSQ-13 (Tactical Air Control System for the U. S. Air Force)

BOMARC Computer for the U. S. Air Force Target Intercept Program

SEA SURVEILLANCE SYSTEM FOR THE U. S. NAVY

AN/USQ-20 (Advanced Computer for the U. S. Navy)

Additional information describing capabilities and experience or career opportunities may be obtained by writing to Remington Rand Univac at the above address.

Technical Countdown

ADVANCED MATERIALS

Stress Relief Metal Loss Reduced

Copper or aluminum precoats designed to protect metal parts during hot forming, stress-relieving heat treating, or annealing have been developed by Chance Vought. The precoating acts as a lubricant for subsequent forming, stops oxidation, and is easily removable.

Refractory Single Crystals in Production

Single crystals of tungsten, molybdenum, columbium, tantalum, and their alloys are in production at the Linde division of Union Carbide. The production breakthrough is applicable to other metals and expansion of the process is in progress (see story on p. 34).

Largest H-11 Tool Steel Forgings

Forward and aft rocket motor closures 40 in. in diameter and weighing 840 lbs. are being produced by Wyman-Gordon. The components represent the largest H-11 tool steel pieces ever forged in a closed die. The firm says that 50-in. diameters are possible.

PROPULSION

Stable Monopropellant

Guanidinium perchlorate, a compound with applications as an explosive or monopropellant, is now available from National Northern Division of American Potash & Chemical Corp. The compound, thermally stable to 350°C, is being produced in pilot plant quantities.

Second-hand Boosters Look Good

Recovery and reuse of large boosters have been proved feasible in studies at Rocketdyne. Rocket and turbojet engines recovered from the ocean within six hours show negligible effects of corrosion if properly cleaned. Studies are part of NASA program which calls for reuse of giant *Saturn* boosters.

ELECTRONICS

Wraps Taken Off SAGE Projector

SAGE Rapid Processing Photographic Projector (RP3) was publicly shown for the first time in London last week. The device photographs the radarscope, develops the photo, and projects it on an 18-ft. diameter screen within six seconds. The RP3 operates automatically, giving SAGE sector commanders a continuous picture of potential enemy aircraft or missiles in flight.

New Minitrack in Works

NASA's new Minitrack network is scheduled for operational status by December. The 136-mc facilities will be able to track satellites in orbits of any inclination, including polar (see story on p. 28).

A Real Hot Dish

Even antennas are being "air-conditioned" these days. Gabriel Electronics has just developed a 16-in.-diameter parabolic which is completely heated for deicing reflector and feed. Heaters are turned on automatically whenever the temperature drops below 39°F.

Radar Gets Credit for Kill

Army is being coy as to the exact nature of the high-performance radar that got credit for last week's knockdown of a *Corporal* by the *Nike-Hercules*. They cite a threefold improvement in capability but will not elaborate on specifics.

Nuclear Space APU Costly

A ¾-million-dollar AEC/Air Force contract for a 300-kw nuclear mechanical space power system was won by AiResearch Division of Garrett Corp. Major subs are Aerojet's Aetron Division (reactors) and Westinghouse (electrical generators). After an initial 18-month design-study phase, the task will eventually require 5-6 years and $8-10 million. Over 25 proposals were considered in this hotly contested project.

$$ Saved in Spite of Phone Bill

A recurring $10,000 item on Douglas Aircraft's long-distance phone bill is a welcome expense. It's the rental charge for a 2200-mile data link connecting the company's Charlotte, N.C. missile plant to its Santa Monica computer facility. Even with operating costs, total is 2/3 less than expense of a duplicate complex and up to five days are saved in obtaining computer solutions (see story on p. 38).

Hydrogen APU/Cooler Proposed

AiResearch has proposed use of liquid hydrogen in an integrated auxiliary power unit and cooling system for *Dyna-Soar* type re-entry vehicles. Based on a recently completed quarter-scale mockup, this is a state-of-the-art system, says the Division's missile system chief, J. G. Kimball—all it needs is a vehicle in which to put it (see story on p. 36).

Exotic Propagation Studied

The possibility that other than conventional antenna and feed systems can be used to advantage for UHF transhorizon propagation is part of a study being conducted by Sylvania for the Air Force. Other phases of the research will look at r-f radiation from flame-excited plasmas.

ALRI Team Chosen

The team has been chosen to produce the ALRI (Airborne Long Range Input) system for the Air Force. Burroughs Corporation is manager of the weapon system contract to produce this system for the seaward extension of SAGE. Others on the team: Electronic Communications, AC Spark Plug, Lockheed Aircraft Service, GPL Division of General Precision, Philco, and Technical Products Division of Packard-Bell.

3200-cps Power Supply for Eagle

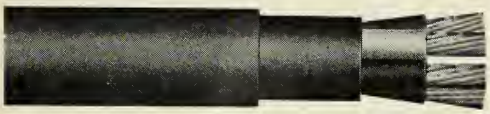
Eagle missile and its launching Missileer aircraft will be equipped with 3200-cycle electronics system instead of conventional 400-cycle. No reasons for the innovations have been given, but one advantage would be smaller size and lighter weight for power supplies.

From missile cable to magnet wire

ANACONDA OFFERS YOU A COMPLETE AND MANUFACTURE OF ELECTRICAL

Anaconda Wire and Cable Company manufactures the broadest line of wire and cable in the industry. A nationwide network of nine fully integrated plants offers cable capability marked by continuous research, product development and rigorous quality control. Some of the many complex cable constructions currently being manufactured by Anaconda are described below.

Umbilical Breakaway Cable. Anocanda designed and manufactured this 99-conductor composite breokowoy cable for the "Corporal" —one of America's first missiles.



Portable Power Cable. Designed for maximum durability and meets flome tests of the Bureau of Mines. Avoiloble with or without grounding wires, round or flat constructions.

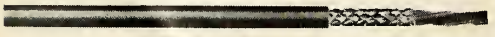
Ground Support Cable (MIL-C-13777). Power ond control cobles for interconnecting units of complex weopons systems.

Launch Control Cable. Seventy-conductor, flexible copper strand, polyethylene insulation, tinned-copper broid shield, nylon jocket, plonetory stronded, oil-, gos-, flame-, moisture-resistant over-all jacket.

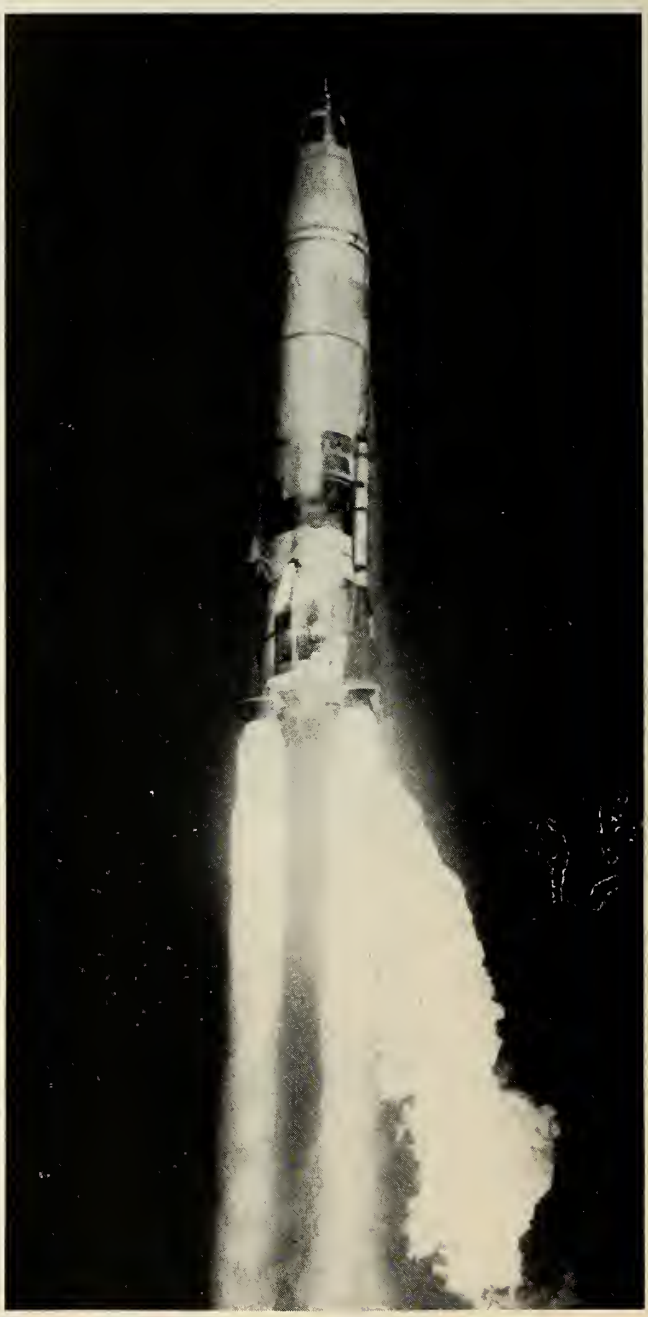
Polaris Cable. Digital tronsmission ond synchro resolver cable developed for the firing system of Poloris submorines. Withstonds open-end hydrostotic pressure of 300 psig.

Nuclear Reactor Cable. Developed by Anocondo far U.S. Navy. In oddition to its absolute wotertight features withstonds high-temperoture operations in the order of 500 F.

Instrument Probe Cable. Miniature cooxiol construction. No. 40 Awg Evonohm resistance conductor, cellulor polyethylene insulation, tinned-copper braid shield, PVC jacket. Overall diameter 0.100".



Radiation Resistant Satellite Cable. Four-conductor miniature construction. Tinned-copper conductors, color-coded HYRAD [irrodioted polyolefin] insulotion, flome-retardont, 90% copper broid shield, irrodioted HYRAD jocket overoll.



THE COMPLEX ELECTRICAL NERVE SYSTEM of many of America's prime missiles, such as ATLAS, TITAN, POLARIS, is composed of many specially designed cables built by Anaconda to strictest military specifications. This proven experience is ready to solve your most critical cable problems.

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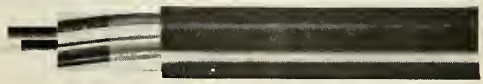
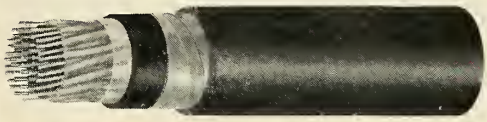


Computer Cable. Multiconductor construction for interconnecting units. Conductors to MIL-W-16878, extruded nylon jacket over primary PVC insulation, tinned-copper braid shield, color-coded PVC jacket over each pair, overall PVC jacket.

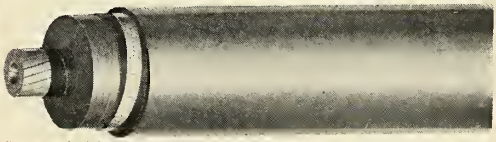
260C High Temperature Missile Cable. Silver-plated copper conductors, fused-wrapped Teflan insulation, flar-glass tape abrasion barrier, Teflon impregnated fiberglass inner braid, silver-plated copper braid shield 90% coverage, Teflan impregnated fiberglass outer braid, conductors cabled, Teflan impregnated fiberglass braid overall.

Quality Military Hook-up Wire. Single and multiconductor, shielded or nonshielded, PVC, Polyethylene, nylan, Teflan, HYRAD insulations, with plastic or braided jackets. Fully water-tested.



Communication Cable — High Reliability. Direct burial telephone cable specially designed for missile complexes. High-molecular-weight polyethylene insulation and jacket, cadmium bronze tapes for shielding and mechanical protection.

High Frequency Cable. Custom designed to meet all industrial and military requirements. Flexible, shielded, coaxial and triaxial cable as radio-frequency lines in radar and communications systems.



Power Cable. For generation, transmission, distribution and utilization of electric power. Paper, rubber, plastic, cambric insulation. Solid, gas-filled, oil-filled or pipe type. All voltages up to 345KV.

Magnet Wire. Round, square and rectangular magnet wire in any single or practical combinations of film or fibrous coverings. Epoxy, enamel, Formvar, nylan, cotton, paper, glass-fiber yarn. Solderable Anolac. 250C Silicone-Teflan. 500C Silatex-N.

For more information about any one of the product categories mentioned on these pages, write: The Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York. 60255

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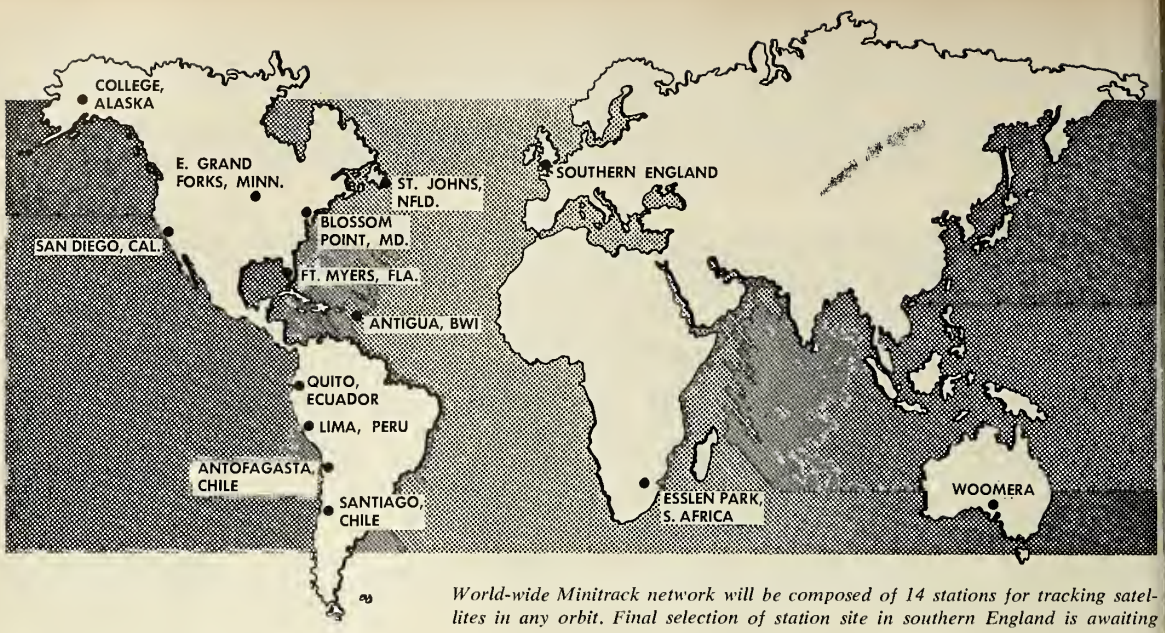


World-wide Minitrack network will be composed of 14 stations for tracking satellites in any orbit. Final selection of station site in southern England is awaiting outcome of current negotiations. Each station will get at least two new receivers.

ground support equipment

New Minitrack to Cover All Orbits

by Hal Gettings

A new NASA Minitrack satellite tracking and data acquisition network is scheduled to be in operation by December of this year. The 14-station, world-wide facility will use the new 136 mc band authorized by the International Telecommunications Union.

According to Robert Coates, associate chief of the space agency's tracking system division, the new network will be similar in many respects to the highly successful Minitrack dedeveloped to track low-inclination IGY satellites. But it will incorporate many new features to make it possible to track satellites at any inclination, from equatorial to polar. Existing 108 mc facilities will be retained.

• **Based on interferometer system**—The Minitrack system uses the interferometer principle for determining satellite positions. Two pairs of antennas, one on an east-west baseline and the other on a north-south, are used to measure the two direction cosines needed to specify the satellite's positions and determining orbits.

The long-baseline interferometers for the 136 mc band will be fitted inside the present 108 mc equipment so that the center of the two systems will be at the same point. The individual antennas of the long-baseline interferometers—or "fine" systems—are eight-element slot arrays with a fan-shaped beam of approximately 10° by 47°.

Present 108 mc stations have the beam oriented north-south, for best interception of satellites traveling roughly east-west in low-inclination orbits.

The new 136 mc facilities will consist of two different interferometer systems. One system will have the fan beam oriented north-south for low-inclination orbits, and the other will have an east-west orientation for high-inclination (including polar) orbits.

The 108 mc ambiguity antennas cluster around the center of the antenna field. Consequently, the new 136 mc ambiguity antenna complex is located away from the center. The off-center location introduces a small parallax error in the calibration which must be compensated for.

The 136 mc ambiguity antennas have symmetrically shaped beams about 75° wide. This allows the use of one set of ambiguity interferometers for both high- and low-inclination orbits. Baselines of each pair are 3.5 and 4.0 wavelengths—since the physical size of suitable antennas makes half-wavelength baselines impractical. Equivalent 0.5 and 7.5 wavelength baselines will be obtained by combining the phase signals of the 3.5 and 4.0 wavelength baselines to resolve the ambiguities of the long baselines.

New tracking receivers for measuring the phase difference between antennas will use the same unique principle of operation as the present 108 mc receivers. Each receiver contains two separate front-end chassis, each connected to one of the interferometer antennas. The two front-end output signals—separated in frequency by a 100 cps phase-locked difference in their respective local oscillators—are combined and fed into the first i-f amplifier. Only minimum gain is used prior to combination, in order to reduce the drift in differential phase between the two signals. After combining, both signals travel through the same i-f amplifiers and mixers to further reduce the possibility of appreciable differential phase shifts.

The 136 mc receivers are triple-conversion superhetrodynes with a predetection bandwidth of 10 kc. They have a noise figure of about 3 db and a dynamic range of 70 db or more.

The outputs of each receiver contain both analog and digital phase meters. The system is designed so that one digital bit is equal to approximately four seconds of space angle in the most sensitive part of the interferometer pattern.

The analog and digital phasemeter outputs will be recorded on multichannel strip-chart recorders along with time signals. In addition, in the near future an automatic digital punch will put the phase readings of all the antenna combinations and a time reference on teletypewriter tape five times a second for immediate transmission to the NASA computing center. The computer is programed to automatically reduce the data and then use it for orbital computation.

• **New equipment for data acquisition**—The main telemetry antenna for the new band will be a self-tracking quad-yagi with a gain of approximately 19 db. The antenna will have crossed yagis permitting diversity reception on two orthogonal linear polarizations, or on circular polarization. The 4-yagi elements will be arranged for phase monopulse operation for automatic tracking. Tracking receivers will be very similar to those just described.

The unique X-Y antenna mount was designed specifically for tracking satellites over the entire sky above a 15° horizon. It has no gimbal-lock positions above the 15° elevation. The ratio of shaft velocity to tracking velocity is unity at the zenith where satellite angular velocities are a maximum; the velocity ratio is high only near the horizon where satellite angular velocities are low. With this combination, excessive shaft velocities are not required. The antenna will follow any satellite pass including the close approach of one in a highly eccentric orbit.

There will be at least two new 136 mc telemetry receivers at each of the 14 stations in the Minitrack network. The receivers are being developed specifically for data acquisition from satellites. The receiving system will consist of low-noise preamps mounted on the antenna and the main receivers located in a nearby building. The preamps will have a noise figure of 3 db and a bandwidth of 3 mc centered at 136.5 mc. The new receivers will also be able to obtain doppler data.

Equipment will be available at each station for direct simultaneous magnetic-tape recording of the undetected and detected telemetry signals from the receivers.

Each station will have only enough data reduction equipment to permit monitoring system operation. It is not planned to have data processing at every station except for special cases where real-time reductions are necessary.

A central facility has been installed at the Goddard Space Flight Center for reducing data on the magnetic tapes from all the stations. At the present time, this center is equipped to handle PDM/FM-AM and FM-FM telemetry. Instrumentation for other types of telemetry is being acquired. Methods to improve the speed and accuracy of data reduction are being developed.

• **Precision time standard added**—Each station in the 136 mc network will have a new precision time standard to provide coded time signals and standard frequencies. Frequencies of 1 kc, 100 pps, and 1 pps are fed to a digital clock which continues the countdown to one pulse per 24 hours and provides a visual display of time in hours, minutes, and seconds.

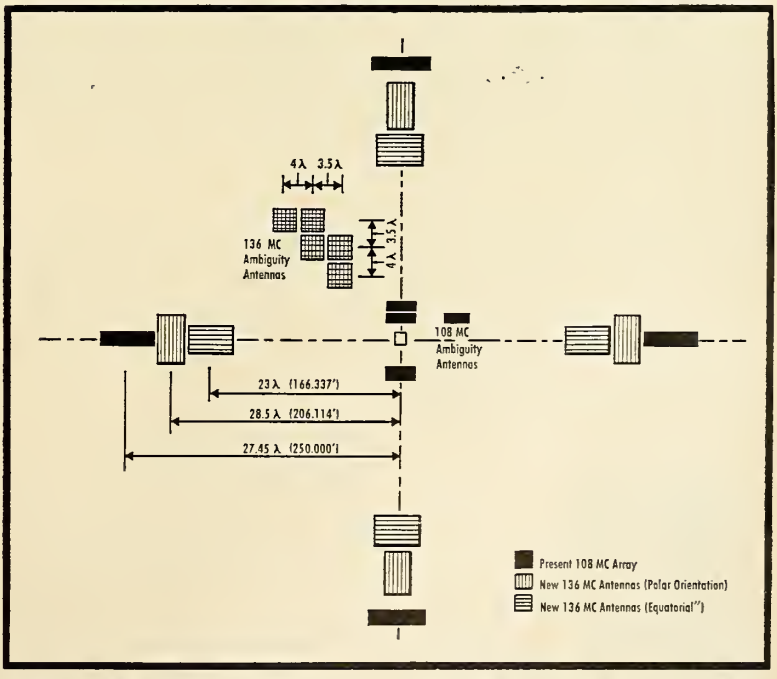
The digital clock also produces two time codes. The first is a combination 1 pps time signal and a serial-digital code of the time in tens of hours, hours, tens of minutes, minutes, tens of seconds, and seconds. This time code is used for precision time marks on strip-chart recorders.

The second time code was designed for putting accurate time on magnetic-tape recordings of telemetry signals in a form compatible with electronic computers for automatic data reduction. This code consists of time-of-year (GMT) in seconds, minutes, hours, and day of year. A complete time frame occurs once each second.

At present, the time standards at each station are synchronized with WWV within ±2 milliseconds. Uncertainties and variations in propagation delay time cause most of the errors in adjusting the time standard. Recent measurements of VLF propagation times indicate that it should be possible to make radio synchronization of clocks ten times more accurate—or better—using VLF instead of WWV frequencies. This is being investigated at Goddard for use at the Minitrack installations.

• **Calibration accuracy two seconds of arc**—Both the present 108 mc and the new 136 mc Minitrack are calibrated by comparison of the optical and radio positions of a night-flying air craft photographed against a star background (M/R, 5/2/60). System calibration accuracy is two seconds of arc, an order of magnitude better than the Minitrack system probable accuracy of 20 seconds of arc.

• **Future will demand higher frequencies**—The 136 mc instrumentation has been designed to meet future requirements for data acquisition and satellite tracking in that band. The bandwidths needed for tracking are relatively small; the total bandwidth required for tracking will fit into the



NEW 136 MC antenna installations will be fitted inside present 108 mc interferometers. Phase-angle difference detected by paired antennas yields satellite position data. Parallax error due to off-center ambiguity antenna location is compensated for.

136 mc band even though the number of satellites in orbit greatly increases.

Tracking at higher frequencies will be necessary in the future, when experiments will demand greater accuracy than that obtainable with present equipment. As an example, geodetic problems such as establishing accurate continental ties will require greater tracking precision.

Systems for precision radio tracking of satellites should operate at frequencies higher than 136 mc, to reduce the effects of ionospheric refraction. Therefore, the bands in the gigacycle range probably will be used for this purpose. A preliminary study of systems for precision radio tracking has been started at Goddard. This will form the basis for the development of a radio tracking system with an accuracy of a few seconds of arc.

The 136 mc band will not accommodate the bandwidths needed for future data acquisition. The sum of the bandwidths required for NASA satellites scheduled for launching in 1961 is about equal to one megacycle—the total bandwidth in the 136 mc band. A greater number of satellites are scheduled in each of the following years; many of these will be large, complex vehicles which will require wide bandwidths for data transmission.

For example, the projected orbital astronomical observatory will be sending TV pictures to earth. Project *Nimbus* satellites will require several megacycles bandwidth for transmission of TV photos. It is apparent that the heavy load of narrow-band telemetry and the additional wide-band telemetry requirements in the near future will demand data acquisition equipment in the 136, 400, 1427, and 1700 mc bands.

A primary disadvantage of the higher frequencies is that satellite-to-ground propagation loss increases as the square of the frequency. To keep satellite transmitter power requirements reasonable, it is necessary to increase antenna gains to compensate for this loss. The gain must be accomplished at the ground station since larger and/or directional antennas on satellites pose too many problems to be practical at present.

NASA is planning several satellites which will have highly eccentric orbits. These satellites will call for very-high-gain antennas for telemetry reception at the long ranges of apogee. Other satellites will require the high gain of a large antenna because of the very wide bandwidth required for telemetry. Some special projects will have both wide-bandwidth and long-range requirements—necessitating the use of high antenna gain for data acquisition.

Tory IIA Testing Will Emphasize Safety

JACKASS FLATS, NEV.—Testing of the Tory IIA nuclear ramjet reactor for the *Pluto* program, to begin here by November, will strongly stress detailed data returns and system safety.

Construction of the maintenance and disassembly building for Tory IIA is well under way, and should not delay the test program. Test cell facilities, now virtually complete, include numerous high-pressure tanks, some built of stainless steel.

Reactor design, directed by the Lawrence Radiation Laboratory of the University of California, is virtually complete; it will change only in minor respects before test firing, according to the Atomic Energy Commission.

Three LRL scientists, C. S. Barnett, H. C. McDonald and P. M. Uthe, told the American Rocket Society recently that several hundred data pickup points will be incorporated into the Tory IIA system, which has a small, high-power-density, air-cooled reactor designed for high-temperature operation.

They said the instrumentation used for basic data collection will also be used, in the interests of simplicity and economy, for control of the reactor experiment. Separation of the two functions was not considered necessary because of the nature of the nuclear experiment.

• **Many channels**—The control room housing the recording and indicating equipment is about two miles from the unshielded reactor in its test bunker. Cables carry signals from the reactor and facility transducers to the control room, after amplification in the test cell.

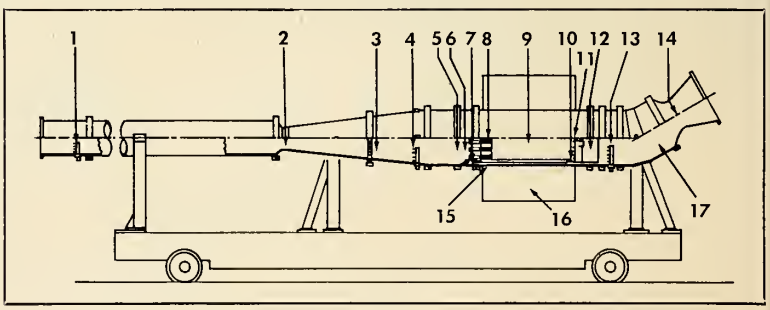
The Tory IIA recording and indicating system revolves around 258 channels of 1.5 cps, pulse-width modulation tape recording equipment, and 72 channels of 120 cps analog strip chart recorders. Additional instrumentation includes meters, scalers and slow response strip chart recorders.

LRL lists the physical quantities to be measured as:

• Neutron flux level of the reactor core and time rate of change in the flux level.

• Air flow rate through the reactor.

• Air temperature and pressure distribution at the reactor core entrance



1—Two total pressure rakes with four probes each. Two total temperature probes (rakes on horizontal center line). **2**—Two static pressure taps. **3**—Two static pressure taps.

4—Two total pressure rakes with four probes each (rakes on horizontal center line). **5**—Three vibration accelerometers, one vertical, one horizontal, and one axial. **6**—Two static pressure taps. Three wall temperature taps. **7**—Three vibration accelerometers, one vertical, one horizontal, and one axial, mountd on front structure. **8**—Eight high-temperature strain gauges mounted on tension rods. **9**—168 thermocouples within core. **10**—Three vibration accelerometers, one vertical, one horizontal, and one axial, mounted on base plate. **11**—One total temperature rake with 19 probes. **12**—Three vibration accelerometers, one vertical, one horizontal, and one axial.

13—Two pressure rakes with four total pressure probes each. One static pressure probe each. Two total temperature probes each. Three wall temperature taps (rakes on horizontal center line). **14**—Two static pressure taps. Three wall temperature taps. **15**—49 ambient temperature strain gauges on structural core components. **16**—13 thermocouples within core, four on reflector, nine on reflector vanes. **17**—Four wall temperature taps.

and again at its exit.

• Material temperature distribution within the core.

• Dynamic and static strain (stress) in the core support structure.

• Vibration of large structural components of the reactor.

• Operating temperatures of auxiliary components.

The neutron flux level and time rate of change of flux level are required for analysis of the reactor behavior and for feedback to the reactor control system.

Air flow and heat transfer characteristics of the Tory IIA core are determined by air temperature and pressure distributions at the reactor extremities and the air flow rate through the reactor core. Complete determination is made with inclusion of data pertaining to temperature of core components. Similarly, these parameters (gas temperature and pressure, and materials temperatures) also serve to warn of dangerous conditions in the core.

Core support structure is instrumented for strain at design pressure differentials before high power and high temperatures are applied. Results are used to predict safety of the structural members when design conditions are applied. The strain gages in the system will not be in operation during high-temperature conditions in the reactor.

Vibrational characteristics of the reactor will be determined through pickups for acceleration and velocity mounted on the core support structure and the air ducts. Since system safety is the prime consideration, there will be little effort to make a detailed breakdown of vibration data.

System safety is also the prime consideration in measurements of the auxiliary components temperature. Nearly all these subsystem outputs are used in a go/no-go manner; they are expected to have little effect on the principal operation.

• **Nuclear measurements**—Eleven nuclear detectors in the system will keep tabs on reactor power from shutdown level to 1000% design power. In addition, an air exhaust monitoring system will detect fission product activity. AEC officials have previously stated that fission products introduced into the atmosphere by the *Pluto* nuclear ramjet will not be any greater than that introduced by the *Rover* nuclear rocket. Two scintillation beta counters in this subsystem will give a semiquantitative indication of airstream activity.

The most extensive measurements in the entire system will be made on the temperatures involved, since the Tory IIA is characterized by its very high operating temperatures. A total of 243 thermocouples for such data collection will cover ranges from room temperatures up to 2000-3000°F. The bulk of these thermocouples, most of them standard design, will be placed in the core fuel elements and structural parts.

Pressure data will be obtained through 36 or more pressure transducers, not including standard dial-type pressure gages. Included in this count are the unbonded strain gages made by Consolidated Electrodynamics Corp., and the Giannini potentiometer types. Pressure measurements range up to 600 psi.

The considerable amount of air mass flow through the core lends a great deal of importance to vibration and strain measurements. Six Endevco 2242 vibration transducers (5-120 cycle) will be mounted on the core, and six Consolidated Electrodynamics 4-121 radiation-resistant vibration transducers (20-2000 cycle) on the air duct structure. The core transducers are expected to be removed after the pre-nuclear blowdown tests and prior to the nuclear power operation.

Prior to nuclear operations, a room temperature blowdown strain survey is planned for core structural members. For these tests, 61 strain gages are

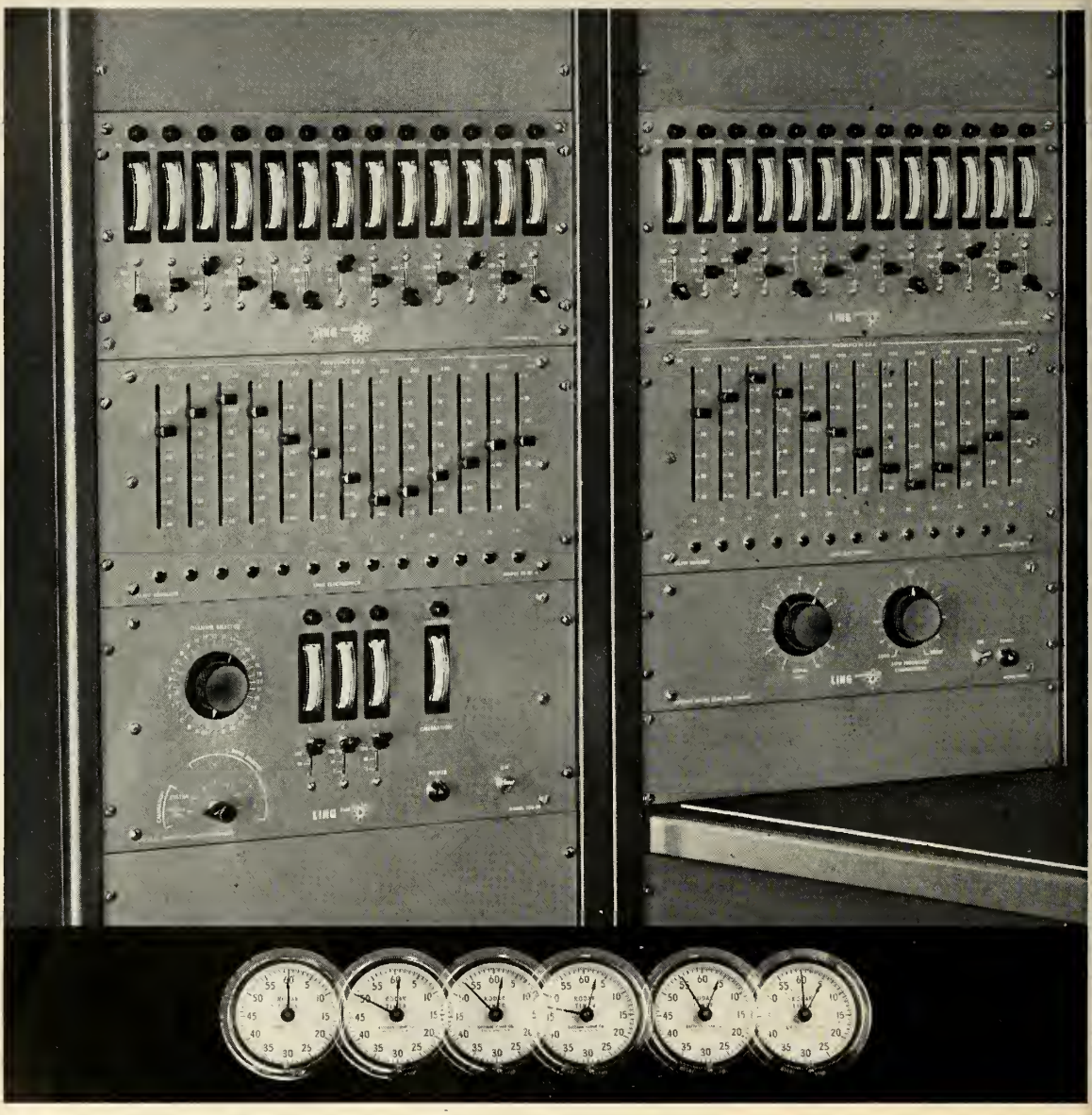
Who Does What for Pluto—

Three organizations are prime contractors on Project Pluto, *the Air Force-Atomic Energy Commission program for developing a nuclear ramjet engine. They are Lawrence Radiation Laboratory of the University of California, Atomics International Division of North American Aviation, and the Marquardt Corp.*

Lawrence Radiation Laboratory has overall system responsibility and does theoretical and laboratory work on the reactor. Atomics International does materials research. Marquardt does engine design and provides laboratory engineering of non-nuclear components.

There are four major subcontractors: American Car & Foundry Corp., Curtiss-Wright Corp., Brush Beryllium Co. and General Electric Co. ACF builds the reactor shell and a car to hold it in the test program. Curtiss-Wright's Research Division is studying the properties of beryllium oxide for use as reflector and moderator material. Brush Berylliuin provides the beryllium compounds. The GE Aircraft Nuclear Propulsion plant is developing fuel elements.

Three companies—Chance Vought, North American and Convair—have made studies for the Air Force of a Pluto-*propelled missile named* SLAM *(Supersonic Low-Altitude Missile).*



LING BREAKS THE RANDOM TEST TIME-BIND WITH A NEW FAST SET-UP

Now Ling brings you another breakthrough in random noise testing. Ling's new Equalizer-Analyzer system lets you set up a shaped input in minutes, analyze unknown variations at a glance and equalize spectrum shifts even while the test is in progress. The simplified controls of this remarkable system feature a series of separate adjustable attenuators which split the entire bandwidth of 10 to 2000 cps into segments of 100 cps or less, giving the operator independent control over each segment. Band-pass characteristics of the analyzer filters are matched to those of the equalizer, giving the operator a continuous picture of shaker acceleration output, calibrated directly in g^2/cps, segment by segment, for an analysis that is 30 times faster than the usual sequential scanning method. Corrections in energy distributions can be made in minutes simply by adjusting the filter attenuators. Enables fast set up without the tedious wait for slow types of analysis, gives you sure control and a correct-as-you-test system. For details, write for a copy of a recent paper on the subject by J. A. Ross, Vice President, Research and Development. And for electronics that help you get out of prototype into production *fast*, look to the leader—Ling Electronics.

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mounted throughout the core. Fourteen are high-temperature gages providing data up to 1000°F, the remainder are standard paper gages.

Air mass flow rate will be measured via a system using one 12 in. x 5 in. and one 22 in. x 14 in. venturi tube. These are equipped with temperature-compensated absolute and differential pressure transducers. The flow rate of interest lies between 3 and 1000 lbs./sec. To cover this range, five differential and four absolute pressure transducers are needed. Outputs of these pickups is controlled through a switch in the control room.

• **Operation**—The principal characteristic of the Tory IIA system is its versatility, according to the Lawrence Lab. "Due to the nature of the experiment," it says, "instrumentation requirements are constantly changing with respect to both the number and type of instrumentation channels necessary." Some requirements, the laboratory adds, will not be known until after initial field tests have been conducted.

A major requirement of the instrumentation system is that test conductors have a "quick look" presentation of critical parameters. This would enable the operating personnel to scan and assimilate a large amount of pressure and temperature data for proper test operation.

If trouble develops in the reactor core during a power run, the operation director can cause a "scram" in a number of ways. This appropriate word —scram—refers to the rapid reduction of reactivity within the core. It can be achieved by applying full control rod effects to the core and/or introducing a substance such as boron to the core, thus absorbing neutrons and squelching the nuclear reaction.

LRL and its associated contractors hope to avoid a scram at full power; the reactor can routinely tolerate scrams at lower power levels. A scram selector switch on the nuclear console permits the operator to select the number and kinds of things which he wants to cause a scram.

• **Data collection systems**—One of two main data collection systems in the Tory IIA setup is that consisting of three units of ASCOP (Applied Science Corp. of Princeton) 1% accuracy, 1.5 cps bandwidth, pulse-width modulation data systems.

The second principal system is comprised of nine 8-channel Offner Dynograph recorders to provide ink records of outputs from strain gages, vibration pickups and pressure pickups which have frequency components of interest up to 150 cps.

Flow rate and temperature of air supplied to the reactor by the blow-down facility is computed and displayed in the control room. Operators in the control room determine the air temperature and flow rate from large circular indicators. A small analog computer supplies these indicators with a voltage proportional to air flow rate and temperature. The computer inputs are the signals transmitted from the flow and temperature transducers. Minneapolis Honeywell Electrick MV/1 transmitters are used for direct cable transmissions of these signals.

The mass flow measurement system is being supplied by CompuDyne Corp.; preliminary design was by the Marquardt Corp.

Another feature is a Raytheon "Rayspan" spectrum analyzer for monitoring and analyzing transient and steady-state noise and vibration wave forms expected to occur at various points.

An Ampex 14-channel tape recorder will provide continuous recording of data with frequencies above 150 cps. This data may later be resolved and analyzed with the Rayspan unit.

The control console in the Tory IIA control room is designed to be operated by eight men: operation director, nuclear operator, nuclear control engineer, coolant engineer, air temperature operator, air flow operator, core data observer and data collector.

CPI Wins Navy Contract For Studies on Skimmers

Stability and control problems with ground-effect machines will be studied by Cleveland Pneumatic Industries, Inc., for the Office of Naval Research.

The recently won contract will provide a one-year program to analyze over-water operation of such air-pressure-suspended vehicles. Three principal areas will be investigated by Cleveland's Systems Engineering Div.: (1) response to a generalized forcing function, (2) effect of annular jet interaction with a deformable surface, and (3) general characteristics of manual control systems.

Dual-Thrust Tartar Motor In Production for the Navy

Booster and sustainer are in a single unit in the *Tartar* surface-to-air Navy missile, Aerojet-General reports.

The powerplant has a high-thrust, short-duration booster that launches and accelerates the missile to supersonic speed. Then a lower-thrust, longer-duration sustainer maintains speed. Aerojet said it is the first dual-thrust, dual-grain solid propellant motor to go into production for the Navy. Aerojet was recently awarded a $2.5 million production contract.

Big Single Crystals Grown en Masse

Linde uses arc fusion method to produce boules free of inclusions, sees it as big advance in technology

by John F. Judge

Large single crystals of the refractory metals are being grown by the Linde Co., division of Union Carbide Corp. on a mass production basis.

Details of the process have not been revealed. It is known, however, that an arc fusion method similar to the Verneuil flame fusion process is involved.

The Verneuil process is used in Linde's production of synthetic sapphires, star sapphires and oxide crystals. Its principal advantage, carried over into the new development, is that no container for the molten substance is required. In addition, wider temperature and atmospheric ranges result when an electric arc is substituted for combustion flames.

The boules grown in Linde's East Chicago plant range up to a maximum of 12 in. long and 0.75 in. diameter. Each boule, the company says, is free of inclusions.

• **Effect of inclusions**—The danger of chemical attack is increased with the presence of inclusions, which also have an undesirable effect on mechanical properties. Linde says that the boules are more ductile and can be worked at much lower temperatures than currently available polycrystalline specimens. Threads have been tapped into single-crystal tungsten bolts without cracking.

• **Crystallographic direction**—The production boules are also characterized by homogeneity and controlled crystallographic orientation. The crystals now available have random orientations. In the metal crystals, according to Linde, the most likely orientation is with the <100> direction making an angle of 30° with the cylinder axis.

Special crystals can be made where the <100>, <110>, or <111> crystallographic directions are parallel to the cylinder axis of the "as grown" crystal. These special orientations are accurate to within ±5°.

A certain amount of lineage in each of the crystals can be expected, says Linde. Lineage, in this case, is defined as areas which are misoriented with respect to each other by not more than 5°. Tungsten crystals up to 0.25 in. diameter can be grown without lineage. Preliminary studies indicate that other metals may be grown without lineage in smaller diameter sizes.

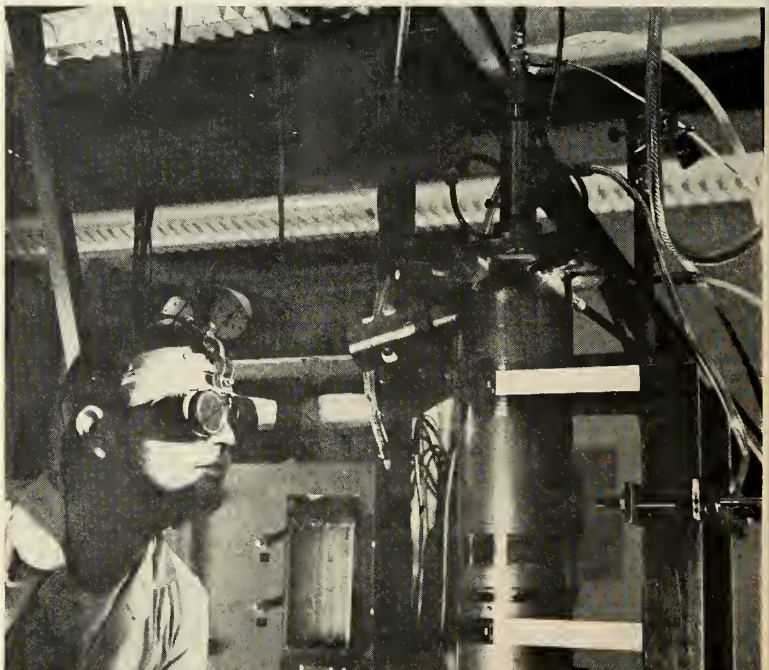
There are no grain boundaries or porosity in the boules. Extremely high purity has been achieved.

• **Theoretical importance**—Tungsten apparently is the only body-centered cubic crystal that is a true cube. For this reason there is theoretical interest in single crystals of this material —the equations governing can be applied without alteration. The absolute single crystal, if obtainable, will help significantly to increase knowledge of the nature of metals.

• **Crystals in stock**—Linde has nine refractory materials available in single-crystal form—tungsten, molybdenum, vanadium, columbium, tantalum, titanium carbide, titanium monoxide, titanium sesquioxide and molybdenum disilicide. Materials to be available in the near future include columbium carbide, vanadium sesquioxide, titanium diboride and tungsten disilicide. Crystals are in the "as grown" form and in swaged or fabricated shapes. Some of the non-metal crystals are expected to find applications as semiconductors in high-temperature and corrosive enviroments.

According to Linde, the development has removed ". . . a serious limitation on progress in the science and technology of high-temperature materials." The National Academy of Sciences has referred to lack of single crystals as a handicap in this area.

Linde is pressing research on the expansion of the crystal growth process, and creating and characterizing new single crystals.



ARC FUSION PROCESS is carried out in individual furnaces. The single crystals produced can be worked at lower temperatures than conventionally produced refractory metals and retain their characteristic qualities.

Materials Analysis Aided By CEC-built Spectrometer

The first commercially available mass spectrometer to qualify as a materials research instrument has been developed by Consolidated Electrodynamics Corp. and delivered to the Air Force's Wright Air Development Center, Wright-Patterson AFB, Ohio.

The high-resolution instrument is expected to contribute in areas that have traditionally defied analysis by commercial means.

According to CEC, the spectrometer is capable of identifying and estimating trace impurities in solids such as semiconductors, ceramics, cermets and high-performance structural materials. Its use makes possible the detection of metal impurities of less than one part per million.

High molecular weight polymeric molecules can be structurally identified with the instrument. The mass range is 2 to 2000.

Unknown materials can be identified through molecular weight information supplied by the spectrometer. Positive separation between molecules such as N_2 and CO is possible even though their molecular weights differ by as little as 1 part in 2500.

A double-focusing resolving system, in combination with a radio-frequency spark ion source, extends the analysis capabilities to cover solids. The mass resolving system is of the Mattauch-Herzog type and simultaneously differentiates between ions within a sample which have the same mass but different velocities.

The spectrometer was developed with the assistance of an R&D contract from WADC by the Central Research Division of CEC, subsidiary of Bell and Howell.

Hydraulic System Seals For Space Under Study

The effect of moon-orbiting conditions on fluid power system connections will be investigated by Republic Aviation Corp. under an Air Force contract totaling $80,000.

According to program requirements the metallic seals must be capable of leakproof operation in temperature ranges from –320° to 800°F.

The vastness of space and the increased altitudes of advanced aircraft are placing greater dependence on fluid power systems for servomechanisms and remote controls.

William Mayhew, chief of Republic's Fluid Systems Laboratory, says that the seal, or gasket, is the key element in the successful operation of such hydraulic systems.

Integrated Power-Cooling for Space

Dramatic weight saving is effected in AiResearch unit using liquid hydrogen; system is designed for Dyna-Soar type space craft

by William J. Coughlin

LOS ANGELES—An integrated power and cooling system employing liquid hydrogen has been proposed for boost-glide re-entry vehicles of the *Dyna-Soar* type by the AiResearch Manufacturing Division of Garrett Corp.

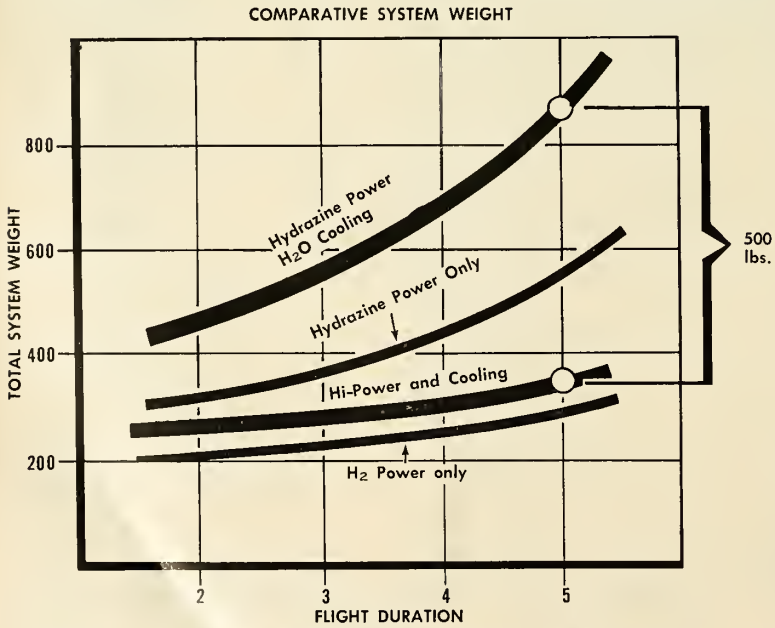
The system is designed to provide secondary power for control, communications and other electronic equipment together with cooling for that equipment, for the pilot and for re-entry. It will supply all necessary power except that for propulsion, and is reported to substantially reduce total vehicle weight.

A quarter-scale mockup has been constructed and AiResearch reports that all hardware needed to put the system together already is in existence.

"Integration of the two systems is the problem, not the development of components," says John G. Kimball, assistant to the chief of missile systems. "We are ready to go ahead with the project. We could have built it some time ago on a state-of-the-art basis, but until now there has been no vehicle to use it."

The system is designed to provide integrated power and cooling for both orbital and space missions for periods between 10 minutes and 14 days. For power requirements of less than 10 minutes, solid propellants or batteries generally are more applicable. Beyond 14 days, solar or nuclear powerplants take over—as fuel requirements of the hydrogen system begin to exceed the fixed weight penalty of those plants.

• **Exploiting cooling**—Basis of the system is liquid hydrogen's potential as a coolant. Its principal competitor as a fuel in this application—hydrazine—has no cooling potential of its own.



HYDROGEN UNIT is 500 lbs. lighter than dual N_2H_2 and H_2O system.

Hydrogen stored at minus 419.72°F, for example, when heated to 285°F will absorb 2545 BTU's in one lb. of hydrogen while at the same time producing one h.p., Kimball points out. The power system, in effect, provides a heat sink for the use of life support engineering.

One difficulty in selling this concept, the AiResearch missile engineer says, has been that historically power and environment have been approached in the aircraft industry as separate problems. AiResearch, one of the few U.S. firms active in both fields, is pushing the integrated concept as a significant weight saving.

Under the AiResearch proposal, hydrogen flows from the tankage through a cooling loop, through a power loop and then overboard.

The cooling and power potentials can be exploited in various applications. Where use of lithium hydroxide presents a weight problem for carbon dioxide removal, with one lb. of lithium hydroxide required to absorb one lb. of CO_2, two heat exchangers can be employed in the hydrogen system to freeze out the CO_2, using them alternately with provision for ice removal.

For vectoring and attitude control, mid-course corrections, and re-entry alignment, a backpressure system can be used on the turbine exhaust to provide low thrust levels at a relatively small cost in fuel. Higher thrusts can be obtained by employing a separate system fed directly from the common hydrogen tank.

Use also can be made of the liquid hydrogen for infrared detector cooling. Kimball notes that while liquid helium cryostats offer considerable potential in this application, the power required to achieve the extremely low temperatures entirely by mechanical refrigeration appears exorbitant, on the order of 4000/1 watts. By placing the helium cryostat in the liquid hydrogen tank, the power requirement—to bring the temperature down from minus 419.72°F. instead of ambient—can be

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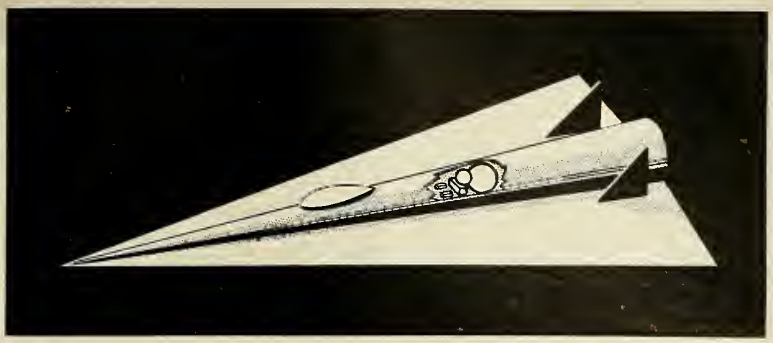


LOCATION OF power/cooler in space vehicles is ahead of propulsion unit. Below is quarter-scale mockup of unit. The small tank holds LOX and under it are heat exchangers and turbines. The large tank holds LH_2.

reduced to a more acceptable ratio of 10/1 watts.

For fail-safe protection in a manned vehicle of the *Dyna-Soar* type, dual systems are provided, including twin turbines, alternators and overboard exhausts. The second system is not a standby. Both operate at half-capability and are able to carry the full load alone if necessary. Components include:

• **Tanks**—Thin-wall vacuum-jacketed tanks in a conventional approach to liquid hydrogen and oxygen storage. A specific mission such as *Dyna-Soar* would call for a 4-ft.-diameter hydrogen tank.

• **Heat exchangers**—These are the result of an extensive research program on hydrogen exchangers which AiResearch has been conducting for some time. They are of shell and tube construction.

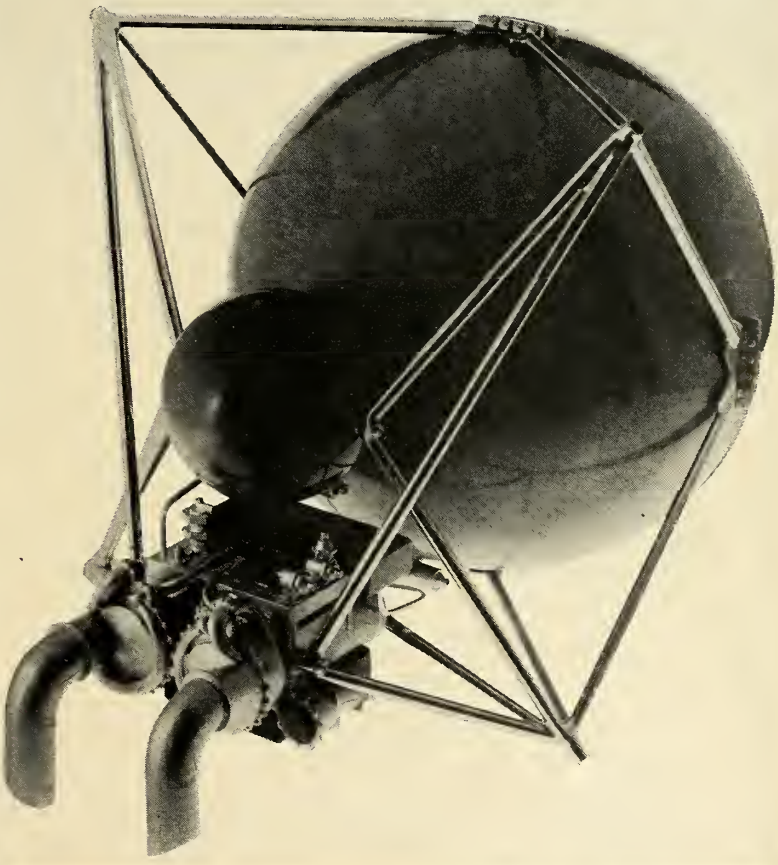
• **Combustors**—A simple small tube with a single spark plug. Oxygen is burned with the hydrogen to raise temperatures at the turbine inlet.

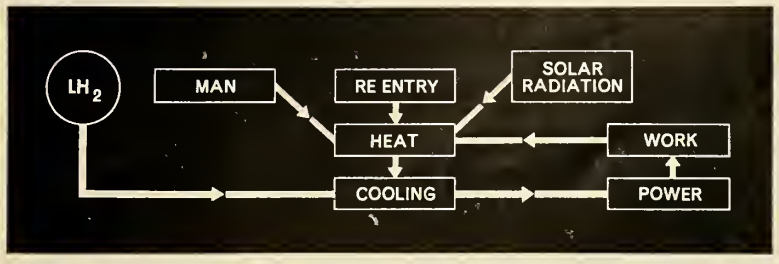
• **Turbines**—A multiple-entry turbine with axial blades. In this the hot gas is fed onto the turbine three times since, due to the large pressure ratio, the wheel cannot absorb the full energy in a single input.

"Since the fuel must be carried aboard, anything that can be done to reduce the fuel consumption by improving turbine performance becomes important in weight saving," Kimball explains. "But once you reach the point where cooling dictates the hydrogen flow, as in the manned vehicle, further improvement in turbine performance is not important."

• **Electrical equipment**—Since almost all space electronics employs a conventional 400-cycle operation, this probably will be provided although use of 3200-cycle power would permit direct driving of the alternator with the turbine, thereby eliminating the gearbox and sharply lowering weight.

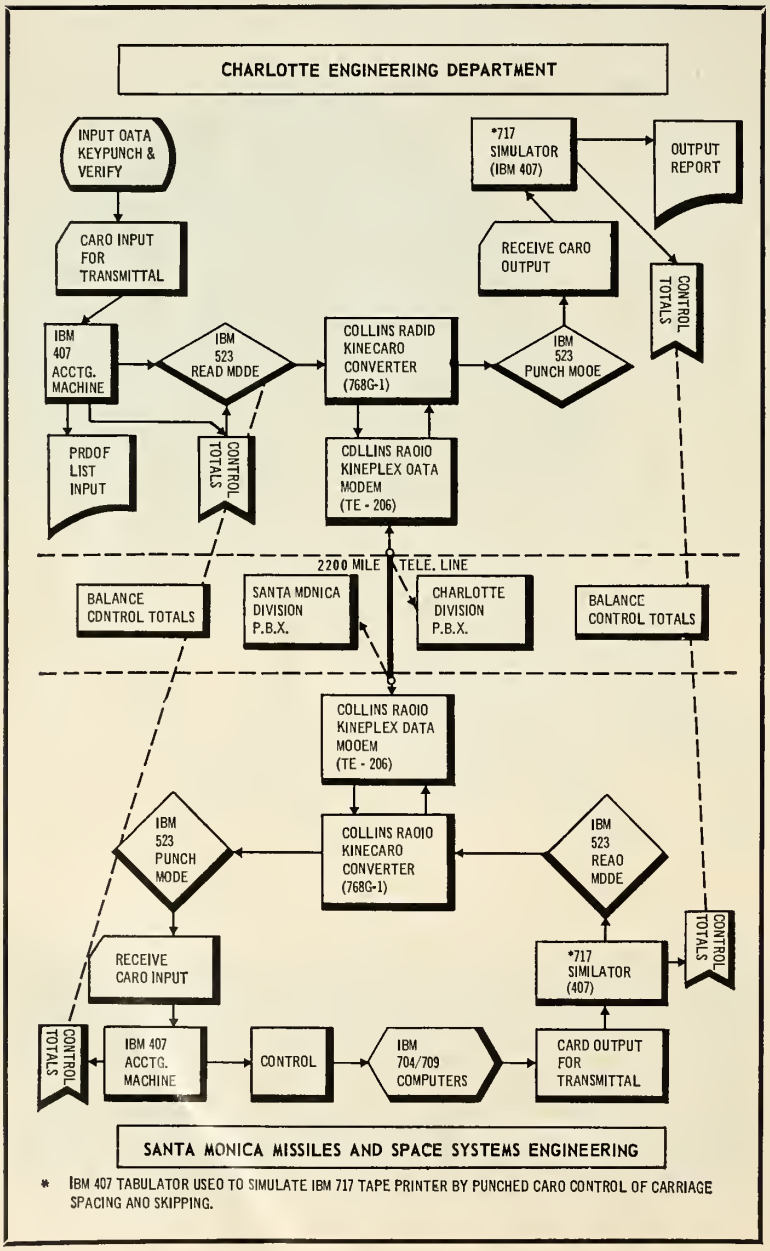
• **Hydraulic equipment**—A conventional 3000 psi system.





SYSTEM PROVIDES power and cooling for up to 14 days duration.

2200-mile Link Cuts Computer Price



Douglas' coast-to-coast tie line costs 1/3 as much as building new facility

by Charles D. LaFond

SANTA MONICA—A 2200-mile data link recently installed for Douglas Aircraft Co., Inc., has given its Charlotte, N.C., missile plant an extensive computer facility at one-third normal cost. It's believed to be the first industrial use of a coast-to-coast high-speed card transmission system.

Formerly, computer service by the Santa Monica center was accomplished by time-consuming mail routing. The new system, supplied by Collins Radio Co., makes it possible to solve complex problems in from 4 to 7 days less time than before.

Douglas says the cost of setting up the system at each terminal, plus $10,000 a month telephone-line rental, is about 33% of the price of installing and operating a comparable computer facility at Charlotte.

• **Computer use grows**—As the computer industry strives to meet missile/space demands for smaller, faster, more flexible and efficient systems, it depends more and more on these marvelous tools to solve otherwise impossible problems.

The Douglas computer complex is typical of those at the big missile primes. Its 14 autonomous computer sections utilize 46 computers, including 17 major systems. (The other 29 equipments are general access types.)

Nearly 1000 computing personnel —including almost 200 analysts and programers—are needed to direct, feed, or operate these machines. Significantly, the company's Missile/Space Computer Engineering Sections employ half of this talent. Including the computer facilities with which they are associated, these two sections represent one third of Douglas' total ex-

penditure for computer service.

The stupendous tasks so often assumed by the nation's large missile prime contractors and various military and government agencies have brought about many such vast computer complexes.

This growth has not been haphazard; investment in such service organizations is dictated by equipment performance and cost in relation to need and available funds and manpower.

Since these machines are expensive, it is obvious that they must be kept busy. The drive to maintain a constant workload has brought about complicated and unusual intraorganization system configurations.

• **Busy tie line**—The Douglas company's unique coast-to-coast card transmission system has tied its Charlotte plant to the Santa Monica computer center, via the leased 2200-mile telephone cable, since March 1, 1960.

With Collins Radio Co.'s Kineplex card converters, data are transmitted at the rate of 100 cards/minute in one direction, 200 a minute in duplex operation.

In its work with the *Nike-Ajax, -Hercules,* and *-Zeus* missile family, the Charlotte plant frequently must relay problems to the West Coast IBM 704 or 709 computers for solution. Everything from missile trajectory calculations to thermal analysis, stress analysis, guidance and control studies and test data reduction has been handled by the computer center.

The long-distance system has been under a continuous heavy workload since its completion. The accompanying flow chart shows just what is involved in the Charlotte-Santa Monica transmission system and how equipments are associated.

Although the diagram tends to oversimplify, it should be noted that in the processing of each problem, the complete cycle back to originator requires 19 major tasks—and still effects a great time saving.

• **Typical problem**—Let's see how a typical problam is handled and exactly what time is saved:

Technical detail is urgently needed for a proposal. An aerodynamacist at the Charlotte plant must determine maximum-range trajectory for a new missile system—one similar in aerodynamic and propulsion characteristics to another missile previously simulated on a Douglas three-dimensional trajectory computer program. Principal differences are in propellant loading and payload.

The needed outputs are plots of proposed trajectory plus trajectory parameters and characteristics in the time domain. These data are needed by a staff artist within four days.

• **How it's solved**—The computer program requires processing the data in two phases: one pass requires a minimum of five solutions varying a control command parameter; the other, a single solution for complete trajectory output, using the control command valve for maximum range from the first five solutions and at least five additional solutions to establish unit effects of variations in aerodynamic and propulsion characteristics.

This means (1) transmitting the data for the first phase to Santa Monica, (2) waiting for return of the output before selecting the proper control command value, (3) transmitting the data for the second pass to Santa Monica, and (4) waiting for the computer output before beginning to prepare the final material.

Input values for the five solutions of the first pass are entered on the program data input loadsheets and submitted to the computing group at Charlotte on a Wednesday morning at eight o'clock. A standard job request form is prepared for scheduling and handling by computing.

In the computing group, a sequence number is assigned to the "urgent" request and the data on the loadsheets are transcribed to punched cards for transmittal to Santa Monica. After the data cards are proof-listed on an IBM 407 tabulator, which also accumulates control totals; the control totals are printed at the end of the listing. The listing is proof-read and the control totals are punched into a job trailer card. The data, now ready to be transmitted, consists of a transmit header, the data cards, and a control total card.

The data transmission operator at Santa Monica is called by phone. The operators complete their preliminary arrangements, the equipment is put in the ready status and transmission on the data is commenced. The data are sent in 100-card batches to expedite retransmission for error correction, should this become necessary.

Duplicate cards are produced automatically at the receiving end, listed and screened for input errors. These are then routed to the computer with a program, and they are processed. Results are again punched for transmittal and the information is returned at 10:00 A.M. to Charlotte, following listing, proofing, and the punching of a new control card.

After processing, the output is delivered to the originating engineer.

The aerodynamicist analyzes the first-phase output, selects the required value of control command parameter for maximum range, and enters it on loadsheets which have been completed except for the computer output. He submits the second-phase input at 8:00 A.M. Thursday to the computer group and the whole transmission-processing-transmission sequence is repeated.

Final results are returned to Charlotte at 10:30 Thursday morning. The aerodynamicist prepares his proposal material by Friday morning, with ample time for checking his work.

Comparison of Tie Line vs. Mail for Charlotte-Santa Monica Computer Solutions

Day	New Transmission System		Mail System	
	Date Submitted	Returned	Date Submitted	Returned
Wed.	8:00 A.M.	10:00 A.M.	8:00 A.M.	.....
Thurs.	8:00 A.M.	10:30 A.M.	.....	.....
Fri.	.....	.....	.....	12:00-4:00 P.M.*
Mon.	.....	.....	8:00 A.M.	.....
Tues.	.....	.....	.....	.....
Wed.	.....	.....	.....	12:00-4:00 P.M.*

*Depending on mail delivery.

• **Time comparison**—Before the data transmission system was installed, computing requests were handled hy mail. The table compares handling times for the same job under the old mailing system and under the data transmission system. The gain is obvious and typical, according to Douglas—slightly over 1 day versus 1 week.

At one time, teletype and facsimile transmission facilities also were considered, but they proved to he inadequate, Douglas officials said, because of slower transmission rates, extra handling requirements, and overall increased joh lag time.

Average card volume now is about 20,000/day. Full capacity for an 8-hr. shift is roughly 100,000 cards, according to Collins engineers. More advanced equipment will be added in 1961 to permit use of a Collin's magnetic tape-to-tape system for vastly increased volume and more rapid communication.

Top Reliability Sought in Minuteman Control, Guidance

Simplicity is keynote in Autonetics drive which demands that vendors steadily improve component performance

by Frank G. McGuire

DOWNEY, CALIF.—The integrated guidance and control system for the Air Force's *Minuteman* ICBM is a masterpiece of simplified design.

With emphasis on reliability through "pedigreed" parts and an uncomplicated marriage of mechanical and electronic subassemblies, Autonetics Div. of North American Aviation, Inc., is developing a G&C system that will work whenever needed.

In addition to incorporating guidance and flight control into a single, highly reliable system, nozzle control units for *Minuteman* combine hydraulics and electronics into one package. This is sealed upon leaving the Autonetics plant and requires no field adjustment.

Special features include:

• Elimination of external hydraulic lines through use of internally drilled channels.

• Employment of a common structure member for all four nozzle control units. This serves as heat sink and dissipater for the solid-state electronics, as well as a hydraulic reservoir.

• Use of etched and solid-state circuitry throughout. Amplifiers, modulators and similar subassemblies employ potted modules.

• Use of the missile guidance computer during ground checkout and test.

Developed by Autonetics, the nozzle control units have been successfully operated during silo tests at Edwards AFB, and have been delivered to all engine contractors in the program, for use in static tests. (Thiokol is producing the first stage, Aerojet the second stage, and both Aerojet and Hercules Powder Company have third-stage designs awaiting AF approval and contracts). The Autonetics system will be used on all stages of the missile.

The nozzle control units are a part of the missile flight control system, which also includes angular accelerometers for stabilization and angular sensors on the gimbal axes of the inertial guidance stable platform for attitude reference. A guidance computer package primarily performs the major computations of the guidance and control system.

During flight, each nozzle control unit governs deflection of an associated nozzle on each engine. Command signals from the computer are sent as DC voltages to the nozzle control units. These move the appropriate nozzle to direct the engine thrust vector.

Each nozzle control unit consists of a battery, hydraulic power supply, hydraulic servocylinder and associated electronics.

Hydraulic components and the amplifier assembly are mounted on a common structure which serves as a carrier for all the electronic assemblies and components of the nozzle control unit, as well as the hydraulic power supply.

In addition, it serves as a heat sink and dissipator for the electronics and hydraulic reservoir. No external hydraulic lines are used in this structural member, all hydraulic passages being internally drilled.

An effective cost-saving feature of the G&C system is that it uses the missile guidance computer and its associated circuitry to perform ground checkout and test functions for the entire system. This eliminates the necessity of designing and procuring separate ground support equipment. The computer itself is a high-speed, high-high-capacity, transistorized digital computer.

Principal Subcontractors

Beckman Instruments, an electronic unit; **Chance Vought Aircraft, Inc.-Elec. Div.**, electrohydraulic actuator assemblies; **Clary Corp.**, printer systems; **Corning Glass**, glass capacitors; **Daystrom Inc.-Pacific Div.**, displacement gyros; **Fairchild Semiconductor Corp.**, transistors; **Firestone Tire & Rubber Co.-Guided Missiles Div.**, program and monitor consoles (for testing flight control devices); **General Electric Co.-Irmo Div.**, foil tantalum capacitors; **Lear, Inc.**, north-seeking gyros; **Marquardt Corp.-Pomona Div.**, test consoles (for testing nozzle control units); **Motorola Inc.-Semiconductor Prod. Div.**, mesa transistors; **Pacific Semiconductors Corp.**, micro-diodes; **Potter Instrument Co.**, punched tape programmers; **Sprague Electric Co.**, solid tantalum capacitors; **Telecomputing Corp.-Cook Batteries**, silver-zinc batteries; **Texas Instruments, Inc.**, transistors; **Transitron Electronic Corp.**, diodes, silicon transistors; **Vickers, Inc.**, auxiliary power units; **Yardney Electric Corp.**, silver-zinc batteries.

• **Unprecedented reliability**—Autonetics's goal in this drive for extreme reliability is to raise component reliability levels by a factor of 100. This of course throws a heavy burden on the many vendors.

For example, Motorola's Semiconductor Products Div. is supplying Mesa transistors. These first production quantities must meet an estimated failure rate of less than 0.01% failure/1000 hrs. But ultimately Motorola must meet a failure rate of 0.0007%/1000 hrs. operation.

In its unprecedented effort to attain extreme reliability in the guidance and flight control system, Autonetics has been using closed circuit television to conduct classes on the production line aimed at educating its workers. An esprit de corps has been instilled in production personnel through repeated reminders of the vital nature of *Minuteman*.

Of the two million parts involved in the production, every one is serialized and a complete record is maintained of its test history. If an error is found in a complete or partially complete system during tests, the mistake can be traced back to the worker involved.

If the mistake is one of a series by that worker, a professional counselor talks with the employee and attempts to solve the problem by increasing his awareness of the possible consequences of such mistakes. A recurrent record results in re-training programs for the worker.

By the end of this summer, Autonetics expects to be using an IBM 705 computer to select parts from stock for assignment to various production line stations. In its efforts to minimize handling of parts, the firm has reduced the handling aspect to the lowest possible level. The parts are received mounted on boards which act as protective measures against damage.

Diodes are placed in "stabilized storage" where a carefully controlled trickle of current is passed through them for three months as a test of stability. A complete record of this test is maintained, and those diodes which vary beyond tolerable limits are rejected. Autonetics emphasizes that this is not a "burn-in" program for the components, but is instead a stabilized storage condition.

The company feels the reliability program on *Minuteman* electronics is rigid enough to qualify as the most advanced in Space Age electronics. The principal effort is to raise the mean time between component failures to as high a level as possible, in order to minimize repair and maintenance requirements on the missile while it lies dormant in its silo.

Navy Demonstrates Hydroskimmer Ship

A new high-speed over-water vehicle—with potential applications from missile launchers to aircraft carriers—was demonstrated by the Navy last week. Called the "Hydrostreak", the vehicle operates on an entirely new technological concept.

Such a craft could be built to almost any size and with a speed capability of 100 knots or more, according to Navy engineer. It could find use as an ASW craft or in any number of high-speed sea applications.

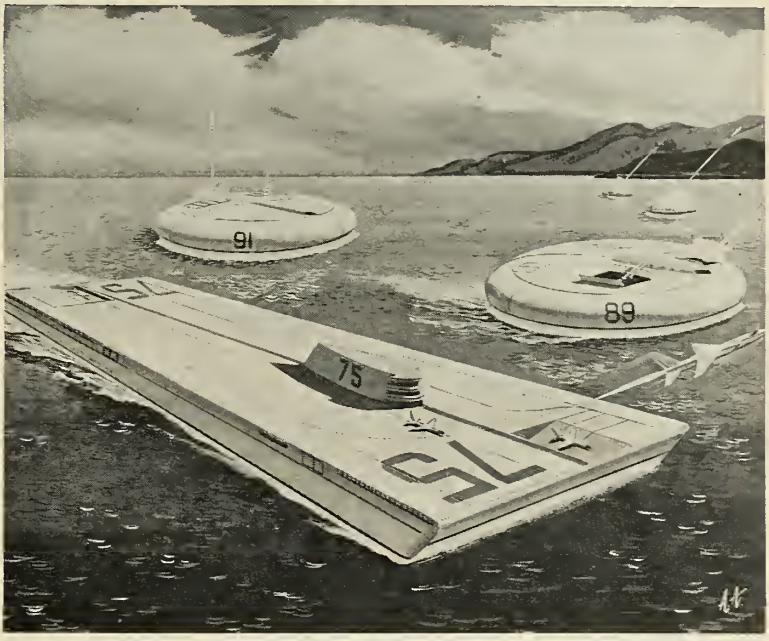
Hydrofoil ships—in which the Navy is currently showing great interest—are believed to be limited under the present state of the art to about 65 knots and 500 tons. There are those who feel that these limitations can be extended somewhat further. The hydroskimmer, however, could conceivably extend the operating parameters into an entirely new area—closing the gap between ships and aircraft.

Similar in some respects to air-cushion, or "ground-effect" machines, the hydroskimmer differs in the application of this principle. The craft uses a "water-wall" to confine the air cushion directly underneath the hull—and therefore requires considerably less power. The water is scooped up from the sea and pumped down in a sheet from nozzle bars at the forward and after ends of the vessel. The prototype craft uses only two water-walls, with solid fins on each side extending down into the water and forming the confining walls. Later models will use water-walls on all four sides.

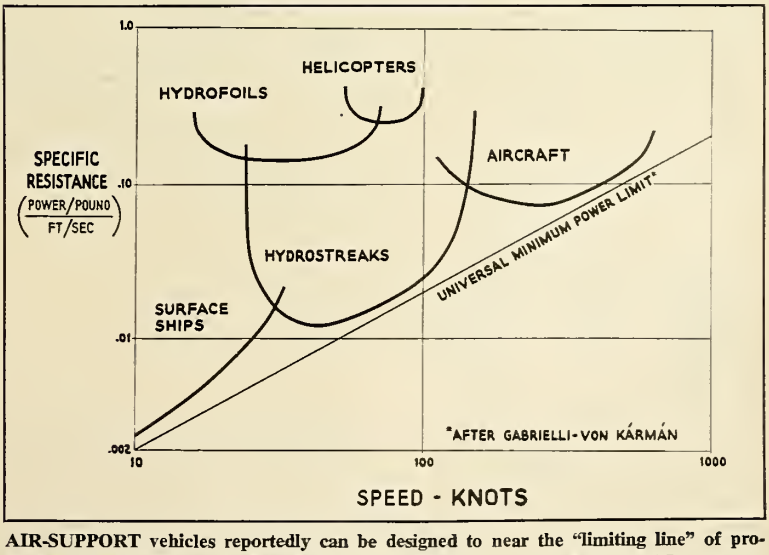
Propulsion for the prototype is furnished by two propellors driven by 80-horsepower outboard engines. A third engine drives a fan to provide the suspending cushion of air. Water jets, turbojets, or even aircraft propellers may be used to propel future models.

The water-wall principle and the experimental Hydrostreak were developed by Hughes Aircraft Division under a Bureau of Ships contract.

The Navy said that this was the first in a series of such craft being developed to evaluate various methods of supporting vessels on air cushions to overcome the limitations in speed and efficiency of surface-supported craft.



HUNDRED-KNOT over-sea missile launchers and 70-knot aircraft carriers are possible Navy applications of new hydroskimmer principle. The circular missile craft, as conceived by Hughes Aircraft engineers, would be 400 ft. in diameter.



AIR-SUPPORT vehicles reportedly can be designed to near the "limiting line" of propulsion system efficiency established by Gambrielli and Von Karman. The concept is considered highly efficient; more efficient devices are unlikely in near future.

Drone Helicopter Drops Torpedoes on Radio Command

A pilotless helicopter carrying two dummy torpedoes for ASW work and controlled by radio link was demonstrated recently for the chiefs of naval operations of Latin American countries.

Gathering for a Key West meeting of the Inter-American Naval Conference, the participants saw a Kaman HTK drone sent from a control station aboard the USS Hazelwood to a target where, upon command, the drone dropped its missiles.

The company reported that the HTK has been flown by remote control by persons without pilot training and with only a few hours' instruction. The craft is easy to manage, according to Kaman, and "winch-down technique makes it possible to effect landing on pitching decks and has been accomplished in winds of more than 30 knots and with the ship rolling 25 degrees in each direction."

The company pointed out that in addition to carrying weapons, the drone could be used for bearing detection equipment for sub location, for testing for radioactivity in presumed "hot" areas, and for getting visual evidence of damage by way of a television link.

Survey Ship Pioneers Ocean Probing Equipment

Pioneering development of equipment and techniques for oceanographic investigation is being carried out aboard the Survey Ship Explorer (OSS-28).

The ship is cruising from Seattle to the East Coast via the Panama Canal, on the most comprehensive oceanographic expedition undertaken by the U.S. Coast and Geodetic Survey since the early 1880's, when the Coast Survey Ship Blake made surveys of great historical value. The expedition is supported in part by the National Science

ARTIST'S CONCEPTION shows torpedo-carrying capability of HTK drone helicopter.

Foundation. A dozen or more research organizations are participating.

Observations have been made at positions off the coast of Oregon by the Scripps Institution of Oceanography, cooperating with Oregon State College. At each station water samples were taken to study the distributions of salinity, dissolved oxygen, phosphate, and temperature. Other important data were collected to determine the oceanographic regime, or makeup. In addition, surface water samples were taken, and the suspended sediments will be studied to determine what becomes of Columbia River water once it enters the Pacific Ocean.

A magnetometer, provided by Scripps at San Diego, Calif., was towed behind the Explorer to record continuously the earth's magnetic field along the ship's course. This information, when studied in connection with documented data on bottom topography, will add to man's knowledge of the intricate magnetic field of the earth. If the magnetometer discovers unsuspected or unexplained magnetic "hills" or "valleys," the ship's plans are flexible—extra time can be taken to survey the area in more detail.

Scientists from the U.S. Navy Electronics Laboratory, San Diego, have brought along deep-sea camera equipment for photographing the ocean bottom off the West Coast of Central America. They will attempt to prove photographically whether or not the ocean bottom at this location is covered with 80 to 100% nodules of manganese, high in nickel and cobalt.

Lear Develops Watertight Servos for Ryan Q2C Drone

Electro-Mechanical Division of Lear, Inc. has developed unusual watertight servos for the Ryan Q2C drone, which allow it to be used even after being brought down on water.

Major watertight packaging problem was in the elevator and aileron servo actuators, part of the drone's automatic flight control system. The servos—which provide up to 15 cycles per second—had to be able to move freely within their housing, yet be protected from sea water.

The servos also had to withstand rapid pressure buildup during a 3000-ft.-per-minute descent from 60,000 ft. to sea level, violent shock on impact with water, total submersion in water and a rapid temperature decline on immersion, with attendant contracting of the metal.

Lear engineers used a single joint casting, sealed with an aluminum gasket using a molded rubber insert, protecting the output shaft with a double lip seal, hermetically sealing all connectors, and impregnating the entire casting to eliminate porosity.

Fast Braking

Fins Stop Sled in First Full Firing

Aerodynamic braking fins developed by the Northrop Corp. stopped a rocket-propelled monorail sled traveling 2688 mph in less than 25000 ft. at the Holloman AFB captive missile test track last week.

The finned sled was tested at peak velocity for the first time by firing all three of the system's single-stage solid *Javelin* rockets developed by the Grand Central Rocket Co.

Initial deceleration causes the fins to open about two inches. Then they are fanned out to full braking capacity by wind blast. The 23-in. fins are prevented from being ripped off by a hydraulic snubber cylinder which dampens initial shock.

The sled will be used to test components of inertial guidance systems, according to Lt. Col. Donald H. Vlcek, Chief of the AF's Missile Development center at Holloman.

U.K. Skybolts Far From Operational

Watkinson says Britain will take part in all phases of development but won't manufacture whole missiles

LONDON—Defense Minister Harold Watkinson has warned Britons that it will take at least another full year of development work to determine whether the Douglas *Skybolt* air-launched ballistic missile project will prove successful.

Speaking on his return from the United States, where the Anglo-American deal on *Skybolt* was settled, Harold Watkinson made these other points:

• Britain is not yet heavily involved financially on the *Skybolt*. "We shall be spending money on developing the prototype environment (i.e. the equipment needed) to fit the *Skybolt* to the Vulcan Mark 2 bombers, and designing the warhead for the missile, but decisions about total cost, numbers and price per missile do not really arise at this moment, until we see much more clearly what the final result may be."

• Most of the work will be done by Douglas Aircraft, with British teams participating. Another British team will be in the Washington Weapons Research Projects Office, watching progress. Britain, in fact, will participate in every phase of the development of the missile, along with SAC.

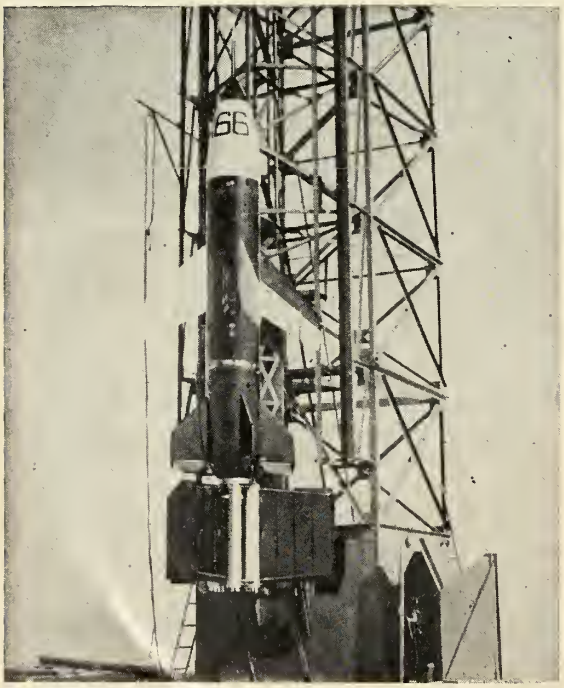
• In the meantime, Britain is accelerating development of the Avro *Blue Steel* guided bomb, which has "further development potentialities." It is not yet decided what missile will go on the Handley Page Victor bombers, according to Watkinson. He may decide soon to put another weapon onto the Victors—a British weapon, of which no details are yet available.

• Britain has already ordered some dummy *Skybolt* missiles in order to help it start its work. Britain will make its own warheads, and may also make some other parts of the missile, but there is no intention of making the whole missile in Britain under license. "That is exactly what I want to avoid doing," says Watkinson.

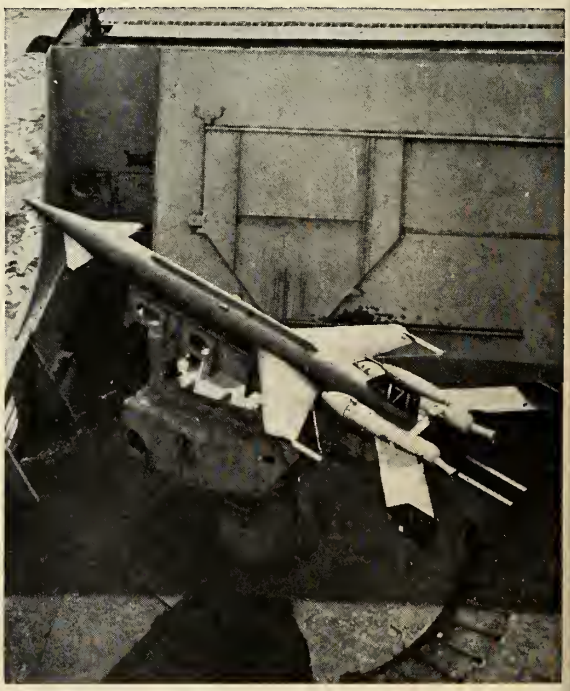
• During his U.S. trip, Watkinson also studied the *Polaris* Fleet Ballistic Missile, and is keeping a continuing watch on its development. So far, no decision has been taken on Britain buying *Polaris* as well as *Skybolt*, but this move may be in the cards for some future date.

British public reaction to the Anglo-American *Skybolt* agreement has been generally favorable. In general, it is thought to be common sense for the two countries to join in developing the missile and thus make the most of the investment in manned bombers, provided the weapon does fulfill all expectations.

Solid-boosted French Missiles



SUD AVIATION'S S.E. *4100* **surface-to-air missile was recently declared operational. The weapon has six solid-fueled boosters.**



FRENCH NAVY'S *Maruca*, **the fleet's most versatile test missile, is a ship-to-air weapon using four solid S.E.P.R. boosters.**

names in the news

Dr. Edward B. Doll: Vice president of Space Technology Laboratories, Inc., appointed director of the company's Systems Engineering Division, with overall responsibility for *Atlas, Titan* and *Minuteman* systems engineering and technical direction.

DOLL

G. Denton Clark: Named manager of the RCA Missile Test project at Cape Canaveral involving range instrumentation acitivities operated by the firm's service company.

Michel J. Fliegler: Appointed chief engineer, Potentiometer Division of Analogue Controls, Inc. Was formerly head of the potentiometer branch of Ketay Dept., Norden Division, United Aircraft Corp.

C. K. Fulton: Elected sales manager of Missile Defense Equipment in General Electric's Heavy Military Electronics Dept.

Maj. Gen. Eugene P. Mussett (USAF-ret.): Named site integration manager for The Martin Co. at the *Titan* ICBM base, Ellsworth Air Force Base, Rapid City, S. Dakota.

Ronald Toms: Formerly director of Wiancko Aeronautics, joins Electro-Optical Systems, Inc., as a senior scientist in the Fluid Physics Division.

James M. Beggs: Named manager of Westinghouse Electric Corp.'s new weapon control department, organized to centralize responsibility for all aspects of the weapon control subsystem of the Navy's new *Typhon* fleet anti-air warfare system.

John C. Christian: Named manager of Ford Motor Co.'s Defense Products Group's newly established Boston office. Was formerly manager of marketing for Space Technology Operations at Ford Motor Co.'s Aeronutronic Division and prior to that staff consultant, market development, at Hughes aircraft Co.

CHRISTIAN

Claude A. Brosterhous: Joins Ford Motor Co.'s Aeronutronic Division as assistant manager of systems test and prototype fabrication for tactical weapon systems operations. Was formerly chief engineer, Coleman Engineering Co.

Melbourne A. Forrest: Named a vice president of Burns and Roe, Inc. He will continue being responsible for the firm's operations in power, nuclear, and industrial facilities, in addition to defense and aeronautical projects.

R. S. Saye: Appointed project engineer for *Thor* systems at Douglas Aircraft Co., succeeding **H. M. Thomas,** named *Saturn* program manager. Other *Thor* project appointments are **D. E. Brimley,** assistant chief project engineer; **H. J. Heckman,** project engineer, field station testing; and **W. H. Hess,** project engineer, missile ground support equipment and contract requirements.

A. E. LeVan: Elected vice president-research and development for American Machine and Metals, Inc. Was previously in charge of research and development at the company's U.S. Gauge Division.

Dr. Wayne Masters: Holder of 15 U.S., patents, named manager of the Antenna Laboratory at Melpar, Inc. Was previously with Boeing Airplane Co. where he supervised the Antenna and Solid Dielectrics Research Groups, and prior to that was an advanced development engineer with RCA.

MASTERS

Pacific Semiconductors, Inc., elects **Lawrence T. Lindgren,** vice president, manufacturing; **Dr. John W. Peterson,** vice president, research and development; and **Sidney L. Spiegel,** vice president, marketing.

Paul S. Dove: Former manager of Allen B. DuMont Laboratories, Inc.'s Washington, D.C. office, joins the Washington staff of Stromberg-Carlson Division of General Dynamics Corp.

Dr. Emanuel R. Piore: Elected IBM's vice president-research and engineering. Prior to joining the firm in 1956 was vice president in charge of research for the Avco Manufacturing Co.

Joseph L. Morgan: Appointed to the newly created position of advertising and promotion manager, Remington Rand Systems Division, Sperry Rand Corp.

Robert J. Lodge: Elected manager, engineering test, for the Rocketdyne division of North American Aviation, Inc., replacing **W. J. Cecka,** appointed assistant to the president in charge of Rocketdyne Specialty Products.

Joseph Stanley: Appointed engineering manager of Meletron Corp., succeeding **Jim Slough,** assuming the duties of Quality Control manager.

Carl C. McCallus: Elected director of marketing for U.S. Relay-Electronics, a division of American Safety Razor Products Co. Was formerly sales manager of the Electro-mechanical division of Hoffman Electronics Corp.

E. H. Livingston: Former American Bosch Arma Corp. contracts marketing manager, named marketing manager-radar at The Crosley Division, Avco Corp. Electronic Systems and Equipment Operation.

Charles J. Disser: Former chief electrical engineer for Telex, Inc., joins the staff of General Magnetics, Inc., as senior electrical engineer.

Kurt Ehrismann: Appointed chief product engineer at Filters, Inc., with responsibility for design and production of the company's complete line of relays.

James R. Conto: Named to the newly created post of vice president in charge of marketing for the Standard Rectifier Corp. Formerly served as general sales manager of International Rectifier Corp.

Charles C. Colozzi: Elected president of the United States Gasket Co., Plastics Division of Garlock Inc., succeeding **A. J. McMullen,** who resigned in order to devote full time as president and chief executive officer of Garlock Inc.

Ernest A. Laufer: Previously with Bell Aircraft Corp., appointed a senior electronics engineer at Hoover Electronics Co.

Dr. Victor J. Young: Elected vice president of Hazeltine Corp.'s Electronics Division. Before he joined the firm in 1949, Dr. Young was in charge of radar, undersea detection and recorder projects for Melpar, Inc. and the Sperry Gyroscope Co.

YOUNG

Leland E. Wells: Former director of engineering for Exide Industrial Division of The Electric Storage Battery Co., promoted to vice president-engineering of the division.

Dr. Chou H. Li: Former senior scientist at Shockley Transistor Corp., appointed head of the Materials and Techniques Research Group at General Transistor Corp.

James G. Wenzel: Named coordinator of antisubmarine warfare programs for General Dynamics Corp., replacing the late **Walter V. R. Vieweg.** Previously served as engineer with Convair.

Gerhard L. Hollander: Appointed manager of newly formed general-purpose computer department at Hughes Aircraft Co.'s ground systems group, was formerly section manager, systems management and control computer systems, Philco Corp.

contracts

NASA

United Technology Corp., for design, fabrication and testing of three experimental conical solid-propellant rocket engines. Amount not disclosed.

$131,800—Leon H. Perlin Co., Inc., Newport News, Va., for services and materials for modification of existing gust tunnel.

$106,926—Doyle and Russell, Norfolk, Va., for services and materials for auxiliary launching pad at Wallops Station.

NAVY

$23,600,000—Raytheon Co., Waltham, Mass., for additional production of *Sparrow III* missiles.

$3,100,000—Raytheon Co., Waltham, for continued research and development on the *Sparrow III*.

$2,082,215—Aerospace Division, Boeing Airplane Co., Seattle, Wash., for construction of the Navy's first hydrofoil warship, a 110-ft. patrol craft displacing 115 tons and expected to be armed with advanced ASW missiles. J. M. Martinac Shipbuilding Corp., Tacoma, Wash., will assist in construction of the vessel.

$580,000—Aerojet-General Corp., for exploration of a "hybrid" rocket combining liquid and solid propellants.

$110,000—Bulova Watch Co., Industrial & Military Products Division, Jackson Heights, N.Y., for warhead fuzes for *Zuni* rockets.

$60,000—National Engineering Science Co., Pasadena, for feasibility and design study related to large propellants and propulsion systems.

$47,900—General Instrument Corp., Newark, N.J., for conducting a research program on semiconducting compounds for thermoelectric generator.

$44,580—Ampex Data Products Co., Los Angeles, for magnetic tape recorder/reproducer system.

$43,142—Power Generators, Inc., Trenton, N.J., for engineering services for development and certification tests of recovery system for *Polaris*.

$32,842—Robert W. King Construction Co., North Hollywood, Calif., for construction of Project NERV launch support facilities, Point Arguello.

$27,284—Stanford Research Institute, Menlo Park, Calif., for feasibility study of optical cement for *Sidewinder* missile.

AIR FORCE

$3,600,001—Olin Mathieson Chemical Corp., Baltimore, for propellants.

$3,500,000—Union Carbide Corp., Lawrenceburg, Tenn., for facilities for research and development of graphite.

$1,511,210—Fairchild Semiconductor Corp., for a silicon transistor reliability improvement program for *Minuteman*. Subcontract from North American Aviation, Inc.'s Autonetics Division.

$630,195—Nortronics Systems Support Div., Northrop Corp., Anaheim, Calif., for ballistic cameras and ancillary equipment.

$412,718—International Business Machines Corp., New York City, sequentializers and switching devices.

$250,000—The Martin Co., Orlando, for GAM-83 guidance equipment for F-105D type aircraft.

$200,000—Bohanan Manufacturing Co., Compton, Calif., for quick disconnects to be used on the *Atlas* silo program. Subcontract from Convair.

$122,328—University of Utah, Salt Lake City, for research on "pressure dependence of mechanical properties of metals and ionic and valence crystals."

$80,000—Republic Aviation Corp., for test and development of leakproof connections or seals for fluid power systems used in future flight vehicles.

$79,601—Hughes Aircraft Co., Culver City, Calif., for missile checkout equipment.

$47,400—Massachusetts Institute of Technology, for continuation of research on "study of interactions among burning fuel droplets and their effects on combustion stability and roughness."

$43,705—Potter Pacific Corp., Malibu, Calif., for propellant loading control.

$42,845—General Electric Co., Syracuse, N.Y., for electron tubes.

$41,000—University of Delaware, for research on "Oxidation of Metals and Alloys."

ARMY

Hogan Faximile Corp., a subsidiary of Telautograph Corp., for a high-speed digital plotting recorder. Amount not disclosed.

$24,408,000—Raymond International, Inc., Henry J. Kaiser Co., Macco Corp., and Puget Sound Bridge & Drydock Co., for construction of *Atlas* launching sites near Plattsburgh, N.Y.

$8,777,222—Radio Corp. of America, Moorestown, N.J., for design, fabrication and delivery of one instrumentation tracking radar.

$2,070,346—Airtemp Div., Chrysler Corp., Dayton, Ohio, for range finder.

$1,950,000—Raytheon Co., Waltham, Mass., for engineering services on the *Hawk* missile system.

$1,150,557—Chrysler Corp., Detroit, for the *Redstone* missile program.

$668,103—H. B. Zachry Co., San Antonio, for *Hawk* training facilities.

$96,700—Continental Technical Service, Inc., Dayton, for technical non-personal engineering services in connection with design, development and testing of rocket motors, airframes, launchers, guidance system and related equipment.

$95,752—Douglas Aircraft Co., Inc., Santa Monica, for repair parts for *Nike-Hercules*.

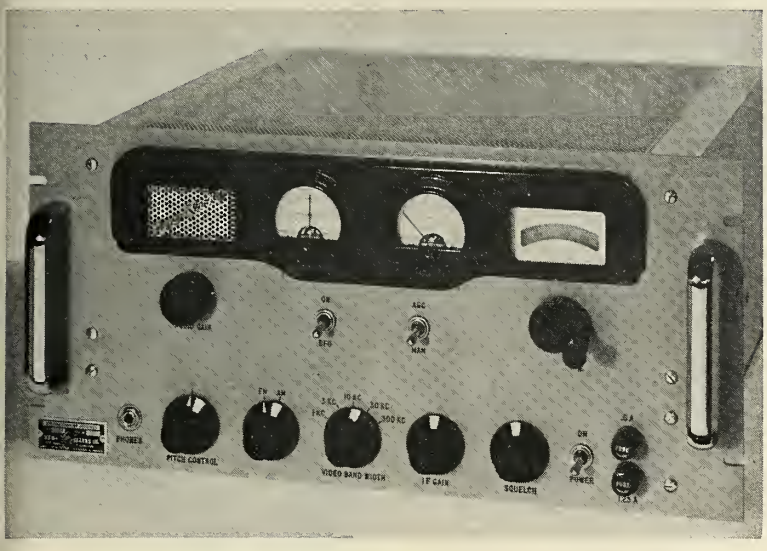
$59,121—Building Mart, El Paso, for *Nike-Zeus* facilities alterations.

$43,730—Douglas Aircraft Co., Inc., Santa Monica, for *Nike* repair parts.

$40,240—Packard Bell Computer Corp., Los Angeles, for components for high-speed digital simulator.

$37,829—Rocket Power, Talco Div., Gabriel Co., Mesa, Ariz., for basic research entitled "thermodynamics of reactions involving the light metal oxides and propellant combustion gases."

$30,000—Electro Optical Systems, Inc., Pasadena, for research and development on solar energy concentrators and their integration into space power systems.



Telemetry Line Introduced

Two new items and a new receiver series to fill out its line of special-purpose telemetry receiving equipment have been put on the market by Nems-Clarke, a division of Vitro Corp. of America.

These include type 1500 series VHF range receivers and a type 2501 special purpose receiver (all 55-260 mc), type PR-203 215-260 mc preamplifier, and a type PBS 10-push button switch.

The 1500 series receivers (7 types) are designed for FM, AM, and CW operation in the VHF range and for use in telemetering, missile monitoring, and other high-performance applications. Receivers offer high stability (AM output varies 7 db max. for input change of 40 db) and high sensitivity (4 μv produces 23 db S/N min. with 100-kc deviation, 1-kc modulation). Noise figure varies for the 7 receiver types: either 6, 11.5, or 13 db max. IF bandwidths similarly vary from 175-500 kc.

The 2501 receiver is AM-CW in 55-260 mc range. Standard 19-in. rack size, it is 8.75 in. high x 15 in. deep and draws 70 watts. Antenna and reference input impedances are 50 ohms nom., noise figure of 6 db max. at antenna input. Sensitivity: 2 μv 30% AM at 1-kc for 10 db S/N. Audio response ±3 db from 0.5 — 25 kc.

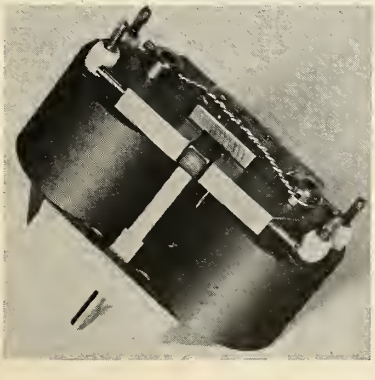
A weather-proofed, pressurized, PR-203 preamplifier eliminates moisture problems. Time losses up to 6 db decrease receiver sensitivity less than few tenths of a db. Offering uniform response within 3 db over frequency range, unit has improved receiver noise figure by from 3.5-4.5 db (assuming lossless lines). Gain is 22-db min. in pass band.

Circle No. 225 on Subscriber Service Card.

Polarized Torque Motor

A high-temperature, electromagnetic polarized torque motor with an operating capability up to 1250°F is now being produced by the Bendix-Pacific Division.

The unit is designed for continuous duty at elevated temperature. It provides a proportional output force and/or motion with input current up to 0.010 in. linear stroke, and a torque output of 0.017 inch pounds at 1200°F. Tests indicate an operating life of at least 20 hours under these conditions, including approximately 7 million full amplitude output motions.



double-throw switch is 5 amps at 30 volts dc. Switch weight is .006 lbs., operating force 3 to 5 oz., dimensions ¼ by ½ by ¾ in.

Circle No. 226 on Subscriber Service Card.

Single-Shot Epoxy Resin

A high strength one-component modified epoxy resin adhesive that permits easy application techniques and provides unlimited working life for bonding high-volume metal and plastic structural assemblies is now available from Adhesives, Coatings and Sealers Division, Minnesota Mining and Manufacturing Co.

SCOTCH-WELD Brand structural adhesive EC-1595, a one-component adhesive, contains a latent hardener which eliminates the need of accurately weighing and mixing a hardener with the base resin at time of use. The adhesive will not harden before curing operations are performed.

This adhesive provides metal-to-metal bonds, with shear strengths of 2500 psi at 75°F, maintains high strength over a service temperature range of minus 67°F to plus 300°F and exceeds requirements of MIL-A-5090B (Class A) and MIL-A-8431 (Type 1) specifications. It has high creep resistance under constant stress, exceptional adhesion to metals and plastics, and excellent resistance to water, 20% salt spray, hydraulic oil and aromatic fuel.

Circle No. 227 on Subscriber Service Card.

Mesa Transistor

A 30 mc amplifier Mesa transistor has been introduced by Motorola Semiconductor Products Division.

The 2N741, as it is designated, is a germanium PNP diffused junction transistor in a TO-18 (3-lead, .100 in. pin circle) package with collector connected to case. A vacuum bake-out at 200°C and a stabilization bake for a minimum of one week at temperatures in excess of 100°C help assure the stability of the device.

Circle No. 228 on Subscriber Service Card.

Semiconductor Furnace

A furnace apparatus for semiconductor preparation and growing single crystal materials has been introduced by Marshall Products Co.

The apparatus consists of two or more tubular furnaces, according to the material's requirements, mounted on a common axis. This permits zone refining, directional freezing or slow crystallization, seeding, and crystal

growing in the quartz work tube which runs through all furnace chambers.

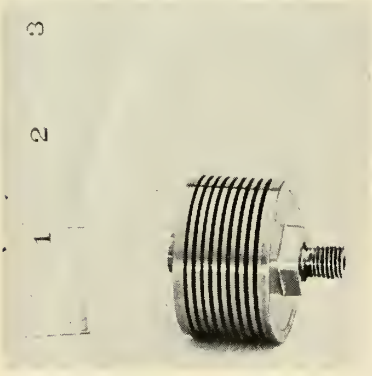
Each furnace is supplied with sufficient shunt taps to establish any reasonable temperature profile within the chamber. Sharp temperature gradients between adjoining units may be established by adjusting furnace spacing.

Once adjusted for the correct spacing, the furnaces can be driven as a unit on ball bushings along the support stand at speeds between 1/8 in. and 6 in. per hour as desired. Stroke length is limited only by the support stand chosen.

Circle No. 229 on Subscriber Service Card.

Cryogenic Sensory Bellows

A lightweight, sensory bellows for airborne applications has been made available by Hydrodyne. Its principal application to date has been in LOX pressure regulation, although it is also suitable for other applications.



It is fully machined, not formed, and designed for a maximum pressure differential of 100 psi and a temperature range of −450°F to +1000°F. The bellows are available in aluminum, stainless steel, nickel alloys, and other materials. Hysteresis is almost zero due to the machined bellows design.

The units are available in an infinite range of diameters and strokes.

Circle No. 230 on Subscriber Service Card.

'Explosion-proof Chamber'

An explosion test chamber designed for temperature operation to +200°F and altitudes to 100,000 feet is being manufactured by Itemco Inc. The explosive atmosphere is attained with propane gas or high octane gasoline.

The chamber body and door are certified at 300 psi operating pressure and 450 psi hydraulic test.

The facility is complete with temperature, altitude, and fuel mixture controls, relief valves which automatically compensate for altitude, and sampling chamber to check and prove the explosiveness of the fuel mixture prior to the operational test.

Circle No. 231 on Subscriber Service Card.

Container Relief Valve

A lightweight, highly sensitive low-pressure container relief valve, P7-637 is available from James, Pond & Clark, Inc. The P7-637 performs two functions: First, by maintaining slight internal pressure in the container, it prevents free breathing that would result in the condensation of moisture or the entrance of foreign material. Second, it maintains an equilibrium between external and internal pressures to prevent explosion or implosion of hermetically sealed containers.

The P7-637 features an exceptionally high flow capacity—with a 1 psi cracking pressure it will pass 50 scfm at an inlet pressure of 2 psi.

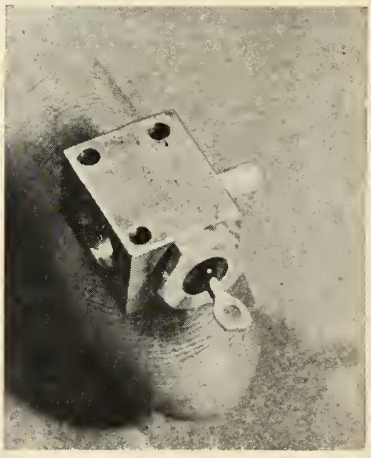
When closed, the P7-637 maintains a dead tight seal to retain a positive internal container pressure. The valve is suitable to protect airborne shipping containers as well as storage containers.

Circle No. 232 on Subscriber Service Card.

Subminiature Actuators

A low-cost family of ballistic actuators is now available from Propellex Chemical Division, Chromalloy Corp. Small, rugged, and with specific energy output, these units are ideal for subminiature applications.

Models have either push or pull action, in a range of predetermined strokes, and force outputs to 25 lbs. Various electric firing characteristics can be provided. The body of the unit measures 0.5 x 0.6 x 0.38 in. and weighs 4 grams without leads. It has a stroke of 1/16 in., and offers a force output of 3 lb. The actuator fires at 28 v, from an energy input of 15,000 erg.

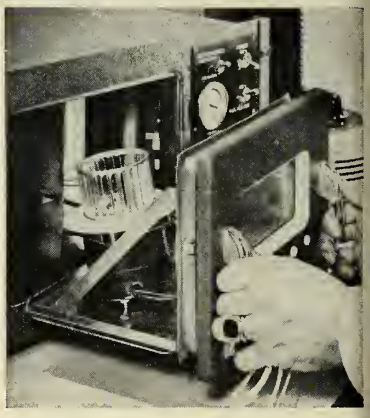


Circle No. 233 on Subscriber Service Card.

Rapid Cycle Chamber

Delta Design, Inc. has perfected an ultrarapid cycling chamber to expedite the testing of various electronic devices and components.

According to the firm, the chamber is capable of completing a hot-cold cycle within the −100°F to +500°F range in slightly less than 10 minutes, thereby materially reducing the time required for such environmental testing.



Circle No. 234 on Subscriber Service Card.

Optical Wedge Available

A simplified method for measuring displacement in vibration testing is available without charge from MB Electronics, a Division of Textron Electronics, Inc.

The "optical wedge" is a pressure-sensitive wedge-shaped sticker that can be affixed to a flat surface on the object under test. The long axis of the wedge should be exactly perpendicular to the axis of vibration. Then, as the wedge vibrates with the piece under test, two triangles will appear. Displacement is indicated on the scale directly below the point of the darkest triangle.

Circle No. 235 on Subscriber Service Card.

Sealed Tunnel Diodes

A series of germanium tunnel diodes, introduced by Philco Corp., are hermetically sealed and designed for low-level switching and small signal applications. Peak point current is closely controlled providing a peak to valley ratio of 8 to 1. Typical per-

formance shows peak voltage of 55 millivolts and a valley voltage of 320 millivolts.

The units exhibits low series inductance of one millimicrohenry and low series resistance of one ohm.

Measured frequency of oscillation is over 1500 megacycles. The new diodes are packaged in shortened, hermetically sealed transistor cases having thin bases and alloy contacts and featuring a specially designed outer tab of triangular configuration.

Circle No. 236 on Subscriber Service Card.

High Temperature Motor

The latest addition to the line of special motors at Airborne Accessories Corp. is the HM420 Type Hi Temp Motor designed for an ambient temperature range of —65° to +600°F. This motor was originally developed for Mach 3 aircraft but is now being offered to the electronics industry.

Nickel-clad copper wire windings are used, insulated by glass impregnated with a specially developed high-temperature additive. Similar problems have been solved in the case of bearing material, stator plating, soldering, etc.

Circle No. 237 on Subscriber Service Card.

Differential Voltmeter

A true differential DC vacuum tube voltmeter capable of 1% accuracy throughout the scale is being marketed by The Decker Corp. Model 410 unit features a zero center scale with full scale ranges of ± 0.3, 1.0, 3.0, 10, 30, and 100 volts DC, and a single input impedance of 20 megohms and 40 megohms differential. In transistorized circuitry the instrument readily provides off-ground readings without loading. The 410 also can be used as a unit cathode follower, having an open circuit gain of .85 which can be varied in definite steps by the input divider maintaining the input impedance with an output impedance of 1000 ohms.

Circle No. 238 on Subscriber Service Card.

Formable Ceramic Powders

Corning Glass Works has developed two ceramic powders that can be formed into shapes used in hot tooling —Corcast and Cortamp.

First applications will be as tools, jigs and fixtures in the aircraft and missile industry, where shaping of exotic metals requires great heat and pressure.

Users of the powders form the shapes they want—when and where they desire. No separate firing is required. Bonding occurs in use. Temperature capabilities go up to approximately 2500°F and 4000°F.

Circle No. 239 on Subscriber Service Card.

Epoxy Casting Compound

A non-burning, self-extinguishing, flexible epoxy casting compound has been developed by the laboratory of Hysol Corp.

Hysol 15-032 is a two-component, filled epoxy casting system recommended for use on transformers and other electronic and electrical parts.

"Non-burning" under ASTM D635-56 T and "self-extinguishing" according to MIL-I-16923C and MIL-T-27A tests, Hysol 15-032 Flame-Out Epoxy Casting System is also flexible and can be used as embedding material when required to meet thermal shock conditions.

A section of the cured material snuffs out immediately upon removal from the flame.

Circle No. 240 on Subscriber Service Card.

Readout Timing Devices

A line of precision stepping devices (Series 18200) featuring digital counter or dial readout and variable settings has been introduced by The A. W. Haydon Co. Units are designed to perform monitoring, indicating and/or control functions.

Included in the new stepping line are predetermined and remotely settable pulse counters and interval timers. These operate only on the number of pulses received, not incremental changes in voltage or phase angle. With accurate power supply, switching precision is equal to the pulse source itself. Haydon's new units are suitable for application in automated production equipment, military and commercial control systems and laboratory timing devices.

Circle No. 241 on Subscriber Service Card.

Stainless Welding Wire

Stainless steel welding wires for use with the submerged arc welding process are now being marketed by Air Reduction Sales Co.

Chemical composition of the stainless wires rigidly conforms to the A.W.S. and A.S.T.M. standards for corrosion-resisting and chromium nickel steels. These rigid standards provide close control of the amount of ferrite in the weld deposit.

Automatic stainless steel welding wires are available for use with 308, 309, 310, 347 and 502 stainless, in 25 and 50 pound coils. Each coil is carefully thread-wound to facilitate unwinding, and a constant controlled tension is maintained during coiling to assure a neat coil that will support itself and keep its designed shape and dimensions.

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editorial . . .

More Money for Samos and Midas

After much backing and filling, Congress finally is on the road to increasing the funding of *Samos* and *Midas,* the reconnaissance and early warning programs.

Although both projects were admittedly proceeding at minimal paces, Congress first added, then took away and finally added again—leaving the final decision up to a conference between the two houses.

The chronology of the effort went like this:

On April 6 the Air Force asked for $26.4 million for *Midas* and $35 million for *Samos-Discoverer,* a total of $61.4 million.

On May 18 Deputy Secretary of Defense James Douglas testified that these funds were sufficient to finance both programs and that DOD needed no more money. At the same time he added the programs were "at minimum."

Early in June the House looked over the programs and added $54 million.

A little later in June the Senate Defense Appropriations Subcommittee cut off this $54 million.

And a little later still, on June 11, Mississippi's Senator John Stennis in full committee moved successfully to add $83.8 million for *Samos* alone, thus restoring the $33.8 million House addition for *Samos* plus $50 million—but not restoring the $20.2 million House addition for the closely-related *Midas* and *Discoverer* programs.

That is the way the matter stands until conference between the Senate and the House. It is reasonable to predict that some addition to the two programs will be made.

The next point is whether or not the Administration will make use of the money to speed up the programs. Congress can give and Congress can take away, but Congress cannot force the Defense Department to use the money.

In light of the facts that the *Midas* could double our warning time on the launching of an enemy ballistic missile, and that *Samos* would make archaic all previous forms of reconnaissance, including the U-2, it would seem to most observers that speed in their development is essential.

Americans On IAS Program

Two Americans, one a scientist and one an international or perhaps interplanatory attorney, will participate in symposia at the International Astronautical Society meeting this August in Stockholm. And both symposia are of considerable interest to us.

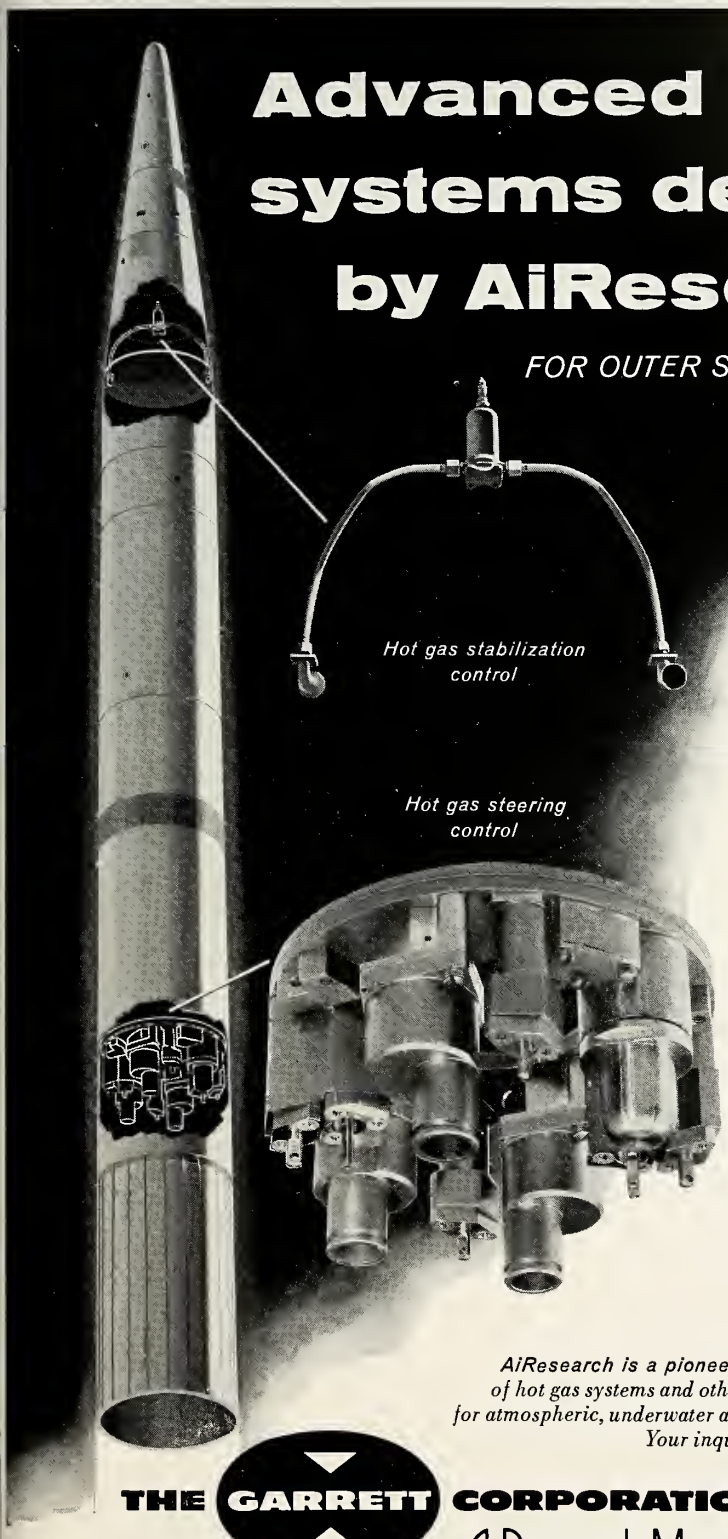
Dr. Fred Singer, professor of physics at the University of Maryland, will conduct a panel on the use of small rockets for space exploration —actually in an effort to urge smaller nations to enter the space field in this manner. Since most of these smaller nations do no rocket manufacturing of their own, they would have to purchase them on the world market.

Attorney Andrew Haley, former president of the IAS and general counsel for the present meeting, will participate in a panel on the "Sovereignty of Outer Space," a topic which, in the light of the recent U-2 incident, has a particular significance for all Americans.

Clarke Newlon

Advanced hot gas systems delivered by AiResearch

FOR OUTER SPACE, ATMOSPHERIC AND UNDERWATER STEERING



AiResearch is now in production on two greatly simplified hot gas steering control systems: a reaction control system for outer space flight stabilization and a hot gas actuator control system for terrestrial steering (in the atmosphere and under water).

Both systems eliminate any need for pumps, heat exchangers, accumulators and other apparatus required in earlier control systems. And both systems utilize hot gas, operating off either the main engine or a separate fuel source.

The gas in the outer space reaction control system is fed into a set of nozzles which imparts spin to the missile to stabilize its flight through space.

In the terrestrial hot gas actuator control system the gas is fed into an on-off controlled linear actuator which moves the fins controlling the missile's attitude in the atmosphere or under water. This system also utilizes a concept developed from the AiResearch hydraulic "printed circuit." This approach eliminates complicated plumbing, thereby decreasing the weight and increasing the reliability of the system.

AiResearch is a pioneer, leading developer and manufacturer of hot gas systems and other nonpropulsive power systems for atmospheric, underwater and outer space missions. Your inquiries are invited.

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100 KMC
MICRO-WAVES
10,000 MC
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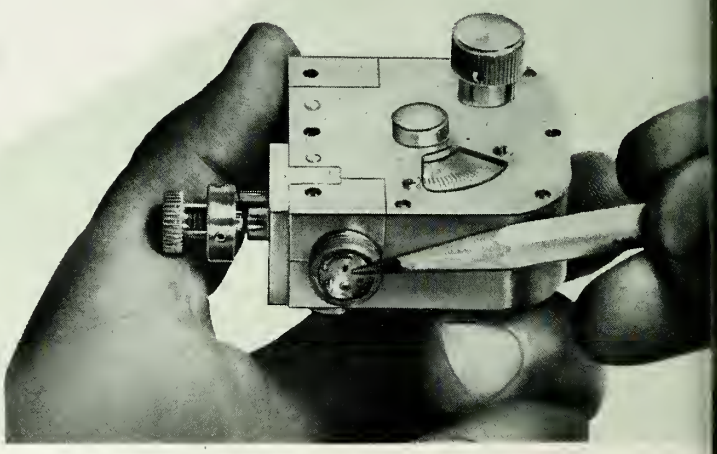
- *Standard Gain Horns.*
- *E/H Tuners.*

Other components shown below.

Slotted section, shown here, actual size.



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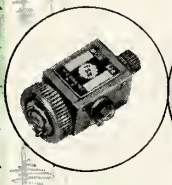
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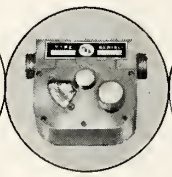
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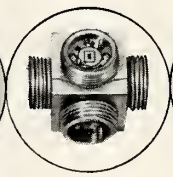
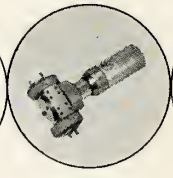

E/H TEE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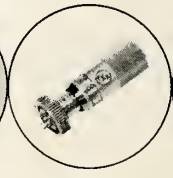
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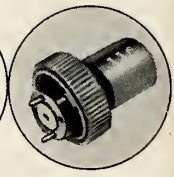
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