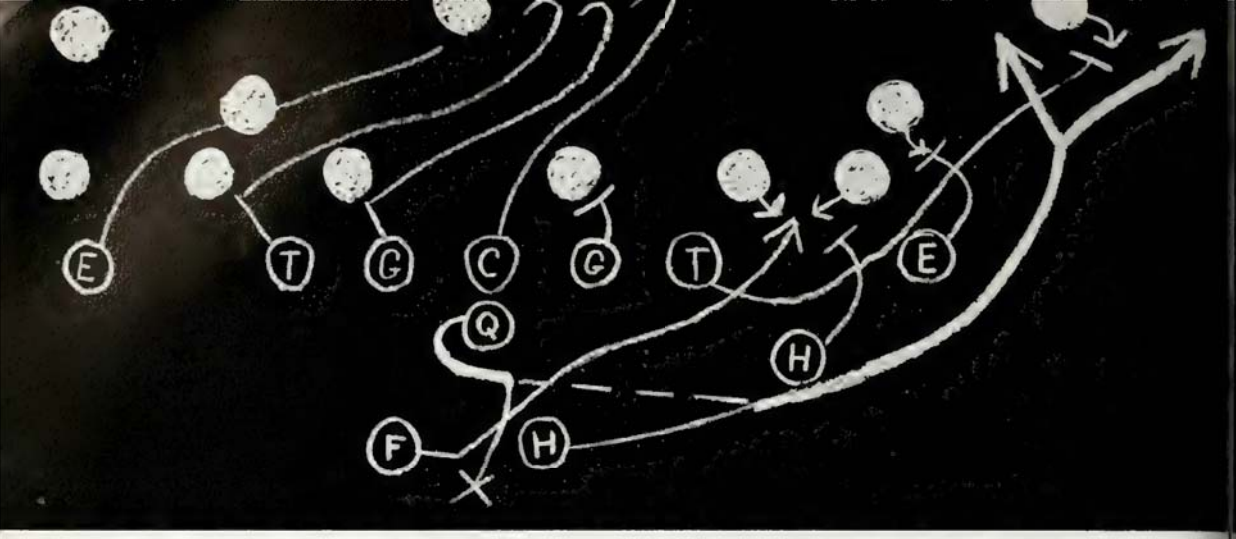
FEBRUARY 16, 1959

X-15 GUIDANCE SYSTEM

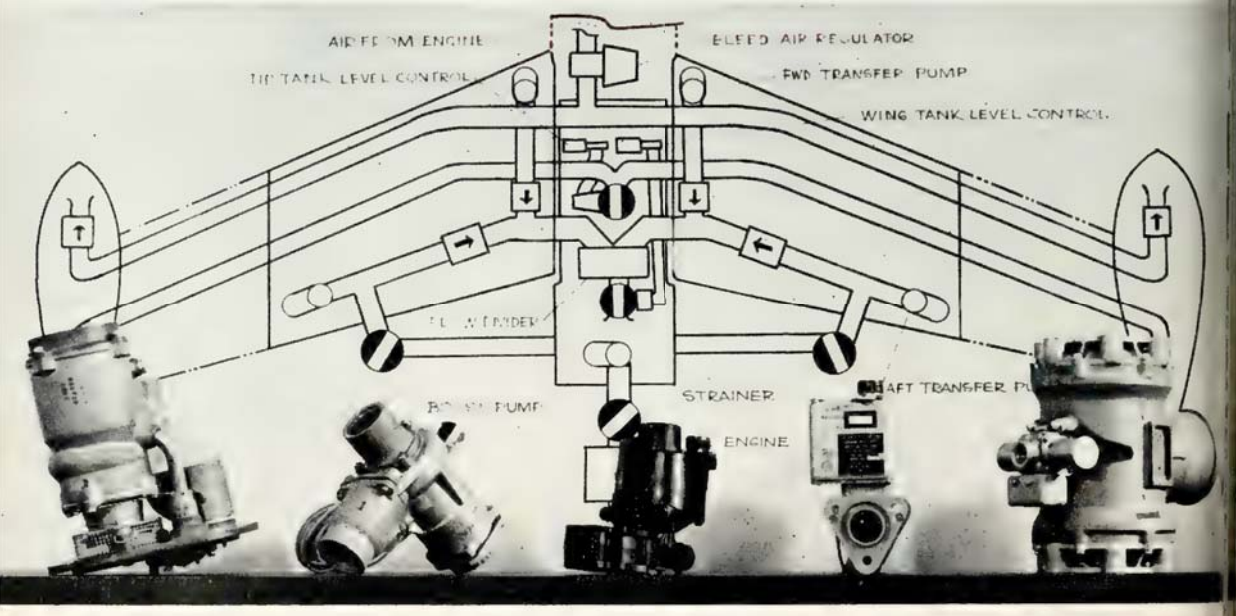
missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION



Team planning...



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he Motion Picture Unit at Rocketdyne, a division of North American viation, Inc., employs both 16mm and 35mm Mitchell cameras to accuately record testing of power plants for the Air Force Thor IRBM and tlas ICBM missiles, and the Army's Redstone medium range and upiter IRBM weapons.

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missiles and rockets Vol. 5, No. 7, Feb. 16, 1

Published every week by American Avia Publications, Inc., 1001 Vermont Ave., N Washington 5, D.C. Printed at the Teleg Press, Harrisburg, Pa. Second class postage at Washington, D.C., and at additional mai offices. Copyright 1958, American Aviation P lications, Inc.

Subscription rates: U.S., Canada and Post Union Nations—1 year, $8.00; 2 years, $12.0 3 years, $14.00. Foreign—1 year, $20.00; 2 yea $30.00; 3 years, $40.00. Single copy rate—$. Subscriptions are solicited only from perso with identifiable commercial or profession interests in missiles and rockets. All subscri tion orders and changes of address should referred to: the circulation fulfillment d partment.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

COVER: Guidance for *X-15* research vehicle will be tested in early phase of program. (p. 26)

FEBRUARY 16 HEADLINES

ASTRONAUTICS ENGINEERING

MISSILE ELECTRONICS

DEPARTMENTS

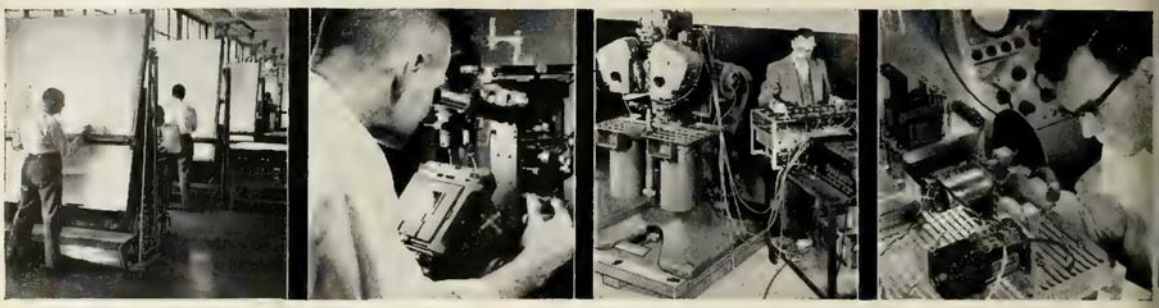
LARGEST one piece infrared dome has been manufactured by Servo Corp. for Navy use. (p. 24)

MAMMOTH *Titan* is checked out in vertical test facility at Martin's Denver operation.

BATTING average for *Titan* has gone up with successful launch from Cape Canaveral.

OTHER side of the moon may look like this, according to a concept by Astronomer I. M. Levitt. (p. 14)

UNITED SHOE OFFERS



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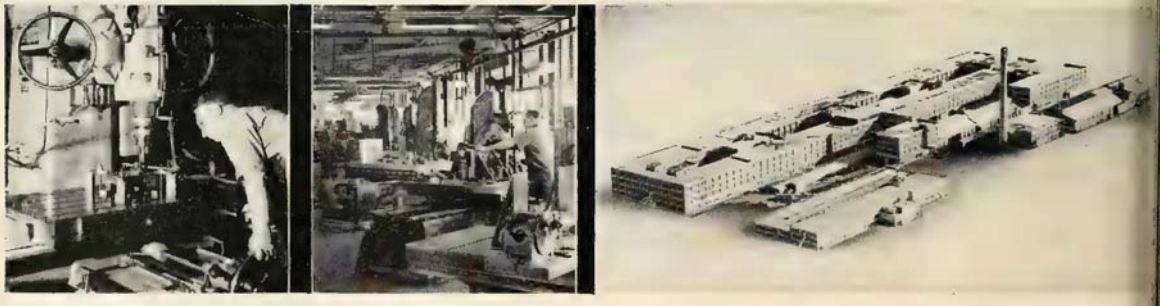

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Reliability Is Our Most Important Headache

The sound and the sight of successful missile firings from Cape Canaveral are no longer a novelty. The bird watchers still gather on the beaches and any big blast-off makes news, but even in the last few months it has come to be taken for granted that the older missiles—the *Jupiters, Thors, Atlases, Redstones* and other vehicles—can be scheduled with reasonable reliability. The first *Titan* got off with such a minimum of trouble it would have been considered miraculous two years ago.

Reliability from the launching pad is no longer the problem, but reliability at the point of impact is probably the greatest factor plaguing industry and the military today. It is the factor which has industry pleading for more missiles for more tests. It is a great factor in the reluctance of the Air Force to abandon the presently available manned aircraft. It is why Defense Secretary Neil McElroy promised the House Armed Services Committee that the missile program will be reviewed each month. It is why the Joint Chiefs of Staff are pushing so hard for *Polaris* and the ALBM—air-launched ballistic missile.

It is pointed up by the remarkably few nose cones which have been recovered. Getting the missile off the pad with a fine degree of certainty is one thing. Hitting the target with it is quite another.

Calculations for use of the intercontinental ballistic missile as a successful weapon call for its impact within a circle of five miles in diameter—with the target in the center. With this margin the warheads which the ICBM can carry will do a successful job of knocking out the target.

Our reliability tests, however, indicate that the reliability at point of impact is more nearly inaccurate by a factor of six. That is, the reliability of the ICBM is such that it can only be counted on to land in a circle of some 30 miles in diameter, with the target in the center.

This means that either more missiles must be fired or that the warheads must be increased in size and weight. The former is expensive and the latter simply brings up more problems. To increase the size of the warhead means increasing the propulsion and possible changes in guidance and these very factors might serve to increase the margins of error on impact.

Defense Secretary McElroy also told Congress "We are not putting our feet into concrete for three or four years ahead." Behind the remark was the reluctance of the Administration to commit itself to any program of missilery until the reliability problem has been solved. Behind it also was the hope which has been based upon the possibilities which the submarine-borne and air-borne ballistic missiles appear to offer.

The greater reliability here is based upon one simple factor—that because they are of much shorter range—1,500 miles for the sea-going *Polaris* and probably 1,000 for the missiles which the Air Force plans to launch from its bombers—they will have a built-in degree of greater accuracy.

There is no doubt that the ICBM programs based upon the *Atlas*, the just-fired *Titan* and the projected *Minuteman*, will and should continue. There is no doubt, either, that a great many missiles will have to be fired at the expense of a great deal of money before they reach a perfection of accuracy intended and planned for them. During World War II the Germans fired their *V-2s* at London from a distance of 200-odd miles and were content to hit within a 20-mile diameter circle 50% of the time. We want to fire 5,500 miles and hit within a five-mile circle. The margin of aiming error from the launching pad must be almost infinitesimal to achieve it.

Neither is there any doubt that we must continue to seek more accuracy in any form and any missile which can guarantee it. This is one of the reasons why the Administration is moving slowly and why reliability remains one of the most important headaches in the missile business today.

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washington countdown

More business for *Corporal* . . .

was indicated by a recent "White Paper" released by the British Ministry of Defense, which stated that the British Army is now being equipped with the rocket. The paper also stated that the Royal Navy is preparing to build four guided missile cruisers and an American-engineered nuclear submarine.

One space agency . . .

sufficiently complete to include military programs was recommended by Rear Adm. John T. Hayward before Congress last week. The Assistant CNO for R&D told the House Space Committee that the Soviet challenge to our defense and in space must be met even if the budget is not balanced.

The list of questions . . .

for Secretary of Defense McElroy continues to grow as Congressional hearings move forward. Chairman Overton Brooks (D-La.) of the House Space and Astronautics committee said that the testimony before his committee up to last week did not support contentions of the Secretary. Brooks said he would welcome McElroy as a witness to the nation's knowledge, development and capabilities now and at the end of the year. McElroy is scheduled to appear before the committee on March 2.

600 space 'flights' . . .

have been made by test personnel in the Navy's centrifuge at Johnsville, Pa. The House space committee was told that about 15% of the "flights" would have been failures for one cause or another. Pilots have withstood 21 g's using a mercury couch and up to 25 g's for periods of 40 seconds.

***TM-76A* Mace will replace . . .**

TM-61C Matadors now with the Air Force's 587th Tactical Missile Group at Sembach AFB, Germany. Deployment is scheduled for this spring.

The much-discussed *Polaris* range . . .

was nailed at 1200 miles by Director of Guided Missiles William M. Holaday. This is the early range objective of the accelerated program. A 1500-mile range will be attained on or before the date anticipated before the acceleration, Holaday predicted.

Basic research . . .

accounts for about 60% of the Navy's half-billion-dollar R&D budget, according to testimony before the House Space Committee. A large part of the money is in over 1500 contracts with non-profit organizations and universities.

Messerschmitt has named . . .

Robert Lusser as Director of Research and Engineering. Just prior to returning to Germany early last month to take over the post, Lusser was reliability coordinator for guided missiles at Redstone Arsenal. He came to this country in 1948 under a Navy contract and until 1953 worked at Point Mugu in missile reliability. At Messerschmitt before World War II, he designed the Messerschmitt 109. During the war he designed the world's first turbojet fighter for Heinkel, the 280. Lusser became an American citizen in 1956.

German marches . . .

were played by the *Atlas* talking satellite at one point during its month-long trip around the earth. Mortimer Rosenbaum, chief engineer of General Dynamics' Convair Astronautics Division, said a German radio station happened to transmit a tone that set the *Atlas* recording and transmitting the station's musical broadcast.

***Plato* "cancellation" reports . . .**

are conflicting to say the least. DOD sources have said the transportable anti-missile defense system has been cancelled. But Sylvania Electric Products, Inc., prime contractor, said it has received "no official" word and is still working on the project which would have been used in conjunction with *Nike-Zeus*. The program started in September, 1953, under Sylvania and Cornell for feasibility R&D and development of some components.

Master plan . . .

for PMR will take 15 years and $4 billion worth of equipment, Congress was told last week. Plans call for 12 instrumented range ships to aid in recovery of test equipment.

***Polaris* doesn't interest British . . .**

who apparently have rejected the missile in favor of their own *Blue Streak* as the nation's major retaliatory weapon.

- **Flat frequency response** from 0 to 100 cps
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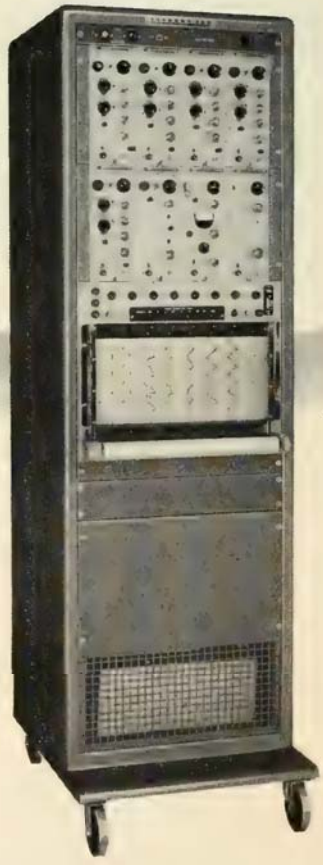

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Only the Sanborn "350" oscillographic recording system offers *both* superior performance *and* operating versatility. You can interchange the plug-in preamplifiers — or use them separately with their own power supplies to drive a scope, meter, or optical oscillograph. The compact recorder (17½ inches tall), complete with transistorized power amplifiers and power supply, may also be used separately (sensitivity 0.1 volt/chart division). That's real versatility!

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industry countdown

Du Pont is boosting production . . .

capacity for sodium and chlorine at its Memphis plant to meet the needs for the basic sodium metal in high-energy fuels and for chlorine in manufacture of titanium dioxide pigment, used in making chlorinated solvents. Completion of new facilities will up capacity for the two metals by about 50%.

Two new marketing units . . .

Defense Industries Sales and Defense Industries Contract Administration—have been established by General Electric's Heavy Military Electronics Department to "enable the Department for the first time to make available directly to major defense prime contractors GE's technical know-how and facilities for designing and producing large, complex electronic subsystems." Systems would be comprised of ground-based radar suited to missile defense, ground control and guidance equipment for aircraft, missiles, spacecraft, etc.

Monsanto Chemical . . .

will soon be producing its high-pressure polyethylene plastic at the rate of 100 million pounds a year. The speed-up is scheduled for completion in the third quarter of this year. High-pressure polyethylene production ultimately will reach one billion pounds a year.

Urgent need . . .

for solving problems in development of the atomic submarine and its marriage to the ballistic missile is the object of a broad coordinated program now being planned by the Westinghouse Air Arm Division. All corporate facilities will be involved in the program with Air Arm acting as the lead division.

Progress of the *Nike-Zeus* . . .

anti-missile missile program, still far from the complete hardware stage, apparently is worrying Pentagon planners who want a stop-gap system until the *Zeus* is ready. For this reason Boeing is expected to take part in AMM work in line with its *Bomarc* program. *Bomarc B* is well advanced and in production, and development of *Bomarc C*, with double the 400-mile range of the B, is underway. If and when Boeing enters the AMM field, its development is expected to be an evolutionary offspring of the *Bomarc* and a marriage of the *Bomarc* system and the *Minuteman* program.

***Hawk* is well on its way . . .**

to becoming an operational weapon system with the latest contract award to Raytheon Manufacturing Co., amounting to $50,731,000, for production of the low-flying surface-to-air bird. Missiles and ground support equipment will be produced at Raytheon's Andover, Mass., plant. Ground support equipment will account for two-thirds of the missile system's dollar.

Vitro Labs will operate . . .

and maintain the land and water ranges at the Air Proving Ground Center at Eglin AFB under a $1.8-million Air Force contract. The *Bomarc* IM-99A is now undergoing operational testing and crew check-out at the Eglin base.

***Polaris* is currently limited . . .**

to the recently-announced 800-mile range by the state of the art of casing fabrication. First firing of the complete *Polaris* (1200-1500-mile version) is expected early this summer.

NASA will close . . .

its liaison office at Wright-Patterson Air Force Base about April 1.

Contractor Relations . . .

will be monitored by a new office set up at ARDC. The office will be under Col. Richard E. Sims, who has been named Assistant Deputy Commander for Technical and Contractor Services. New ARDC regional offices are being established in Boston, Washington, Denver and Dallas to supplement existing offices in New York, Chicago, and Los Angeles. Objective is to speed the evaluation and processing of R&D ideas.

Major Expansion . . .

of Pennsalt Chemical Corp's four-month old plant at Portland, Ore., already is in the works. The new plant will expand ammonium perchlorate capacity by several thousand tons. Sodium chlorate facilities will have a 25% increase in capacity.

...speaking of

Missile Ground Support **MOBILITY**

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BRUARY 16, 1959—VOL. 5, NO. 7

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

What Will Be Outcome of Probe of STL?

Congress may recommend that STL sever all financial ties to Thompson Ramo-Wooldridge, and that a limit be placed on profits and salaries of company officials

WASHINGTON—Although the current Congressional scrutiny of the Air Force's ballistic missile program and management by Space Technology Laboratories is not expected to change the concept or its operation, look for these Congressional recommendations:

1. That STL divest itself completely of any financial ties to Thompson Ramo-Wooldridge Corp.

2. That a limit be placed on profits and salaries of captive company officials.

• **Air Force-TRW defense**—The Military Subcommittee of the House Government Operations Committee heard AF officials strongly defend their management concept, claiming it was responsible for their ballistic missile successes, that "we're well ahead of schedule" and that had the regular line command prevailed, time lost would have been "not a matter of months but a matter of years."

Both AF and TRW officials pointed out that the corporation is now severely handicapped when it comes to getting Air Force business.

The Air Force has issued a directive that bars TRW from contracting with them on the ballistic missile program, except where it is the sole source or otherwise uniquely qualified. In view of the furor it would cause, Air Force contractors are hardly likely to override the directive unless absolutely necessary.

STL officials told the committee that although their stock is owned by TRW, from which it split off, its management is entirely separate. The company indicated it would break its financial tie to TRW "if such a step is later found to be desirable and proper."

• **More questions**—Other subcommittee questions and STL answers:

Q. What advantages did the company gain from its five-year "privileged" position as management team for the ICBM program?

A. STL does get proprietary information from contractors, but it hands out more such data to contractors than it takes in by virtue of the fact that "it is the technical leader in the field." It makes less money than "the average contractor who builds the hardware."

Q. How much has the Ramo-Wooldridge Corp. (of which STL was formerly a division) earned since it first entered into the contract with the Air Force in October, 1953?

A. Total retained earnings for the five years were about $4 million; its reimbursements paid by the Air Force totaled 2.8% of the overall cost of the AF ballistic missile program or something under $100 million; the systems engineering approach saved the government $200 million over the conventional method of contracting.

Q. Does STL recommend or decide which companies should be given contracts?

A. This is held in the Air Force. STL directs the program, gives technical advice, writes specifications. The Air Force then goes to the best source.

The hearings brought out that the system engineering approach grew out of a study made in January, 1954, by an Air Force committee of which Dr. Simon Ramo and Dr. Dean Wooldridge were members. They resigned shortly afterward but as early as October, 1953, they had an Air Force study contract. In July, 1954, the Scientific Advisory Committee recommended that the team of Ramo and Wooldridge be given the job of technical direction and systems engineering of the ballistic missile program. Under terms of the agreement, they were barred from any physical development that might lead to production contracts.

After three days of testifying, the STL witnesses—including President Louis G. Dunn and Board Chairman Jimmy Doolittle—went to their hotel to pack for the trip back to the coast and to celebrate the first successful *Titan* flight, announced that afternoon.

Scout Could Orbit 150 lbs.

WASHINGTON—The National Aeronautics and Space Administration is developing a "poor man's rocket" with an estimated weight of 3500 pounds capable of orbiting 150 pounds at a nominal 300-mile altitude.

Called Project *Scout*, the vehicle will be a four-stage rocket using modified *Sergeant* engines and newer solid motors of advanced design and high performance.

The first stage will be a modification of the test *Sergeant* (XM-33) developed by Thiokol for the earlier *Polaris* vehicles.

The other stages will be modified *Sergeants* and newer solid engines under development by the Allegheny Missile Laboratories. Contracts have been let to Thiokol and Allegheny for procurement of motors for all stages.

NASA is currently negotiating with North American Aviation, Inc., on the structure contract.

Basic development of the rocket is being carried on for NASA by the Langley Aeronautical Laboratory.

The *Scout* should provide for NASA and the military services a cheap, reliable, efficient rocket for high-altitude research, re-entry tests, and for testing components before miniaturization.

The weight of the *Scout* indicates the number of pounds of vehicle needed to put one pound into orbit will be drastically reduced. According to Dr. Homer Joe Stewart, director of NASA's Office of Program Planning and Evaluation, today's best ratio is 1000 pounds of vehicle for every pound orbited. The *Scout* will apparently reduce this ratio to anywhere from 25 to 40 to one.

Dr. Stewart also said that the new rockets developed specifically for space exploration could reduce cost down from the $10,000-per-orbiting-pound expended by the military rockets to about $300-per-orbiting-pound.

WILL PHOTOGRAPH of the far side of the moon be similar to this concept by the author? First successful lunar probe television camera could transmit such a photograph back to earth.

What Is Topography of Moon's Other Side?

That terrain may be rougher with more craters and smaller mares, astronomer believes

by Dr. I. M. Levitt
Director, Fels Planetarium of the Franklin Institute

HEAT FROM a small planetismal impacting near Mare Imbrium (dotted line) created a lava flow that probably formed other seas on the earth side of the moon (solid line). Moon is inverted with the south pole at the top.

PHILADELPHIA—At the dawn of time when the moon was still hot, plastic and near the earth, giant tides were generated on its crust. Eons later, when the moon had solidified, the 3600-foot tide was locked into the solid structure of the moon. The earth's gravitational field then captured the long axis of the moon, keeping it always pointed toward the earth.

The events of that time are apparent today: The same side of the moon always faces the earth and the other side is largely a secret.

It is not entirely accurate to say that we have never seen the other side of the moon. We actually do catch glimpses of part of the other side. This "libration" is created as the moon turns on its axis uniformly while circling the earth in an ellipse.

Since the motion of a body in an ellipse is not uniform, the moon as seen from the earth speeds up or slows in its rotation, permitting us to see slightly more than half of its surface.

Actually 41% of the moon is always seen, 41% is never seen and the other 18% can be seen at one time or another.

• **Secrecy nears end**—The moon will not keep its secret for very long because man will soon—perhaps within the next decade—photograph its far side. In the meantime, if plans of the new National Aeronautics and Space Administration are consummated, a lunar probe to circle the moon and relay back information may be realized in the next few months.

Hence, we may have answers in the immediate future to these age-old questions: What does the other side of the moon look like? Is it the same as our side or is it radically different?

Scientists have long speculated, but nothing definitive has ever been presented. The question naturally arises: Is there any way in which we may postulate a surface "picture" of the far side?

Despite the fact that astronomers have considered the moon a lifeless body without water and atmosphere, many believe that man can build up a civilization and live "off" the moon. In the course of an intensive study some intriguing facts about the moon were unveiled and from these it is possible to arrive at a statistical picture of the moon's other side.

What is on the other side is related to the surface conditions of the side facing the earth. For that reason it is well to spend some time discussing the features which can be seen.

• **Visible clues**—A picture of the full moon shows that fully half the surface is made up of flat areas which early astronomers called "maria" or seas. The other half of the visible side is composed of pitted areas or craters

ith an incredibly rough topography.

The aspect of the other side is ighly dependent on how the seas ame into being. The answer to this ay not be realized until man puts ot on the moon. But it is possible ow to draw some conclusions.

The consensus is that several bil-on years ago a giant meteor, or lanetesimal, hit the moon at the place day called Mare Imbrium. The lanetesimal was supposedly from 125 200 miles in diameter and struck e moon with a nominal speed, which r. Harold Urey puts at about 1.5 iles a second. If the speed were reater the resulting explosion would ave given the region a symmetrical ttern which is not apparent.

• **Mighty blow**—There was a tre-endous amount of Kinetic energy in-erent in the moving planetesimal due its motion. If the planetesimal was 25 miles in diameter with a density of 5 and a speed of 1.5 miles a second, en the energy released on impact ould have been 4.15 x 10^{29} ergs. Dr. eorge Gamow has indicated that an g is the energy of a small mosquito ying across a room. Yet, the energy impact suggested above is equal to 50 billion atomic bombs.

To represent this in another way, e entire earth might be divided into ty blocks. Then, says Dr. Urey, if e atomic bomb were exploded on very city block we would have ex-ended the same amount of energy as as given up when the planetesimal ruck the moon.

• **Seas formed**—Precisely what hap-ened at the time of impact no one nows. But this much is known: There as a tremendous amount of energy vailable as the kinetic energy of mo-on. This was converted to heat and e result was the formation of a emendous pool of lava which flowed om the Mare Imbrium region to rm, to the east, the Mare Nubium d the Oceanus Procellarium.

The lava flowed to the west to form e Mare Serenitatis, Mare Tranquil-tatis, the Mare Foecunditatis and the iver we call Mare Nectaris. If other as existed prior to this event, and ere is some evidence to indicate this, ey were submerged in the flood of va which flowed from the impact oint.

Prior meteoritic impacts could have rown up mountain ranges and the va flows would have inundated ese as well as some of the larger aters bordering this region. The ooding of the Mare Imbrium floor indicated by isolated peaks still ound in that region.

Violent explosions ripped along the rface through mountains to create the valleys and rifts which can all be traced back to the impact point in the Mare Imbrium. Away from the seas around the south pole, we find the old moon whose craters antedate the Mare Imbrium catastrophe.

• **Some conclusions**—If what has been said makes sense, we can say that nowhere else on this side of the moon was there an impact by a planetesimal of the size that struck the Mare Imbrium region. Certainly if there was we would see it and no comparable area is visible.

There are several other small seas on the moon which we see when the moon librates. But in every case, except one, we see the entire small sea. Thus it becomes apparent that the only region where another planetesimal could have hit the other side to create a large sea area similar to the Mare Imbrium is directly in the center of the other side. Unless it hit dead center we would see the edges of the seas coming around the limb.

Now we begin to use probabilities. The odds of a planetesimal hitting directly in the center of the other side are so small as not to merit serious consideration.

Thus we come to the conclusion that the other side of the moon is wholly unlike the side facing the earth.

• **A likely picture**—It appears possible to obtain a statistical picture of the other side of the moon.

A careful look at the near side shows that the southern half is composed principally of the old pre-mare areas, unaffected by the encroachment of lava flows from the impact center. Thus we should expect to see the other side as made up of material which comprises the southern half of the visible moon. But what sort of craters, how many, and what kind of seas should we find?

To arrive at this picture, the moon is divided into its northern and southern regions. Then the areas of the moon which were obviously the result of the lava flows are traced. This ratio of the old moon to the total southern half which may be called the "deficiency factor" turns out to be 79.6 per cent.

Then the craters are counted on the whole moon which have diameters from 20 to 29 miles, from 30 to 39 miles, from 40 to 49 miles, from 50 to 59 miles, from 60 to 79 miles, from 80 to 99 miles and finally from 100 to 146 miles. The same range of crater sizes were counted in the southern half. The ratio of the two gave a number which may be called the "rectification factor." This factor is used to eliminate the effect of the seas in the northern hemisphere.

By taking the number of craters of a given size in the southern half and multiplying by two we have the number for the entire side of the moon. This number multiplied by the deficiency and rectification factors yielded the number of craters on the other side of the moon of a given diameter.

The total number of craters 20 miles or over in diameter on the side of the moon facing us is 227. However, the total for the other side is 395 craters or more. Thus the absence of the large sea areas on the other side of the moon almost doubles the number of craters.

• **Smaller seas**—Examination of the near side and the limb due to libration discloses many of the smaller seas like the Mare Crisium, Mare Marginus, the Mare Symthii, Mare Humboltianum, etc. From the presence of these we may draw the conclusion that there should be at least four or perhaps five small maria on the other side of the moon which we cannot see.

Thus from a purely statistical study it is possible to derive the total number of craters and the maria that should be present on the other side of the moon. Whether the numbers are precise we do not know, we can only indicate the order of magnitude of this array.

The positions of the craters and maria we cannot know. This is a mystery which will be resolved only when we get around to the other side of the moon.

Perhaps in 1959 a lunar probe will leave the earth to circle the moon and televise back a picture of the other side. If such a picture looks like the one accompanying this article, no one will be more surprised than the author.

5½ Million Units

Transistor Sales Reach Another Record

WASHINGTON—Sales of transistors in December increased substantially over November to establish an all-time-high for any given month in the history of the industry, the Electronic Industries Association has announced. Unit sales of transistors during 1958 increased by 64% over 1957.

Factory sales of transistors in December totaled 5,627,700, valued at $16,595,616, compared with 5,440,891 units valued at $12,441,759 in November, and 2,773,000 units valued at $6,-619,000 sold in December, 1957.

Cumulative sales of transistors during 1958 totaled 47,050,814, valued at $112,729,427, compared with 28,738,-000, valued at $69,739,000, during calendar year 1957.

Thor IRBM Production

by Fred S. Hunter

LOS ANGELES—Final assembly of the 65-ft. *Thor* missile is underway on four parallel lines at Douglas Aircraft's Santa Monica missile plant. No production figures have been released, but the company has disclosed that all requirements have been filled and an accumulation of missiles are in reserve for emergencies.

To date 32 *Thors* have been fired in the flight program of the Douglas IRBM. Of these, 16 have been described as completely successful, 12 as partially successful (meaning important data has been obtained) and only four were categorized as failures.

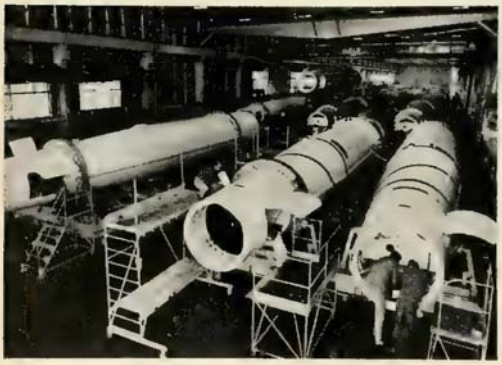
Design of the *Thor* is now frozen, but Douglas and its associated contractors will continue to seek improvements in the system, President Donald W. Douglas, Jr., reported.

Douglas noted that, although many changes have been made in small items in development of the *Thor*, no structural modifications have been required. "There has never been a major fix on the *Thor*," he said.

Born of the urgent military need for a ballistic missile which might be set up in NATO countries, notably Britain, the *Thor* program was set in motion at the Douglas company on Dec. 27, 1955. Within one month the size of the missile was determined; within seven months engineering drawings had been released, and within 13 months the first test firing took place.

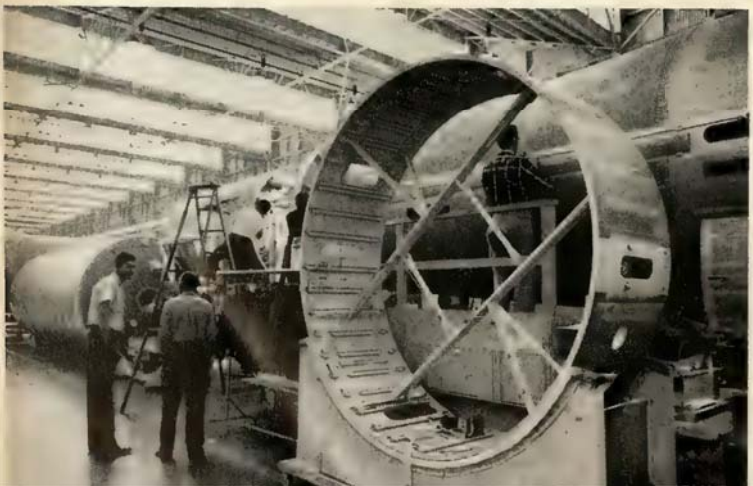
This was unsuccessful, but defects were subsequently ironed out and by December, 1958—within two years after the project's start—a *Thor* with guidance system flew its prescribed course over the Atlantic test range with impact very close to target. From the first missile, Douglas has used production tooling in turning out the *Thor* at Santa Monica.

No new information on costs of the *Thor* project has been released. The missile itself has been disclosed as costing between $650,000 and $700,000, without R&D.



THREE *Thors*, **minus warheads and nose cones, have guidance systems installed on the final assembly line at the Douglas Santa Monica plant.**

ENGINE sections, tanks, and guidance and control sections are joined and all cables and lines attached to *Thor*.



THE 150-165,000-lb. thrust engine system for *Thor* **is joined to the engine body section. Missile is reported to cost between $650-700,000 dollars.**

Jupiter IRBM Production

by Alfred J. Zaehringer

DETROIT—With its *Redstone* mis-le nearing end of production and ith a limited outlook for producing *upiter* IRBM's, Chrysler Corp.'s Mis-le Division has formed a special roup aimed at keeping the firm in ie missile business. The new group known as the Advanced Projects rganization.

APO, m/r has learned, was formed bid on the *Minuteman* ICBM sys-em. After plunking several thousand an hours and several hundred thou-nd dollars into the Air Force pro-osal, Chrysler decided to keep APO oing to look for new business.

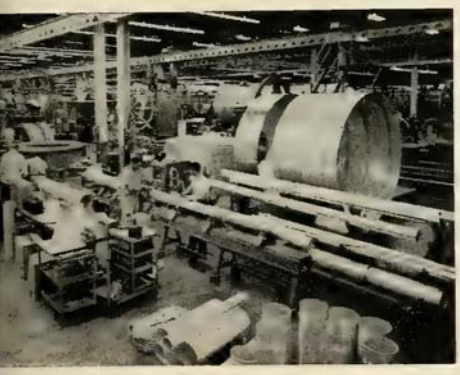
Biggest hope at Chrysler and ABMA is use of existing vehicles as research and development tools in up-and-coming programs. It was learned that the advanced projects group is actively working on proposals for use of *Redstone* missiles in high-altitude research, satellite vehicles, and nuclear weapons testing at extreme altitudes.

If warhead tests prove successful—and if *Nike-Zeus* can be brought to test soon, Chrysler's APO hopes that either *Redstone*, or more probably *Jupiter*, will be used as a target missile for the anti-missile missile.

Usually reliable industry and Army sources have told m/r that ABMA will try to keep *Jupiter* going through use of missiles as supply and troop carriers.

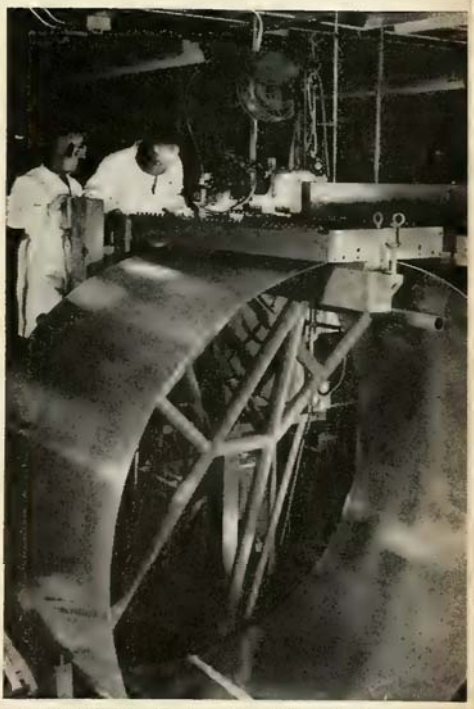
For the immediate future, however, APO is trying to up-grade present missiles. Some proposals include: substituting nitrogen tetroxide for LOX to produce storable, ready-to-fire missiles; switching RP for alcohol, and using the hydrazines for better performance.

In addition, a strong segment of APO is keeping a firm eye on all solid propellant developments just to be on the safe side of any possible weapons systems trends. Along these lines, one big hope for Chrysler may be selection as systems manager for the *Nike-Zeus*. And use of *Jupiter* or *Redstone* as target missiles could also be a healthy stimulant.



TANK sections, with circumferential stiffeners attached, forming and assembling jigs, and propellant flow lines are shown being assembled on the *Jupiter*.

UIDANCE and control ection of *Jupiter* is oined to the forward tank ection. Aft section can e seen at the right.



BODY SKIN for *Jupiter* is rolled and joined by automatic welding equipment in the fabricating tank section of the Chrysler Corp.'s Missile Division.

New Approach for Liquid-Floated Gyros

Norden Division of United Aircraft gets patent for unheated gyro that mechanically compensates for temperature variations

WASHINGTON—The persistent problem of temperature that has dogged designers of liquid-floated gyros since their inception seems to be on the way to solution.

In a patent (No. 2,865,206) granted Dec. 23, Thomas Quermann of the Ketay Department, Norden Division of United Aircraft, describes a new unheated, floated rate gyro in which temperature compensation is achieved by mechanical means.

• **Present drawbacks**—Liquid gyros presently in use operate well but have the disadvantage of the flotation fluid changing viscosity and density with changes in temperature. This means that unwanted torques and, consequently, precessions are set up within the gyro unless the fluid is kept at an even, high temperature.

Because of this, liquid-floated gyros are usually kept at operating temperature from the time they are manufactured until they are used. Present guidance systems using liquid-buoyed gyros are the *Atlas, Titan, Thor, Mace* (in its inertial version), *Sergeant,* and presumably, the *Polaris.*

The only serious competitor to the liquid units for high-accuracy guidance systems has been the air-bearing gyro manufactured by Ford Instrument Company for the *Jupiter* and the *Redstone* and by the Eclipse-Pioneer division of Bendix for the *Pershing.* But here, while temperature is not a serious problem, a supply of clean dry air is a necessity.

This brings in the requirement of more weight for carrying and processing the air. The liquid-floated gyros in use stem from early inventions of Dr. C. S. Draper of MIT and the air-bearing gyros come from Dr. Wernher von Braun's group at ABMA.

• **Constant damping**—The new component, called the buoyed rate gyroscope in the patent application, proposes to solve the foregoing problems by adding mechanical elements to achieve temperature compensation. This keeps the damping force exerted on the gimbal housing substantially constant. Most liquid gyros maintain a uniform damping force by means such as a volumetric thermostat which controls a heater in response to changes in volume of the liquid temperature and hence the liquid viscosity.

The patent points out that while an electrical system maintains the temperature constant, it operates only to heat the liquid and includes no means for cooling it. This requires that the liquid be maintained at a temperature higher than the maximum to which the assembly will be subjected. A mechanical compensator eliminates this high-temperature requirement.

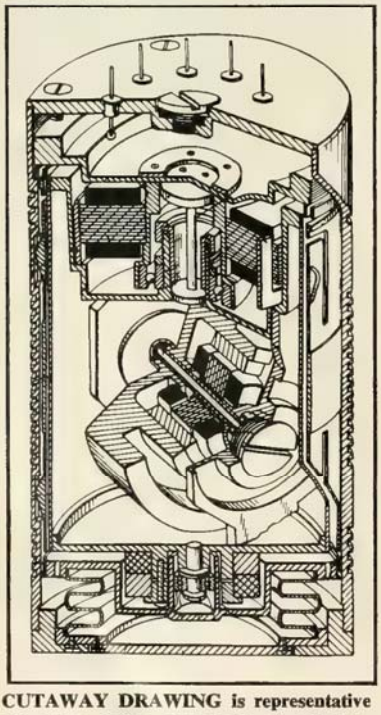
Reports are that most liquid-floated gyros now in use operate somewhere in the vicinity of 180°F. Quermann estimates that most of these gyros need between 50 and 100 watts to maintain this temperature.

• **Shifting cage**—The gyro has a motor supported in a sealed housing buoyed by a liquid contained in an outer housing while being constrained to rotate about an axis at right angles to the gyro spin axis. An axially-shiftable, cylindrical cage between the housing and the casing, restrained against rotation relative to the casing, holds a film of liquid which provides a damping force for the housing. The cage has a wall formed by a number of resiliently-supported sections adapted to be actuated effectively to decrease the cage diameter.

A bellows which responds to changes in liquid volume shifts the cage longitudinally in reference to the outer casing. Interengagable means carried by the casing and the cage walls move the walls inward or outward from the housing to increase or decrease the thickness of the liquid film providing the damping force. The decrease in liquid viscosity resulting from change in temperature therefore is compensated for to maintain a substantially constant liquid damping force.

• **In production**—The accompanying cutaway drawing is not intended to show the exact gyro being produced by Norden. It is only representative of a family of such units that have been in production for more than a year. Of the group in production, some units operate on 115 volts and others use 26 volts. Either inductive or potentiometer pickoffs are supplied with various values of excitation.

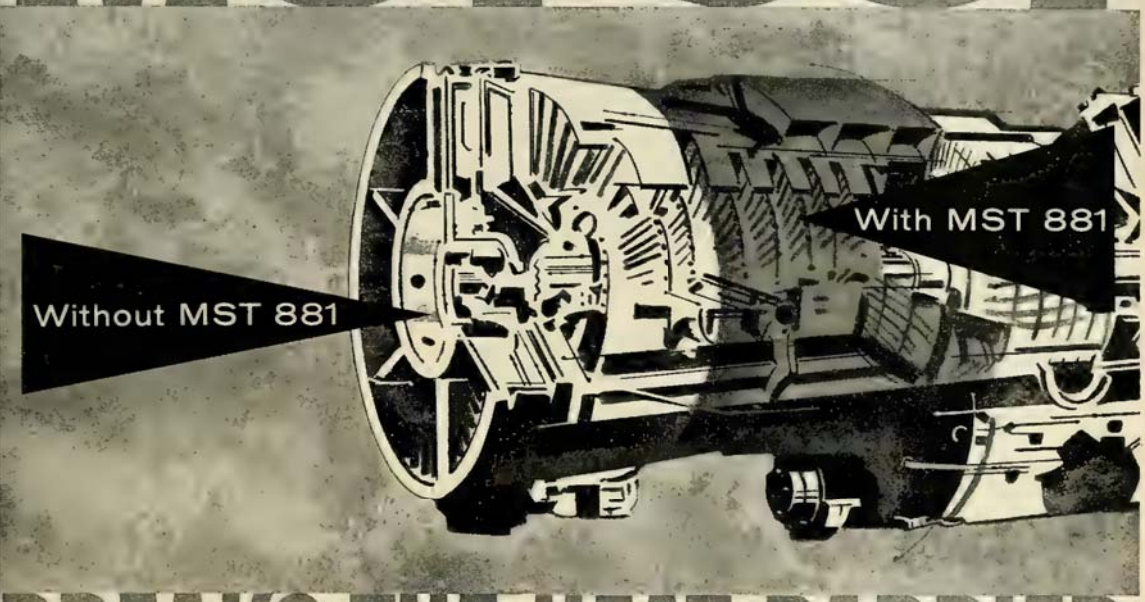
The company was reluctant to discuss present buyers of the units, but one announcement said the gyro "has already become an important component on the *Atlas, Polaris, Titan* and *Snark* missiles."



CUTAWAY DRAWING is representative of gyros being produced at Norden.

New Mallory-Sharon 1100° Titanium Alloy

MST 881



BREAKS THE HEAT BARRIER

Note high stress/density ratio of MST 881 at 1000° F., compared to MST 821 alloy, 304 and A-286 stainless steels.

Visit our Booth No. 1151 at Western Metal Exposition, March 16-20, Pan-Pacific Auditorium, Los Angeles.

Now, after 2½ years of intensive research, Mallory-Sharon has developed a new titanium alloy with elevated temperature properties far surpassing those of any existing titanium alloys.

What this means in terms of jet engine construction, for example, is illustrated above. The weight-saving advantages of titanium can now be obtained in additional stages of hot Mach 3 engines through use of MST 881.

At a temperature of 1000 degrees F., a level of increasing importance in the aircraft industry, MST 881 has *more than twice the creep strength* of any existing commercial titanium alloy. Even at 1100 degrees F., MST 881 will have only about 0.5% deformation at a stress at 25,000 psi in 150 hours.

Write today for technical data sheet on MST 881.

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...NEWS IS HAPPENING AT NORTHROP
Latest Astronertial Navigation and Guidanc
system is revealed by Dr. William L. Park
Chief of Systems Development at Nortronics
division of Northrop Corporation.

NORTRONICS SYSTEM CAN GUIDE MAN TO PLANETS!

NORTRONICS ASTRONERTIAL: THE ONE GUIDANCE CONCEPT READY NOW FOR THE DAY MAN FIRST EXPLORES THE PLANETS!

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Astronertial Navigation and Guidance has been under continuous refinement since 1946. The only operational guidance concept capable of interplanetary navigation, it is applicable today to missiles, manned aircraft, surface ships and submarines. Astronertial typifies the years-ahead thinking of Northrop Corporation and all of its divisions. The Corporation's continuing goal: design concepts for tomorrow, hardware for today–in a balanced flow–developed and delivered on time, and at minimum cost.

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Now in production, the USAF T-38, America's first supersonic trainer, combines Century-Series performance with unique economy, ease of maintainability.

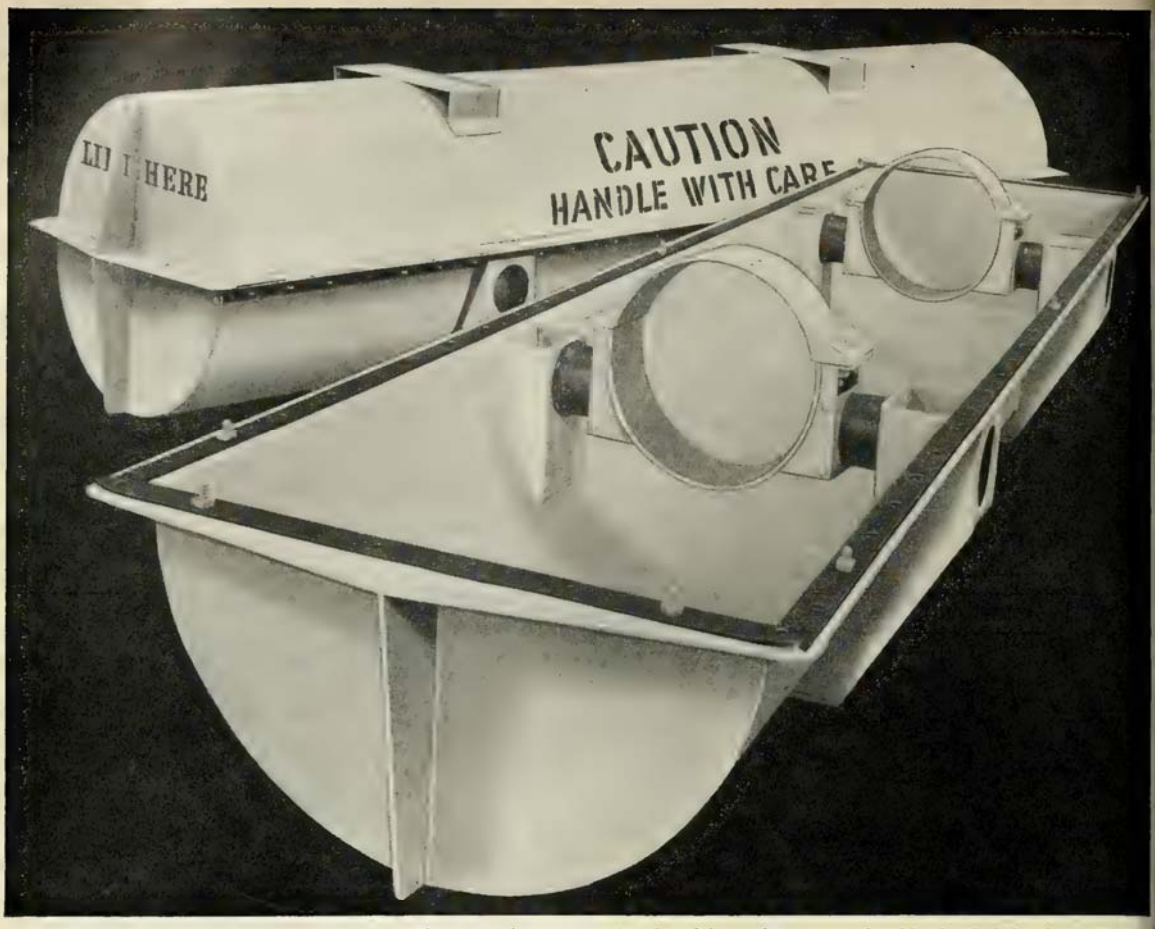
NORAIR

Demanding test for advanced U.S. weapon systems is the XQ-4 supersonic target drone, soon to be followed by the even faster and more sophisticated XQ-4A.

RADIOPLANE

The N-156F counterair fighter is designed to provide friendly free nations effective tactical defense–at little more than half the cost of comparable fighters.

INTERNATIONAL



Shipping and storage container for solid propulsion unit produced by the Thiokol Redstone Division.

METAL FABRICATION PROBLEMS?

better see Butler

Prime contractors and major sub-contractors in government missile programs find the fastest and most economical way to solve metal fabrication problems is to turn them over to Butler.

One of the largest fabricators of aluminum and steel with 8 strategically located plants, Butler has proven capability to design, engineer and deliver complex single units or volume production.

Butler is currently producing reusable metal shipping and storage containers for missiles and missile components, and also mobile fuel service units for the Redstone and Jupiter. Butler is participating in developing and producing the first shelters for Bomarc.

For a comprehensive picture of Butler's capabilities and facilities, write:

Water-alcohol fuel service unit for Redstone. Research, design testing and fabrication by Butler Contract Mcnufacture Division.

Butler was prime contractor for designing, developing, fabricating and erecting prototype Model III Bomarc launching shelter.

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Two Approaches for Cooling IR Detectors

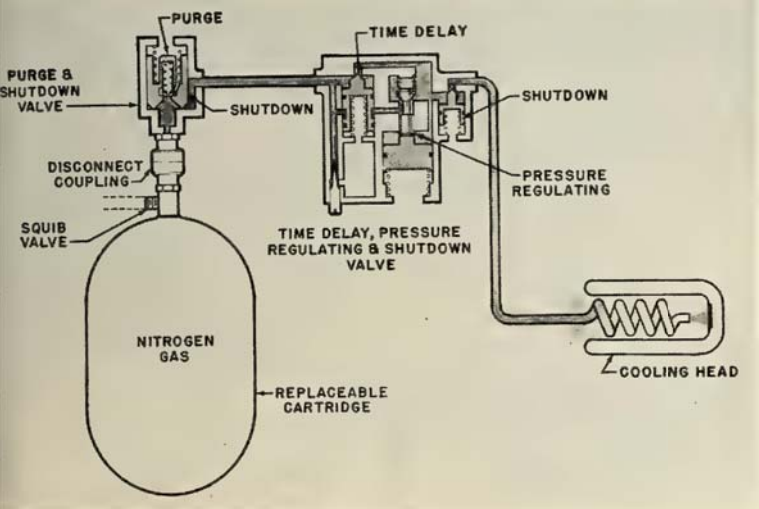
LOS ANGELES—Two types of cryo-
at cooling systems, designed to im-
rove the sensitivity and spectral re-
ponse of infra-red detector units on
issiles, have been developed by The
arrett Corporation's AiResearch Man-
facturing Division, Los Angeles. The
yostats cool the semiconductor ele-
ents which detect infra-red radiation
roduced by heat from the target which the missile is seeking.

For maximum response to this radiation, the semiconductors must be maintained at an extremely low temperature. The AiResearch systems are capable of maintaining the temperature of a steady –300°F.

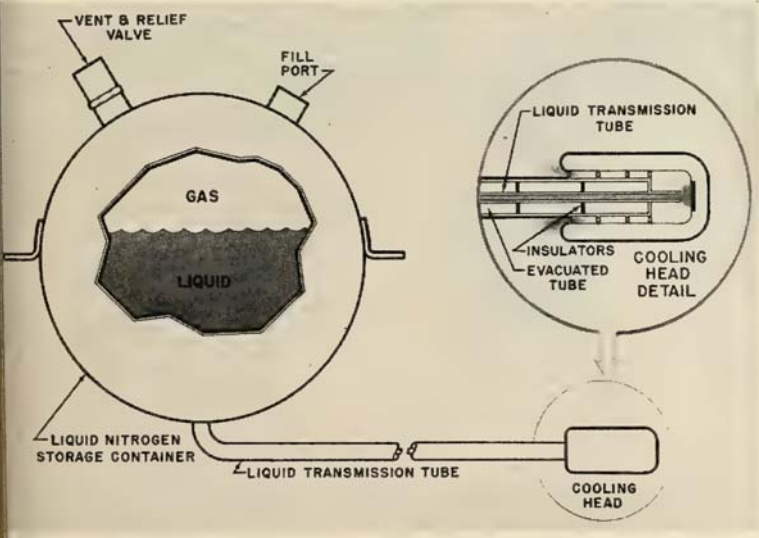
One system uses liquid nitrogen at low pressure with a special Dewar flask. A controlled flow of liquid is transferred from its container by means of a small special insulated tube to the I.R. detector element.

The other method uses nitrogen gas contained at high pressure (3000-5000 psig). The gas, regulated by special valving, travels through an extremely small heat exchanger in the flask where regenerative precooling takes place. Final cooling is accomplished by expanding the gas through an orifice adjacent to the detection element. This expansion causes the gaseous nitrogen to liquify. The latent heat of vaporization is then utilized to maintain the ultra low detector temperature required.

Each system operates in conjunction with a miniature Dewar flask that contains the infra-red detection element in the vacuum annulus. AiResearch is using two methods in the cooling of the elements. One will be liquid and the other will be gas. This diversified approach is expected to come up with the most optimum method of cooling for any given situation. Both liquid and gas models are now being produced by the company.



NITROGEN GAS method used by AiResearch Division of Garrett Corp.



IQUID COOLING system uses insulated tube as transfer means.

Space Requirements Upping Astronomer Needs

ANN ARBOR—Space age demands will increase the number of astronomers in the U.S.—who now total 800—at least three or four-fold in the next 10 years, a University of Michigan astronomer predicts.

Recent estimates have indicated the number will double in the next 15 years to more than 1600. But Prof. Leo Goldberg, head of the U-M Department of Astronomy, said the present shortage will get much worse, and doubling the number of astronomers will not ease it.

The most pressing shortage apparently is in the field of celestial mechanics, which deals with the orbits of planets and provides—among other things—the information needed to chart a rocket course to the moon, Mars and Venus, the American Astronomical Society has reported.

Because of limited opportunities for basic research in celestial mechanics, few astronomers have concentrated in it. The advent of satellites and other space vehicles has not changed this situation, but it has created a demand for application of knowledge in celestial mechanics to practical rather than basic problems.

Servo Corp. Manufactures 12-inch IR Dome

LARGEST INFRARED dome manufactured in one piece, which will be used on classified IR search equipment has been delivered to NADC, Johnsville.

NEW YORK—An infrared dome claimed to be the largest manufactured in one piece, destined for use on classified infrared search equipment, has been delivered to the U.S. Naval Air Development Center, Johnsville, Pa., by Servo Corporation of America, New Hyde Park, Long Island.

The 12-inch, hemisphere-shaped arsenic trisulfide dome will be included in an experimental test vehicle designed to use various infrared detectors in comparative ground and airborne studies of detection capabilities.

The program calls for initial studies to be performed on the ground with fly-over targets. Pending results of the ground tests, the equipment is to be installed in a nacelle hung on a high performance aircraft and flown at high altitudes.

Transmitting out to 12 microns, the infrared dome will be able to cover applications in the near through the far infrared regions. The unit is made of glass which is stable, reportedly does not deteriorate with use and is non-hygroscopic and non-photosensitive. In addition, it should retain its shape without suffering plastic deformation under pressure.

Lockheed Delivers 9-lb. Rugged TV System to ABMA

SUNNYVALE, CALIF.—First units of a tiny battery-powered television system, weighing only nine pounds yet rugged enough to withstand the forces of being rocketed into space, have been delivered to the Army Ballistic Missile Agency by the Lockheed Aircraft Corp.'s Missiles and Space Division.

The system, which has a 1000-mile transmitting range, consists of a camera and three small units which easily fit into a brief case. The camera itself is only 7¾" long and 2¼" in diameter with a weight of 42 ounces, including lens. Yet its picture transmission quality, Lockheed says, compares with commercial TV cameras and transmitting stations.

In addition to the camera, the TV system includes a transistorized control unit weighing 42 ounces, a 14-ounce unit containing camera controls and a 50-watt transmitter weighing 4 ounces. It is powered by a 28-volt dry cell battery and has been tested to 40 gs of shock, 50 gs of acceleration and 10 gs of vibration.

• **Surveillance improved**—In the missile field, the miniaturized TV could be used to follow a missile's perform

MIDVAC SUPER ALLOYS

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Midvac Alloys insure increased tensile and impact properties, improved stress rupture strength at elevated temperature, and longer fatigue life.

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MidVac Steels

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Subsidiary of HEPPENSTALL COMPANY, Pittsburgh, Pa.

ance after it has been launched and has disappeared from sight of ground observers. On a monitor at a ground station you would actually be able to look at such critical things as a stage separation or an engine firing.

Samuel Schwartz, Lockheed research scientist, has patent applications on portions of the electronic design of the system. Initial development was headed by Nicholas K. Marshall, senior scientist. This new piece of space-age hardware was displayed when the Lockheed Missiles and Space Division exhibited some of the advanced scientific research in which it is engaged. "In our current planning," said general manager L. Eugene Root, "we have listed numerous programs as most desirable for LMSD from all aspects of its operations. Some 60% of these are for projects in the space area. Of a large number of proposals submitted by the division in recent months about half have been for space projects."

X-15 Drop Soon

Guidance To Be Tested in Early Program Phase

EDWARDS AFB, CALIF.—The *X-15*, designed to carry man farther into space than he has ever been, will have its first air-borne test this Wednesday, if the present schedule holds.

North American Aviation's Scott Crossfield will crawl into the cockpit of the slender, black experimental craft and be carried aloft for a static test as the *X-15* clings to the right wing of a modified B-52.

About Feb. 27 or 28, the rocket plane will be taken up again—and this time released for its first glide test. The third flight, shortly thereafter, will again be static, to test emergency measures such as releasing fuel from both the *X-15* and the B-52. First powered flight will probably come sometime in mid-April if earlier tests go on schedule.

The engines, made by Reaction Motors Division of Thiokol Chemical Corp., were installed in the test plane early in February and have been firing much of the time since.

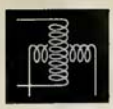
•**Joint project**—The *X-15* was built by North American as a joint project for the Air Force and old NACA (now NASA), with the Navy participating. It is 50 feet long, 22 feet at wing span and 13 feet high, with a 31,275-pound launch weight. The plane is designed to reach 100 miles altitude. First flights will be made with two old X-1 engines, later to be replaced by one—the XLR-99. Both engine types were made by Reaction.

Riding in the B-52 which carries the *X-15* will be Capt. Charles C. Bock, pilot; Capt. James E. Allavie, co-pilot, and William Berkowitz of North American, launch pilot. Flying chase will be Capt. Robert White, Air Force test pilot who will actually fly the *X-15* to maximum altitude and speed after Crossfield has tested the initial performance. White will chase first in an F-100F and later in an F-104.

Telemetry of information will be checked out through the master station for high range located in the NASA building at Edwards.

•**Sperry guidance**—Scheduled for testing in the early phases is the guidance system manufactured by the Sperry Gyroscope division of Sperry Rand Corp. To date, six such systems have been delivered to Edwards. On

KEARFOTT PRECISION RESOLVERS FOR EVERY SYSTEM APPLICATION



Kearfott has available a complete line of precision resolvers for every system application. Computing resolvers range in functional accuracy from .05% to .005%, in bridge accuracy from 3 minutes to 20 seconds of arc and in size from 11 to 25. Non-compensated resolvers range from 5 minutes to 20 seconds of arc in accuracy, from 8 to 25 in size. All Kearfott resolvers feature stainless housing, shafts and bearings and corrosion-resistant lamination materials for maximum environmental resistance. Optional designs available for operation at 200°C and in environment of 2000 cps vibration at 30 g's.

Computing Resolvers

Available with integral compensating windings. Can be provided with trimming networks to match existing isolation amplifiers or Kearfott-designed transistorized amplifiers.

Size 11

For applications where size and good functional accuracy are of paramount importance. Functional accuracy as good as .05% and bridge errors of 3 minutes of arc are in production.

Size 15

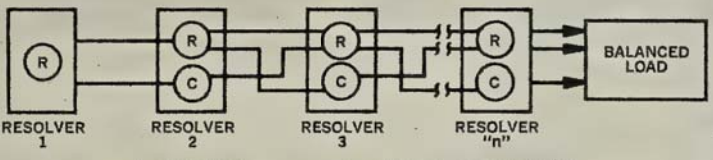
A 2:1 improvement in functional accuracy and bridge error obtained in this configuration. Unit tabulated is the direct equivalent of standard Navy BuOrd Mark 4 Mod 3 and contains necessary trimming network for standard buffer amplifiers. Transformation ratio is 1.000 ± .0001, phase shift 0° ± 1 minute. Functional accuracy of .025% and bridge error of 1.5 minutes of arc are standard.

Size 25

For applications demanding the highest order of accuracy. Close attention has been paid to design parameters.

Size 18

A special resolver which permits a unique cascading of these units without the necessity for buffer amplifiers. Typical application is illustrated in following cascade:



R=RESOLVER C=INTEGRAL COMPENSATOR

COMPENSATED RESOLVERS FOR PRECISE COMPUTER APPLICATIONS

SIZE	11		15	18	25
PART NUMBER	R980-01	R980-41	T980-51	V980-004	425506-1
Excitation Volts–(Max.)	60	60	26	26	25
Frequency–(cps)	400	400	400	400	400
Primary Impedance	629 + j2510	450 + j2200	220 + j1000	3000 + j (0 ± 40)	1630/78.5°
Secondary Impedance	695 + j2750	500 + j2300	240 + j1100	3000 + j (0 ± 40)	1620/80°
Transformation Ratio (Primary to Secondary)	.980	.980	.980	.775	.980
Transformation Ratio (Compensator to Rotor)	.985	.985	.950	.775	.985
Phase Shift (Lead)	8.5°	7.5°	8.5°	0° ± 10'	1°
Fundamental Null (MV)	15	15	8	15	15
Bridge Error From E.Z. (Max.)	7 mins.	5 mins.	3 mins.	3 mins.	20 Seconds
Primary	Stator	Stator	Stator	Stator	Stator

Non-Compensated Resolvers

Basically for application in precise data transmission systems. These synchro resolvers permit system designer to achieve system errors of better than 1 minute of arc without using 2-speed servos and elaborate electronics. By proper impedance matches up to 64 resolver control transformers can also operate from one resolver transmitter.

Size 11

Where size is important. These units have a maximum unit error of 3 minutes of arc.

Size 25

Where highest accuracy is required. These units have a maximum error as low as 20 seconds of arc.

NON-COMPENSATED RESOLVERS FOR PRECISE DATA TRANSMISSION

	SIZE 11			SIZE 25		
Type Resolver	Transmitter	Differential	Control Transformer	Transmitter	Differential	Control Transformer
Part Number	R982-004	R982-011	R982-012	Z5161-001	Z5191-001	Z5151-003
Excitation Volts (Max.)	26	11.8	11.8	115	90	90
Frequency (cps)	400	400	400	400	400	400
Primary Impedance	170/77°	850/80°	2000/80°	400/80°	800/80°	8500/80°
Secondary Impedance	42/80.5°	1000/79°	8000/76°	260/80°	900/80°	14000/80°
Transformation Ratio	.454	1.000	1.906	.7826	1.000	1.278
Max. Error from E.Z.	3 mins.	3 mins.	3 mins.	20 seconds	20 seconds	20 seconds
Primary	Rotor	Stator	Stator	Rotor	Stator	Stator

Write for complete data.

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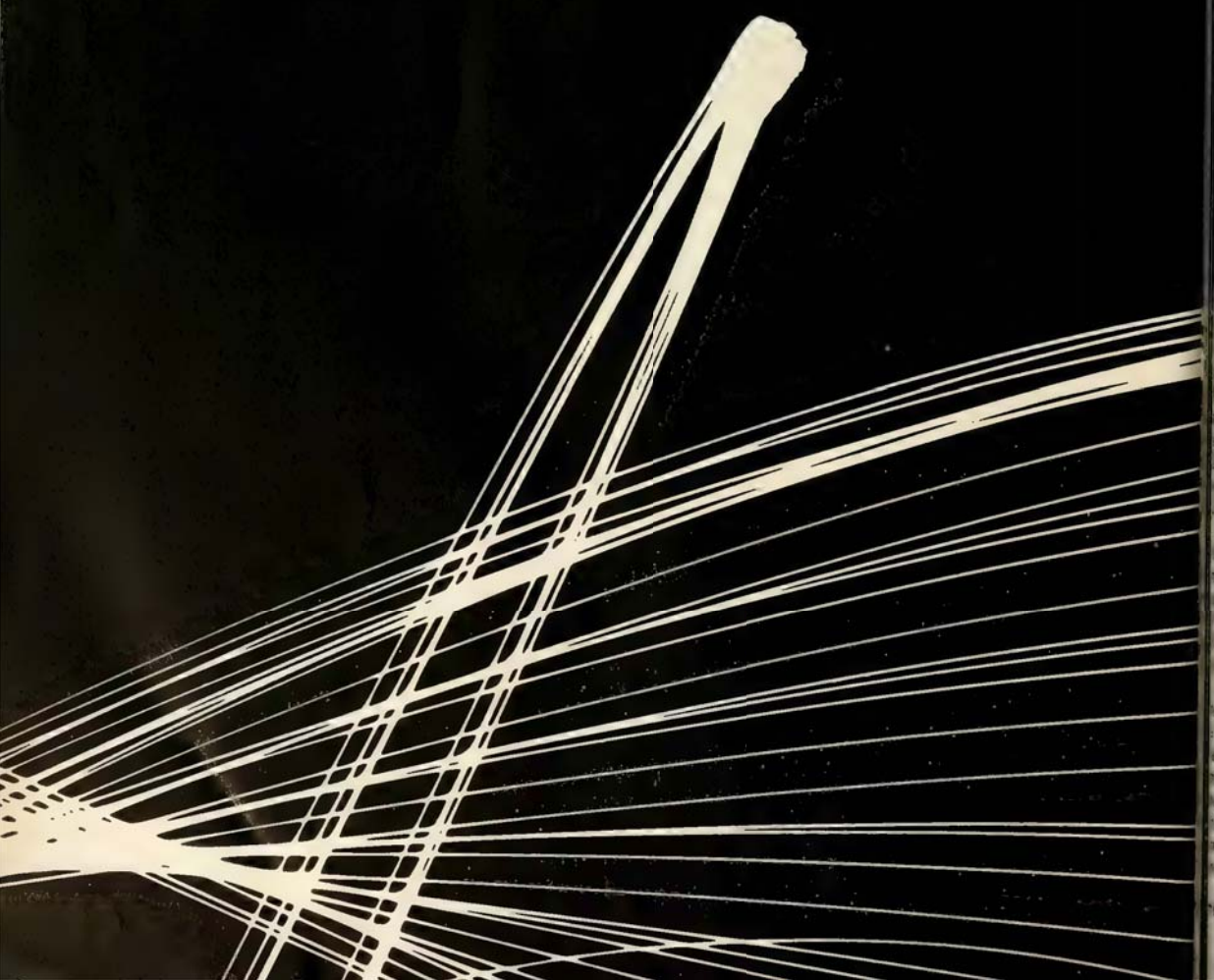
GENERAL PRECISION EQUIPMENT CORPORATION GPE

BURROUGHS COMPUTATION GUIDES ATLAS INTO ORBIT

Back of the history-making Burroughs computation that guided the Atlas Satellite into orbit—and that also guides the big bird to its earthbound targets—lies a dedication to continuing advancement. Coming: even greater developments geared to the mounting challenge of the space age.

Burroughs Corporation

"NEW DIMENSIONS | in computation for military systems"



this week's m/r cover, Dr. Carl A. Frische, president of Sperry, and Nathan P. White, section head for the *X-15* system program, examine the stabilized platform which is the heart of the inertial system. The blackboard equation refers to velocities which will be encountered during the *X-15* missions.

Inertial guidance was chosen for the *X-15* because, all other factors being approximately equal, the sole limiting factor with an inertial system was flight duration—and even this could be improved with better components.

The present system can be divided by functions into two groups. The first group, carried in the *X-15*, consists of the platform, the computer, and indicators. The second group, located within the B-52, supplies the proper initial conditions to the computer prior to launch.

•**Elaborate equipment**—The platform has three gyros for stabilization and three accelerometers for measurement of velocity, altitude, position and attitude relative to the earth. It is maintained normal to the geographic vertical and, because of the extreme altitude and velocity changes of the *X-15*, all accelerations due to kinematic velocities and changes in the earth's mass attraction force are computed and inserted into the system.

Ten transistorized amplifiers to operate the gyros, accelerometers and gimbal servos are located on the platform. There are four gimbals—roll, pitch, inner roll and azimuth.

The pitch, inner roll and azimuth axes are maintained mutually perpendicular. The outer roll axis is gimballed with respect to the fore-aft aircraft axis and operates in conjunction with the inner roll axis to produce an angular displacement proportional to aircraft roll attitude. The redundant roll axis allows the *X-15* unlimited motion about any degree of freedom without the possibility of gimbal lock or loss of verticality.

The computer provides a number of functions including Doppler inertial mixing, gyro drift storage, acceleration to velocity integration, velocity to position integration, earth rate computations and acceleration corrections due to kinematic velocities.

The unit is constructed with two basic building blocks. One of these is a precision integration that uses a DC tachogenerator as the accuracy-determining element. The integrators are packaged in two groups of three each (position integrator group and velocity integrator group) and include all electronic accessory equipment.

Martin-Baltimore Reorganized

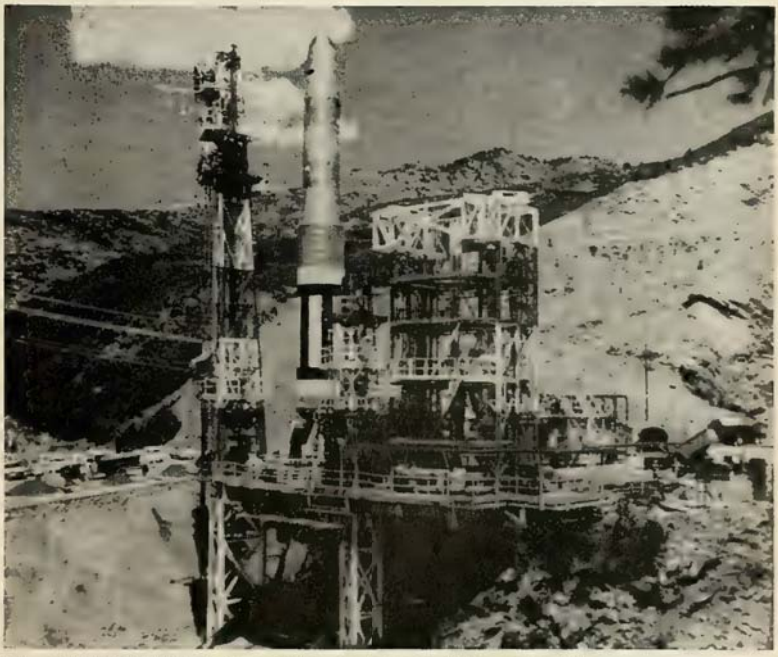
BALTIMORE — Martin-Baltimore — breaking sharply with traditions of the aviation industry, has reorganized its 2,000-man engineering organization into separate "task forces."

Replacing the previous single engineering division are two new organizations—Manned Vehicles and Missiles-Electronics. The first division will include manned aircraft of conventional and advanced types.

Frederick R. Dent, Jr., retired Air Force major general and former chief of the Wright Air Development Center, has been named head of Missiles and Electronics Engineering. Herman Pusin, former chief engineer of the Baltimore Division, has been appointed to direct the Manned Vehicles Engineering Division.

MARTIN-DENVER'S *Titan* undergoes checkout in Vertical Test Laboratory.

LOOMING UP 13 stories, *Titan* is checked for interconnection of all subsystems.



***Titan* UNDERGOES static test in mountains at Colorado facility.**

letters

Budget Figures

To the Editor:

Has any other reader of your fine and necessary magazine pointed out several discrepancies in the charts on pg. 21-23 of the Jan. 26 issue?

Page 21—Col. 1, 22,477 + 20,231 = 42,708 not 42,709; Col. 4, 8,492 + 10,817 = 19,309 not 19,308; Col. 6 22,319 + 19,030 – 405 = 40,944 not 40,945; Col. 8, 6,625 + 5,727 + 155 = 11,597 not 11,596.

Page 22—1960 estim col. 3, 18,000,000 + 128,100,000 + 307,900,000 + 21,900,000 = 455,000,000 not 445,000,000.

Page 23—Est. 1960, 1958 actual 25027 + 16561 = 41,588 not 41,587.

Missile Expenses: 344.4 + 442.5 + 904.3 + 17.4 + 132.1 + 179.1 + 323.6 + 135.1 + 34.2 = 25,127 not 25,027.

Also in text col. 3, page 21, Army's 9.35 billion should be 9.53 billion. From Col. 7, page 21, 7,108 + 2,422 = 9,530.

Would appreciate knowing if any other reader has apprised you of the above. Thank you and sincere best wishes.

Frank W. Finnegan
400 Butler St.
Brooklyn 17, NY

The tables referred to are official and correct. For conciseness, Defense budgeteers omitted amounts of less than half a million so that the totals do not exactly agree with the sums of the columns. The figure $445 million is a typographical error and should be, as Reader Finnegan notes, $455 million. The $9.35 billion figure for Army is correct as given for Army's new obligational authority (not expenditures).

Star-Cross?

To the Editor:

ASTROPHOBIA
Integrating image tubes
Cosmic intensification
Trajectories and orbit planes
Descent of mass acceleration
Occluded stars, orbital paths
Computed force of gravitation
I'd do my typing on the moon
To rid myself of this aggravation!

I wrote this verse as a tribute to the pioneer-secretary employed in the ever-rising branches of astronautical sections throughout the U.S.

Lois Utz
Astronautics Anonymous
130 Park Place
Pompton Lakes, N. J.

RADAR ON EVERY UNITED PLANE ADDS EXTRA DEPENDABILITY TO YOUR SHIPMENT

Captain H. L. Baird explains something of interest to every shipper

"This is airline radar. It's a big help in making your United shipments as dependable as they are. Because radar shows us weather up to 150 miles ahead, it prevents long delays or detours caused by storms or turbulence. Every plane in our fleet has radar. So when you ship United, you can be surer of on-time deliveries and smooth trips for fragile items."

United offers you more guaranteed space availability (Reserved Air Freight) with greater frequency to more destinations than any other airline. And when you ship United, you have the opportunity to lower marketing costs through better inventory balance, broader markets, lower packaging and insurance costs. These features, plus radar, are good reasons to ship dependably by United Air Lines.

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The SMALLEST—and the FASTEST—high pressure pneumatic solenoid valves ever made!

On the left above, the world's smallest 3000 psi pneumatic solenoid valve. (Overall height 3⅝", total weight 3.04 oz.) Beside it, the world's fastest 3000 psi pneumatic solenoid valve, with a response time of 0.018 seconds! Developed by Walter Kidde & Company, and now available on an off-the-shelf basis, these two valves were developed primarily for missile applications, but a glance at their specifications and performance data suggests uses in both today's—and tomorrow's—high-speed *manned* aircraft.

For more information on these new tested and proven valves, as well as more than 100 qualified pneumatic system components, write to Walter Kidde & Company—pioneers in aircraft pneumatic systems, and *still* first with the finest in pneumatic components!

KIDDE VALVE #872071 (The tiny one)
Operating Pressure 0-3000 psi
Temperature Range −75°F. to +350°F.
Leakage 3 cc/hr.
Flow Equivalent to .05 orifice.
Operating Current .5 to 1.5 amps.
Operating Voltage 14-30 V.D.C.
Mounting by tubing support
Life 100 to 10,000 cycles depending on operating conditions.
Weight .19 lbs.

KIDDE VALVE #872458 (The speed demon)
Operating Fluid Dry air/nitrogen gas
Operating Pressure Range 80 to 3250 psi
Proof Pressure 4875 psi
Burst Pressure 8125 psi minimum
Ambient Temperature Range −65°F. to +160°F.
Flow Factor 1.37
Voltage Range 18 to 30 V.D.C.
Current (28 V. @ 80°F.) 1.2 amps.
Coil Resistance (80°F.) 21.5 to 24 ohms
Weight 1.40 lbs
Response Time 0.018 seconds

Kidde

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propulsion engineering

by Alfred J. Zaehringer

Piping LOX and other cryogenic fluids over long distances can be made easier with equations and empirical studies now made available by the National Bureau of Standards. Such information is expected to play a leading role in designing hard ICBM bases for *Titan*.

About 20% of U.S. LOX output now goes into missiles. Total yearly use—government and industry—is pegged at 80-100 billion cubic feet. Low purity LOX goes for $10-15 per ton while high purity sells for $30-50 per ton. This year, oxygen sales should hit $150 million.

First private helium plant may portend increased availability for missiles and rockets. A $13.5-million helium extraction plant is being built by Helex Co. (a joint venture of Northern Natural Gas and Air Products) at Sunray, Tex. Helium at present is under governmental control and has been in relatively short supply.

Modular rocket design is being proposed on several fronts to increase reliability and relax stringent design requirements of present liquid propellant missiles. Standard tanks would be connected to manifolded or clustered standard engines. Though this concept could be applied to a large number of mission requirements, it would generally result in a larger missile for a particular mission than a specially-designed, optimized missile. The building block concept would, however, speed development and production of large space vehicles. Clustered 1.5-megapound-thrust *Jupiter* engines, now under development, may allow such modular rockets.

Thrust control for rocket engines developed by Bendix Products Div., South Bend, Ind., measures rate of change of chamber pressure plus chamber pressure and compares it with a variable reference to generate an error signal. Signal drives a power piston. System is designed to limit thrust overshoot which might result during a severe starting transient.

Rocket nozzles and other hot components can be fabricated from Avocite, a quasi-ductile reinforced ceramic for use at 5000°F. Developed by Avco, the material resists heat shock and high-temperature gas erosion. Tests have been made with both liquid and solid propellants.

Boron trichloride, a vital intermediate in the manufacture of boron fuels, will get close scrutiny through a joint venture of Dow Chemical and US Borax Research Corp. Economical production would mean lower boron fuel costs. Another significant aspect of this joint program is that Dow has an ARPA solid propellant research contract and US Borax Research has been working toward inorganic boron polymers for solids.

Ultra-fine aluminum powder with average particle size of 300 Angstroms is looked on by National Research Corp. as a potential additive for solid or gel propellants. Other possibilities: burning rate increases because of small particle size, or combustion catalyst.

Double-base solid propellant for *Polaris* missile is being worked on jointly by Allegany Ballistics Laboratory and Naval Propellant Plant. The latter facility, formerly the Naval Powder Factory, is recovering from a recent drastic cutback in operation. Composite propellant for *Polaris* is now being worked on by Aerojet-General.

Solid lubes—in film form—can take 1800°F. Expected to be of value for solid rocket engines, APU's, and other propulsion hot spots, the inorganic lubes were developed at Washington State Institute of Technology.

missile business

by Reed Bundy

The Air Force has warned manufacturers that it expects to spend less money per unit on missiles and components in the future with its "building block" approach to weapon systems. It says companies that want to continue getting AF business must cut controllable costs, make accurate bids, deliver on time, and do as much R&D work as possible on their own.

"It appears that controllable costs have risen at a higher rate than has performance," Lt. Gen. C. S. Irvine, AF Deputy Chief of Staff for Materiel, recently told the Northrop T-38 Suppliers Symposium in Los Angeles. "It is not enough," the top AF procurement officer declared, "that prime contractors or system managers improve their management technique so as to reduce costs. First, second, and third-tier sub-contractors must do likewise. This applies whether the company is large or small; there is always room for improvement."

Irvine said a company bidding for a contract "should make certain that its proposed costs are factual and accurate. Estimates, no matter how valid they may appear, are not sufficient. When the Air Force commits itself to obligate taxpayers' dollars, it must do so with every assurance that the price is as low as can be reasonably obtained."

Delivery on time is another "absolute must," Irvine said. But he stressed that delivered items must reflect the lessons learned in tests—not "blind adherence to initial design" that would guarantee on-time delivery.

A third "must," according to Irvine, is company-supported research and development. Most-likely contract recipients, he said, will be those "who have enough initiative not to wait for subsidies before going ahead on their own . . ."

A new mechanical manufacturing information system (MMI) has been developed by Westinghouse Electric Corp. to save money and cut the time required to get defense hardware from drawing board into production. The company says the system, involving specially-designed semi-automatic and automatic business machines, will save its Air Arm Division about $500,000 by 1962 in paperwork processing costs alone. Under conventional systems, basic data on new military products is passed from one operating section of a company to another. In the MMI system, the information is put on perforated tape, with data needed by each department issued simultaneously on tape or punched cards, so that purchasing can begin to buy materials while manufacturing is preparing to process them.

DOD and NASA have asked Congress for authority to insure their contractors against "unusually hazardous" risks in nuclear, missile and volatile fuel programs. The requested authority, limited to a 10-year period, would provide for a maximum indemnity of $500 million for any one incident.

Some government contractors would lose their immunity from state and local taxes under a bill reintroduced by Sen. Strom Thurmond (D-S.C.). The bill, which passed the Senate in the 85th Congress, reportedly is aimed mainly at firms which buy materials in the name of the Federal government, and fabricate them into products which will belong to the government.

A wave of acquisitions and mergers reflects industry's effort to keep up with the growing needs of missilery. Monogram Precision Industries, Inc., of Culver City, Calif., has acquired Lamatic Co., of North Hollywood, from Angelus Industries, Inc. . . . Electronic Communications, Inc., of St. Petersburg, Fla., acquired by merger Standard Products, Inc., of Wichita, Kan. . . . Airtek Dynamics, Inc., of Los Angeles, purchased Research Welding & Engineering Co., Inc., of Compton, Calif. . . . Metal Glass Products Co., of Elkhart, Ind., became a subsidiary of Barler Metal Products, Inc., of Goshen, Ind. . . . Firth Sterling, Inc., of Pittsburgh, Pa., bought the Kellogg specialty alloy steel manufacturing business from The M. W. Kellogg Co., of New York City.

THE DIVISIONS OF THOMPSON RAMO WOOLDRIDGE INC.

ıe completely transistorized RW-30 airborne gital computer has a volume of 4.19 cu. ft. ıd weighs only 203 lbs., including power supply

ımo-Wooldridge is responsible for advanced ectronic sub-systems development for application th both current and projected missile programs

portant infrared "search and track" equipment now being developed by Ramo-Wooldridge r applications in modern U.S. Military aircraft

W is one of the major participants working th the Boeing Airplane Co. Systems Management ffice on the U.S. Air Force Dyna-Soar project

ew type of radar data processing system eveloped by R-W materially increases the pabilities of ground defense radar

RAMO-WOOLDRIDGE

While it is now a division of **Thompson Ramo Wooldridge Inc.** instead of a separate corporation, **Ramo-Wooldridge** remains an integrated organization for research, development, and manufacture of electronic systems for military and commercial applications. R-W's military work is covered by thirty-four contracts with the Army, Navy, Air Force, and other government and industrial organizations. These support a broad technical and—in some cases—manufacturing program in such varied fields as Electronic Reconnaissance and Countermeasures; Microwave Techniques; Infrared; Analog and Digital Computers; Air Navigation and Traffic Control; Antisubmarine Warfare; Electronic Language Translation; and advanced Radio and Wireline Communication.

In the commercial field, the well-known RW-300 industrial process control computer and associated equipment—the basis of the expanding business that **The Thompson-Ramo-Wooldridge Products Company** is doing with process industries—was developed and is manufactured by the Ramo-Wooldridge division.

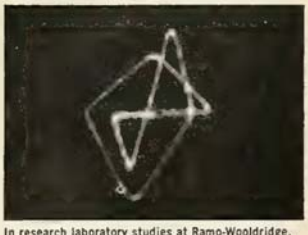
Men, machines, and manufacturing know-how from other TRW divisions will be added as needed to build up the growing production strength of the Ramo-Wooldridge division. In other ways, too, the availability of the special skills and facilities of the rest of the corporate family will broaden the services R-W can offer to its customers. However, R-W's major systems work will continue to be done in an organizational framework that brings the engineering and manufacturing groups into close-knit project teams in the division's own integrated development and manufacturing facilities in both Los Angeles and Denver.

Ramo-Wooldridge is production-oriented in the sense that its end objective is the manufacture and sale of equipment. However, because of the highly technical nature of its product lines, the R-W division will continue to give unusual emphasis to maintaining a high degree of professional scientific and engineering competence.

The RW-300 digital control computer has broad applications in automatic process control, data reduction and test facility operation

Systems are being developed for the ground processing and interpretation of photographic and other data collected by aerial reconnaissance devices

The Military and Ramo-Wooldridge are studying the use of automatic data processing techniques



In research laboratory studies at Ramo-Wooldridge, electrically-charged particles are contained and supported in a vacuum by an alternating electric field

Thompson Ramo Wooldridge Inc.

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contract awards

ARMY

$50,731,000—**Raytheon Manufacturing Co.,** for production of *Hawk* system.

$5,000,000—**Sylvania Electric Products Inc.,** for development and production of three additional MOBIDIC computers and programing assistance (four contracts).

$1,450,000—**California Institute of Technology,** for R&D (two contracts).

$1,247,403—**Jefferson Construction Co.,** Miami, for construction of Eglin Gulf Test Range.

$1,240,428—**Western Electric Co., Inc.,** for *Nike* spare parts and components (13 contracts).

$1,120,000—**Douglas Aircraft Co., Inc.,** for supplies, services and repair parts (two contracts).

$596,369—**Radioplane Co.,** Van Nuys, Calif., for target drones.

$303,458—**Motorola, Inc.,** Phoenix, for telemetry sets.

$150,000—**Columbia University,** for analysis of radar noise in *Nike* and related systems.

NAVY

$1,300,000—**Allen B. Du Mont Laboratories, Inc.,** Clifton, N.J., fo production of 22 universal missi test sites for *Sparrow III* progra (sub-contract from Raytheon Mf Co.).

$609,353—**Eitel-McCullough, Inc.,** Sa Carlos, Calif., for electron tub (four contracts).

$500,000—**Aeronutronic Systems, Inc** Glendale, Calif., a subsidiary Ford Motor Co., for instrument tion planning for the Pacific Mi sile range. Six-month study to b carried out by Aeronutronic an its associated contractors—**Coo Research Laboratories, Dunlap Associates, Eastman Kodak C** and **Page Communications Eng neers.**

$500,000—**Federal Pacific Electri Co.,** Newark, N.J., for electric equipment for missile sites Vandenberg AFB and Pt. Arguell Calif.

$493,372—**Walker Electrical Co., Inc** Atlanta, for *Tartar* missile switch board, gunnery switchboard an underwater battery switchboards.

$194,530—**General Electric Co.,** fo electron tubes (four contracts).

AIR FORCE

$985,109—**Collins Radio Co.,** Dalla for labor and material to provid microwave communications syste between central missile comman facility at Warren AFB and fou remote missile launch sites.

$900,000—**The Martin Co.,** for im plementation program for *TM-76* missiles.

$723,118—**Raytheon Mfg. Co.,** fo electron tubes.

$500,000—**Bogue Electric Manufactu ing Co.,** Paterson, N.J., for d velopment and production of ultr sonic fuel measuring and contr system for *Titan* (sub-contract fro The Martin Co.).

$307,766—**Tung-Sol Electric Inc** Newark, N.J., for electron tube

$225,000—**Beckman Instruments, Inc** Berkeley, Calif., for high-spe analog computer for *Bomarc* sy tem (sub-contract from Boeing Ai plane Co.).

$209,568—**Wood Electric Co.,** Ne buryport, Mass., for circ breakers.

$168,825—**Sylvania Electric Produc Inc.,** for electron tubes.

$160,528—**Eitel-McCullough, Inc.,** f electron tubes.

$105,993—**Aeronautical Div., Minn apolis-Honeywell Regulator C** for research study on non-ma netic stable platform for use connection with magnetome measurements from *Aerobee* sounding rockets.

missile people

Dr. Hubertus Strughold, Advisor Research and Professor of Space edicine at the Air Force School of viation Medicine, has been named the 58 winner of the Dr. John J. Jeffries ward for his outstanding contribuns in space and aviation medicine earch. Dr. Strughold is a conbuting editor to m/r.

The award, one of the highest and st coveted in the aero-medical field, presented annually to the individual sponsible for outstanding contribuns to the advancement of aerotics through medical research.

Howard P. Mason, formerly Aero-General's coordinator of the *Titan* gram and more recently executive sistant in the company's Missile nge Division, has been appointed rojet's Corporate Base Manager for Pacific Missile Range. He will coordinate Aerojet's activities at Vandeng Air Force Base, the Naval Missile cility—Point Arguello—and range erations at the Navy's Missile Test nter, Point Mugu.

The Air Force has announced apintment of **Dr. Jack P. Ruina** as puty for Requirements to the Assist-t Secretary, Research and Develop-nt. Dr. Ruina previously served with University of Illinois as Associate ofessor of the Department of Elecal Engineering and as Research sociate Professor of the Control stem Laboratory.

J. M. Gruitch has been appointed the newly created post of director government products of ACF Instries, Inc. He was formerly director defense products for ACF's Ameri-n Car and Foundry division.

Dr. Thomas J. Carroll, authority the electronic phenomenon known twilight scatter propagation, has en a new post at the Radio Divin of Bendix Aviation Corp. He will ve on the Advanced Development ff of the division's Government oducts Group.

Ralph W. Waniek, formerly senior entist at Harvard University and T's Cambridge Electron Accelerator, s been appointed Director of Rerch of the Magnetohydro-dynamics boratory recently organized at Gani Plasmadyne Corp.

Dr. Hans Wolfhard has joined the earch staff of Thiokol's Reaction tors Division as manager of the ysics Department. Dr. Wolfhard, a ysics and combination research ext, will be responsible for the technological advancement in the field of ysics.

Advertiser's Index

Advertising correspondence should be addressed to Advertising Sales Manager, Missiles and Rockets, 17 East 48th Street, New York 17, N.Y.

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New York City: 17 E. 48th St., New York 17. Edward D. Muhlfeld, Advertising Sales Manager; P. E. Kinney and G. T. O'Mara, regional adv. mgrs. Phone: PLaza 3-1100.

West Coast: 8929 Wilshire Blvd., Beverly Hills, Calif. Fred S. Hunter, manager; Walton Brown, regional adv. mgr.; James W. Claar, regional adv. mgr. Phones: OLeander 5-9161 or OLympia 7-1555.

Chicago: 139 N. Clark St., Chicago 2, Ill. George E. Yonan, regional adv. mgr. Phone: CEntral 6-5804.

Cleveland: 244 Hanna Bldg., 1422 Euclid Ave., Cleveland 15, Ohio. Douglas H. Boynton, regional advertising manager. Phone: PRospect 1-2420.

Detroit: 201 Stephenson Bldg., Detroit 2, Mich. Kenneth J. Wells, regional advertising manager. Phone: TRinity 5-2555.

Florida: 268 Almeria Ave., Coral Gables, Fla. Richard D. Hager, advertising sales representative. Phone: Highland 4-8326.

Canada: Allin Associates, 12 Richmond Street East, Toronto 1, Ontario. Phone: Harbour 6898. Allin Associates, 1487 Mountain St., Suite 4, Montreal, Que.

Geneva: American Aviation Pubs., 10 Rue Grenus, Geneva, Switzerland. Anthony Vandyk, European Director. Cable address: AMERAV GENEVA.

London: Norall & Hart Ltd., 28 Bruton Street, London W. 1., England. Phone: Grosvenor 8356.

Paris: Jean-Marie Riche, 11 Rue Condorcet, Paris (9e), France. Phone: TRUdaine, 15-39, Cable address: NEWS AIR PARIS.

when and where

FEBRUARY

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

Conference for Manufacturing and Engineering Management, Computer and Data Processing in Industry, Purdue University, Lafayette, Ind., Feb. 12-13.

Heat Transfer Div. of American Society of Mechanical Engineers, Third Annual Symposium on Thermal Properties, Purdue University, Feb. 23-26.

EIA Sixth Industrial Relations Conference, Chase-Park Plaza Hotel, St. Louis, Feb. 25-27.

1959 Engineering Exposition, Balboa Park, San Diego. For information, contact exposition office at 422 Land Title Bldg., San Diego. Feb. 26-Mar. 1.

MARCH

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

Institute of the Aeronautical Sciences, Flight Propulsion Meeting (classified), Hotel Carter, Cleveland, March 5-6.

Second Western Space Conference and Exhibits, Great Western Exhibit Center, Los Angeles, March 5-7.

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

Third Annual Shock Tube Symposium, Old Point Comfort, Ft. Monroe, Va. For details: Armed Forces Special Weapons Center, Kirtland AFB, Albuquerque, N.M. Attn.: SWRS R. R. Birnoff. March 10-11.

American Society for Metals, 11th Western Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, March 16-20.

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

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