



X-15 GUIDANCE SYSTEM

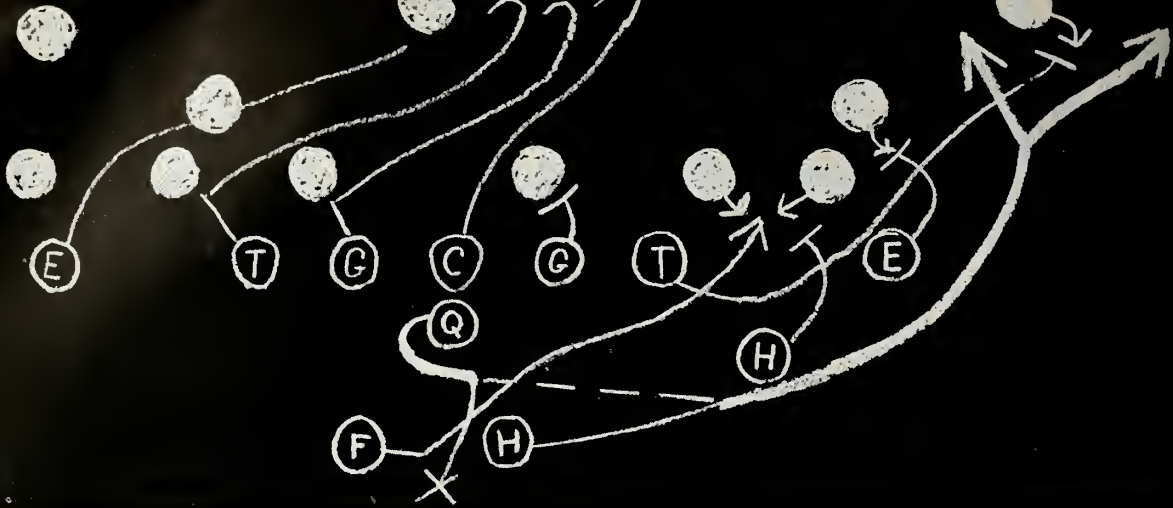
missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

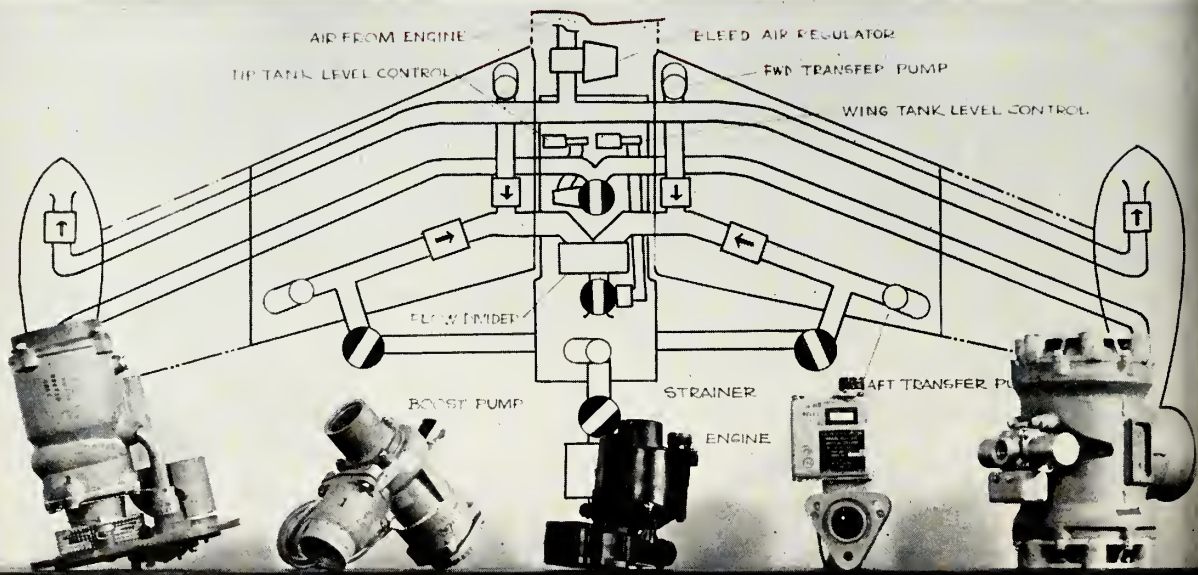
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-4



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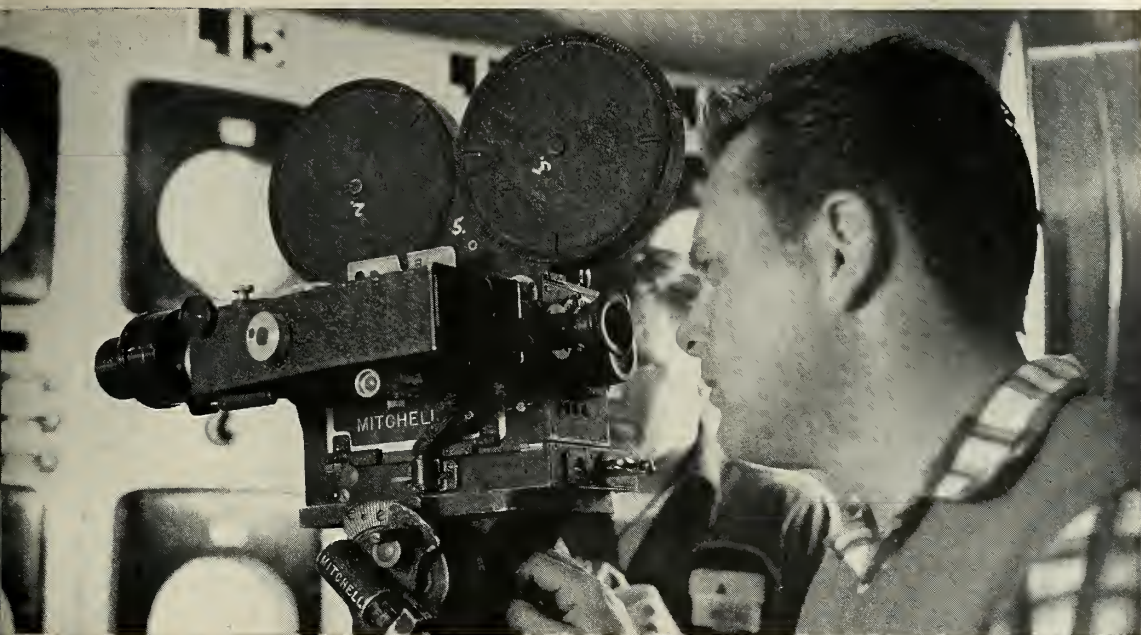
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missiles and rockets, February 16, 1958

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS



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

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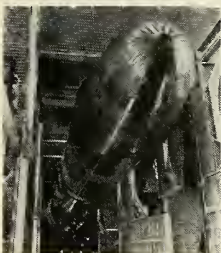
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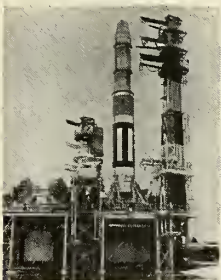
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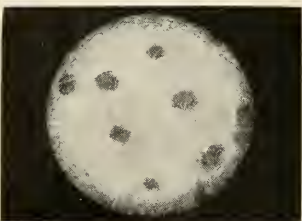
LARGEST one piece infrared dome has been manufactured by Servo Corp. for Navy use. (p. 24)



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

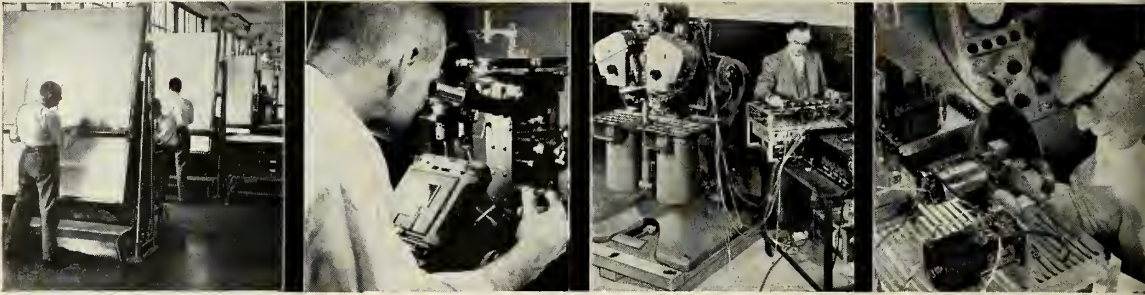


BATTING average for *Titan* has gone up with successful launch from Cape Canaveral.



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

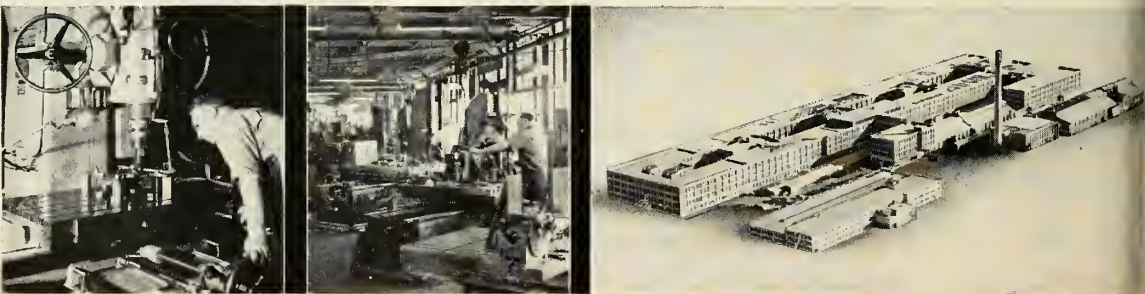
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Reliability Is Our Most Important Headache

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.

PERFORMANCE

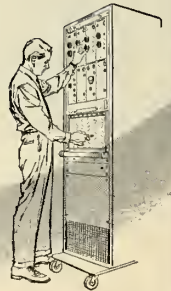
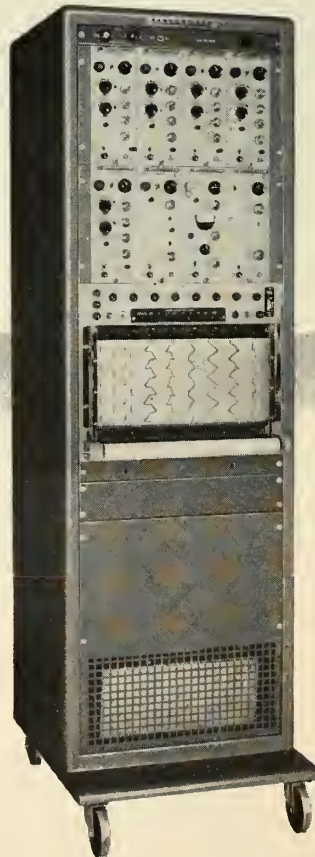
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industry countdown

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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



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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 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 overrule 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.

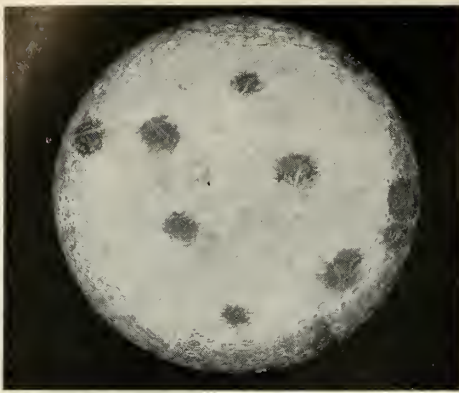
NASA is currently negotiating with North American Aviation, Inc., on the structure contract.

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.



HEAT FROM a small planetesimal 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:

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*

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 crater

with an incredibly rough topography.

The aspect of the other side is highly dependent on how the seas came into being. The answer to this may not be realized until man puts foot on the moon. But it is possible now to draw some conclusions.

The consensus is that several billion years ago a giant meteor, or planetesimal, hit the moon at the place today called Mare Imbrium. The planetesimal was supposedly from 125 to 200 miles in diameter and struck the moon with a nominal speed, which Dr. Harold Urey puts at about 1.5 miles a second. If the speed were greater the resulting explosion would have given the region a symmetrical pattern which is not apparent.

• **Mighty blow**—There was a tremendous amount of Kinetic energy inherent in the moving planetesimal due to its motion. If the planetesimal was 25 miles in diameter with a density of 3.5 and a speed of 1.5 miles a second, when the energy released on impact would have been 4.15×10^{33} ergs. Dr. George Gamow has indicated that an erg is the energy of a small mosquito flying across a room. Yet, the energy of impact suggested above is equal to 50 billion atomic bombs.

To represent this in another way, the entire earth might be divided into city blocks. Then, says Dr. Urey, if the atomic bomb were exploded on every city block we would have expended the same amount of energy as was given up when the planetesimal struck the moon.

• **Seas formed**—Precisely what happened at the time of impact no one knows. But this much is known: There was a tremendous amount of energy available as the kinetic energy of motion. This was converted to heat and the result was the formation of a tremendous pool of lava which flowed from the Mare Imbrium region to the west, to the east, the Mare Nubium and the Oceanus Procellarum.

The lava flowed to the west to form the Mare Serenitatis, Mare Tranquillitatis, the Mare Foecunditatis and the river we call Mare Nectaris. If other seas existed prior to this event, and there is some evidence to indicate this, they were submerged in the flood of lava which flowed from the impact point.

Prior meteoritic impacts could have brown up mountain ranges and the lava flows would have inundated these as well as some of the larger craters bordering this region. The flooding of the Mare Imbrium floor indicated by isolated peaks still found in that region.

Violent explosions ripped along the surface 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.

ASTRONAUTICS in the news...

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.

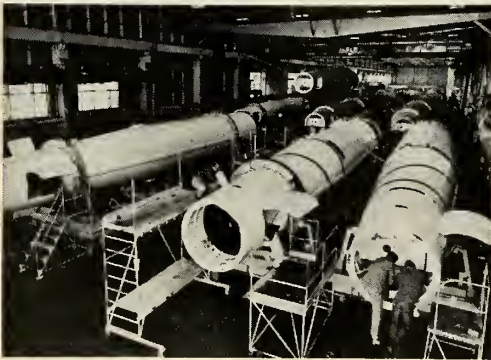
Douglas noted that, although many changes have been made in small items in development of the *Thor*, no structural modifications have been required. "There has never been a major fix on the *Thor*," he said.

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; with-

in 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.

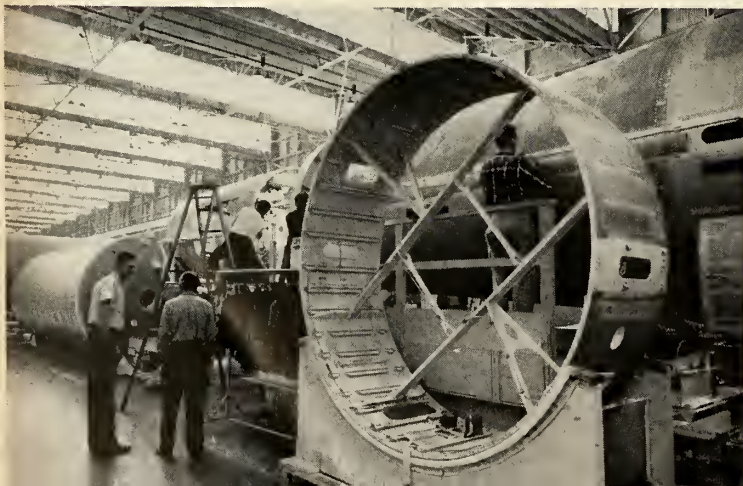
No new information on costs of the *Thor* project has been released. The missile itself has been disclosed as costing between \$650,000 and \$700,000, without R&D.



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. Zaehring

DETROIT—With its *Redstone* missile nearing end of production and with a limited outlook for producing *Jupiter* IRBM's, Chrysler Corp.'s Missile Division has formed a special group aimed at keeping the firm in the missile business. The new group is known as the Advanced Projects Organization.

APO, m/r has learned, was formed to bid on the *Minuteman* ICBM system. After plunking several thousand man hours and several hundred thousand dollars into the Air Force proposal, Chrysler decided to keep APO going 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.

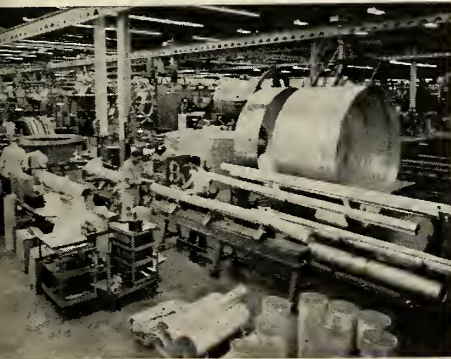
If warhead tests prove successful—and if *Nike-Zeus* can be brought to test soon, Chrysler's APO hopes that either *Redstone*, or more probably *Jupiter*, will be used as a target missile for the anti-missile missile.

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.

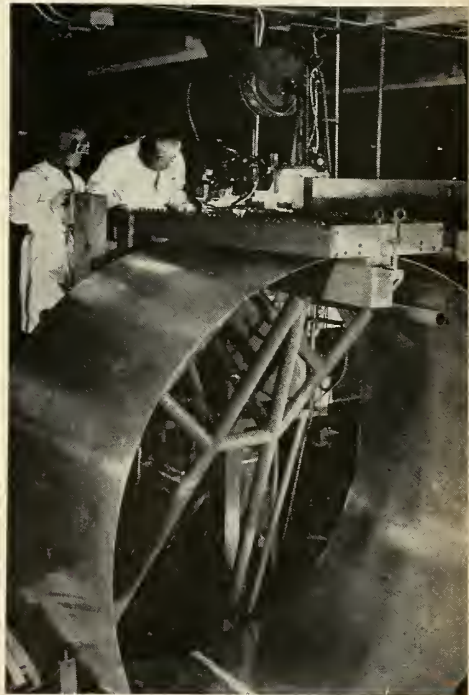
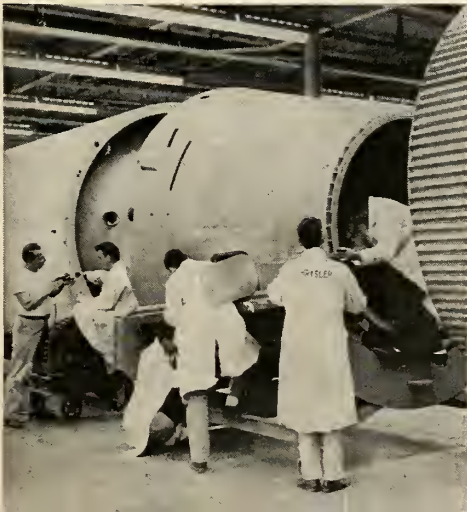
For the immediate future, however, APO is trying to up-grade present missiles. Some proposals include: substituting nitrogen tetroxide for LOX to produce storable, ready-to-fire missiles; switching RP for alcohol, and using the hydrazines for better performance.

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*.

GUIDANCE and control section of *Jupiter* is joined to the forward tank section. Aft section can be 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.

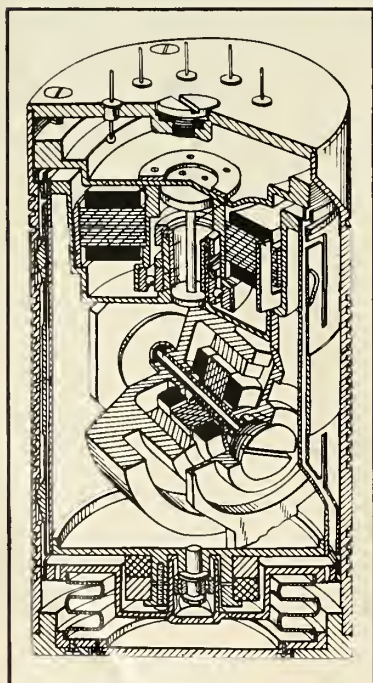
Reports are that most liquid-floated gyros now in use operate somewhere in the vicinity of 180°F. Quermann estimates that most of these gyros need between 50 and 100 watts to maintain this temperature.

• **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 angle 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 this group in production, some units operate on 115 volts and others use 26 volt. Either inductive or potentiometer pickups are supplied with various values of excitation.

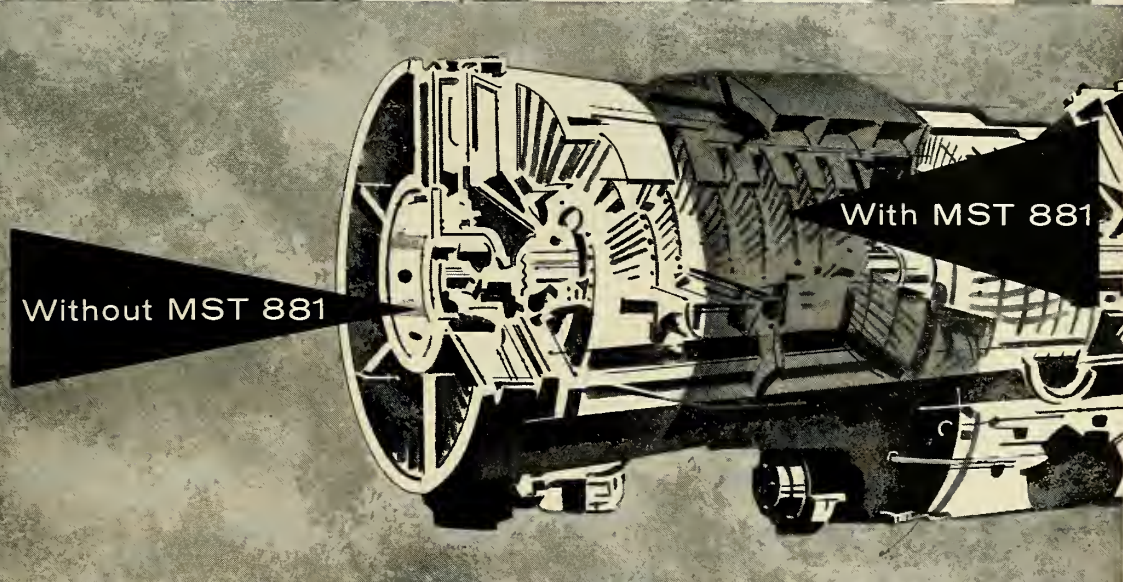
The company was reluctant to discuss present buyers of the units, but one announcement said the gyro "has already become an important component on the *Atlas*, *Polaris*, *Titan* and *Snark* missiles."



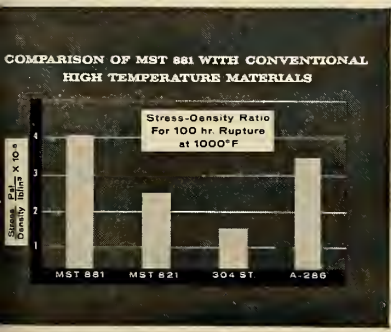
CUTAWAY DRAWING is representative of gyros being produced at Norden.

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 286 stainless steels.

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.

Visit our Booth No. 1151 at Western Metal Exposition, March 5-20, Pan-Pacific Auditorium, Los Angeles.

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MALLORY-SHARON METALS CORPORATION · NILES, OHIO

...NEWS IS HAPPENING AT NORTHROP

Latest Astronautical Navigation and Guidance system is revealed by Dr. William L. Park, Chief of Systems Development at Nortronic 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!**



Astronertial Navigation and Guidance has been under continuous refinement since 1946.

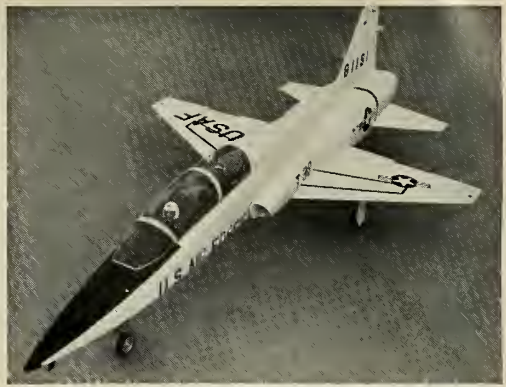
The only operational guidance concept capable of interplanetary navigation, it is applicable today to missiles, manned aircraft, surface ships and submarines. Astronertial typifies the years-ahead thinking of Northrop Corporation and all of its divisions. The Corporation's continuing goal: design concepts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

NORTHROP CORPORATION

formerly Northrop Aircraft, Inc.



Beverly Hills, California



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

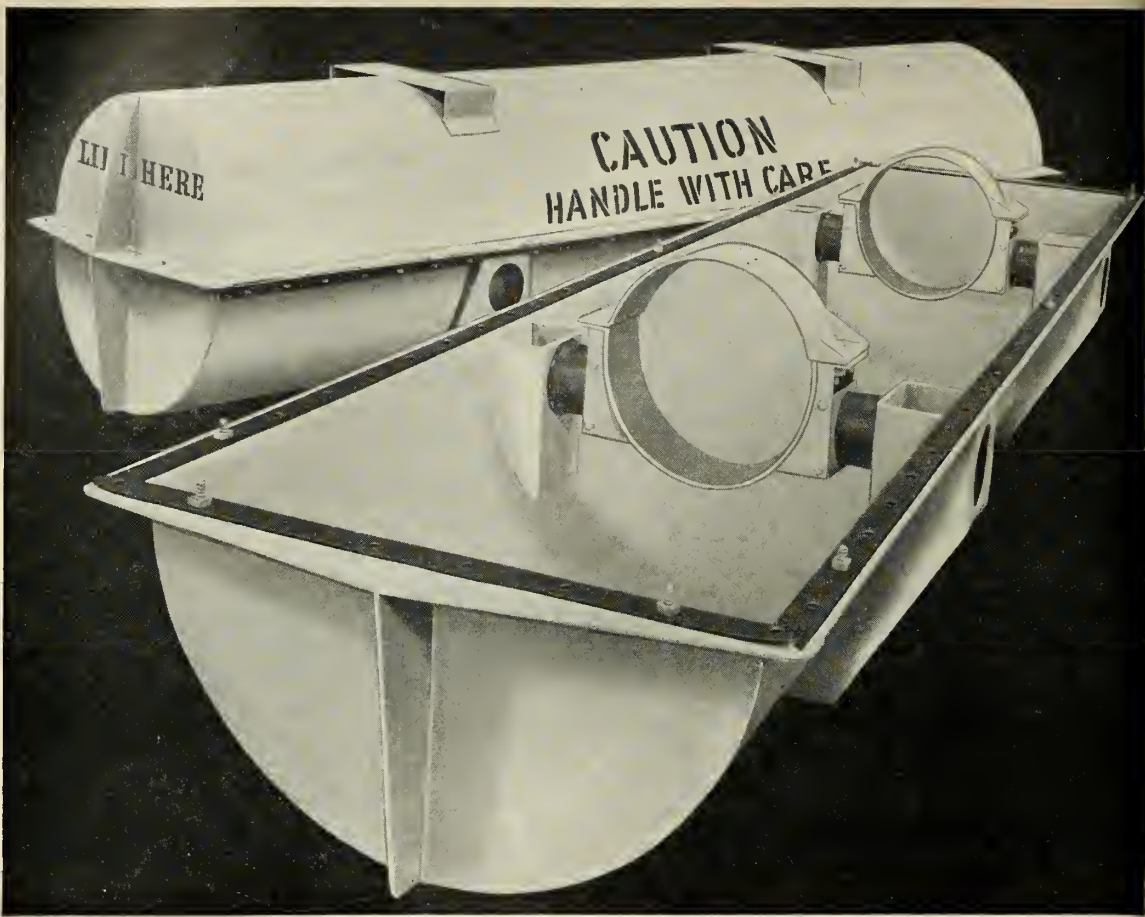


Demanding test for advanced U.S. weapon systems is the XQ-4 supersonic target drone, soon to be followed by the even faster and more sophisticated XQ-4A.



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.





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.

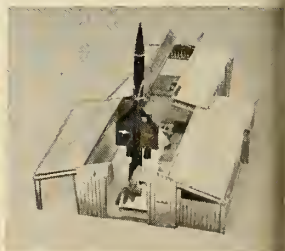
One of the largest fabricators of aluminum and steel with 8 strategically located plants, Butler has proven capability to design, engineer and deliver complex single units or volume production.

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 Manufacture Division.



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



BUTLER MANUFACTURING COMPANY
BUTLER CONTRACT MANUFACTURE DIVISION
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Two Approaches for Cooling IR Detectors

LOS ANGELES—Two types of cryo-cooling systems, designed to improve the sensitivity and spectral response of infra-red detector units on missiles, have been developed by The Garrett Corporation's AiResearch Manufacturing Division, Los Angeles. The cryostats cool the semiconductor elements which detect infra-red radiation produced by heat from the target which

the missile is seeking.

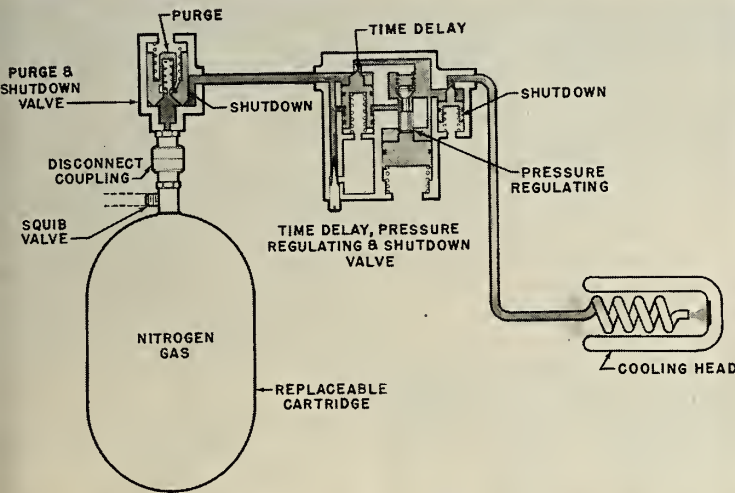
For maximum response to this radiation, the semiconductors must be maintained at an extremely low temperature. The AiResearch systems are capable of maintaining the temperature of a steady -300°F .

One system uses liquid nitrogen at low pressure with a special Dewar flask. A controlled flow of liquid is trans-

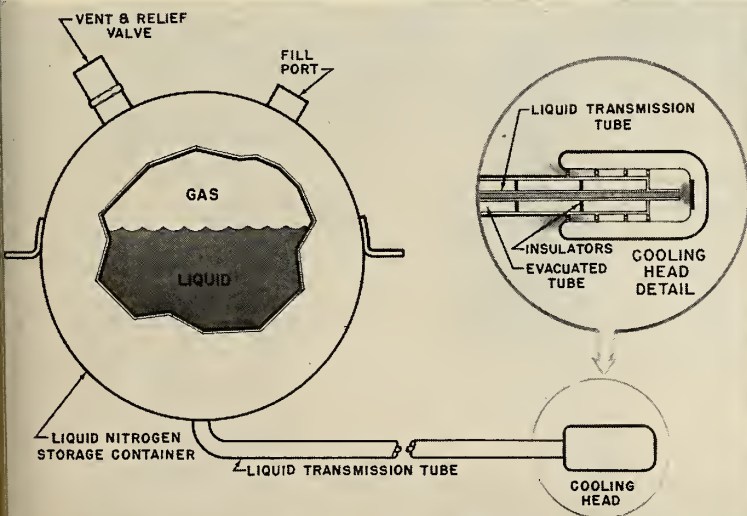
ferred from its container by means of a small special insulated tube to the I.R. detector element.

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.



LIQUID 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 force 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-mil 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 49 ounces. It is powered by a 28-volt dry cell battery and has been tested to 4 gs of shock, 50 gs of acceleration at 10 gs of vibration.

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

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during static firing tests.*




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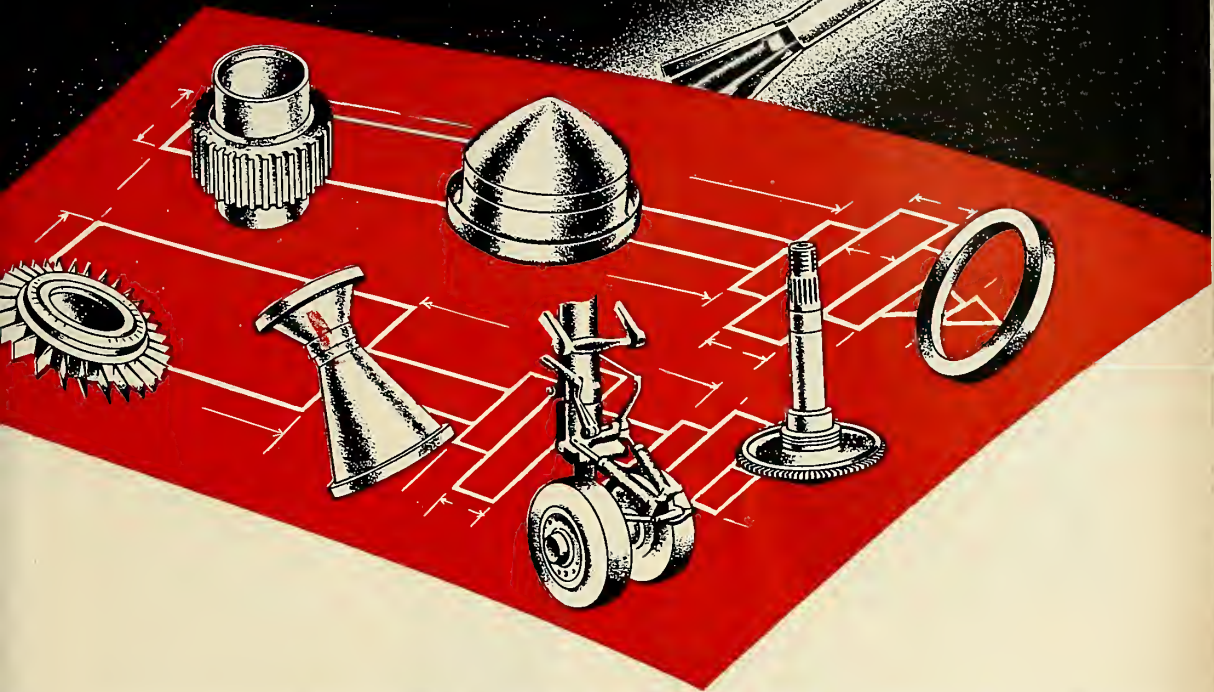
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Midvac Alloys insure increased tensile and impact properties, improved stress rupture strength at elevated temperature, and longer fatigue life.

Standard commercial alloys can also be made with increased cleanliness resulting in higher properties than have been available under conventional means.

Offered in ingots, billets or forgings for the production of missile combustion chambers, tail cone assemblies, jet engine parts, aircraft landing gear components or any other parts requiring properties beyond the capabilities of conventional steels.

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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.

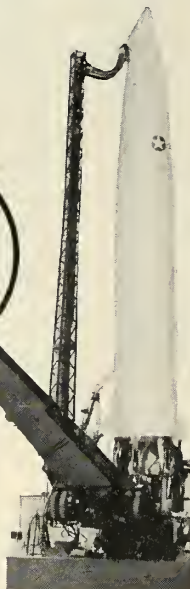
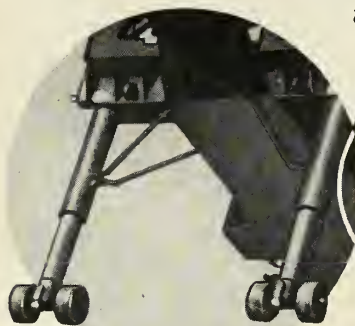
•Joint project—The X-15 was built by North American as a joint project for the Air Force and old NACA (now NASA), with the Navy participating. It is 50 feet long, 22 feet at wing span and 13 feet high, with a 31,275-pound launch weight. The plane is designed to reach 100 miles altitude. First flights 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

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Binkley's extensive experience stems from over 25 years designing and manufacturing truck and trailer body parts and components, including landing gear similar to that shown here. You can benefit from this experience by taking your ground handling equipment problems to Binkley for expert confidential attention.

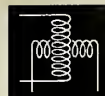


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seconds of arc in accuracy, from 8 to 25 in size. All Kearfott resolvers feature stainless housing, shafts and bearings and corrosion-resistant lamination materials for maximum environmental resistance. Optional designs available for operation at 200°C and in environment of 2000 cps vibration at 30 g's.

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

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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 8uOrd Mark 4 Mod 3 and contains necessary trimming net-

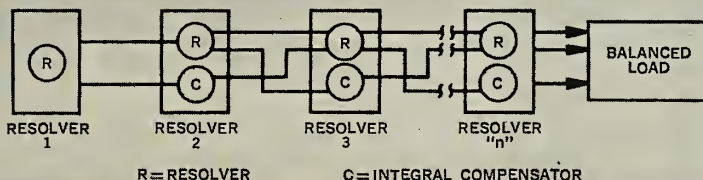
work for standard buffer amplifiers. Transformation ratio is $1.000 \pm .0001$, phase shift $0^\circ \pm 1$ minute. Functional accuracy of .025% and bridge error of 1.5 minutes of arc are standard.

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:



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	$629 + j2510$	$450 + j2200$	$220 + j1000$	$3000 + j (0 \pm 40)$	$1630 / 78.5^\circ$
Secondary Impedance	$695 + j2750$	$500 + j2300$	$240 + j1100$	$3000 + j (0 \pm 40)$	$1620 / 80^\circ$
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°	$0^\circ \pm 10'$	1°
Fundamental Null (MV)	15	15	8	15	15
Bridge Error From E.Z. (Max.)	7 mins. Stator	5 mins. Stator	3 mins. Stator	3 mins. Stator	20 Seconds Stator
Primary					

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		
	Transmitter	Differential	Control Transformer	Transmitter	Differential	Control Transformer
Type Resolver	R982-004	R982-011	R982-012	Z5161-001	Z5191-001	Z5151-003
Part Number						
Excitation Volts (Max.)	26	11.8	11.8	115	90	90
Frequency (cps)	400	400	400	400	400	400
Primary Impedance	$170 / 77^\circ$	$850 / 80^\circ$	$2000 / 80^\circ$	$400 / 80^\circ$	$800 / 80^\circ$	$8500 / 80^\circ$
Secondary Impedance	$42 / 80.5^\circ$	$1000 / 79^\circ$	$8000 / 76^\circ$	$260 / 80^\circ$	$900 / 80^\circ$	$14000 / 80^\circ$
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

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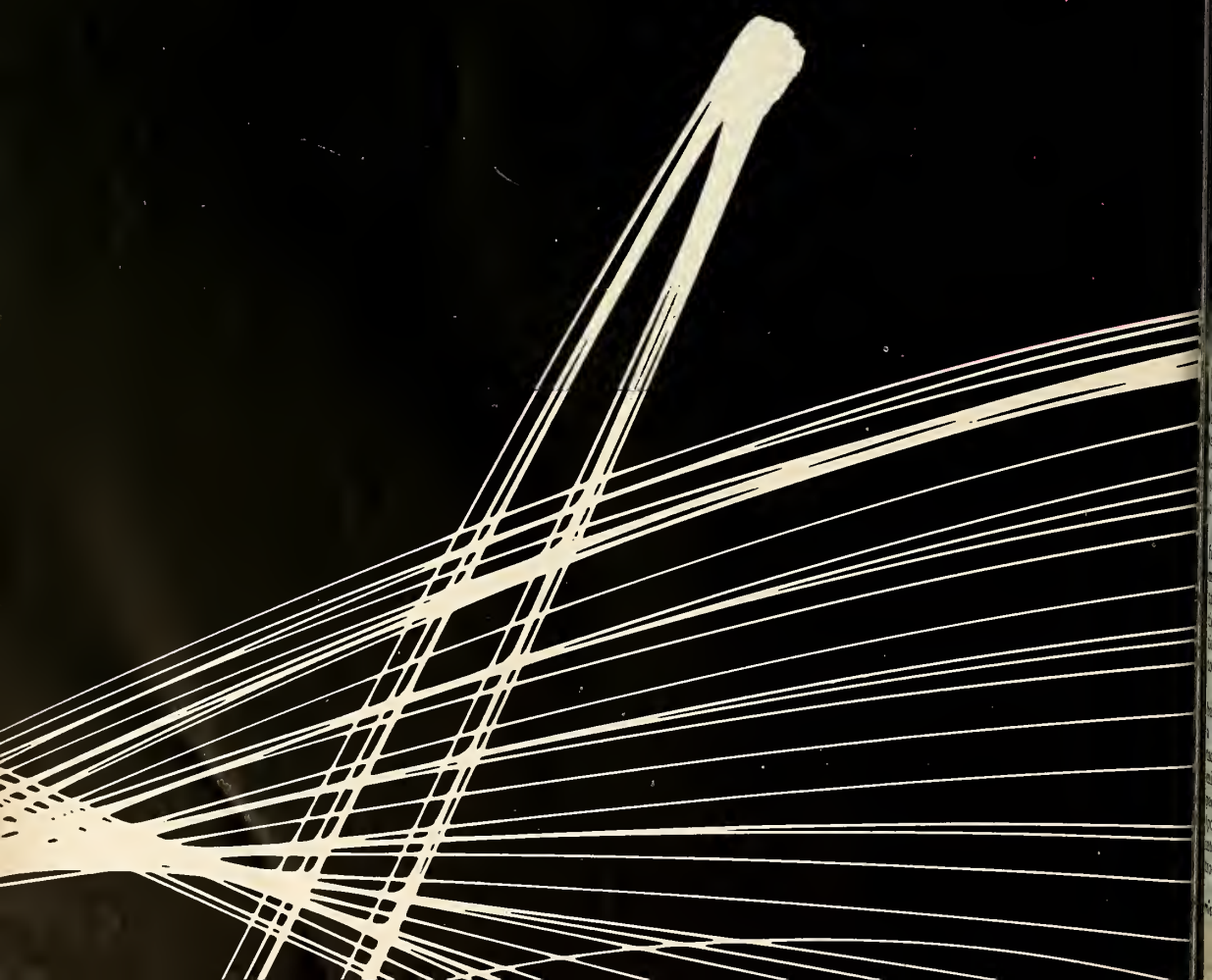


BURROUGHS COMPUTATION GUIDES ATLAS INTO ORBIT

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"



Martin-Baltimore Reorganized

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 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.

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

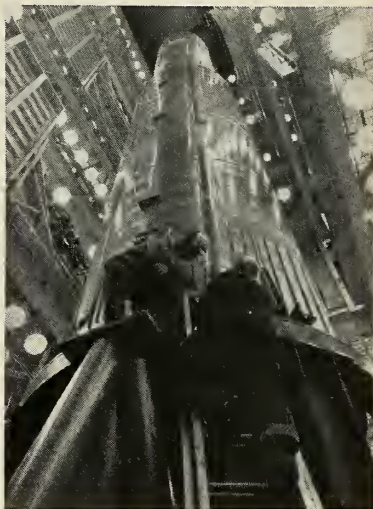
Replacing the previous single engineering division are two new organizations—Manned Vehicles and Missiles-Electronics. The first division will include manned aircraft of conven-

tional and advanced types.

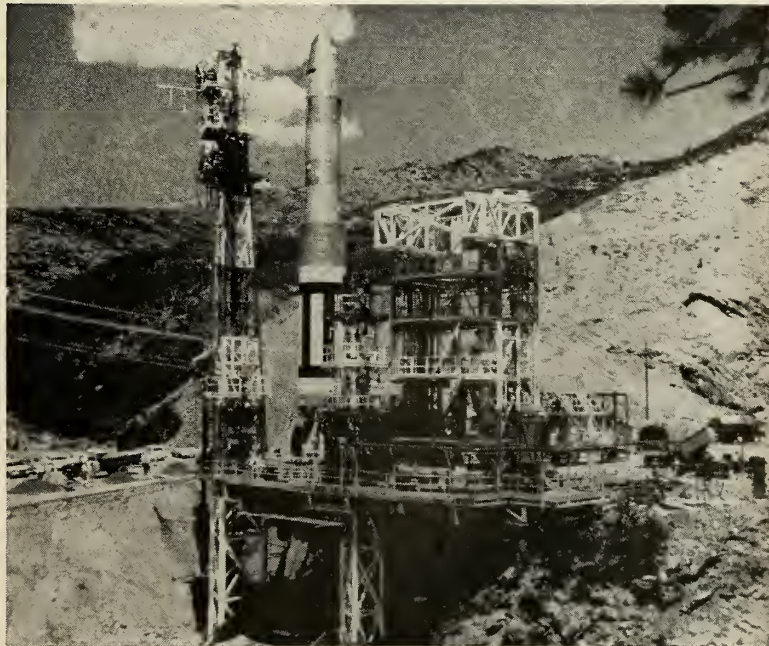
Frederick R. Dent, Jr., retired Air Force major general and former chief of the Wright Air Development Center, has been named head of Missiles and Electronics Engineering. Herman Pusin, former chief engineer of the Baltimore Division, has been appointed to direct the Manned Vehicles Engineering Division.



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.

REDUCE BREAKDOWN FAILURES



NEW WELWYN MOLDED DEPOSITED CARBON RESISTORS



The use of a thermo-plastic insulation material has resulted in an economically priced molded carbon resistor of markedly improved endurance and long term stability.

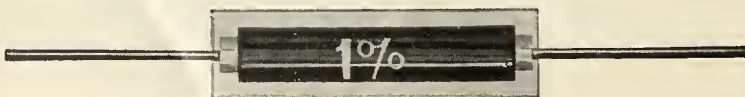
Type N resistors subjected to several one-hour cycles of immersion in boiling water — while DC polarized — have revealed only negligible changes in resistance. Continuous operations at 150°C caused no damage to the component.

The new Type N resistor, a deposited carbon film fired onto a porcelain rod, is first tropicalized with multiple coatings of pancratic lacquers to give it long term moisture resistance, and is then molded in a thermo-plastic material.

This molded insulation has an effective resistance in the order of 10^{13} ohms. Its inherent thermal conductivity is approximately ten times that of air, resulting in substantially improved load life under conditions involving excessive or high wattage dissipation. Similarly, Type N resistors may be soldered as close to the insulation as desired without fear of melting or deforming the cover.

One added advantage of the Type N is that the original markings on the resistor body remain visible and legible through the transparent molded material.

Welwyn Type N carbon resistors meet the requirements specified by MIL-R-10509B, and are available in all values, ranging from 10 ohms through 1 megohm. For complete data and specifications write to Welwyn International, Inc., 3355 Edgecliff Terrace, Cleveland 11, Ohio.



SAMPLES AVAILABLE ON REQUEST.

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 budgeters omitted amounts of less than half a million so that the total 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 non-obligational authority (not expenditures

Star-Cross?

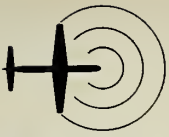
To the Editor:

ASTROPHOBIA

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Trajectories and orbit planes
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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 astronautic sections throughout the U.S.

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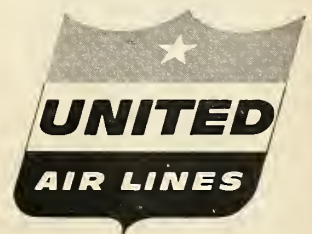
Captain H. L. Baird explains something of interest to every shipper

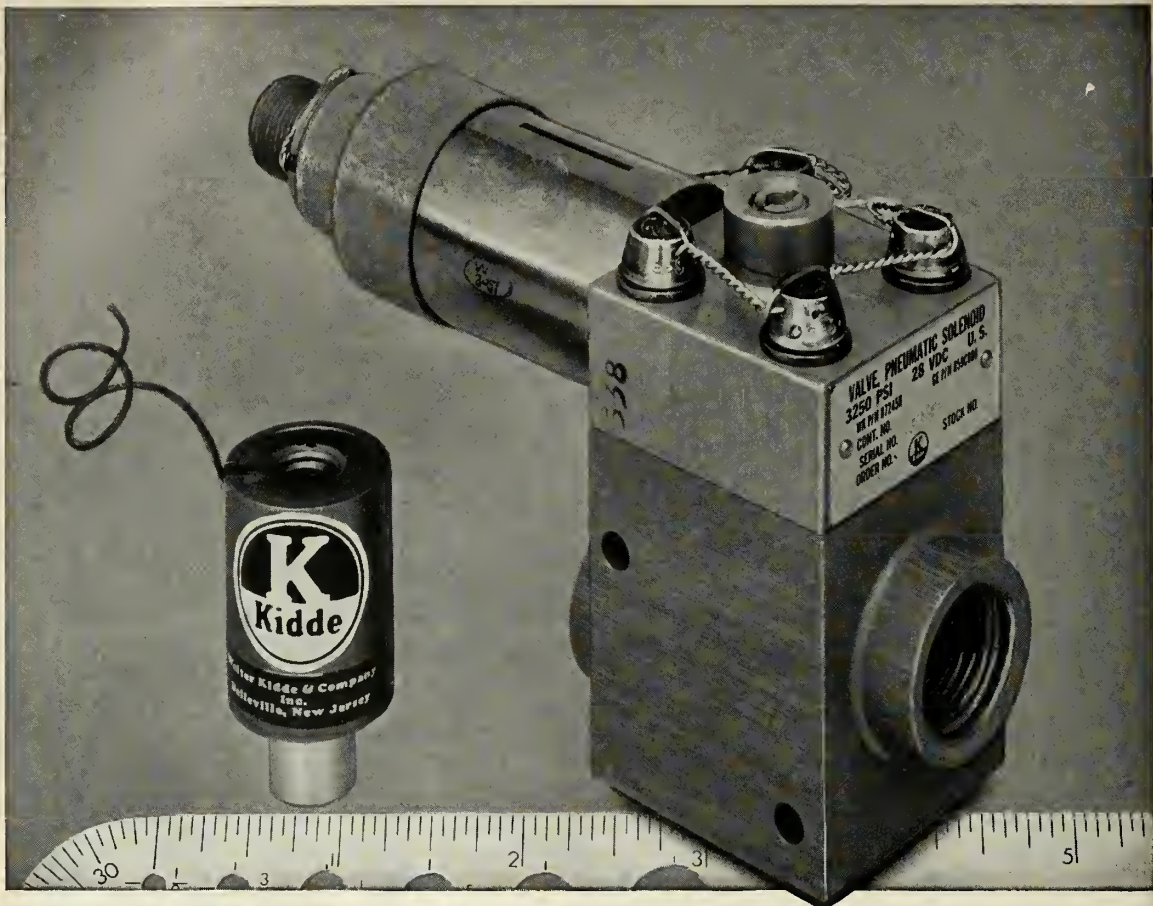
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 Life 100 to 10,000 cycles depending on operating conditions.
 Weight .19 lbs.

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 Proof Pressure 4875 psi
 Burst Pressure 8125 psi minimum
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 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

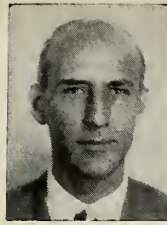


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propulsion engineering



by Alfred J. Zaehring

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.

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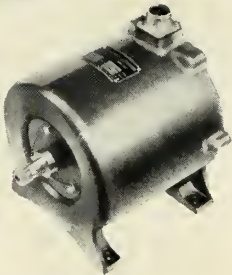
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The Air Force has warned manufacturers that it expects to spend less money per unit on missiles and components in the future with its "building block" approach to weapon systems. It says companies that want to continue getting AF business must cut 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.



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.

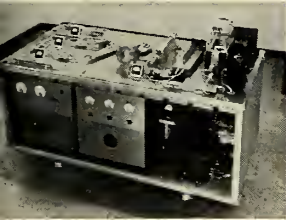
In the commercial field, the well-known RW-300 industrial process control computer and associated equipment—the basis of the expanding business that **The Thompson-Ramo-Wooldridge Products Company** is doing with process industries—was developed and is manufactured by the Ramo-Wooldridge division.

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.

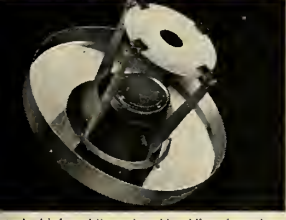
Ramo-Wooldridge is production-oriented in the sense that its end objective is the manufacture and sale of equipment. However, because of the highly technical nature of its product lines, the R-W division will continue to give unusual emphasis to maintaining a high degree of professional scientific and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



The completely transistorized RW-300 airborne digital computer has a volume of 4.19 cu. ft. and weighs only 203 lbs., including power supply



Ramo-Wooldridge is responsible for advanced electronic sub-systems development for application in both current and projected missile programs



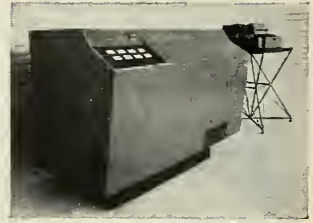
Important infrared "search and track" equipment now being developed by Ramo-Wooldridge for applications in modern U.S. Military aircraft



TRW is one of the major participants working with the Boeing Airplane Co. Systems Management Office on the U.S. Air Force Dyna-Soar project



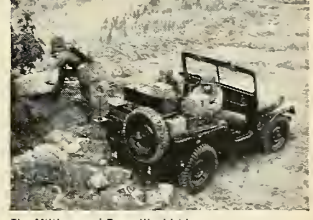
A new type of radar data processing system developed by R-W materially increases the capabilities of ground defense radar



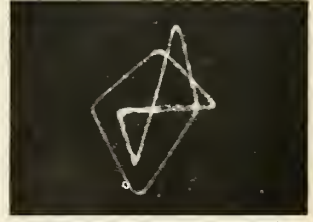
The RW-300 digital control computer has broad applications in automatic process control, data reduction and test facility operation



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.

MAIN OFFICES
CLEVELAND 17, OHIO
LOS ANGELES 45, CALIFORNIA

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 programming 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., for production of 22 universal missile test sites for *Sparrow III* program (sub-contract from Raytheon Mfg. Co.).
 - \$609,353—**Eitel-McCullough, Inc.**, San Carlos, Calif., for electron tubes (four contracts).
 - \$500,000—**Aeronutronic Systems, Inc.**, Glendale, Calif., a subsidiary of Ford Motor Co., for instrumentation planning for the Pacific Missile range. Six-month study to be carried out by Aeronutronic and its associated contractors—**Coolidge Research Laboratories, Dunlap & Associates, Eastman Kodak Co.** and **Page Communications Engineers.**
 - \$500,000—**Federal Pacific Electric Co.**, Newark, N.J., for electrical equipment for missile sites at Vandenberg AFB and Pt. Arguello, Calif.
 - \$493,372—**Walker Electrical Co., Inc.**, Atlanta, for *Tartar* missile switchboard, gunnery switchboard and underwater battery switchboards.
 - \$194,530—**General Electric Co.**, for electron tubes (four contracts).
- ### AIR FORCE
- \$985,109—**Collins Radio Co.**, Dallas, for labor and material to provide microwave communications system between central missile command facility at Warren AFB and four remote missile launch sites.
 - \$900,000—**The Martin Co.**, for implementation program for *TM-76* missiles.
 - \$723,118—**Raytheon Mfg. Co.**, for electron tubes.
 - \$500,000—**Bogue Electric Manufacturing Co.**, Paterson, N.J., for development and production of ultrasonic fuel measuring and control system for *Titan* (sub-contract from The Martin Co.).
 - \$307,766—**Tung-Sol Electric Inc.**, Newark, N.J., for electron tube
 - \$225,000—**Beckman Instruments, Inc.**, Berkeley, Calif., for high-speed analog computer for *Bomarc* system (sub-contract from Boeing Aircraft Co.).
 - \$209,568—**Wood Electric Co.**, Newburyport, Mass., for circuit breakers.
 - \$168,825—**Sylvania Electric Products Inc.**, for electron tubes.
 - \$160,528—**Eitel-McCullough, Inc.**, for electron tubes.
 - \$105,993—**Aeronautical Div., Minneapolis-Honeywell Regulator Co.** for research study on non-magnetic stable platform for use in connection with magnetometer measurements from *Aerobee* sounding rockets.



EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

...operations research

Future advancements in missile and space technology are largely dependent on activities today in operation research. At Lockheed, operations research scientists explore future programs, evaluate the objectives and requirements of new proposals, establish parameters for the most effective procedures, determine specifications, perform preliminary design and analysis and originate proposals for both immediate and long term development.

Scientists in this area must extrapolate from known scientific laws or engineering principles, new methods, techniques and applications as far as a decade or more away. Studies include: game theory; linear programming; decision theory; statistics applications; logistics; cost analysis; industrial economics; electronic systems; operations engineering; military operations; development planning; and weapon systems operational analysis.

Scientists and engineers of outstanding talent and inquiring mind are invited to join us in the nation's most interesting and challenging basic research and development programs. Write: Research and Development Staff, Dept. BB-29, 962 W. El Camino Real, Sunnyvale, California.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics. National Missile Industry Conference award."

Lockheed / MISSILES AND SPACE DIVISION

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CAPE CANAVERAL, FLORIDA • ALAMOGOROO, NEW MEXICO

missile people

Dr. Hubertus Strughold, Advisor in Research and Professor of Space Medicine at the Air Force School of Aviation Medicine, has been named the 1958 winner of the Dr. John J. Jeffries Award for his outstanding contributions in space and aviation medicine research. Dr. Strughold is a consulting editor to *m/r*.

The award, one of the highest and most coveted in the aero-medical field, is presented annually to the individual responsible for outstanding contributions to the advancement of aeronautics through medical research.

Howard P. Mason, formerly Aerojet's coordinator of the Titan program and more recently executive assistant in the company's Missile Range Division, has been appointed Aerojet's Corporate Base Manager for the Pacific Missile Range. He will coordinate Aerojet's activities at Vandenberg Air Force Base, the Naval Missile Facility—Point Arguello—and range operations at the Navy's Missile Test Center, Point Mugu.

The Air Force has announced appointment of **Dr. Jack P. Ruina** as Deputy for Requirements to the Assistant Secretary, Research and Development. Dr. Ruina previously served with the University of Illinois as Associate Professor of the Department of Electrical Engineering and as Research Associate Professor of the Control System Laboratory.

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

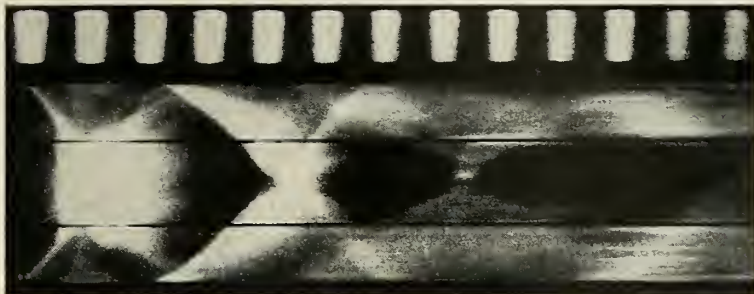
Dr. Thomas J. Carroll, authority on the electronic phenomenon known as twilight scatter propagation, has been named to a new post at the Radio Division of Bendix Aviation Corp. He will be in charge of the Advanced Development Staff of the division's Government Products Group.

Ralph W. Waniek, formerly senior physicist at Harvard University and director of the Cambridge Electron Accelerator, has been appointed Director of Research of the Magnetohydro-dynamics Laboratory recently organized at Gianini Plasmadyne Corp.

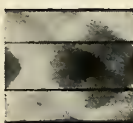
Dr. Hans Wolfhard has joined the research staff of Thiokol's Reaction Motors Division as manager of the Physics Department. Dr. Wolfhard, a physicist and combination research expert, will be responsible for the technological advancement in the field of rockets and missiles.

REPORT ON

Plasma Propulsion at Republic Aviation



Space-Time Trace: With space as ordinate and time as abscissa, photograph shows development of pinch effect in plasma, followed by shock waves. Picture was obtained with special streak camera—part of the instrumentation devised for Republic's experimental Plasma Propulsion program. Each space at top measures an interval of 10 microseconds.



An experimental Plasma Propulsion System under test at Republic Aviation gives promise of a power plant ideally suited to space vehicles. The system generates plasma from a heavy gas and subjects it to magnetic acceleration to produce thrust at high exhaust velocity.

Research and Development in Plasma Propulsion and in a number of branches of Hydromagnetics and Plasma Physics is being sharply expanded as part of Republic's new \$35,000,000 Research and Development Program. Investigations currently in progress include studies of plasma generation of electricity and the application of Hydromagnetics to Hypersonics.

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PHYSICAL CHEMISTRY	HIGH POWER PULSE ELECTRONICS

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Write in confidence directly to:

DR. THEODORE THEODORSEN, Director of Scientific Research



REPUBLIC AVIATION

FARMINGDALE, LONG ISLAND, NEW YORK

IMPORTANT ANNOUNCEMENT TO
ALL ENGINEERS—EE, ME, AE, CE:

A New Organization Now Forming at General Electric to Integrate and Direct Systems Management of Prime Defense Programs

From within General Electric, and from industry at large, talented scientists and engineers from diverse disciplines are coming together to form the nucleus of the new Defense Systems Department.

The responsibilities of this new group encompass management of theoretical and applied research as well as advanced development on major terrestrial and space-age systems.

Engineers and scientists interested in exploring the broad new possibilities in the Defense Systems Department are invited to investigate current openings.

*Direct your inquiry
in confidence to Mr. E. A. Smith
Section 2-G*



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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.

missiles and rockets, February 16, 1959



CONVAIR'S B-58 HUSTLER and CONVAIR'S ATLAS ICBM

PARTNERS FOR PEACE... manned and unmanned!

Long range planning of yesterday by the U. S. Air Force is taking shape today in *manned and unmanned* weapons systems such as Convair's B-58 Hustler—our *first supersonic bomber*; and Convair's Atlas—the *free world's first Intercontinental Ballistic Missile!* In utilizing the outstanding features of both systems, this unmatched combination offers the Air Force maximum flexibility in carrying out its Strategic Mission. These *partners for peace*, both *manned and unmanned*, integrated into a single instrument of defense, play a vital role in keeping the free world free!

CONVAIR

A DIVISION OF

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THIOKOL AT ELKTON MARYLAND

ROCKETS FOR SAFETY • ROCKETS FOR DEFENSE • ROCKETS FOR RESEARCH

On a 300 acre site in Maryland, Thiokol's Elkton Division pursues advanced programs of basic and applied rocket research, development and production.

In current production are rockets for low altitude cockpit ejection systems. One such device—powered with a Thiokol rocket—has been instrumental in saving life in two emergencies.

Nucleus of Thiokol's rocket team was organized at Elkton in 1948. Recruit, solid propellant rockets for "Operation Farside" and Cajun, for upper atmosphere research,

are marked milestones in Elkton's progress.

Equipped with the most modern laboratory, production and testing facilities...the Elkton Division is engaged in the development of advanced rocket motors of diversified size and type, of high energy fuels—and their adaptation to military and civilian use.

Scientists, Engineers: perhaps there's a place for you in Thiokol's expanding organization. Our new projects present challenging problems and a chance for greater responsibility.

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