MARCH 16, 1959

ATLAS SKIN STRETCHING

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

MARCH 16 HEADLINES

ASTRONAUTICS ENGINEERING

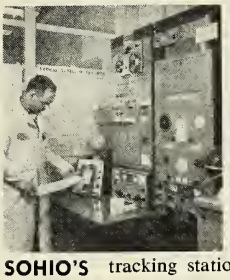
MISSILE ELECTRONICS

MISSILE SUPPORT EQUIPMENT

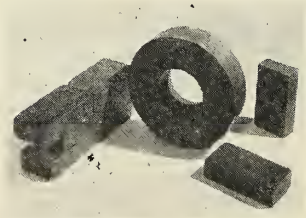
DEPARTMENTS

COVER: Alloys for *Atlas* are formed with Bath Company's "skin-stretching" machine. (p. 24)

FIRST stage of *Titan* moves on North American transtainer for test at Cape. (p. 22)



SOHIO'S tracking station is getting valuable data with simplified equipment. (p. 29)



BEING used in a nuclear reactor is paraffin-lead which has future application for space vehicles. (p. 34)

RADOME costs may be reduced by new spraying technique of Gladding, McBean & Co. (p. 37)

CHECKMATE

in the face of enemy countermeasures

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Progress Report

Over the past year it has become more and more apparent that the Department of Defense, other agencies of the United States government and aircraft, missile and electronics manufacturers have been placing more and more emphasis upon the systems concept for weapons and space flight development.

In order to keep pace with the evolvement of this concept, and to remain a true industry medium for all those who design, develop, test, manufacture and operate missiles, rockets and space vehicles, and their supporting equipment, *Missiles and Rockets* has been gradually broadening its editorial scope with more and more attention to the systems approach and a consequent and necessary increase in the amount and caliber of technical editorial coverage.

Furthermore, while *Missiles and Rockets* will always believe it an obligation to champion any cause or program which will further the nation's defense and space development capabilities, *Missiles and Rockets* will scrupulously avoid the undue influence of any individual association, group or service.

Missiles and Rockets' current editorial expansion plan, now all but completed, is under the direct supervision of Clarke Newlon, who was appointed executive editor on September 2, 1958. It calls for a staff of 12 full time editors, 12 contributing and regional editors, 12 correspondents, and an eight-man editorial advisory board.

Among the recent appointments by Mr. Newlon as full time editorial staff members are:

Charles LaFond, formerly Page Electric Co., electronics engineering.

Hal Gettings, formerly Radiation Inc., electronics and support equipment;

Allan D. Seltzer, formerly Redstone Arsenal Research and Development, chemical engineering and weapon systems;

William Hall, Washington Industrial Public Relations and formerly UPI—government agencies;

William Howard, formerly United Press International, missile and space industry;

James Baar, formerly United Press International, military and weapons systems.

Added as contributing staff members on a regular basis are: James J. Haggerty, Jr., authoritative aero/space writer; and Michael Lorenzo, advisor to the U.S. Air Force on propulsion.

In its 30 months of publication since October, 1956, *Missiles and Rockets* has grown from a revolutionary idea on the horizon of the business publishing field to an extremely successful and vital weekly magazine. In 1958, among the some 2700 listed business publications of all types in the U. S., it ranked 63rd in advertising volume, a record possibly unmatched in all business publishing history. During the past several years it has scored time and again with exclusive news and technical reports in the missile and space flight fields; it has carried more editorial pages devoted to those subjects than any other magazine of any type.

Enthusiastic support from all phases of industry made it possible for *M/R* paid circulation to grow to 29,997 for the last issue of 1958, subject to ABC audit; it carried 1686 pages of advertising in its second full year of publication, far more than any other business publication covering the same market.

In a recession year when business publications as a group showed a 14% revenue loss, *M/R* showed a 58% gain over the previous year, the largest of any publication reporting to Industrial Marketing magazine. Revenue for the first two months of 1959 increased 43% over the same period of 1958.

In short, *Missiles and Rockets* has telescoped a normal business publication growth of some 20 years into a period one-tenth as long. It has pioneered a totally new concept of market coverage, causing a major revolution within its field. It has kept pace with a market which has grown from $21 million to $7 billion in just eight years.

As another major move to strengthen the organization behind *Missiles and Rockets,* Edward D. Muhlfeld, advertising sales manager since the magazine's founding, has been named Assistant Publisher with headquarters in Washington. Walton E. Brown, regional advertising manager in Los Angeles, has been named advertising sales manager with headquarters in New York. With editorial and advertising performance measured by the Eastman and Mills Shepard Research organizations, *Missiles and Rockets* will strive for a maturity calculated to provide for its readers a true industry medium deserving of its description, namely, the technical news weekly of the missile/space industries.

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washington countdown

Pioneer IV and *Mechta* . . .

comparison works out like this (*Mechta* in parentheses): Weight, 13.4 lb (796.5); moon miss, 37,000 miles (4,660); time tracked, 84 hours (62); distance tracked, 406,020 miles (370,000); perihelion, 91,744,000 miles (91,500,000); aphelion, 105,829,000 miles (123,250,000); velocity at perihelion, 69,500 mph (72,360); velocity at aphelion, 60,000 mph (54,360); time of orbit, 392 days (447).

DOD confirmed *Discoverer I* . . .

orbit (m/r, March 9, p. 20) after press deadline. Some 41 tracking reports were received verifying the orbit. Life expectancy is 30 days with apogee of 519 and perigee of 176 statute miles.

France's Saharian . . .

test range of Colomb-Bechar has started the first of 50 scientific rocket firings using *Veronique* and *Monica* birds. Under sponsorship of newly-created French Space Committee, rockets will explore at altitudes between 30 and 150 miles.

British missiles only . . .

interest the Australian Navy insofar as their surface units are concerned. While very interested in *Sidewinder* and other air-launched missiles, the Australians say problems of training personnel and acquiring experience with American guidance and support equipment give the advantage to British-made missiles. The Australians are reported considering several, including *Seaslug*.

In missile management . . .

investigation by House Military Operations Subcommittee, Assistant DOD Secretary Quarles came to the defense of the Institute for Defense Analyses (m/r, Jan. 5, p. 20). Quarles said IDA is limited to technical advice and has no power to select a specific contractor. IDA has 30 non-government staff members, he said, and operates on a non-profit basis.

Legislation to reinstate . . .

the excess profits tax of 1950 has been introduced by Sen. Richard L. Neuberger (D-Ore.). The bill would reimpose the tax for the taxable years beginning July 1, 1961.

Merger of Navy bureaus . . .

is again being rumored in Washington. Plan to merge the Bureau of Aeronautics and the Bureau of Ordnance into a Bureau of Weapons has been reported before. Navy would only say that no definite decision in the matter has been made.

Renegotiation Act probe . . .

will have to take a back seat, according to reports from the Hill, with discord over extension of unemployment compensation nosing the Renegotiation Bill out of first place on the agenda of the House Ways and Means Committee.

Renegotiation . . .

has been left out of a procurement bill introduced by Rep. William Bates (R-Mass.). That's its only real difference from a procurement bill introduced by Sen. Leverett Saltonstall (R-Mass.). Both bills would put negotiation on a par with advertised bidding and permit use of the technique termed "competitive negotiation." Another section would give specific authority and guidelines for use of the weapons system—redefined as "operational system."

Zeus production . . .

commitment is far from settled one way or the other with Congress hearing from Army R&D Chief Trudeau that it is "our only hope for the early 1960's." DOD's Holaday said he concurs at maintaining program at present R&D level but wants another $40 million for engineering development work. JCOS have said they think Army money for air-to-surface missiles is "substantially below" recommended 1960 needs, and that AF needs more money for *Bomarc* procurement.

Supplemental FY 1959 . . .

appropriation of $48,350,000 has been approved by the Senate for NASA. Most is for R&D on *Project Mercury* ($20,750,000) but there's $24,250,000 for construction and equipment.

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industry countdown

Decision on ALBM . . .

contractor will be made about April 15. Sixteen firms have put in proposals out of 20 called in. Earlier R&D feasibility studies (WS-199B, m/r Dec. 1, p. 11) were made by Martin, Lockheed-Convair and McDonnell. On the engine, all three want Thiokol. Martin's subcontract system would be Thiokol, General Precision Equipment Corp., Librascope, Inc., Kearfott Co., and Kollsman Instrument Corp., guidance.

30,000-pound solid . . .

booster for a manned space capsule is unofficially being pushed by Grand Central Rocket Co. Company says it would have less than 2 g's acceleration compared with 6 g's for *Atlas*. So far design is only on paper. Company also says it can put a four-stage solid propellant space vehicle on a launch pad within four years at a cost of $70 million compared with $102 million, which Grand Central says is needed for a 1.5-megaton single-chamber liquid booster.

***Minuteman* R&D propulsion . . .**

contracts totaling $162 million have gone to Aerojet and Thiokol. Latter's work under $77 million contract will be at Brigham City, Utah. Aerojet-Azusa will research under $85 million award. AF has announced seventh site for ICBM near Lincoln AFB, that could be model for *Minuteman*, which may be accelerated by as much as six months, according to Lt. Gen. C. S. Irvine.

First *X-15* glide test . . .

is due this week at Edwards AFB to be followed by powered flight. *X-15* last week rode on a special pylon under right wing of modified B-52 for first captive flight test.

Major *Polaris* missile . . .

and submarine system contracts now total 440. Missile system contracts, including guidance account for 140, but some 4000 vendors are involved in the FBM program.

DOD will have . . .

available this week a study for the Labor Department to determine how much of the missile dollar goes to manufacturers of airframes, electronics and propulsion. While the Holaday report will not be exact, it should help to resolve the question of a redefinition of aircraft to include missiles and missile electronics. AIA wants the redefinition, EIA opposes it.

Convair has a "task force" . . .

studying use of *Lobber* as an anti-submarine weapon for depth charging or placing of sonobuoys and flares.

Air Force has biggest piece . . .

of the missile obligations for the six-month period ending Dec. 31. Breakdown for the first half of FY 1959 shows: Army, $4.3 million; Navy, $4.1 million; Air Force, $1.45 billion, for a total of $2.3 billion. Missile expenditures in December were $2.8 million, for a six-month total of $1.5 billion.

$61.8 million contract . . .

has gone to McDonnell for F-4H-1 airplanes. They will be armed with *Sparrow III*, and will be partially recessed into the fuselage for supersonic flight.

***Vanguard II*'s cloud cover . . .**

instrumentation transmitted 250,000 ft. of taped signals, but because of an unexpected precession of the satellite, it will take Army Signal Corps scientists months to decode the signals.

NASA's Scout will cost . . .

in the neighborhood of $500,000 per vehicle. This is less than $15 per pound for the total vehicle, and less than $3,500 per pound orbited.

Solid propellant . . .

escape rocket contract for *Mercury* capsule has been awarded Grand Central Rocket Co. by McDonnell Aircraft, prime. It's the first NASA project to go to the Redlands R&D center.

HUNTER-KILLER

TEAM TRAINING

NTDC'S* ANTI-SUB TACTICS TRAINERS BY ERCO;
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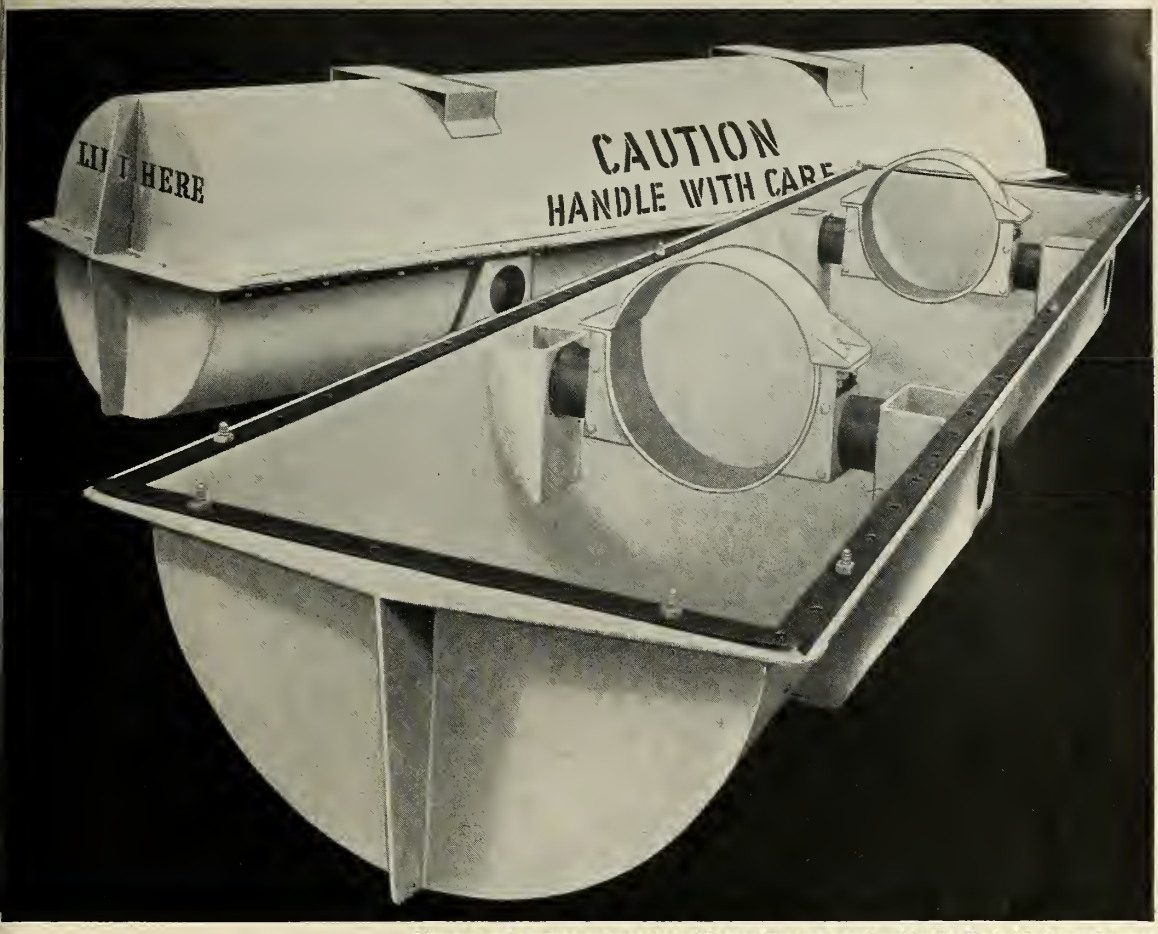


Shipping and storage container for solid propulsion unit produced by the Thiokol Redstone Division.

METAL FABRICATION PROBLEMS?

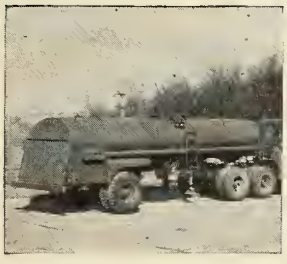
better see Butler

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 7 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:



Woter-olcohol fuel service unit for Redstone. Reseorch, design testing ond fabrication by Butler Contract Monufocture Division.

Butler wos prime contractar for designing, developing, fabricating ond erecting prototype Model III Bomarc launching shelter.

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For the fourth time in three years, a new *Crusader* type is extending the power of the Fleet. Chance Vought's F8U-2N has been ordered by the Navy for delivery next year. It will deploy alongside the Navy's swiftest photoplanes and two first line day fighters – all *Crusaders*.

The F8U-2N is another step in *Crusader* growth. Speed of this newest version has been advanced to near Mach 2. It will carry the deadliest air-to-air missiles. It is instrumented and radar-equipped for supersonic combat in darkness or bad weather.

This will be a new capability for the Fleet. Yet it is being acquired at low risk and cost. The F8U-2N's basic design has been proved simple, serviceable and economical . . . compiling an enviable performance record in a year of foreign duty with two Fleets.

Again, the growth provisions of the Vought *Crusader* have provided immediate, low-cost upgrading of the Fleet's aircraft inventory.

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

MARCH 16, 1959—VOL. 5, NO. 11

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Transistors vs. Tubes

. . . are arbitrary military design specifications jeopardizing U.S. security?

by Donald E. Perry

WASHINGTON—Arbitrary military design specifications which call for complete or nearly complete transistorization of missile electronic equipment are placing the nation's defense system in jeopardy, industry officials have told m/r

And if another nation should strike first with nuclear weapons, there is widespread doubt in the industry that this country could effectively retaliate, with many aircraft and missile systems said to be virtually useless.

Industry and the military are differing on the merits of the vacuum tube vs. the solid-state devices such as the transistor and diode. Industry's point is that not enough research is being carried out to determine if the highly touted transistor can survive and perform satisfactorily while going through fields of nuclear radiation.

And with suspension of atomic tests many scientists feel a conclusive decision has not and cannot yet be made in favor of either the tube or the solid-state device.

It's obvious that radiation causes changes in the physical and chemical nature of components traveling through such fields. U.S. research today is aimed at how much it changes, and most important, how it affects a particular missile or aircraft circuit.

• **Stability lost**—Present research, m/r has been told, indicates that transistors in high neutron fluxes are not stable because of physical changes in their nature. This particularly applies to the audio-type transistors. Research has shown, however, that the thin-based high-frequency transistors "suffer less" from radiation effects.

This has led many weapon systems designers to believe strongly that the action of a transistorized system entering a cloud of primary and secondary fission products would be completely unpredictable.

While industry agrees with the military that the use of transistors should be pushed because they are lighter, require less power, and generate less heat, industry believes it's to the detriment of the nation that military design specifications in many cases require *complete transistorization* of equipment.

• **Services differ**—What's being done? The Navy, m/r has been told, has adopted a radically new procedure which says, in effect, that in the *Polaris* program vacuum tubes and solid-state devices will be given an "equal shake."

The Air Force, on the other hand, is still insisting on solid-state devices in most design specifications, m/r has been told. One instance was cited involving automatic test equipment using only solid-state devices. The equipment still has not been demonstrated after three years of work.

Here are other cases reported to m/r:

• A Navy missile was partially transistorized to test the reliability of transistor usage. It reportedly required 40 transistors to replace five vacuum tubes in order to overcome the lower performance of the transistor units.

• A top designer of a company manufacturing autopilots for aircraft said he "shudders to think of using transistors in autopilots because they are so unstable." He said he must compromise his design to use transistors because he has no choice—the military is demanding transistorized units. He pointed out that there is a real danger to life and property involved because autopilots designed with tubes include fail-safe mechanisms whereas those using transistors normally do not.

• A recent military request for bids for design and development of a celestial body sensor had a preamble in which the contractor was directed to conduct a thorough background investigation to determine the most suitable materials and techniques for use in the sensor. But the fourth sub-specification contained these arbitrary directions: "The associated sensor electronics *shall be completely transistorized.*"

• One large computer manufacturer reported it employs a print-out circuit which is served by a special high-voltage pulse tube. The tube is being used in the company's commercial versions of the circuit; however, military specifications require the use of transistors for this function. The company said its cost is $6.50 more per stage by using transistors and totals several hundred dollars per printer.

• A mammoth military computing system built with transistors has been unable to operate satisfactorily for the past nine months because of transistor failures. Designed for vital defense information data processing, the system has suffered failure after failure and for all practical purposes has been completely inoperable.

• **Wishful thinking?**—In a recent symposium, a well-known designer presented a table of major factors for consideration in the design of transistorized equipment. He compared vacuum tube equipment with what he termed "wishful thinking" in transistor design goals. He cited, for example, that tubes are rated at 300 hours for reliability while transistors have a *goal* of 600 hours.

This same designer compared the maintenance time of the tube and the transistor version. He listed tube replacement time as 50 minutes and transistor replacement time as five minutes. However, he said that in designing the transistor equipment, indicator lights were used to point out which circuits had failed, thus saving much time looking for failure.

While many believe that transistors are just as reliable as tubes, industry observers object strenuously to comparing known facts about tubes with hopeful goals of transistors. To do so, they say, is "blue-sky" propaganda which is unduly and dangerously influencing military defense designs.

G. T. WILLEY . . . management leadership for field testing.

Titan's Testing Time May Be One Half *Atlas'*

SAC personnel to join Martin's streamlined test division in September; static firings may be eliminated at Cape.

by Donald E. Perry

CAPE CANAVERAL—Testing of the Air Force *Titan* should be shortened to one-half of the time required for *Atlas,* and the first SAC crews will be integrated into The Martin Company's Cocoa testing division as test conductors by September, m/r has learned.

The Air Force personnel will arrive during second and third lot testing (B and C series birds) and will include test conductors, lead engineers and technicians for electrical, mechanical, flight controls, missile safety and propulsion.

Static firings at the Cape will be eliminated for *Titan,* which should shorten the time for operational availability by months. Basis for this unprecedented action is the *Titan's* record of performing successfully on its first two flights and the Air Force's conviction that engineering and static tests in Denver are sufficiently advanced to place this much reliability in the missile.

The immediate goal is to fire a *Titan* within one week from its arrival at Patrick AFB via Douglas C-133. Already, the Martin-Cocoa division has chalked up some notable firsts and shown industry that it is neither desirable nor advantageous to regard a testing operation as a stepchild of the parent engineering group. The first test firing on Feb. 6 required a seven-hour countdown. The second firing on Feb. 25 shaved four hours off that time. To top it off, two completely different test crews have fired the bird, and another crew is scheduled to fire the next missile.

• **The man behind it**—The man back of this enviable record is soft-voiced, British-born G. T. (Tom) Willey, senior Martin vice-president and general manager of the Cocoa Division, who continues to speak softly but wields a big management stick with force when he has to.

In October, 1957, Willey established shop at Cocoa Beach and promptly announced he was determined to give real management stature to field testing operations. At that time, there were 100 employees and there was not too much planning to strengthen test schedules for the Big *T* and *Vanguard.* Today there are 945 employees.

Martin's move is being copied by other prime contractors who have since announced full-scale strengthening of testing operations by creating separate management divisions.

The first step was to let a skeleton field force know he was on board. He used the standard industrial engineering approach: housekeeping and cleanliness of the operation—watch the coffee breaks, etc.—which affected employees personally.

• **Tightening up**—After this came a beefing up of the organization with key men transferred from Martin's other divisions. Testing schedules were worked out well in advance and Martin-Cocoa tightened up rules and regulations and refused to take "no" for an answer. The philosophy in effect was to tell the parent plants (Denver, Orlando, Baltimore), that "we can't hold up our testing operations because of you."

At this time, *Vanguard* was requiring about 300 modifications in the field. Willey resolved not to let that happen to *Titan.* "We did not want to become a major modification center for work which could have been done more effectively at the factory," he says. He proved it when it came to flight testing the first *Titan.*

An engine failure during FRF (flight readiness firing) brought one big on-the-spot decision: ship it back to Denver. The division doesn't regret this decision. The vehicle was fired Feb. 25, and required less than 20 field modifications. Further, it backed Willey's theory: a testing operation should work hand-in-hand with the parent group but not be subservient.

While Willey is the first to admit that his division got the benefit of a

COMPLEXITY of *Titan's* ground port equipment is evident as a first s is moved on to Pad 15 at Cape Ca eral for erection.

lot of information from earlier *Vanguard* testing, a Cocoa Division system of coordinating engineering changes necessary in the field with the parent engineering group at Denver has paid dividends.

• **Quick liaison**—A Denver field office was set up at Cocoa to act as a liaison between the Cocoa Division and the Martin-Denver division. When a minor field modification is needed (changing wiring circuits, etc.), the Cocoa Division writes a Liaison Call Sheet (LCS) which says in effect it would be advantageous to the success of the bird presently on the stand if a modification were made as an interim measure.

Without having to await approval from Martin-Denver engineering, the minor mod is made with the concurrence of the Denver field office. Then, Cocoa engineers write a Field Change Authorization (FCA). This is sent to Denver immediately, and if Denver engineering concurs, that group issues a Drawing Change Notice (DCN), listing complete effectivity, thus changing engineering both at Denver and at Cocoa. The FCA takes about a day to jell between the two widely-separated operations.

This system has kept to a minimum the number of modification kits sent from Denver. It has drastically reduced the time for missile checkout. Less than 10 changes—half the number required in the first bird—were made in the second test vehicle fired Feb. 25.

• **Fingers crossed**—*Titan* is a long way from its ultimate goal: capability of eight to 20 servicemen to fire it within 15 minutes. The Cocoa division is keeping its fingers crossed when it enters second-stage testing. But if the division continues to operate the way it has on the first two vehicles, then Martin test people can take just pride.

For Feb. 6 was a milestone date. It was the third-year anniversary of ground breaking for the Denver plant, and it was exactly one year to the day after the Cocoa Division was given first access to the Cape complex area. At that time the area was mostly sand, with only a small amount of concrete poured. Yet in less than nine months, the complex was completed and the ground bird had been erected and checked out.

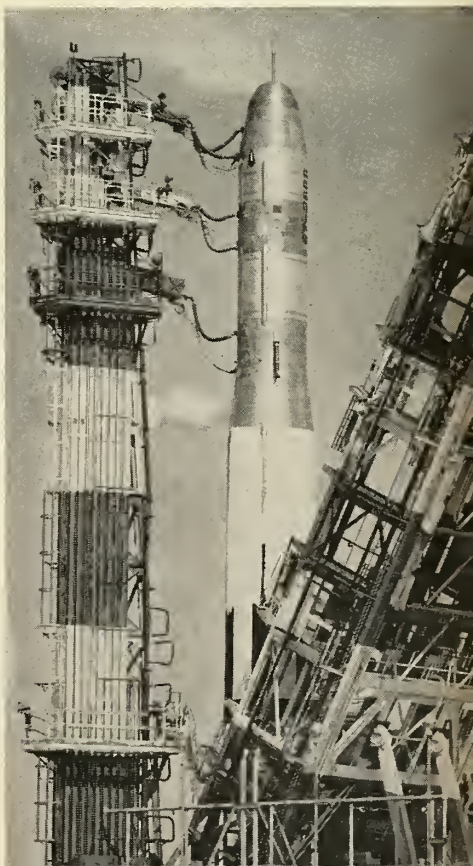
Willey and teams are proud of *Titan's* record but just as proud of the success of *Vanguard II* on Feb. 17. *Vanguard,* first of the big rockets and missiles, had a rougher row to hoe than any of its successors, Willey is quick to point out. Each *Vanguard,* whether it flew or not, contributed valuable information for succeeding missiles and furnished industry with invaluable data, he said.

The next big step for Martin's Cocoa division is to assist ABMA in testing of the *Pershing,* being built by the company's Orlando division. With this missile, the Army will have charge of testing, and undoubtedly new approaches will be demanded. But already, the Cocoa division is preparing for the day with a *Pershing* operations manager on the job. Work is progressing on preparing a test complex at the Cape with site clearing already underway.

Willey's first-string team of directors includes:

R. L. Sansbury, military relations; Kenneth Traut, customer services; William Harwood, information services; C. Q. Butler, procurement, production control and supply; James Holley, industrial relations; F. M. Pilachowski, finance and office services; D. S. Levin, *Titan* operations; R. L. Schlechter, *Vanguard* operations; H. E. Haydon, *Pershing* operations; J. S. Barnitz, programming and contracts; J. S. Krawczyk, quality assurance; W. C. Janda, test services, and E. J. Mommer, *Mace* operations.

TRANSTRAINER vehicle, manufactured by North American Aviation, is used in transporting *Titan* from Denver to Florida on C-133 aircraft and then takes to the road for delivery to pad.



READY for prelaunch checking is test vehicle A-5. The "A" series birds have water-filled second stages but have required a minor number of field modifications after arriving at Cape.

U.S. Surplus Sales Are Rising in Volume

Total of $5.6 billion was sold in Fiscal 1958; efforts made to protect investment and prices.

by E. E. Halmos, Jr.

WASHINGTON—Surplus material with an original value of more than $5.6 billion—ranging from underwear and office machinery to jet airplanes and missile components—was sold by the U.S. government during Fiscal Year 1958.

Average return to the government was about 6% of the original purchase price, meaning that Uncle Sam got back about $336 million of his investment.

Nearly $5 billion of the total surplus sold came from the military departments. And in Fiscal 1959's first quarter, military surplus alone put up for sale totalled about $1.5 billion in original value.

• **Government alert**—There is ample evidence in Washington, according to m/r's careful analysis of the surplus situation, that the government is making every effort to get as much back for Uncle Sam as possible on his original investment—and to prevent adverse effect on markets.

The present system is a great advance over the often chaotic days shortly after World War II, when tons of material of every kind were being indiscriminately dumped, amid endless complications and miles of red tape. Today there is a careful attempt—supervised by two principal agencies—to screen the material turned in as surplus and to market it in locations and in a manner that will not upset prices. Several of the armed services even conduct schools where officers are taught marketing techniques.

• **Terminology first**—Before you talk about "government surplus," you have to understand government terminology. Three terms are the keys: "Personal Property," "Excess" and "Surplus."

"Personal property" means virtually any property that is movable—nearly everything except buildings and land. Airplanes, desks and office machinery, as well as clothing and filing cabinets and rugs, are considered to be personal property.

"Excess" personal property is considered to exist when the head of any major executive agency (such as the Secretary of Defense) decides he doesn't need some equipment or material to further the operations or program of his agency.

"Surplus" doesn't come into being until other agencies of the government have had a chance to look over the "excess" and decide which of it they can use. Whatever is left after this screening becomes "surplus."

There's one more term: "Donation." When all agencies have had a chance to look over "excess" property, the Government's property manager—the General Services Administration—may "donate" some of the surplus to tax-supported or non-profit educational institutions and public health and civil defense organizations. Something like $320 million was donated—including medical supplies and some scientific laboratory equipment—in the 1958 Fiscal Year.

• **What is it?**—At this point, there is very little direct missile material in the mountains of surplus. Not enough missiles of any type have been manufactured to make up much of the pile. But there is a lot of electronic components—most of it part of aircraft and aircraft-handling systems.

About the Cover

This "skin stretching" machine developed by the Cyril Bath Company, Solon, Ohio, is being used for forming alloys of the *Atlas* ICBM, and an electronic control unit allows the metal to be formed with precisions that was previously unheard-of.

The electronic control unit was developed by Assembly Products Systems, the special controls department of Assembly Products, Inc., of Chesterland, Ohio.

The unit receives signals from the Bath load cell and translates them to determine the yield point of the metal to be shaped. Among the design features of the control is the use of locking contact meter-relays as stable reference points for electronic components.

Control signs from electronic units first pass to the meter-relays for checking against values that must be maintained. Then the meter-relays trigger other signals to controlling apparatus that might otherwise tend to hunt and drift.

In any case, most of the material going up for sale is military hardware and weapons. And the largest share of these weapons is airplanes themselves, which explains the low percentage return to the government on its original investment.

The bulk of the surplus items, then, is outmoded weapons—most of which can be sold only as junk. Another large share of the pile is vehicles. And much of the remainder is working machines—ranging from bulldozers turned in by the Corps of Engineers, to conveyors, materials-handling rigs, and picks and shovels. Worn clothing, damaged items and the like make up the rest.

• **Where is it?**—The size of the military share of surplus is obvious from the figures. In Fiscal 1958 it added up this way: The Army sold material with an original value of $1.5 billion—out of which $925.6 million was sold as scrap, the remaining $592.7 million as still-usable; the Navy sold a total of $1.7 billion worth—$881 million scrap, $802 million usable; the Air Force sold $1.6 billion worth—$1.1 billion scrap, the rest usable.

The process works this way:

In the Department of Defense, when the Army, say, decides that some property is excess, it reports this fact to one of the subordinate organizations under the control of the Assistant Secretary of Defense for Supply and Logistics.

Periodic checks with the other services establish what use, if any, can be made of the Army's excess. If there is none, the list is turned over to the General Services Administration, which sees to it that a similar check is made of all interested government agencies.

If no use is found, the material becomes surplus. If it cannot now be donated, it is put up for sale.

Military sales are then conducted at some 300 military installations around the continental United States.

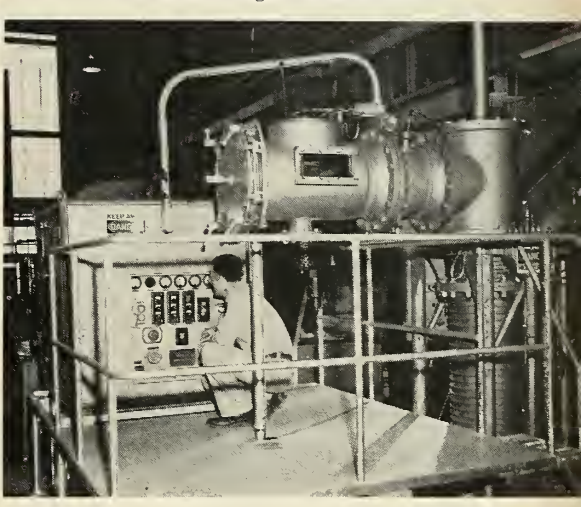
• **Why is it?**—Government officials contend that bad business practices are only a minor reason for the huge amount of surplus.

In order of importance, they put the reasons for surplus this way: obsolescence; wearing out; standardization of equipment; re-programing. Last—bad purchasing.

ASTRONAUTICS in the news . . .

WESTINGHOUSE Research Labs technician uses experimental apparatus to demonstrate solar-thermoelectric power source which will have eventual application on space vehicles.

PITMAN Manufacturing Co. has delivered several of these "high-reach" units for maintenance and servicing of *Jupiter.*

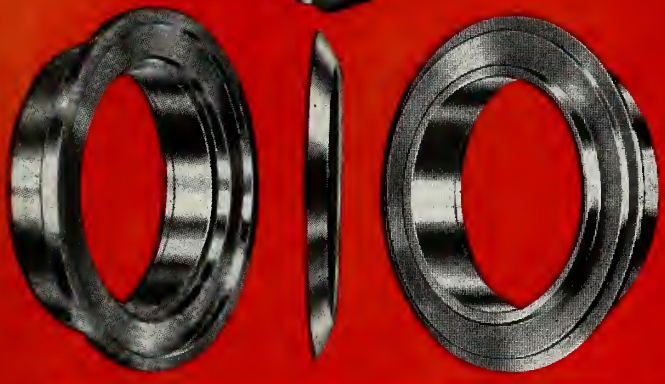


ENGINEER operates Air Reduction Company's new electron beam welder for reactive and high-melting point metals. Controllable 1/16" diameter electron beam bombards materials in a high vacuum chamber.

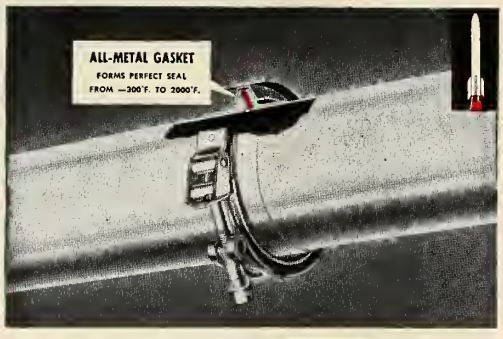
NAVY'S *Weapon Able,* long-range anti-submarine rocket (conventional high explosives) is fired from destroyer.

THIS eight-element spiral antenna at GE Schenectady and a special parametric amplifier permitted 410,000 mile tracking of *Pioneer IV.*

Only the MARMAN CONOSEAL Joint



PROVIDES ALL THESE ADVANTAGES



100% Metal! That's Why MARMAN CONOSEAL Joints Assure Unlimited Shelf Life With Perfect Seal

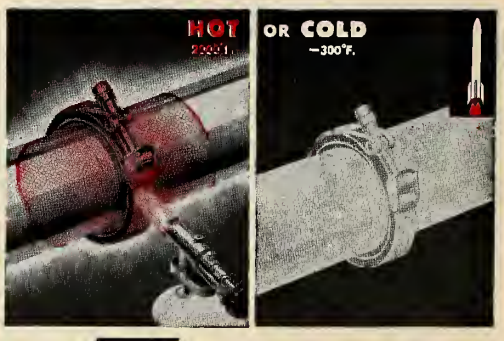
Marman's all-metal CONOSEAL Joint provides two basic advantages over organically sealed tube joints:

1—shelf life is practically unlimited
2—seal is maintained from —300°F. to 2000°F

The CONOSEAL Joint utilizes a new concept of metal-to-metal sealing in which the conical metal gasket is completely encased by mating flanges. Compressed radially and axially, the gasket forms a superior seal that withstands extreme pressures and wide thermal cycling. Distortion, shock, even minor linear deflections are absorbed without loss of seal.

The compact design of the Marman CONOSEAL Joint minimizes envelope clearance needed. Single bolt fastening simplifies installation. Ideal for fluid transfer lines and structural joints, it is available in four weight/strength configurations for both air and ground installations. Mail coupon for complete new catalog.

CONOSEAL is an Aeroquip Trademark.



Only MARMAN CONOSEAL All-Metal Joint Gives You Perfect Seal

From red hot missile engine heat to the super cold of the laboratory —and at all temperatures in between—the versatile, all metal Marman CONOSEAL Joint connects tubing and gives a perfect seal. Even linear deflections up to 1/16 inch, the result of temperature and pressure extremes on tubing of dissimilar metals, are accommodated without loss of perfect seal.

The Marman CONOSEAL Joint installs quickly because it fastens with a single bolt; requires minimum envelope clearance because of its compact design; assures indefinite shelf life because it is all metal. It is recommended for use with a wide range of fluids including liquid metals. Four configurations, from light to heavy duty, meet a wide range of requirements with maximum savings in weight.

Return the coupon for complete information.

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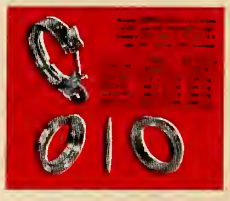


CONOSEAL is an Aeroquip Trademark

For Quick Connection of High Performance Tubing, Specify MARMAN CONOSEAL Joints

ONE BOLT FASTENS SECURELY

Connect high performance tubing quickly! Get perfect seal! Use the Marman CONOSEAL Joint that tightens with a single bolt—a simple, positive operation even in confined areas.

Important design advantages: The Marman CONOSEAL Joint requires minimum envelope clearance because its diameter is only slightly larger than the tubing it connects. Four configurations, light to heavy duty, provide maximum opportunities for weight savings.

Important operating advantages: The Marman CONOSEAL Joint seals perfectly at extreme temperatures. It joins tubing of dissimilar metals, and accommodates linear deflections up to 1/16 inch resulting from temperature and pressure variations. It has indefinite shelf life because it is all metal; and it may be used for many fluids, including liquid metals. Return the coupon for complete information.

MARMAN CONOSEAL Joints Assure Perfect Seal of Dissimilar Metals at Extreme Low Temperatures

Even at extreme cold of —300° F., tubing of dissimilar metals can be joined in a perfect seal by the all-metal CONOSEAL Joint. Seal is maintained through the full temperature range up to red hot 2000° F. (for applicable tubing). Strength and sealing capabilities are also unaffected by distortion, shock or minor linear deflections.

The Marman CONOSEAL Joint assures unlimited shelf life because it is made entirely of metals not subject to deterioration. Its compact design requires minimum envelope clearance; single bolt fastening simplifies installation. Recommended for a wide range of fluids, including liquid metals, the CONOSEAL Joint is available in four weight/strength configurations. Mail coupon below for complete new catalog.

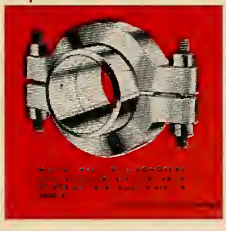
CONOSEAL is an Aeroquip trademark.

MARMAN Heavy-Duty CONOSEAL JOINT Seals Perfectly at High Temperatures and Pressures

Where extremes of pressure and temperature are standard operating conditions for fluid lines, specify the all-metal Marman Heavy-Duty CONOSEAL Joint. It is designed to provide absolute dependability in connecting and sealing piping, even when subject to severe shock and distortion.

Marman Heavy-Duty CONOSEAL Joints provide maximum insurance against leakage or failure where dissimilar materials must be joined, such as stainless steel to aluminum or Zercalay. Made entirely of metals not subject to deterioration, CONOSEAL Joints have long shelf life, require no maintenance.

Successfully performing now on jet and rocket engine test stands, high pressure fueling systems, missile test stands and launching platforms, the Heavy-Duty CONOSEAL Joint offers rugged dependability and simplicity of installation to meet a wide range of ground applications. Lightweight configurations of the CONOSEAL Joint are also available for aircraft and missile applications. Mail coupon below for full information.



Solve high performance tube and pipe joining problems with the versatile Marman all metal CONOSEAL Joint. Four configurations, covering temperature requirements from —300°F. to +2000°F. and pressure requirements from 1200 psig. to 6000 psig., are available for a wide range of missile, ground support equipment, aircraft and other applications. Weight-saving, space-saving Marman CONOSEAL Joints are leakproof, simplify tubing installation, accommodate linear deflections, assure indefinite shelf life. Return the coupon for complete information.

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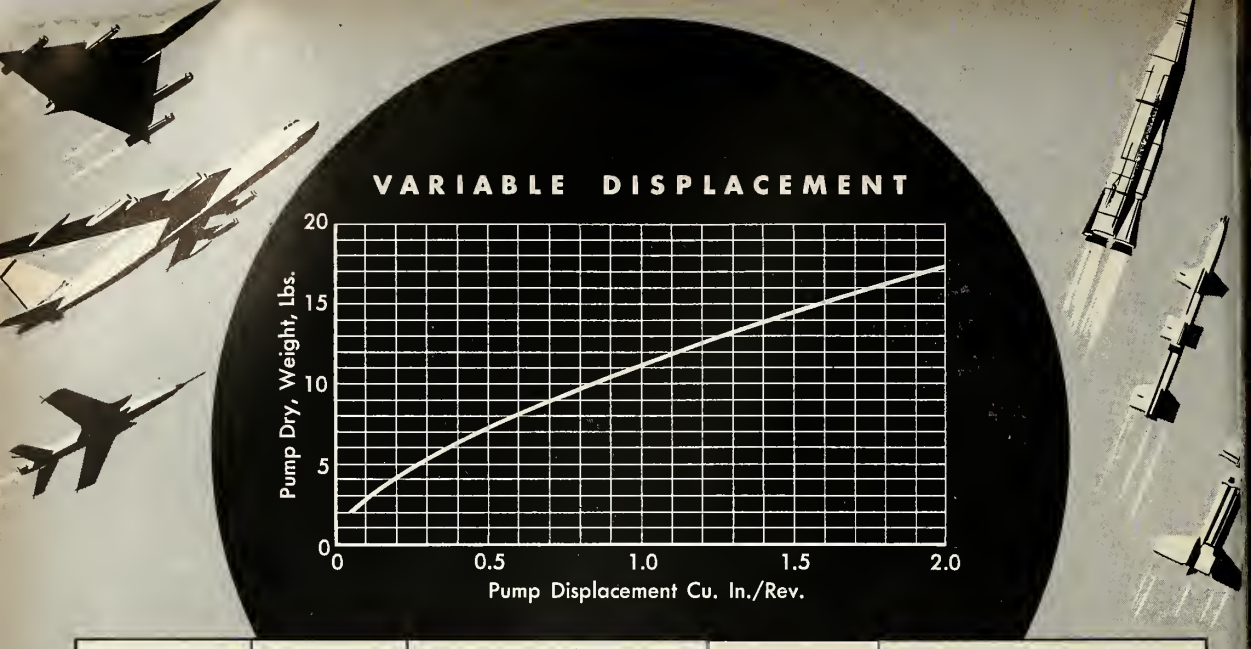
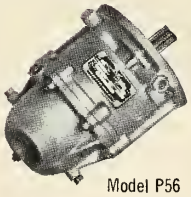


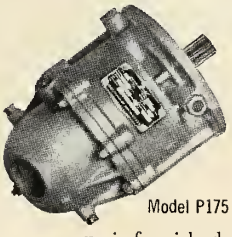
Model	Displacement In 3/Rev	Rated		Max. RPM	Envelope Dimensions	
		RPM	GPM		Diameter	Length
P175	1.750	4000	29.4	5000	5.750	8.320
P105	1.050	4000	17.3	6000	5.250	7.250
P56	.568	6000	13.9	8000	4.687	6.625
P16	.163	12000	7.9	16000	3.000	4.250
P11	.115	12000	5.5	16000	2.750	3.625
P064	.064	12000	3.1	18000	2.125	3.125
P044	.044	12000	2.1	18000	2.125	3.062

A NEW FAMILY OF . . . HYDRAULIC PUMPS WITH THE LOWEST WEIGHT DISPLACEMENT RATIO

For Aircraft, Missiles, and Systems!



Model P56



Model P175

This new family of rotary plunger pumps is furnished with forged aluminum housings for fluid operating temperatures to 400°F. Thousands of hours of endurance and qualification testing, as well as flight tests, have proven that these new pumps will satisfactorily handle all MIL specification hydraulic fluids including Oronite 8515 and will exceed MIL-P-19692 specification requiring 750 hours of endurance. The low weight displacement ratio is accomplished by utilizing space not available in other designs to incorporate the variable displacement feature and servo system. Plungers operate on an inclined axis to provide centrifugal return force and are arranged such that the side loading on each plunger is minimized when the maximum overhung moment occurs.

Fixed displacement pumps are also available in all models with reduced weight and envelope dimensions.

The proven experience of Bendix in manufacturing thousands of direct injection pumps and fuel systems for reciprocating engines, fuel supply pumps, fuel systems for turbine engines, hydraulic pumps, and hydraulic systems for high performance missiles assures you of a quality unit or system meeting the high reliability standards of the industry.

FOR 3000 AND 4000 PSI
SPEEDS TO 18,000 RPM

MAJOR PRODUCTS—aircraft and missile hydraulic pumps; hydraulic components and sub-systems; engine fuel pumps and fuel system components; precision bellows and bellows assemblies; thermostats and related sub-assemblies; and sub-contract manufacturing and brazing.

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Bendix
AVIATION CORPORATION

Simplified Tracking Gear Provides Much Data

Independent Sohio station uses interferometer principle to track satellites—even *Lunik*—and records on two-channel direct-writing oscillograph

by Donald E. Pierce
Brush Instruments
Division of Clevite Corporation

CLEVELAND—Satellite tracking equipment distinguished for its simplicity is providing a wealth of authentic data quickly and accurately at the Standard Oil of Ohio (Sohio) Research Center here.

Two channels of information recorded on a direct-writing Brush Mark II oscillograph can be read directly to determine immediately whether a satellite has gone into orbit. On subsequent passes of the satellite the traces on the oscillographic charts can be interpreted directly to obtain satellite meridian passage time, angular velocity, period of orbit, and rotation modulation.

By utilizing the interferometer principle to track satellites and the two-channel oscillograph to record data, the station is deriving information never before obtained from a single source. Independent of the Minitrack chain of stations, the Sohio station was built as part of Project *Moonbeam*, and is operated as an extra-curricular activity by the scientists on the staff.

Data from a series of passes is correlated to obtain further orbit characteristics and to study the nature of the ionosphere, solar flares and other phenomena. By studying the differences between orbit information obtained theoretically and orbit information interpreted from satellite signals recorded on the oscillographic charts, the research staff has consistently obtained orbit characteristics with a high degree of accuracy.

• **Results obtained rapidly**—Since the station is not part of a chain and does not depend on information from other sources, results can be obtained rapidly. By correlating calculated information and recorded data, Dr. A. L. Jones, head of the research center, was able to predict accurately within a few minutes that *Vanguard II* would not orbit.

Original recordings of *Sputnik III* recorded on the Brush oscillograph are sent periodically by Sohio to the University of Illinois to be used in a joint study of ionosphere density patterns. By sending the original traces Sohio avoids the additional step of duplicating the trace from a magnetic tape recording on which the signals are also recorded.

In transferring a signal there is always the possibility of human error where signals recorded on tape are transferred to oscillographs for study. Errors in correlation with the time signal are frequently encountered in such procedures. With the time signal being recorded directly on the oscillograph chart at the same time the signal is recorded, there can be no error.

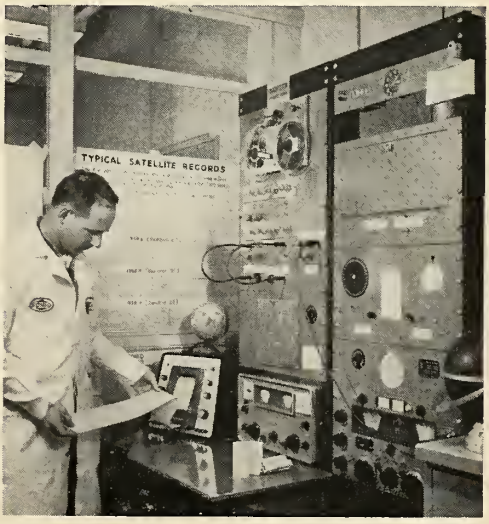
• **Recording signals**—Signals obtained from satellites are recorded to obtain three different types of information. Each requires a different method of analysis.

1. Amplitude—The amplitude of a signal emanating from a satellite as it crosses a lobe pattern is recorded on the direct-writing oscillograph as a series of peaks and nulls. From this single line, information on orbital characteristics can be obtained.

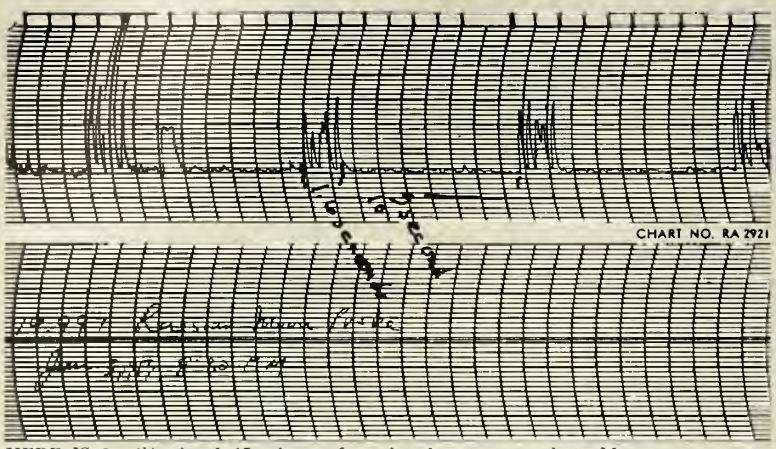
2. Doppler Shift—Frequency shift of a satellite signal as it approaches and recedes rapidly is recorded by passing the signal through a frequency-to-voltage converter and recording it on the direct-writing oscillograph. Doppler shift can be recorded from signals picked up with either the interferometer or a standard dipole antenna.

3. Telemetering—Telemetered information contained in a signal can be decoded by recording the signal on magnetic tape and playing it back through a computer for analysis. Duplicates of tapes made at Sohio are sent to agencies interested in satellite telemetered data. A rare recording of the Russian moonshot signal recorded at the Sohio tracking station was recently sent to the Air Force Research Center for study and analysis.

• **Information varied**—Built to track man-made satellites, the real value of the station's combination of



SOHIO research scientist examines oscillograph trace as satellite 1959 A passes through lobe pattern of Cleveland tracking station.



HERE IS *Lunik's* signal 45 minutes from its closest approach to Moon.

interferometer and oscillographic recorder lies in its function as a radio-telescope. It can intercept radio waves emanating from any signal-transmitting body in space including the sun, radio stars and planetary bodies. Orbit characteristics and velocities of celestial bodies can be obtained from the two channels of information recorded.

Determination of orbital characteristics from single-station observations are made using the satellite's synodic period. A theoretical synodic period is computed and compared with the observed period. From observed angular velocity, which can be read directly from one channel, orbital parameters are obtained.

In addition to orbit characteristics, the Sohio group is obtaining information on solar flares and their effect on the ionosphere and on the magnetic field of the earth.

A very rare phenomenon was recorded at the station during a pass of *Explorer I*. As the satellite was passing through the antenna pattern a solar eruption was simultaneously recorded as a signal superimposed on the satellite signal. The day after this phenomenon was recorded, the area around Cleveland experienced the most beautiful aurora borealis observed in that region in a number of years.

• **Interferometer**—The interferometer measures the distance between nulls corresponding to crossing planes parallel to the meridian. The time between nulls is given by time signals obtained from either WWV in Washington or CHU in Canada. The Brush recorder makes an instantaneous written record of the time signals and satellite radio signals. Each channel of the recorder has two pens, one for recording the time marks and the other for recording satellite data. The data records are accurate to 0.1 seconds.

The Cleveland station can hear satellite launching efforts about four minutes after blast-off and can determine within two hours afterward whether the artificial moon has gone into orbit. The four-minute delay exists since the Cleveland horizon is 125 miles above ground at Cape Canaveral.

• **Receiving system**—The interferometer design of the Cleveland station is a slight variation of the Navy's Minitrack design. The Sohio station is unique as compared to other amateur stations because the Sohio group combines two interferometers on one receiver to resolve ambiguity of the null point at the meridian. The tracking apparatus consists of antennas, a hybrid junction, a converter, a communications receiver, time-marker circuit, direct writing oscillograph and a tape recorder. Band width of the receiver is 500 to 1000 cps.

• **Antennas**—In the original interferometer design suggested by the Navy, two receivers were operated off one antenna 180° out of phase. This design was proposed to eliminate anticipated noise interference. The satellite, however, puts out such a strong signal that this type of setup is not required. Instead, two antennas are connected to one receiver.

Another variation from the Navy design is the use of Yagi antenna arrays instead of dipoles and screen reflectors. Because of the generally low altitude of the satellites at this station and because most American satellites travel south of this station, the Yagi directional antennas are used.

A steerable antenna, the latest addition to the tracking station, is used to pick up signals too weak to be detected by the interferometer.

It can scan the entire horizon in 30 seconds and receive signals 250,000 miles away—20,000 miles beyond the moon.

The interferometer antennas are situated on a true east-west line. The center of the lobe pattern (meridian) is directed to follow the north-south meridian line exactly. This orientation permits accurate detection of the meridian line passage of the satellite.

• **Density variation**—Although the antennas of the interferometer are accurately aligned with the sun, a consistent error of .03 degrees is observed at 108 mc. Error is detected by comparing data recorded at Sohio with data made available from the Naval Research Laboratory. The error is apparently caused by the electronic density of the ionosphere. Study of data obtained over a long period can reveal information on densities, refraction, and variance with many more possibilities existing.

Electronic density variations are part of the study made by the University of Illinois on the ionosphere. In conjunction with this study the Sohio center is sending all data recorded from *Sputnik III* to the university. By studying the data collected from various stations and applying methods of triangulation, the university is carefully calculating density patterns of the ionosphere.

Data Obtained

Successive meridian passage times give more than just the orbit period of a satellite. The interval between passes and the change in interval during a succession of passes are clues to the position of the perigee point and its rate of shift in the orbit plane. The slow pivoting of the orbit plane as a whole about the earth's axis also contributes to this change in interval.

The dimensions of the orbit as well as the linear and angular velocities of the satellite follow from the orbit period and eccentricity. Eventually, it is hoped to combine the peak spacing in the oscillograph trace with a calibration of the antenna to show the inclination of the orbit to the meridian and to the horizontal at each passage.

Meridian passage time—Meridian passage time can be placed to within 0.1 second of passage by locating the center of the lobe pattern as shown on the oscillographic chart.

Period—By referring to the time the satellite passes the meridian on a number of occasions, subtracting the time interval for the rotation of the earth and correcting for other factors, the period for one complete orbit about the earth is accurately established.

INSIDE A

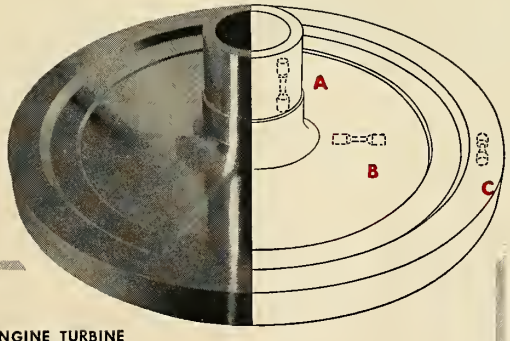
CAMERON FORGING

Unique Metallurgical Properties

AMS-6407 LANDING GEAR COMPONENT MUST WITHSTAND UNUSUAL STRESSES.

Typical Properties

		Tensile Strength	Yield Strength	Elongation	Reduction of Area Transverse
A	Tube, Tronsverse	236,000	203,000	12.7%	45.1%
B	Fork, Tronsverse	233,000	205,000	10.6%	31.9%



A-286 JET ENGINE TURBINE WHEEL OF SPECIAL ALLOY MEETS UNUSUAL DEMANDS.

Typical Properties

		Tensile Strength	Yield Strength .2% Offset	Elongation	Reduction of Area
A	Hub, Longitudinol	158,000	117,000	22.2%	40.0%
B	Web, Rodiol	159,000	116,000	21.3%	40.0%
C	Rim, Tongentiol	162,000	117,000	20.3%	39.7%

UNIFORMLY FINE GRAIN SIZE and uniformly high properties from center to surface are characteristic of the Cameron technique. Intricate, unusual, or conventional shapes are produced in a single heat.

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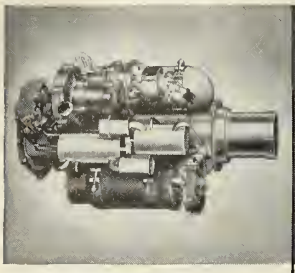
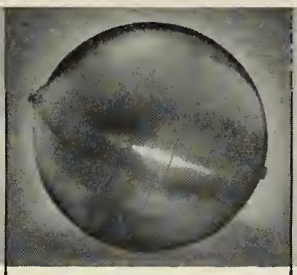
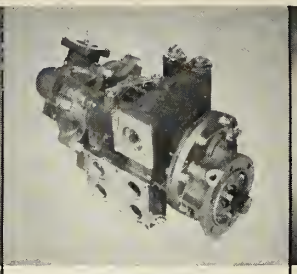


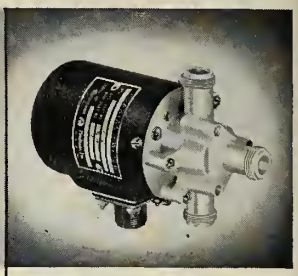
Solid-propellant auxiliary power unit



Titanium missile pressure vessel



Combination main and after-burner fuel pump



Coaxial switch

100 MILLION JET ENGINE BLADES
1.1 MILLION AIRCRAFT AND MISSILE FUEL PUMPS
APU'S FOR 6 DIFFERENT MISSILES

TAPCO GROUP

These are some of the products of the Tapco Group of Thompson Ramo Wooldridge Inc. With $150,000,000 of high-efficiency production facilities, Tapco is one of the nation's leaders in the development and manufacture of mechanical systems, equipment, and components that must meet stringent performance specifications under extreme conditions of temperature, corrosion, and stress.

Through its metallurgical and chemical laboratories, Tapco continually extends its capabilities in the technology of high-temperature alloys, powder metallurgy, cermets, ceramics, and other materials. Tapco was one of the principal pioneers in the fabrication of titanium, and is currently engaged, in cooperation with E. I. du Pont de Nemours & Co., in the development of manufacturing techniques to handle niobium and its alloys.

In product design and development, Tapco's 500-man engineering team is experienced in a wide range of specialties, including hydraulics, aerodynamics, electronics, pneumatics, thermodynamics, and nucleonics.

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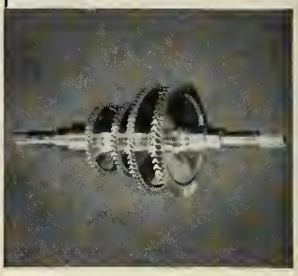

Four-stage turbine wheel

100,000 rpm turbine-driven alternator

Missile gyro ground test unit

Jet engine case assembly

Thompson Ramo Wooldridge Inc.

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Angular velocity—The satellite's angular velocity through the center of the lobe pattern can be used to derive orbit characteristics when repeated measurements from succcessive passes are available. Angular velocity is read directly from the oscillographic chart.

Rotation modulation frequency—When the symmetry of the satellite antenna pattern is known and subsequent charts are compared, information relating to rotation rate changes is obtained. Dips observed in the charts are caused by rotation of the satellite. The signal frequency is modulated as the satellite rotates and the antennas cycle.

Orbit characteristics—To obtain orbit characteristics comparison is made between observed intervals and calculated intervals between successive meridian passages.

• **Moonrocket signals**—Attesting to the effectiveness of signals recorded at the Sohio tracking station is the record of distinct signals sent out by the Russian moonrocket. The signal was picked up in Cleveland on three different occasions.

The Russian *Lunik* was missed almost completely by tracking stations across the country. Jodrell Bank in Manchester, England, with the largest radio telescope in the world, failed to pick up the rocket's signals.

Signals from the moonshot were picked up, however, at the Sohio station by a 24-foot dipole antenna.

The signal reported by the Cleveland station was confirmed by Air Force intelligence as coinciding with reports on the frequency of the space vehicle's signal. This included number of components in the keyed signal, duration of the signal and time between pulsed transmissions. Pulses had an average duration of 1.6 seconds and occurred every 10 seconds.

The first and third occasions on which the signals were recorded were by reflection from the ionosphere. The other was picked up directly. Duration of the signals recorded was approximately two hours.

Announcement of the moonshot was made at 5:00 PM Friday, January 2. Signals were first picked by Sohio at 7:30 PM the same day and were recorded for two hours. They reappeared at 3:30 AM Saturday and lasted until 5:00 AM. The last time the signal was picked up was from 8 to 9:30 PM Saturday.

Four frequencies were transmitted from the moonshot, 19.993, 19.995, 19.997 and 183.6 mc. The 183.6 mc signal was transmitted from the second stage of the rocket. This stage was dropped before any signal could be picked up on that frequency.

Paraffin Wax May Be Better for Shielding

Researchers feel hydrogen atoms in wax could absorb more neutrons than plastics

by W. C. Parle and A. M. Erskine

Paraffin-lead shielding will have important use in future space vehicles, particularly for biological shielding and protecting instrument packages against gamma rays and neutrons.

This article by W. C. Parle, technical director of California Ink Company, Inc., Berkeley, Calif., and Dr. A. M. Erskine, the firm's research consultant, discusses a new approach to the combined use of sheet lead and paraffin wax. The material is being used in a portable research reactor at Atomics International, Canoga Park, Calif.

BERKELEY, CALIF.—Sheet lead and paraffin wax in slab form have long been used as shielding materials for absorption of gamma rays and neutrons, respectively. Now the Radiation Laboratory of the University of California, assisted by The California Ink Company, has worked out a new method to combine use of the two materials by uniform dispersion of very finely powdered lead in wax with close tolerances as to density and uniformity of composition.

• **The problem analyzed**—At first it was thought that the lead-wax composition could be manufactured in the form of granules. But consideration of the desired final composition indicated that the problem was actually one of dispersion, analogous in principle to the dispersion of a pigment in a vehicle.

The lead powder, if sufficiently finely divided, would function as a pigment, and the wax in the melted condition would behave as the dispersing medium or vehicle. Because of the wide difference in density between the two components, leading to rapid settling of the lead phase on discontinuing agitation or standing in molds before solidification, it became essential to find some means of appreciably increasing the viscosity of the wax just above its melting point.

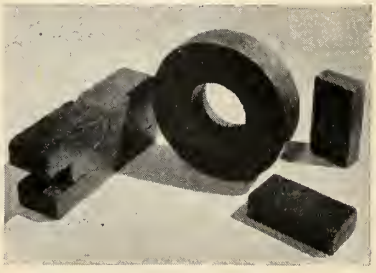
It was also desired to manufacture the product in two general forms: one involved pouring the fluid dispersion into containers of various intricate shapes, in which the suspension would solidify on cooling and completely fill the containers with a composition of uniform density; the other form was bricks or large blocks of various sizes having small tolerances in dimensions and readily adaptable to built-up structures.

• **Process development**—There was an extensive laboratory search for additives which in very small amounts would increase the viscosity of the melted wax at a temperature a few degrees above its melting point. This was complicated because the additive could not contain significant quantities of elements which could give undesirable nuclear reactions with gamma radiations or neutrons.

Investigations were also made of types of equipment in which efficient dispersion could be carried out in batches of at least a ton. Other requirements included capability of the dispersion equipment to pour the mixture into molds, close temperature control, etc.

It proved to be relatively easy to manufacture bricks, as well as large blocks, by pouring the suspension into wooden molds, and removing the side walls after solidification.

• **Raw materials**—The lead powder used in this process met rigid specifications of purity and fineness. The purity was controlled basically by requiring that the powder be manufactured from corroding, chemical, or desilvered commercial pig lead. In addition, the maximum permissible percentage of arsenic, antimony or tin was very small (of the order of a few parts per million) and oxygen contamination was kept below a few parts per thousand by weight. The fineness of the lead was specified by a screen analysis, which included at least 30% passing through a 325-mesh screen (44 microns).



REPRESENTATIVE lead wax forms.

The paraffin wax was covered by Federal specifications including a minimum melting point of 160°F. The oxygen specification was the same as that applied to the lead.

• **Physical properties**—The weight ratio of lead to wax (84/16) used in the composition met the specification of a density of 4.0 or 250 lbs./cu. ft. (plus or minus 5%) in the final product. A major problem was to maintain this uniformity of density throughout the large masses which were cast. Obviously, air inclusions had to be prevented completely.

Although gamma ray shielding depends solely on the dense lead present in the mixture, the density of the composition as a whole was brought into a range which permitted relatively easy handling.

Other properties of interest shown by the lead-wax product were: tensile strength 200-250 lbs. per square inch, shear 213 lbs. per square inch, elongation 0.6% and compression 30 lbs. per square inch at 90°F.

• **Shielding effects**—Tests of the lead-wax product for effectiveness in shielding against gamma rays have shown an attenuation coefficient of 0.567 for gamma rays with energy of 1.28 Mev (million electron volts) produced by sodium-22 isotope source. (See S. Glasstone, "Principles of Nuclear Reactor Engineering," page 75, equation 2.60.3). This shielding power may also be expressed as a "mean free path for gamma radiation protection" of 10.2 cm. (4 inches).

Corresponding tests for shielding against neutrons gave an attenuation coefficient of 0.147 for fast neutrons with energy of 2 to 4 Mev from a plutonium-beryllium source. Expressed in terms of "mean free path for fast neutron protection" the value of 10.2 cm.—same as above—was obtained.

Since neutron absorption depends entirely upon the hydrogen atoms in the wax, the use of paraffin wax offers an advantage over plastics, such as polyethylene, because of its higher hydrogen content.

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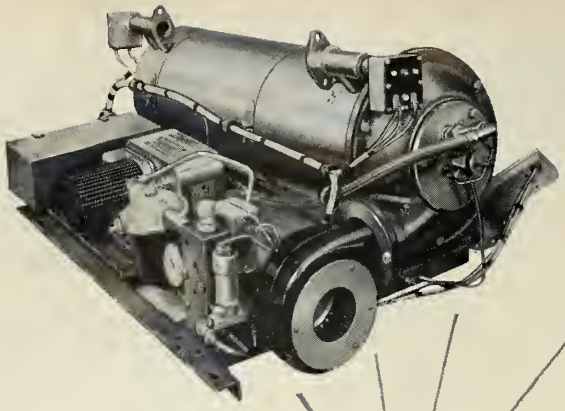

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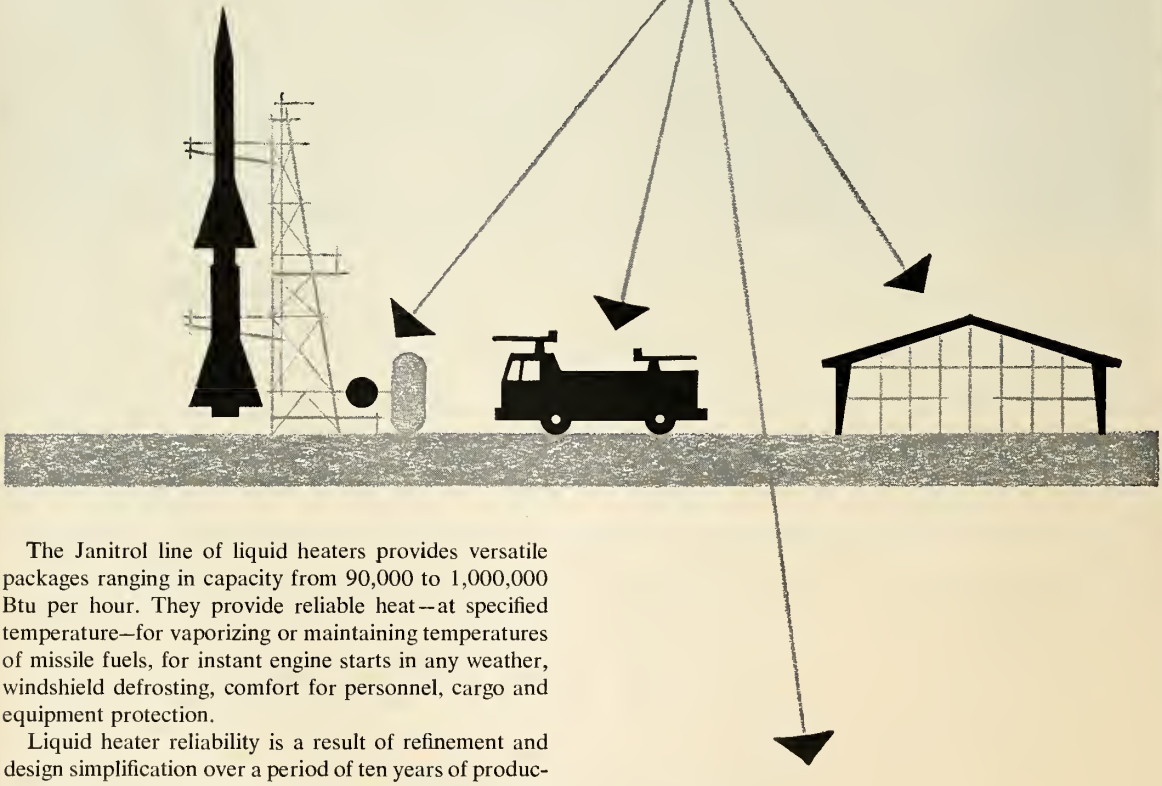

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Janitrol Aircraft Division, Surface Combustion Corp., Columbus 16, Ohio.

Spraying Technique May Cut Radome Cost

Gladding, McBean process aims at doing away with precision grinding. Company has tool-up contract for *Sparrow III* radome and sees great potential for future.

by Richard Van Osten

LOS ANGELES—The high cost of ceramic radomes for missiles may be reduced by a new technique developed by Gladding, McBean & Co., 84-year-old ceramic firm.

First application will be a radome for the *Sparrow III* air-to-air missile. A contract for a tool-up phase has been awarded to GMB by Raytheon, *Sparrow III* prime contractor. Dollar value and number of units to be produced have not been disclosed.

Prime target of the new process was elimination of expensive and time-consuming precision grinding steps, which are suitable for one-of-a-kind or very low production runs, but completely unsuitable for high production.

To meet military specifications on shrinkage, shape, tolerances and electrical uniformity, GMB chose alumina —either 97% or 99% pure, depending upon ultimate use of the radome.

• **Slurry spraying**—First step is the spraying of the high-purity slurry over a special steel mandrel. Mandrel dimensions allow for dimensional tolerances, but the spraying operation is the main key to final success.

The slurry must be sprayed at a pressure high enough for maximum particle packing. It also must be of the proper viscosity to pass through a specially-designed spray gun and atomized to partly dry during buildup.

To accomplish this, alumina is mixed with an organic binder that is soluble in a volatile liquid. The latter remains "tacky" upon contact with the preform and with itself, yet does not soften or deform. The binder is removed during preliminary firing, leaving a final body of either 97% or 99% pure alumina as required.

• **Pressure and firing**—After the slurry has dried on the preform mandrel, the entire assembly is enclosed in a neoprene bag and placed in a reactor where it is subjected to pressure of over 30,000 psi. This achieves a uniform density over the entire radome surface. The radome is then stripped from the mandrel and sent through a preliminary firing at about 2000°F.

• **Machining and firing**—Next step is to machine the radome to the final wall thickness and aerodynamic configuration—with a low-cost process developed by GMB for making joints in sewer pipe!

This machine step allows also for the calculated shrinkage that occurs in final firing. Last phase is the firing in a regenerative kiln at a temperature of over 3000°F.

Much of the procedure is not really new, except to the ceramic industry. Basic development was accomplished under a $215,000 contract from AMC's Aeronautical Systems Center, WADC. Contract calls for two study phases and delivery of other (not *Sparrow III*) radomes to WADC.

• **Great potential**—The process applies to fabrication of other ceramic items of high-purity oxides, and is believed to have much future potential. Time and cost figures are only calculated, but the technique is said to be cheaper than Fiberglas layup methods on a size-for-size, shape-for-shape basis.

It also offers the ability to mass-produce ceramic radomes with wall thicknesses of 0.05 in. with tolerances of ±0.001 in., an important factor in obtaining constant dielectric characteristics throughout the structure.

• **Varied products**—The Raytheon and WADC contracts mark GMB's first major step into the missile field, although it has produced alumina connector insulators used in missile umbilical cords and in ignition systems subject to high pressure and temperature.

The company has also produced ceramic antenna "windows" for missile and aircraft radar use; ceramic printed circuit boards with a unique plating process; zirconia rocket nozzles; diode holders; solar furnace parts, and ceramic suspension mounts for liquid oxygen containers in liquid propellant engines. GMB is also engaged in classified studies involving nuclear reactor cores and shielding. Certain of these areas involve ceramic laminates in combination with epoxy plastics and foamed ceramic sandwiches.

In R&D studies, sponsored mainly with company funds, GMB has investigated control of electrical characteristics in relation to porosity of ceramics; the use of glass fibers to prestress ceramics; and the addition of metal fibers to increase conductivity.

STEEL MANDREL is sprayed with solution containing 97-99% alumina.

PRESSURE IN reactor assures uniform density over entire surface.

TECHNICIAN PLACES radome in bottom of the kiln preparatory to firing.

AMERICAN AVIATION PUBLICATIONS ANNOUNCES

airlift

the magazine of world air transportation

Beginning in April, AMERICAN AVIATION Magazine becomes ***airlift***—the monthly magazine serving the world air transportation market. This is not only a change in title but an updating of editorial concept brought about by the evolution within the air age itself. ***airlift*** is edited for the worldwide commercial, military and corporate Air Transportation Industry. Feature articles are designed to interpret trends and developments. They highlight new products and equipment, operations, maintenance, communications, and engineering. ***airlift*** offers editorial coverage of *all* phases of the market concerned with transportation of people and goods by air.

Airlift—a Multi-Billion Dollar Market. With 25,000 circulation, ***airlift*** reaches men in management, engineering, operations, maintenance, overhaul and purchasing, in *all* segments of the Air Transportation market. This includes both domestic and international air carriers, supplemental and all-cargo carriers, military transport and logistics, airways and navigational facilities. Also business aircraft, terminal airports, helicopters and fixed base operators.

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missile business

by Reed Bundy

Missile and rocket stocks have been pushing the New York stock market to all-time highs recently, with Thiokol Chemical providing much of the impetus. The exchange set successive new records on March 2, 4, 5 and 9. During this period, Thiokol's gains ranged at times as high as 12 points, although profit-taking took some of the wind at times. Other stocks that rang up heavy gains at one stage or another included General Tire, American Potash, Zenith, RCA, Raytheon, Texas Instruments, Litton, I.T.T. and Hoffman.

Some experts called it a "buy now, pay later" push resulting from big contract awards *(Minuteman)* to Thiokol and Aerojet-General (a General Tire subsidiary) and the general lift in missile-space business.

Some of the most spectacular missile-space growth is reported in Florida, where electronics companies alone have 15,000 employees, an annual payroll of $60,000,000 and a gross annual product figured conservatively at $180,000,000, according to the Florida Development Commission. The commission emphasized that these figures do not include Cape Canaveral or Eglin Gulf Test Range—only private manufacturing activity. Its new directory lists some 221 companies "engaged in manufacturing and research related to electronics, aircraft, missiles and scientific instruments."

The Armed Services have reported to Congress that they are stepping up use of incentive contracts to hold down "spiraling costs" of Defense contracts. In separate reports to the Senate Appropriations Committee:

The Air Force said constant requirements for technically superior weapons caused by "competitive technological advances" keep pushing prices higher. It said it is concentrating on incentive-type contracts and such other steps as tighter monitoring of contractors' overhead, closer surveillance of subcontracting activities and research, and greater standardization.

The Army said it was applying similar checks, seeking competitive bids wherever possible and, in missile procurement, using the "breakout" technique. Under this program, as components are developed to the stage where drawings and specifications are available, they are broken out from the prime contract, procured by the government on a competitive basis, and furnished to the subcontractor.

The Navy reported it too was applying closer checks and surveillance and putting greater emphasis on profit incentives. "Implicit in the rewarding of contractors with incentive payments is the assumption of greater risks by them," the Navy said.

Fairchild Engine & Airplane Corp. is closing its Engine Division at Deer Park, L.I., and will sell the plant with the exception of the Gas Turbine and Research Laboratories. J. H. Carmichael, company president, said the move resulted from cancellation of the J83 engine program by the Air Force and because of serious financial losses experienced by the company last year.

Some 160 of the remaining 625 employees at the Engine Division will be retained for a short time.

A "tithe for science" bill has been introduced by Rep. Overton Brooks (D-La.), chairman of the House Space Committee. He said the bill will provide that whenever a contract of $10,000 or more for research and scientific investigation is awarded, 10% of the value of the contract shall be set aside for scientific research programs. He said this would give basic research a badly needed shot in the arm.

More acquisitions have been reported as firms move more heavily into missiles and its allied fields. To mention a few: Northrop Corp. is proposing to acquire Page Communications Engineers, Inc., of Washington, D.C., for 95,000 shares of its common stock. The deal is pending before the California Corporations Commission but is expected to be completed in a few more weeks. Meantime, Northrop has approved a $4,000,000 expenditure for a new R&D building for its Nortronics Division . . . Bendix Aviation has entered into an agreement to acquire, for an undisclosed amount, the business and substantially all the property and assets of M. C. Jones Electronics Co., of Bristol, Conn. . . . Turbo Dynamics Corp., of Los Angeles, has acquired 30% of the common stock of National Research Associates, Inc., College Park, Md., and 50% of the common stock of Iresco, Inc., of Santa Monica.

propulsion engineering

Key to cheaper boron fuels: recycle the reactants; end the need to collect, purify, or discard unreacted starting materials. This seems to be the reason Stauffer-Aerojet feels confident its new process will greatly undercut Callery and Olin Mathieson, pricewise. Stauffer-Aerojet will use the new process in its Sacramento, Calif., plant announced in January.

Beryllium fuels will not have Congressional sympathy this year. Some research sponsored by Government agencies will help beryllium pushers, but the biggest aid is not forthcoming—there will be no rapid amortization of equipment needed for development work. A House Ways and Means Committee insider puts it this way: "Fast tax write-offs are out of fashion." Even industries already engaged in proven defense production will find rapid amortization blessings from the 86th Congress very few and far between, he says. Thus, he offers no encouragement to companies ready to invest in equipment and tooling for exotic fuels and materials yet to be proved.

Ozone will be cheaper, more plentiful as soon as a new National Bureau of Standards process goes commercial. The Bureau is almost ready to talk about the process, reveals this much in advance: it goes at a low temperature, the key is a microwave discharge. Bureau of Standards practically never discusses commercial possibilities of its developments, but one scientist says: "The industry boys will be happy with this one."

Demand for oxygen at the turn of the year was steady enough to keep suppliers busy and reassure them on the business success of new plants underway. The Department of Commerce says industrial gases made a good come-back from the early 1958 recession. "Some surplus capacity" is the story in almost every section of the country, but new government projects and an increased steel industry need will swallow this before the year is over. This is why industrial gas leaders can smile when they talk about their new facilities coming on stream this year and early next.

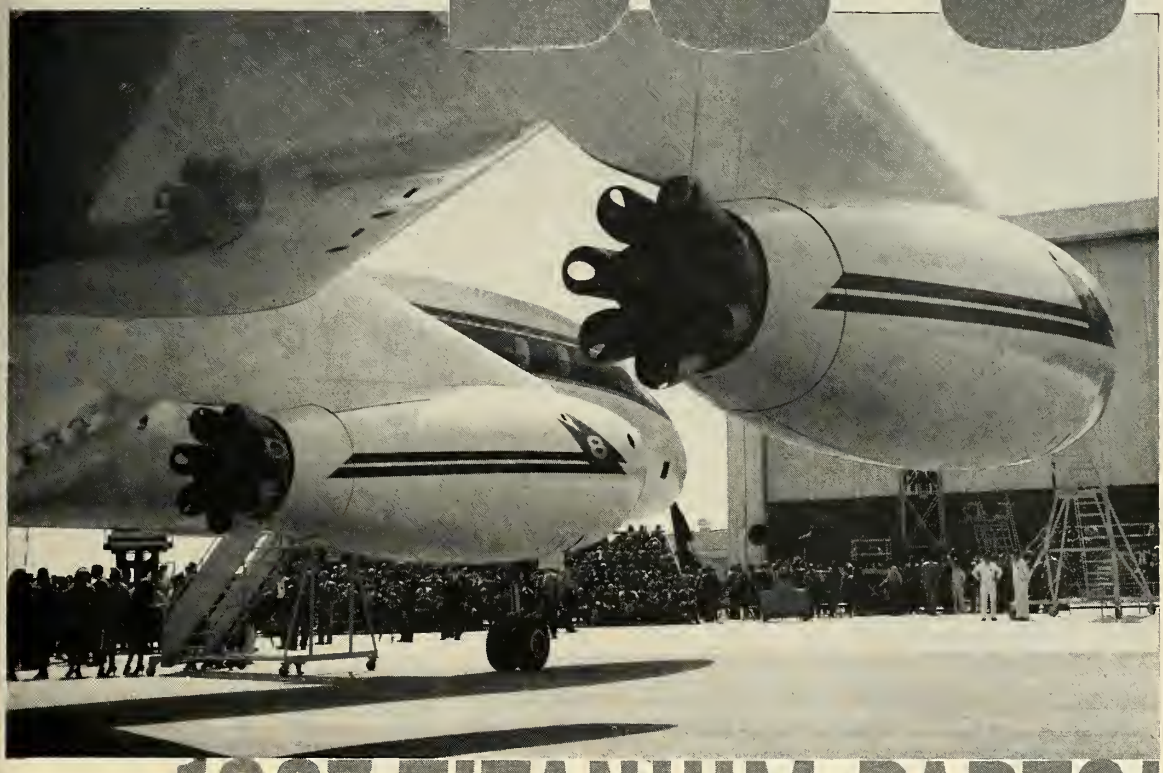
Most talked-about new oxygen plant is Union Carbide's 100 million cubic feet/month facility due early in '60 near Huntsville. Carbide is assuring a bright and long future for its Linde Division operation by looking beyond the government and missiles for its market. Besides missile business around Huntsville, the heavy steel-aircraft-chemical complex between Birmingham and Chattanooga assures Linde a good market, makes steady, high-volume output economical and thus guarantees missilemen a good on-the-scene supply.

A new gelling agent expected to find a use in solid fuels is available from American Cyanamid. Cyanogum-41 converts thin solutions to stiff gels either instantly or at a predetermined later time, depending on the catalyst system and temperature. Add the catalyst just after white Cyanogum-41 powder is added, and many electrolyte solutions immediately take on solid properties. Add the catalyst later, and control the temperature between 26 and 185°F, and the solution gels within 10% of a preset time, up to 24 hours later. Alter the catalyst, the company reports, and the new product will also gel ethylene glycol, glycerine, sulfuric acid and other solutions which to Cyanamid means a "use for Cyanogum-41 in solid fuels."

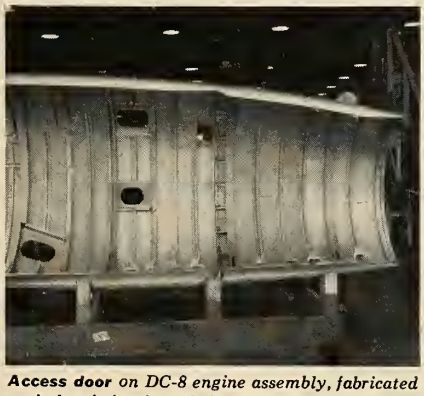
Plastic piping is getting wider use around chemical plants and some missile facilities. Du Pont's Harvey E. Atkinson told the national meeting of the American Institute of Chemical Engineers that polyvinyl chloride (PVC) Type I is working out best for handling corrosives at low and medium temperatures—from 0 to 150°F. He cited cases where PVC is replacing rubber-lined steel pipe for handling acids. An example: $20,000 saved in an operation involving 5000 feet of pipe.

For improved strength / weight in the...

DC-8



1667 TITANIUM PARTS!



Access door *on DC-8 engine assembly, fabricated entirely of titanium. Skin is .016" thick, ribs and longerons are .032" thick.*

Access doors on engine assemblies, pylon skirts, and hundreds of other structural parts on the Douglas DC-8 are fabricated from high strength, light weight, corrosion resistant titanium.

Mallory-Sharon service engineers have worked closely with Ryan Aeronautical Company engineers—a major supplier of parts and components for the DC-8. New high strength titanium alloys, improved methods of machining and forming, have been developed and employed. The result has been increasingly wide application of titanium's weight-saving advantages—*up to 57%* over stainless steel in many cases.

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contract awards

AIR FORCE

$85,000,000—**Aerojet-General Corp.,** for R&D on the *Minuteman* program.

$77,000,000—**Thiokol Chemical Corp.,** for R&D on the *Minuteman* program.

$3,678,000—**Sperry Phoenix Co., div. of Sperry Rand Corp.,** for remote guidance and control systems for pilotless jet planes.

$776,625—**Tele-Dynamics, Inc.,** Philadelphia, for telemetric data transmitting sets, major components (black boxes), spare parts, test equipment and data for QF-80 drones.

$568,470—**Lewyt Manufacturing Co.,** Long Island, N.Y., for coordinate data monitor.

$410,371—**United States Steel Corp.,** for stainless steel sandwich rolling program.

$200,000—**Epsco-West,** Anaheim, Calif., Div., for switch timing and monitoring systems for *Atlas* program at Vandenberg AFB (sub-contract from Convair).

$193,839—**Northrop Aircraft, Inc.,** for development and design of improved methods for production of high-strength, lighter weight aluminum and magnesium castings using permanent molds and centrifugal force techniques.

$151,072—**Gilfillan Bros., Inc.,** for modification kits to make spare units compatible with modified radar sets.

$103,951—**New York University,** for studies of electromagnetic theory stressing problems in waveguiding, radiation and diffraction.

$99,193—**Bendix Aviation Corp.,** Pacific Div., for telemetry system used in support of missile test track project WS-133A.

(**Horkey-Moore Associates,** Torrance, Calif., reecived a subcontract from Convair for additional force ejection launchers for *Genie* missiles on F-106 interceptors; **United Control Corp.,** Seattle, was awarded a Convair sub-contract for accelerated engineering and development of equipment to be installed on *Atlas* missiles. Dollar amounts of these awards were not announced.)

ARMY

$2,733,000—**Winger Construction Co., Inc.,** Ottumwa, Iowa, for furnishing and installation of propellant loading system skids at Offutt AFB and Warren AFB.

$2,500,000—**General Instrument Corp.,** Brooklyn, N.Y., for miniaturized air-borne radar "beacons" for target-spotting drones.

$1,010,720—**Western Electric Co., Inc.,** for *Nike* spare parts and components.

$794,285—**Robert J. Genofile, Inc.,** Montrose, Calif., for construction of shops, guard house and weather facility at Vandenberg AFB.

$785,598—**Radio Corporation of America,** for electron tubes (three contracts).

$659,480—**Gordon Fields, Builders,** San Bernardino, Calif., for construction of data acquisition building at Vandenberg AFB.

$402,596—**Sperry Gyroscope Co.,** for additional klystron development models and man-hours of work on broad-banding of high-power C-band klystron amplifiers.

$149,535—**Eitel McCullough, Inc.,** San Carlos, Calif., for electron tubes (two contracts).

NAVY

$51,900,000—**Sperry Gyroscope Co.,** for missile-guidance radars on *Terrier*-equipped ships.

$5,500,000—**National Company, Inc.,** Malden, Mass., for "no drift" radio receivers.

$137,487—**Cutler Metal Products Co.,** Camden, N.J., for shipping containers for major missile section.

when and where

MARCH

The American Rocket Society, National Capital Section, luncheon sponsored by m/r. Speaker is Richard E. Horner, Assistant Secretary of the Air Force (R&D). National Press Club, Washington, D.C., March 19.

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

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

Institute of Radio Engineers, National Convention, Coliseum and Waldorf-Astoria Hotel, New York, March 23-26.

Society of the Plastics Industry, 16th Annual Conference, Pacific Coast Section, Hotel del Coronado, San Diego, March 25-27.

American Society of Mechanical Engineers, Instruments and Regulators Division Conference, Cleveland, March 29-Apr. 2.

Society of Automotive Engineers, National Aeronautic Meeting, Hotel Commodore, New York, March 31-Apr. 3.

APRIL

Conference on Electrically Exploded Wires, sponsored by the Thermal Radiation Laboratory of the Geophysics Research Directorate of the Air Force Cambridge Research Center, Somerset Hotel, Boston, Apr. 2-3.

American Society for Quality Control, Portland Chapter, Oregon Museum of Science and Industry, Portland, Apr. 3-4.

1959 Nuclear Congress, Municipal Auditorium, Cleveland. For information: Engineers Joint Council, 29 West 39th St., New York, Apr. 5-10.

American Welding Society, 1959 Welding Show and 40th Annual Convention, International Amphitheatre and Hotel Sherman, Chicago, Apr. 7-10.

Air Force Association, World Congress of Flight, Las Vegas, Nev., Apr. 12-19.

Aeronautical Training Society, 17th Annual Meeting, Las Vegas, Apr. 16-17.

American Society of Tool Engineers, Annual Meeting, Schroeder Hotel, Milwaukee, Apr. 18-22.

American Rocket Society, Man-in-Space Conference, Hotel Chamberlain, Hampton, Va., Apri. 20-22.

Institute of Radio Engineers, Spring Technical Conference on Electronic Data Processing, Cincinnati Section, Engineering Society Bldg., Cincinnati, Apr. 21-22.

Institute of Environmental Engineers, 1959 Annual Meeting, La Salle Hotel, Chicago, Apr. 22-24.

American Rocket Society, Controllable Satellite Conference, Massachusetts Institute of Technology, Cambridge, Apr. 30-May 1.

MAY

Institute of Radio Engineers, 11th National Aeronautical Electronics Conference, Dayton, Ohio, May 4-6.

Instrument Society of America, 5th National Instrumentation Flight Test Symposium, Seattle, May 4-7.

International Scientific Radio Union, Spring Meeting, Willard Hotel, Washington, D.C., May 5-7.

1959 Electronic Components Conference, Benjamin Franklin Hotel, Philadelphia, May 6-8.

Aviation Writers Association, 21st Annual Meeting and News Conference, Washington and Willard Hotels, Washington, D.C., May 10-16.

Armed Forces Day, Observances scheduled throughout week of May 9-17.

The Society for Experimental Stress Analysis, 1959 National Spring Meeting, Sheraton Park Hotel, Washington, D.C., May 20-22.

Institution of Electrical Engineers, The Radio and Telecommunication Section, Earl's Court, London, England, May 21-27.

American Rocket Society, Institute of the Aeronautical Sciences, American Institute of Electrical Engineers and the Instrument Society of America, Brown Palace and Cosmopolitan Hotel, Denver, May 25-27.

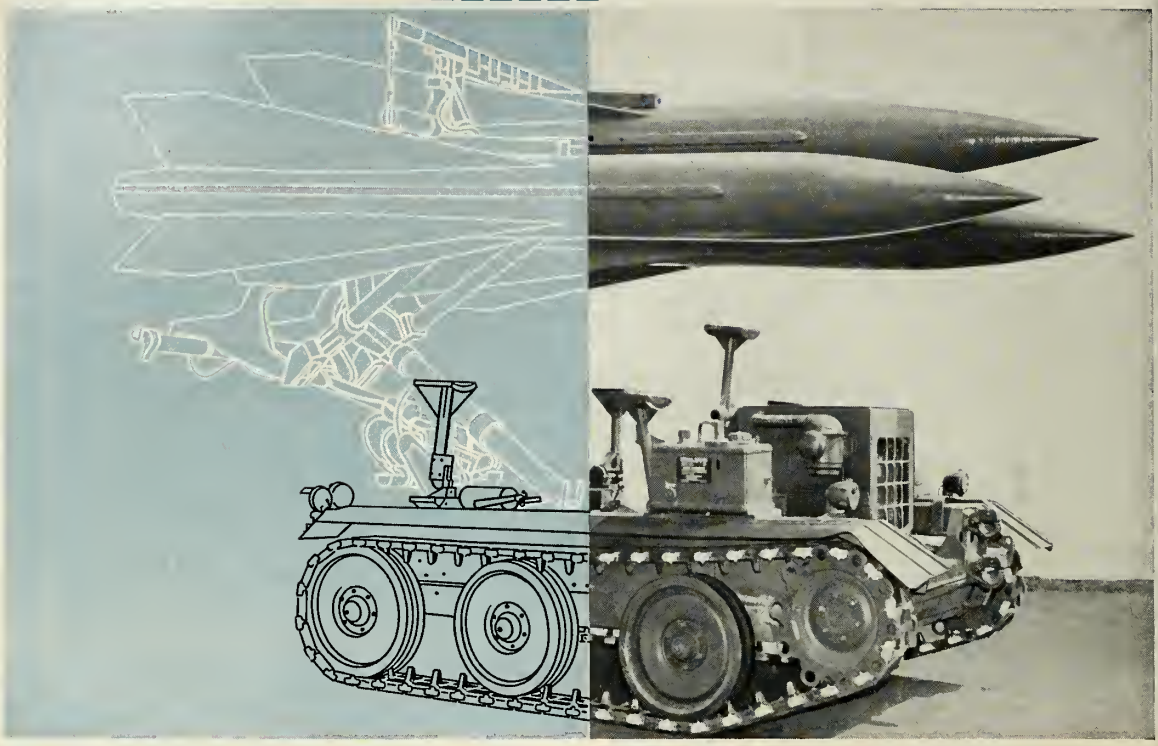
Federation Aeronautique Internationale, Annual Conference, Moscow, May 28-31.

JUNE

American Rocket Society, Semiannual Meeting, San Diego, June 8-11.

...speaking of

Missile Ground Support **MOBILITY**



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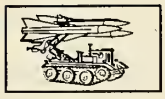
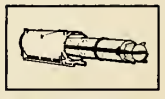


Transporter-Looders

Launcher-Erectors & Power Units



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Ordnance Division

Missile Equipment Section 1-B

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Here is AOMC's *Jupiter* Contract Breakdown

WASHINGTON—More than two-hundred contractors had a part in producing the modified *Jupiter* IRBM used to send *Pioneer IV* into orbit around the sun.

According to a fact sheet released by the Army Ordnance Missile Command at Redstone Arsenal, Chrysler, the prime *Jupiter* contractor, furnished engineering services and some hardware, although the booster was fabricated by ABMA at Huntsville.

Major *Jupiter* subcontractors are Ford Instrument Co., guidance and control; and Rocketdyne Div., North American Aviation, propulsion. For this project, Reynolds Metals Co. built the shell of the rotational launcher.

Other contractors:

Adel Precision Products Corp., check values for high pressure air supply, air bearing system and fuel system; Aeronutronic Systems Inc., research on high precision orbit determination; AFR Products, Inc., meter and tuning unit; Aircraft Porous Media Co., filter for hydraulic control system in rocket engine; filter for cooling system; Airesearch Mfg., absolute pressure regulator, in instrument compartment; Allen Mfg. Co., cap screw for rotational launcher assembly; Alto Scientific Co., tuner; American Lava Corp., heater core for air bearing system.

Ampex Corp., recorder and magnetic tape recorders for testing booster components and overall missile flight checkout; Anadite, Inc., conduit, fuel and vent pipes; Apor Heating Corp., thermostats for temperature control coding system; Armstrong Products Co., cement for destructor and adapter assembly; Baldwin-Lima-Hamilton Corp., measuring systems for loads, cells and thrust in testing operations; Beckman Instruments, Inc., frequency meter; Beckman and Whitley, Inc., arming unit in destructor and adapter assembly.

Bendix Aviation Corp., Los Angeles, gas reaction controller; Bendix Aviation Corp., Detroit, reaction controller and rotation machinery; Bendix Filter Division, Madison Heights, Mich., hydraulic filters for control actuators; Bendix Aviation Corp., Utica, N.Y., high pressure spheres, fiberglass containers for pressurizing systems; Benson Mfg. Co., fuel suction connector; Benton Valve Corp., valves for hydraulic and measuring systems; Bomac Labs, Inc., magnetron tube; Bomar Instrument Co., speed changer; Bournes Laboratories, Inc., variable precision resistors used in several electronics systems; D. S. Brown Rubber Co., rubber connection and seals for cluster assembly; Brown Engineering Co., bolts for large access door on aft section; tilt frames for guidance system.

Brush Electronics Co., oscillographs used to record results of flight dynamics study; Burroughs Corporation, computers used in developing data in several ABMA laboratories; Byron-Jackson Tools, Inc., cryogenic pumps, valves and trailers used in testing operation; Cadillac-Gage, air pendulum to level gyro stabilizer platform; Cambridge Corp., cryogenic tanks, pumps, valves and trailers used in testing; Camloc Fastener Corp., structural quarter-turn fasteners for access doors in aft section; Cannon Electric Co., plug for rocket engine modification; J. C. Carter Co., cryogenic pumps, valves and trailers for testing operations; Century Electronics & Instruments, Inc., pressure switches for propulsion system measurements and controls.

Cincinnati Testing and Research Laboratory, sealer for shroud coating; Cherry Burrell Corp., container tests for propulsion system; Chicago Pneumatic Tool Co., high pressure compressors; Chromalax, Inc., heating blanket; Chrysler Corp. Missile Division, quick-disconnect couplings for fuel and liquid oxygen systems; cables and valves in aft and tail sections; Chrysler Corp. Airtemp Division, air-conditioning; C. P. Clare and Co., selector switch to coordinate resolver computer in guidance and control system; Clevite Corp., recorder, oscillograph, and amplifier; Component Parts Co., check valve for fueling system; Communication Measurement Lab, frequency converter.

Consolidated Electrodynamics Corp., millisadic, recording oscillographs, transducers, oscillogram processors, D.C. power supplies, used for testing components and overall missile flight checkout; Cornelius Co., safety valves for air bearing system; Crane Co., cryogenic pumps, valves and trailers; high pressure valves and pipe fittings for testing operations; Cyril Bath, ring, channel and "Z" frames for support of missile's outer shell; Daven Co., attenuator; De Mornay Bonardi Corp., waveguide, mount, coupler, tee, mixer tunes, shorts, flange, stand and screws; Dow Chemical Co., insulators for tail and aft section; E. E. du Pont Co., booster and actuator used in missile's destruction apparatus; D. S. D. Manufacturing Co., toruseals for liquid oxygen system.

Eagle-Picher, batteries for power supply; Eastern Air Devices, Inc., alternator for spin launcher, a component of cluster speed control system; Edcliff Instrument Co., angle-of-attack instrument for control system; Elastic Stopnut Corp., machine nuts for LOX and fuel systems; floating anchor nuts for rotational launcher assembly and instrument compartment; Electro Data Division of Burroughs Corp., digital computers used for stability accuracy determination and analysis of flight dynamics of missile; Electromation Co., micro-miniaturization program device; Elgin National Watch Co., relay; Ensign-Bickford Co., prima cord for destructor and adaptor assembly and for separation of nose and aft sections.

Fairchild Control, potentiometers for velocity computer in guidance system; Fansteel Metalurgical Corp., rectifiers and capacitors for guidance system; Firestone Co. (West Coast Division), radio beacon for tracking of missile; air-bearing gyro for stabilized platform in guidance system; Fenwal Electronics, Inc., thermistor type temperature gages for guidance system; thermostats for air bearing system; Flexonics Corp., flexible hoses in instrument compartment; hoses for hydraulic, air and liquid oxygen in tail section; Flexitallic Gasket Co., toruseals for liquid oxygen and fuel systems; Ford Instrument Co., regulating system, program device and velocity computer in guidance and control assembly; Friden, Inc., transmitter-receiver; Fruehauf Trailer, 5,000-gallon trailer for fuel trans-

(Continued on page 48)

fer; Futurecraft Valve Corp., valves, rings and plugs for fuel system.

Garlock Packing Co., grease and air pressure seals for rotational launcher assembly; U.S. Gauge Co., manifold pressure gage for main valve box; General Electric Computer Center, operates part of Computation Laboratory, ABMA, where general development and trajectory computations were accomplished; General Electric, transistors and semiconductors for telemetry, transmitter and data equipment; GE, Fort Wayne, Ind., DC motor for spin launcher; General Motors Corp. (New Departure Division), ball bearings for rotational launcher assembly; General Radio Co., miscellaneous electronic components; G. M. Giannina and Co., pressure transducer to measure propulsion system pressures; accelerometers to measure longitudinal acceleration of the missile; Gilfillian Brothers, Inc., radio beacon for tracking of missile for flight instrumentation; Globe Industries, timer, DC motor and gear box assemblies used in upper stages of missile; electro-mechanical actuators for spatial attitude control system; Greer Hydraulic, Inc., hydraulic accumulators for *Jupiter* hydraulic system.

Handley Electronics Inc., variable precision resistors used in electronic control systems; Hammel-Dahl, high pressure valves and fittings used in testing operations; Hayes Aircraft Corp., flame shields used to protect booster and components; Heath Corp., Heathkits for flight simulation studies; Helipot Corp., potentiometers for velocity computer in guidance system; Heli Coil Corp., threaded inserts used at missile handling points; Tom Henkel, ring frames for support of outside skin; Henry Vogt Machine Co., Inc., high pressure valves and pipe fittings used in testing; Hufford Corp., knuckle, ring, channel and "Z" segments used to support outside skin and tank construction; Herrick L. Johnston, Inc., cryogenic tanks, pumps, valves and trailers; Hewlett Packard Co., counter and recorder, voltmeter and oscillator; Hoffman Electronics Corp., Evanston, Ill., transistors and semiconductors for missile attitude measuring adapters; Huck Mfg. Co., bolts and blind rivets for shroud and aft section assembly; Humphrey, Inc., potentiometers for *Jupiter* engine gimbal actuators; Hydraulic Research, servo valve for rocket engine modification; Hydromatics, Inc., liquid oxygen replenishing vent for transfer system; valve for cooling system in instrument compartment.

Industrial Tectronics, ball shaft assembly; Ingersoll-Rand Co., high pressure compressor for testing; International Business Machine Corp., supplier and servicer of computers and auxiliary equipment used in computing of data on the project; Joy Mfg. Co., blowers for cooling instrument compartment; Kerper Products Co., check valve for lube oil drain; Keystone Carbon Co., thermistor for instrument compartment cooling system; Kirkhill Rubber Co., rubber connection seals for nose cone connection; Kearfott Co., Inc., rate gyros and servo components and amplifier for guidance and control system; servo components used in flight simulation studies; Linair Corp., teenut for instrument compartment panel.

Linde Air Products Co., liquid oxygen and nitrogen; Leeds and Northrop Co., electronic strip-chart recorders used in testing; W. O. Leonard, Inc., regulators air flow; Lockheed Aircraft Corp., camera equipment; Lord Mfg. Co., shock mount in instrument compartment cooling system; Marotta Valve Corp., solenoid valve used in control of air flow; valves for propulsion system and instrument compartment; Magnetic Research Corp., magnetic amplifier for temperature measurements; Marman Products Co., Inc., clamps used in liquid oxygen and fuel systems, instrument compartment cooling system; Mark's Oxygen Co., Inc., liquid oxygen.

Melpar, Inc., transponder used in missile-borne radar tracking beacon; Metron Instrument Co., contractor for rotational launcher assembly; Micro Switch, limit switches for spatial attitude control system; Microswitch Division of Minneapolis-Honeywell, microswitch used in fuel transfer system; Microwave Associates, Inc., varactor diode; Midland Mfg. Co., frequency control components for tracking station built by ABMA; Minnesota Mining and Manufacturing, sealer coating for shroud; sealing compounds and insulation tape for aft section; Minneapolis-Honeywell, transistors for attitude measuring and control; Minneapolis-Honeywell Regulator Co., electronic recorder; Mooga Valve Co., Inc., linear actuators and valves for guidance and control system; Modern Industrial Plastics, seals and gaskets for liquid oxygen, hydraulic and oil system.

Motorola, Inc., telemeter antennae; flowmeter adapter for propulsion system; McKay Tool and Engineering Co., explosive bolts for nose cone separation; Neptune Meter Co., flow meter and seal for fuel transfer system; New York Air Brake, hydraulic pumps in several areas of missile and ground support equipment; Noble Norman, actuator and nozzle assembly for spatial control system; Norda Microwave, attenuator; North American Aviation, regulator and coupling on liquid oxygen and spatial attitude control systems; Omega Labs, Inc., termination and waveguide attenuator; On-Mark Couplings, couplings for fuel system.

R. H. Osbrink Mfg. Co., missile antennae; Owens-Corning Co., fiberglass for rocket engine modifications; Parker Aircraft Co., check valves for hydraulic system; Parker Appliance Co., restrictor check for hydraulic control system; reducers and elbows for pneumatic systems; Parker Hannifin Corp., fittings for liquid oxygen, fuel and pneumatic systems; Philbrick Corp., amplifiers for guidance and control; Philco Corp., transistors and semiconductors for telemetry, transmitter and data equipment; Perkin-Elmer Corps., vernistats used in analog computer simulation of missile flight dynamics.

Permanent Filter Corp., filter for high pressure air supply; PIC Design Corp., gears used in coordinate resolver computer; Polytechnic Research and Development Co., amplifier, bridge, generator, meter, and crystal mount waveguide; Potter Aeronautical Corp., flowmeters for liquid oxygen and fuel; Potter Aeronautical Corp., frequency converter; William Powell Co., pumps and valves for testing; Precision Equipment Co., check valves for instrument compartment cooling system; Precision Rubber Products, gaskets for engine modification; Protective Closures, Inc., caps and plugs for fuel system; Purolator Products Co., oil hydraulic fluid fliters; Quester Corp., endless hose.

Raytheon Mfg. Co., transistors and semiconductors for telemetry and transmitter equipment; Radio Engineering Labs, Inc., receiver; Resdel Engineering Corp., receiver set; Resistoflex Corp., flexible hoses for hydraulic, liquid oxygen, fuel and pneumatic systems; Reynolds Industries, antenna mount and telemetering in nose section; Robinson Aviation Inc., shock mount vibration isolators to measure propulsion system pressures; Rosan, Inc., threaded inserts for rotational launcher assembly; Ronan & Kunzl, Inc., liquid oxygen/nitrogen container; Arthur G. Ruge Associates, Inc., resistance type temperature gages for temperature measurement; Scientific-Atlanta, Inc., pattern platter; Simons Fastener Corp., quick fastener for instrument compartment; Servo-Mechanism, Inc., computer (liquid oxygen level indicator); A. O. Smith Corp., high pressure vessels for testing operation.

Southwestern Industries, pressure switches to regulate fuel tank pressure; valves for fuel and air systems; Southwest Products Co., bearings for booster roll control; Spectrol Electronics of Carrier Corp., potentiometers for spatial control system; Spincraft, Inc., bulkhead for tank section; Spitz Laboratories, Inc., lunar flight trajectory models; Stathem Laboratories, accelerometers for attitude measuring control; Systems, Inc., antenna; Technical Appliance Corp., antenna; Texas Instruments, Inc., transistors and semiconductors for telemetry and guidance and control equipment.

Thiokol Chemical Corp., small rocket motors for booster; Thermo Form, bulkhead, component of tank assembly; H. I. Thompson Co., fiberglass flame shields and insulators in tail section; Transistron, transistors and semiconductors for telemetry and transmitter equipment; Tube Turns, Inc., high pressure valves and pipe fittings for testing of booster; Turbocraft Co., cryogenic pumps, valves and trailers for testing operations; United States Rubber Co., drive belts for rotational launcher; U.S. Steel Corp., high pressure vessels for testing operations; United Transformer Co., transformers and inductors for guidance and control system; University of Illinois, study of radiometric missile tracking; Utility Metals Products, rings, doors and door frames for booster.

Varian Associates, Inc., Klystron; Vulcan Trailer Mfg. Co., modification of semi-trailer; Wallace Barnes Co., springs to modify valves and other components; Walter Kidde Co., filter for instrument compartment cooling system and high pressure air supply; Wallace O. Leonard, regulator for air bearing system; Weinschel Engineering Co., termination attenuator and tunes; W. M. Whittaker Co., air flow control valve; Wiancko Engineering Co., transducer mounts to measure propulsion system pressures; E. B. Wiggins Oil Tool Co., Inc., quick disconnect apparatus and couplings for hydraulic, liquid oxygen and fuel systems; Franklin C. Wolf Co., Inc., seals and gaskets for aft section assembly; Zenith Radio Corp., receiver for command-destruction signal.

Bomarc Vendors

Boeing List Shows 35 Major Suppliers

SEATTLE—A breakdown of *Bomarc* subcontractors has been furnished m/r by Boeing Airplane Company. The vendors and their products are:

Aerojet-General Corp., boost rocket motors; American Gyro Division, rate gyros; American Machine & Foundry Co., weapon support equipment; Armco, 17-7PH steel; Bendix Aviation Corp. instrumentation beacon and inverter.

Bill Jack Scientific Instrument Co., motors; Brunswick-Balke-Collender Co., radomes; Blount Brothers Construction Co., weapon support equipment; Burns & Roe, Inc., ground support equipment; Cadillac Gage Co., servo valves; Cushing & Nevell, illustrated parts breakdown; Daimo-Victor, drive assemblies.

Farnsworth Electronics Co., operation test equipment and electrical launching equipment; Federal Telephone & Radio Co., GAT amplifiers; Food Machinery & Chemical, weapon support equipment; Foote Brothers Gear and Machine, gear boxes; Kalser Metal Products, Inc., fuel tanks; Leer, Inc., coordinate converter and data link receiver.

Librascope, Inc., transformer-rectifier; Minneapolis-Honeywell Regulator Co., weapon support equipment; Moogl Valve Co., Inc., valves; Motoroia, Inc., guidance beacon and data link decoder; Radio Corporation of America, radar; Southgate Aluminum and Magnesium Co., chassis assemblies.

Stewart-Warner Corp., cooling assembly; Taylor Forge & Pipe Works, forgings; Telechrome Mfg. Co., transmitters; Texas Instruments, Inc., telemeter; Thompson Products, Inc., switches; United Control Corp., switches.

Varian Associates, Inc., kyistron tubes and transmitters; Westinghouse Electric Co., homing radar and control equipment; Westvaco Chlor-Alkali Division, UDMH fuel; Whittake Gyro., rate gyros; and Yardney Electric Corp., batteries.

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