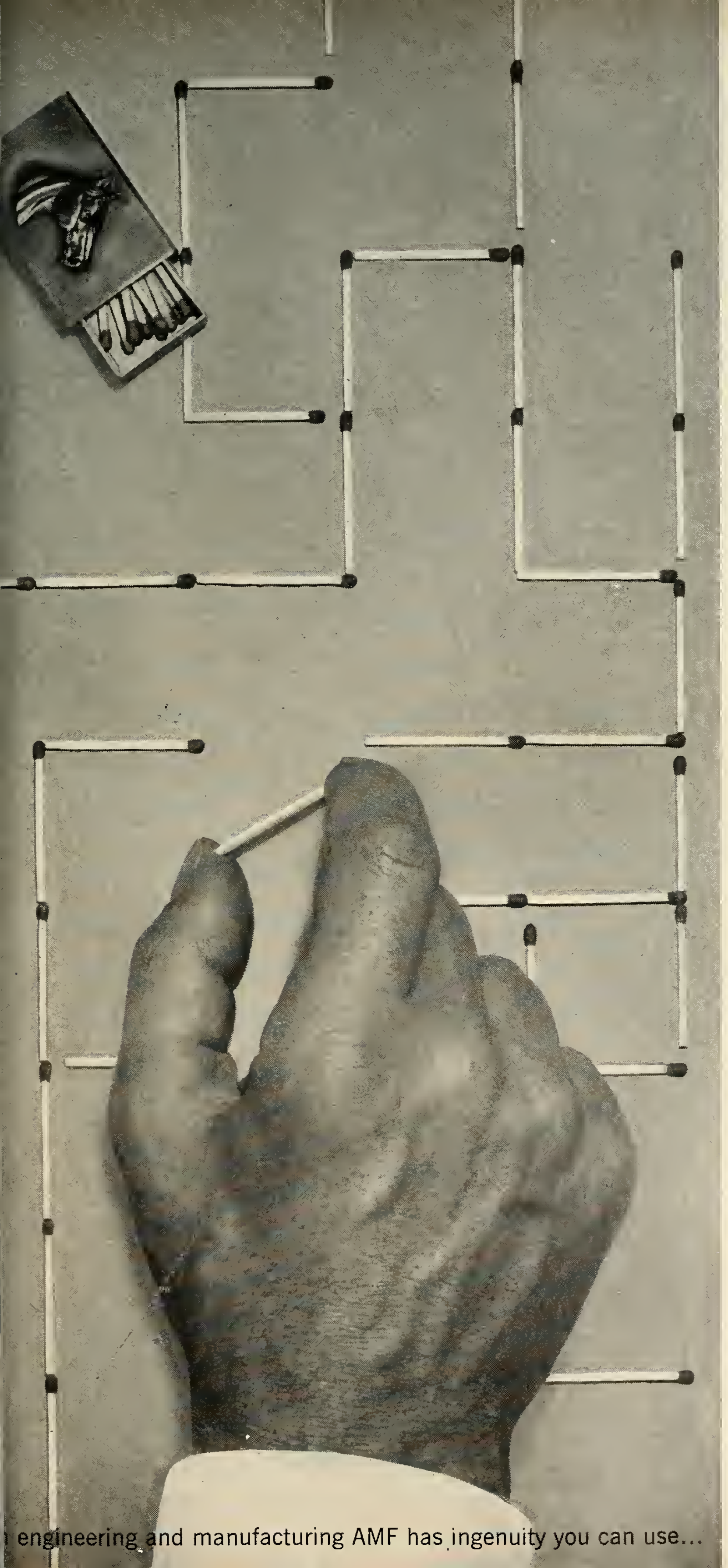
AUGUST 1, 1960

missiles and rockets

HE MISSILE/SPACE WEEKLY

Minuteman Re-entry Shape

AN AMERICAN AVIATION PUBLICATION



He designed a new interchange for radio traffic

This AMF engineer, part of an AMF-U.S. Army team, solved the problem of traffic delays and personal danger in manual re-connection of jumpers when interchanging R.F. transmitters and antennas.

His solution is a push-button-operated, coaxial crossbar switching system, using vacuum switches for circuit selection. A typical system consists of 4 transmitter inputs, 7 antenna outputs plus a dummy load, in a 4 x 8 matrix that can be mounted in a 19" rack. It can be controlled locally or remotely over any type of communication network having a bandwidth of at least 200 cycles.

AMF's coaxial crossbar switching system provides 100% flexibility in circuit path selection and accommodates power levels as high as 500,000 watts and frequencies up to 30 megacycles. It allows 100% utilization of all transmitting equipment. Stubs are automatically eliminated.

To insure fail-safe operation, power is required for the vacuum switches *only* during change of condition. Selection rate: 1 per second. Operating transmitters are safety-interlocked to insure a load. There are no hazards from open wires or inadvertent application of power to dead-lined antennas.

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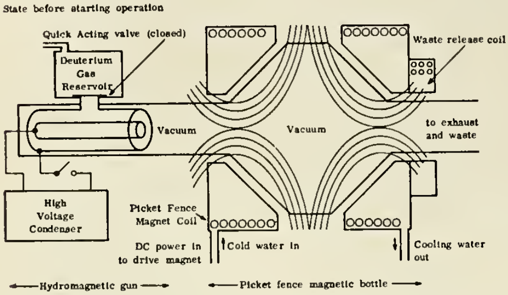
AMERICAN MACHINE & FOUNDRY COMPANY

Science non fiction at Los Alamos

Is this the shape of things to come in Sherwood?



The cusped geometry or picket fence was proposed back in 1954 independently by Grad at N.Y.U. and Tuck at Los Alamos, to get around hydromagnetic instability of plasma-magnetic field interfaces. Nobody did much about it at the time. The pinch effect seemed to hold more promise, so why bother about a leaky picket fence? A large magnet to produce a DC picket fence geometry was built but laid aside. For several years the stabilized toroidal pinch (called Perhapsatron at Los Alamos) held the stage. But as our measuring techniques got better, the pinches began to show a most sinister behavior. An apparently stabilized pinch which should have been radiating energy at the rate of several kilowatts, turned out to be losing it at a rate of hundreds of megawatts. As we got the impurities out of the system, the losses seemed to go down. One pinch (Perhapsatron S-5) has seemed so clean we are trying to raise its temperature to thermonuclear levels by pouring in more power.

Then there appeared the spectre of plasma oscillations and their evil effects on magnetic confinement. In principle, plasma oscillations can thrive on the interaction of a fast wind of plasma electrons moving through a slower cloud of plasma ions. This makes things look bad for the pinch effect, because the plasma has to have a large electric current in it, and therefore an electron wind.

The Russians delivered the next blow. Trubnikov and Kondryatsev predicted an enormous cyclotron radiation flux from a plasma containing a magnetic field. This would ruin the chances for DD reactors, and make things tough even for DT reactors. Among other complications, a nearly perfect mirror would have to be placed around the inner wall of the plasma container to reflect the radiation back.

Then Rosenbluth and Drummond argued that when the angular distribution is considered, the radiation isn't really so bad—say 1/50th of what T and K say. Now Trubnikov has come right back with another paper that says it is five times worse than R and D said it was. The above theories are pretty simple—the real problem is exceedingly difficult theoretically. It may be quite a while before there is anything new in this direction.

Anyhow, the point is that DD reactors with magnetized plasmas now seem to be out. But some people, like Tuck, claim that DD reactors are the only ones that make sense, since a DT reactor which must carry on its back a monstrosity of a tritium recovery plant could never compete with fission power anyhow.

This brings us to the point that if we want to have a DD reactor, it has to have no magnetic field in its plasma. So all right, don't put a magnetic field in the plasma. Unfortunately, there aren't any magnetic confinement systems stable enough to hold a pure plasma, except one. You've guessed it—it's the picket fence.

So we went back to the warehouse and dusted off the magnet we built long ago. Already it is going full blast, a second one has been built and a third one is on its way. Of course, we aren't alone any more in this field. Small cusped geometries are being studied at General Atomic, Livermore, Stevens, Harwell, Utrecht and Kharkov. Pretty soon we will have only picket fences and plasma guns at Los Alamos, aside from a few Scyllas to study plasma at thermonuclear temperatures, unless old Perhapsatron S-5 does something pretty spectacular.

The diagram of Picket Fence I (above), run by D. Hagerman and J. Osher, shows how plasma is injected as a slug, strong enough to push through the magnetic field and spread out inside. (This is called entropy trapping, but that's another story). Does it work? Well, that depends. It's a lot more complicated than we thought. At first, we nearly died of joy when the plasma was shot in and seemed to stay around for ages in our time scale (1000 microseconds), emitting light in the process. But when a magnetic probe was inserted, the harsh truth was revealed—the containment lasted only a few microseconds. In other words, the long time period we thought we had observed was merely cold plasma emitting light by recombination.

Just lately, however, Messrs. Hagerman and Osher have cleaned things up to the point that hot plasmas are pushing the field aside strongly and are keeping the inside field pushed aside for very satisfying periods, like 50 microseconds. Also, if we keep the magnetic probe out of the way of the plasma, it stays around longer, which is what it should do. This particular picket fence is a horror to keep a vacuum in, as it is completely overrun with O rings. The next one will be baked. Fun, eh?

What about the leaks in the fence? It is pretty leaky, but we think we have an answer to that too, so watch for the story on the TLC picket fence one of these days.

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Wayne W. Parrish
President

Leonard A. Eiserer
Exec. Vice President and General Manager

Fred S. Hunter
Vice Pres. and Editorial Director

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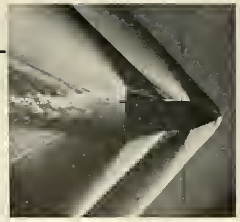
THE COVER



An experimental Minuteman nose cone model is caught a fraction of a second after being fired from a light-gas gun at Avco's Ballistic Range. (Avco photo.)

AUGUST 1 HEADLINES

RE-ENTRY VEHICLES

PROPULSION ENGINEERING

GROUND SUPPORT EQUIPMENT

ADVANCED MATERIALS

ASTRONAUTICS ENGINEERING

DEPARTMENTS

30,074 copies this issue

Another USAF missile
develops from a program
which is in itself a...

Titan, America's two-stage intercontinental ballistic missile, is making giant strides—attaining new goals in U.S. missile technology. It has repeatedly demonstrated its ability to accomplish stage separation and altitude start of the sustainer engine. Equally outstanding successes in guidance and nose cone ejection-recovery are making Titan a significant contribution to our national space potential; a highly sophisticated missile system powerful enough to deliver a warhead accurately at more than 5,500-mile range.

As Titan continues to develop toward a state of operational capability, it provides another demonstration of the remarkable successes of the U.S. Air Force's ballistic missile program. This program, conceived only six years ago, has produced progress beyond expectation in an undertaking never before equalled in complexity.

Space Technology Laboratories is responsible for over-all systems engineering and technical direction for Titan, as it has been for Thor, Atlas, Minuteman and related space programs. Principal associate contractors for Titan include: The Martin Company for airframe and system integration, Avco Manufacturing Corporation for nose cone, Bell Telephone Laboratories and Remington-Rand for guidance, Aerojet-General Corporation for propulsion.

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The Countdown

WASHINGTON

Polaris vs SAC

Chances are good the Eisenhower Administration will duck the prickly decision of whether to create a joint strategic command which would include control of the Navy's *Polaris* submarines (see p. 12). The Navy is understood to be deeply embroiled in a fight against such a move—on grounds such a command would be dominated by SAC. One of the key elements in the battle is money for more missile submarines. The Navy—to get the money—could be forced to capitulate.

ARM Becomes a Nose

The Air Force has dropped, at least for the present, plans to develop the ARM (anti-radar missile) into a full-fledged weapon system. Instead, just the anti-radar warhead will be developed and attached to the nose of such missiles as the North American *Hound Dog* and Douglas *Sky Bolt.*

B-70 Decision On Way

Insiders expect a decision from the Administration in short order on whether some or all of the extra $190 million to $290 million voted by Congress for the B-70 will be released. Any great delay now would make release of the money for the Mach 3 missile-bomber relatively meaningless.

Pershing's Secret Oomph

Despite what many say to keep within service "roles and missions" rules, the Army's *Pershing* has the power now to smack a target better than 500 miles away. Moreover, the *Pershing's* "350-mile range" is reported to be capable of being easily upgraded to 1000-miles.

Budget Thunderhead

Weather forecasting by satellite is in danger of being washed out by a budetary jurisdictional ruling. The Budget Bureau has turned down a Weather Bureau request for $5 million to capitalize on the *Tiros* program—claiming NASA should put up the money. But, NASA officials contend they haven't the funds—either—since the space agency's job is just R&D, not the establishment of an operational system for another government bureau. The Budget Bureau action has inspired top NASA officials to re-examine the agency's mission—with an eye toward changing FY budget requests due in October.

INDUSTRY

Super Sidewinder

Navy reportedly is developing a new, super version of *Sidewinder* at its China Lake ordnance test station. The new missile will have an improved rocket motor utilizing a graphite and phenolic-impregnated asbestos nozzle being produced by Horkey-Moore Associates, a subsidiary of Houston-Fearless Corp.

Giant Valves Installed

Elmco of Los Angeles is installing 11 of the largest cryogenic valves ever built at Edwards AFB Test Stand Bravo 2, which will be used to test the 1 and ½ million lb. thrust Rocketdyne F-1 engine. Made of stainless steel, the valves were designed by Vickery Co. of Oakland and manufactured under license by Pelton Co., San Francisco.

From Missiles to Cans

Reynolds Metals Co. is thinking of shifting operations at its Sheffield, Ala., plant—where *Redstone* boosters were produced—to the fabrication of either aluminum cans or automobile parts. Missiles frame manufacture shut down at the plant on July 1.

Help Wanted

NASA is seeking administrators for Project *Mercury* tracking stations in Faraway places: Zanzibar, Nigeria, Canary Islands and Mexico. Qualifications lean toward administrative, missile/space background and understanding of foreign relations. Salaries will be in $8000-$9000 bracket plus overseas pay benefits, according to NASA Langley Field Space Task Group Personnel Office, which is accepting applications.

INTERNATIONAL

French Put Up IRBM Money

Extra funds are being allocated the Service Des Poudres in the FY '61 French budget for facilities to develop solid propellant motors of 5 tons. There also is R&D money for 22-ton solid motors—indicating a serious backing of its IRBM program.

Fairey Selling Malkara

Australia has licensed Fairey Engineering Ltd. To sell the *Malkara* anti-tank missile in western countries except the United States, Britain, Australia and New Zealand. Fairey also has rights to sell the Australian Jindivik target drone in Europe.

Missiles in Portugal

There is some serious talk of stationing NATO intermediate range missiles in Portugal in the event France balks at allowing them in more preferable North African sites.

Navy Eyes $100 Million Range

Plan for '62 budget encompasses huge new ASW missile test range in Atlantic—AUTEC—and satellite-launching ship for orbiting Transit

by James Baar

The Navy is seriously weighing proposals to make two major additions to the nation's vast missile range empire.

One would be the construction of an ASW missile test range—possibly in the Bahama Islands.

The other would be the conversion of a Navy ship into a mobile satellite-launching platform.

The cost of the ASW test range is estimated at about $70 million. The cost of the ship is estimated at about $35 million.

Both programs are under consideration for inclusion in the Navy's FY 1962 budget which is now being put together.

Navy missile experts regard the building of an ASW test range as a basic requirement for the future development of anti-submarine missiles.

Firms already are making proposals for the range—called AUTEC, the Atlantic Underwater Test and Evaluation Center.

Present methods for fully testing ASW missiles are considered crude compared to the instrumentation available for the testing of missiles designed to fly in the atmosphere and space. An ASW test range would be equipped with instrumentation capable of providing minute data on the performance of a missile as it seeks and attacks its target underwater.

THE BAHAMAS are regarded by the Navy as an ideal possible site for a $70 million ASW missile test range. The range's center could be Exuma Island.

• **Exuma Sound site**—The ASW test range needed also must be large enough and deep enough to enable the simulation of tactical conditions. A range of this size is particularly desirable so that a missile's target can take normal evasive action.

Other ASW range requirements include the need for stable water and temperature, clear water and a minimum of current.

Some experts are understood to regard two sea areas southeast of Nassau in the British-owned Bahamas as particularly well suited for AUTEC, although there are a number of other possibilities.

The two Bahama areas—Exuma Sound and Tongue of the Ocean—flank the Exuma Cays and Great Exuma Island. Both the Sound and Tongue of the Ocean extend about 90 miles and have an average depth of about 5400 feet.

Such an area would be ideal for full-range testing of such an ASW missile as Goodyear's *Subroc* and its more advanced successors. *Subroc*, is undergoing late R&D testing, is reported to have a range of more than 20 miles.

The use of Exuma Sound and Tongue of the Ocean would call for negotiations with the British.

The United States already operates tracking stations including one on nearby Eleuthera as part of the Atlantic Missile Range and a now closed naval base on Great Exuma was leased to the United States by Britain for 99 years as part of the 1941 Destroyer Deal.

• **Transit launcher**—The proposal to build a satellite-launching ship is advocated on the grounds that such a ship would provide a platform from

Additions

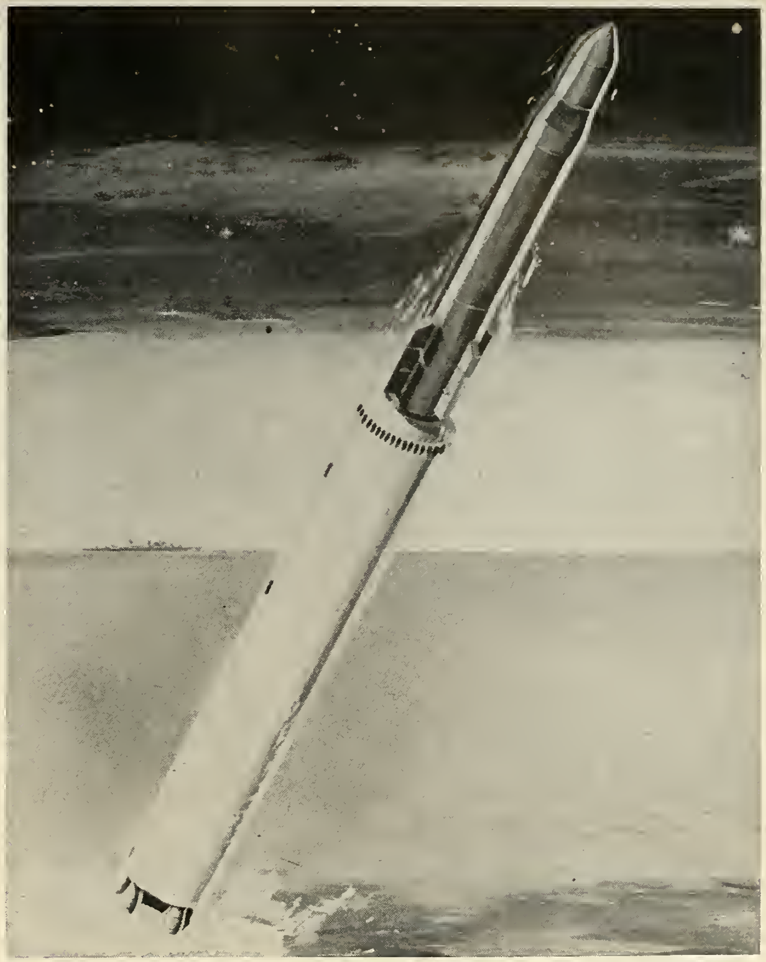
which sizeable payloads could be placed in any desired orbit. U.S. space programs would no longer be limited by the trajectories that can be obtained from Cape Canaveral and the Vandenberg AFB-Point Mugu pads on the East and West Coasts.

The launching ship would first be employed in firing operational *Transit* navigation satellites.

The operational *Transit* system in late 1962 calls for four 50-pound satellites: Two in an orbit with an inclination to the equator of about 70° two in an orbit of about 27°.

However, an orbit with an inclination of about 22 degrees for the second two *Transits* is considered preferable for obtaining maximum coverage of the earth's surface. *Transits* could be launched into the preferred orbit from a launching ship.

The Navy is considering construction of the launching ship by converting either an Albemarle or somewhat large Currituck Class seaplane tender. This has already been done once. A 9000-ton Currituck Class seaplane tender was converted into the Norton Sound which has been used for a number of missile tests including Project *Argus*—the high altitude nuclear blast tests in 1958.



SUB-KILLING SUBROC, a nuclear-tipped ASW missile in advanced development, is depicted in the first Navy-released artist's conception.

The satellite-launching ship would have the capability of putting into orbits payloads up to about 200 pounds. It also might provide facilities for testing anti-missile missiles.

Both the ship and the ASW range are seen by many in the Navy as vital additions to U.S. missile and space programs in the decade of the '60's.

Institute of Space Law Up for IAF Consideration

The 11th International Astronautic Congress of the International Astronautical Federation is expected to attract more than 500 delegates to four lecture symposia. The Congress meets in Stockholm, Aug. 15-20.

Lecture series will include:

–A Space Law Colloquium dealing with international control of outer space and damages to third parties on the earth's surface caused by space vehicles.

–An Astrodynamics Colloquium covering orbit determination, perturbations and orbit optimization.

–A Space Medicine Symposium will feature lectures on man-machine systems in space vehicles, biodynamics of manned lunar landing and return, telemetering of physiological data from space capsules, and biological significance of space ambient radiations.

–A Small Sounding Rockets Symposium will discuss range and launching problems and instrumentation.

More than 80 papers are due to be delivered at the Congress which this year is expected to approve a constitution setting up an International Academy of Astronautics and a International Institute of Space Law.

Formation of the International Academy of Astronautics to provide world technical leadership for the peaceful conquering of space and to serve as a clearing house for astronautic information was proposed at the London Congress last year. Since then the Daniel and Florence Guggenheim Foundation has agreed to provide $75,-000 for its operation during the first three years. After that the Academy is expected to support itself.

The International Institute of Space Law would replace the Permanent Legal Committee of the IAF. Former IAF President Andrew G. Haley of the American Rocket Society has pledged $35,000 to aid in the operation of the Institute for the first five years.

The Missile Week

GE Wins Titan II Nose Cone Contract

Missile and Space Vehicle Department, General Electric, Philadelphia, will develop the big Mark VI ablative-type nose cone for *Titan II*. This is a switch from Avco, which built the Mark IV re-entry vehicle used on *Titan I*.

Development of Mark VI, the biggest re-entry vehicle yet, will net GE many millions of dollars. The exact sum has not been disclosed. A contract is expected to be signed shortly.

$28 Million in Polaris Work to Northrop

Nortronics Division, Northrop Corp., last week received Navy contracts totaling $28 million for design, development and production of electronic components for the *Polaris* system. The work includes automatic checkout systems, gyroscopes, periscopes and radiometric sextant. Checkout system on the missile is produced by Northrop Systems Support Department, Anaheim, Calif. Submarine components are produced at Precision Products Department, Norwood, Mass.

Boeing Seeks 1000 Engineers

Boeing Airplane's Aero-Space Division is putting up a "help wanted" sign for 500 electrical and electronics engineers, 300 mechanical engineers and 200 structures engineers.

The new talent, said Stanley M. Little, division director of industrial relations, will be used on the *Minuteman* and *Dyna-Soar* projects and on Boeing's search for new products. Last year, the division added 1200 scientists and engineers to its current employe roll of 8200.

Nike-Zeus Component Work Authorized

Contracts totaling $18 million to establish pilot lines for manufacture of components for the Army's *Nike-Zeus* antimissile missile were awarded last week to Western Electric.

One contract, for $11,341,510, is for development and proofing of high-volume manufacturing and inspeetion techniques, special tooling, test equipment and facilities needed for critical components. Four other contracts, totaling $6,658,490, are for development of advanced techniques in producing vital electronic components.

Goodyear Aircraft and Douglas Aircraft will participate with Western Electric in work under the contracts, awarded by Army Signal Supply Agency, Philadelphia.

Minuteman Assembly Plant Construction to Start

Construction will begin late this month on the Boeing-operated *Minuteman* assembly plant at Hill Air Force Base, Utah. Although no expected completion date was announced, it was understood the plant is to be ready in about a year.

Atlas-Able Has Understudy Twin for Fall Shot

NASA has two backup payloads and one backup *Atlas-Able* available for its fall moon orbit shot. If the first shot, scheduled for around Oct. 1, should fail, the second *Atlas-Able* will be set up on the same pad at Cape Canaveral. This would take from a month to six weeks.

Paul F. Glaser, project engineer for Space Technology Laboratories, payload manufacturer, said last week that if the first shot is successful the second may be launched as an identical twin to double-check the measurements from the first shot. Glaser spoke before the American Electroplaters' Society in Los Angeles.

NASA spokesmen said no decision has been made on the idea of a twin shot.

ICBM Slippage

Industry Top Brass Called to Pentagon

The mass summoning of top ICBM contractors and labor officials to the Pentagon this last week underlined the serious affect of recent slippages in *Atlas* base construction.

Delays in completing ICBM launching sites at three missile bases—Vandenberg, Offutt, and Warren—put the first sizeable deployment of *Atlases* back nearly a half year. More than 30 *Atlas* sites are involved.

As one insider put it: "With the numbers of missiles we're building we just can't afford that sort of thing."

Defense Secretary Thomas Gates summoned the heads of 49 companies holding contracts connected with the construction, installation and checkout of ICBM bases. He also invited AFL-CIO President George Meany.

The meeting—aimed at preventing further slippages and seeking possible ways to regain lost ground—was called against the background of preparations for the presidential election campaign in which U.S. missile strength is certain to be a major factor.

Gates' action followed a series of moves by the Air Force and Army Corps of Engineers designed to tighten schedules for ICBM base construction.

The Air Force transferred from the Air Research and Development Command to the Air Materiel Command the management responsibility for ICBM base construction except Vandenberg, Offutt and Warren.

The Army Corps of Engineers announced the establishment of a Ballistic Missile Construction Office at Los Angeles under command of Brig. Gen. Alvin Welling. The Army said the new office "is being established to further streamline, strengthen and expedite" ICBM base construction.

Missile Price List

Latest official cost figures on the *Atlas*, *Titan*, *Minuteman* and *Polaris* programs show:

Hardened *Atlas* squadrons will cost $152 million each.

Hardened *Titan* squadrons will cost about $138 million each.

Hardened *Minuteman* squadrons are expected to cost about $58 million each. (All of these figures cover for the most part the bases and production-line missiles, not R&D.)

Total cost of a fleet of 45 *Polaris* submarines equipped with missiles is placed at $8.6 billion. (This figure includes R&D.)

HOUSING PROBLEM in Los Alamos, where millions are spent to make rockets, but little is spent to house rocket makers.

Housing Shortage Hamstrings Rover

Los Alamos Director fears loss of key personnel because of substandard living conditions

by Frank G. McGuire

Los Alamos, N.M.—The U.S. effort to build a nuclear rocket is threatened with serious delay because of a failure to build a few houses.

This is the opinion of Dr. Norris E. Bradbury, director of the $270 million Los Alamos Scientific Laboratory where the *Rover* nuclear rocket is being developed.

Dr. Bradbury's 3200 charges—some of the best nuclear rocket experts in the world—are living in substandard housing, all of it hard-to-get. They are beginning to heed private industry's offers of higher pay and better living conditions elsewhere.

The problem will become worse because of LASL's need to acquire 600 to 900 more personnel. The Laboratory has tentatively hired 300 new employees who can't start work because they have no place to live.

• **Source of difficulty**—According to LASL officials, the government doesn't want to build houses because that might hurt private enterprise. Private contractors don't want to build houses in Los Alamos because the buyers can't get government loans. So the housing doesn't get built and the Laboratory's turnover increases.

The *Rover* nuclear rocket is presently scheduled to fly by 1965. Some LASL optimists believe this can be done by 1962. But the project will be seriously delayed, LASL officials believe, if they can't hold onto all of their present personnel as well as hire new talent.

"We have the technology, the facilities, and the potential funding," one LASL official said, "but we're hamstrung by as incredible a reason as housing."

"All I can predict now with certainty," Dr. Bradbury warned, "is trouble for the future, accelerating with passage of time; avoidable only by prompt and possible drastic action in the form of extensive housing construction and maintenance."

"We must have action on this program, anywhere we can get it, from anyone who will listen, and at the earliest possible moment."

• **How bad is it?**—Presently LASL employees are housed in everything from modified WW II barracks to trailers.

The rare house that becomes available is rationed on a point system. An employee gets one point for each dollar he makes per month and two points for each month of service up to ten years.

For example, a Ph.D. who was employed recently makes $750 per month and has 750 points. This puts him in 526th place on any waiting list for a single three-bedroom house.

Many who have been with LASL for several years have piled up over 1000 points. There are now 300 of these people—and six vacancies.

Furthermore, recent surveys show that almost every lucky LASL member who has some place to lodge his family is living in housing far below what he could afford in any other area of the country.

All attempts to interest private contractors into building new houses have failed.

In February, the Atomic Energy Commission invited bids from over 250 private contractors to develop a housing area near the Laboratory.

Not one bid was received.

When asked why, the contractors replied that the Federal Housing Administration had refused to guarantee home loans in the area, thereby making the enterprise too risky.

• **Four years in making**—The government on the other hand, refuses to build the houses because they don't want to deter private industry.

This situation was predicted by LASL over four years ago in a set of recommendations to the AEC. But only one of the four recommendations—the modification of existing housing—was achieved.

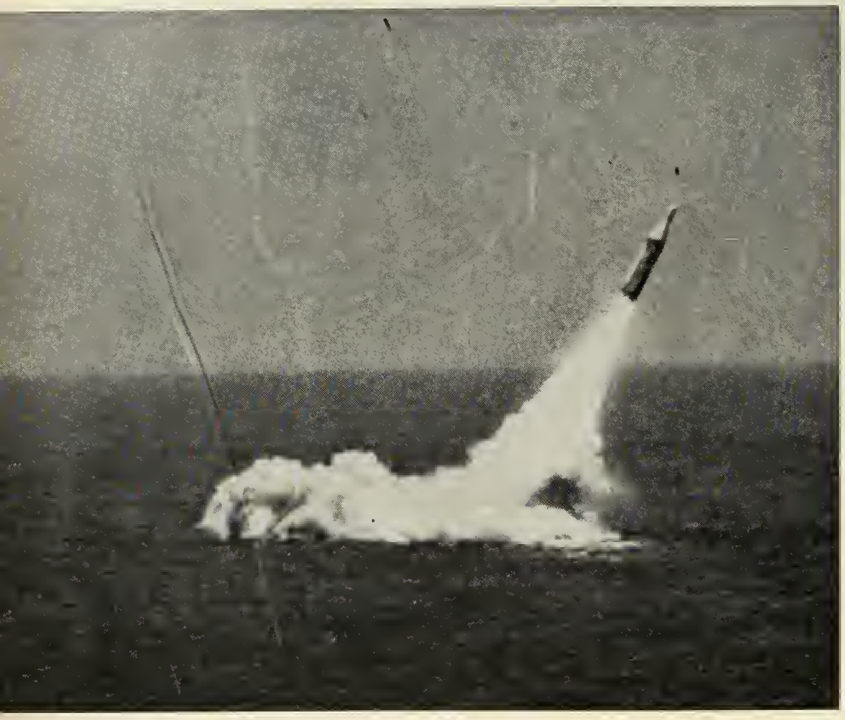
LASL has proposed that $2 million be spent annually for ten years, or $20 million be appropriated in a lump sum to remedy the situation.

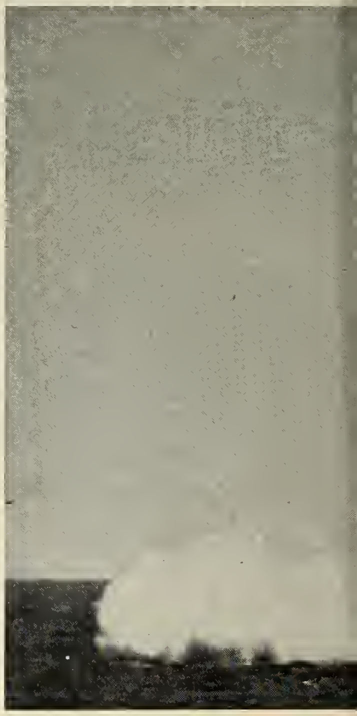
The government has refused to appropriate the money, and so far has only agreed to make some modifications in the barracks-type housing now in use.

In other words, the government is willing to pour $270 million into a facility, $60 millions into its programs annually, but refuses to spend $20 million to house its employees.

As one LASL employee bitterly put it, "Los Alamos may become the most expensive and best equipped ghost town in the West."

Next Administration May Inherit Polari





One of the hottest bequests that the Eisenhower Administration may leave for its successor is the decision whether all U.S. strategic missiles should be placed under a joint command.

The issue is being debated in the Pentagon in the wake of the complete success of the Navy's "proof of the pudding" launchings of *Polarises* from beneath the surface of the Atlantic by the nuclear-powered sub George Washington.

The Air Force has been pressing intermittantly since last year for the creation of a Joint Strategic Command which would control SAC's bomber fleet and ICBM bases as well as the Navy's fleet of *Polaris*-launching submarines. The Navy has fought the proposal at every step.

So far the Navy has succeeded and is continuing to push for the creation of a 45 ship fleet of *Polaris* submarines that would operate as an integral part of U.S. Naval forces. This last week the Navy took several new steps toward its goal:

–Contracts were awarded for three more *Polaris* submarines. A $60,113,000 contract went to Electric Boat for two ships; a $32,405,000 went to Newport News Shipbuilding for one. That brought to 14 the total number of *Polaris* subs built, under construction or for which contracts have been let.

Polaris: Up from the Deep

The first Polaris to be launched from a submerged submarine ripped through the surface of the sea off Cape Canaveral at a sharp angle, ignited and swiftly righted itself. Shot No. 2 the same day—July 20—burst straight up through the surface (far right). Both landed in the target area more than 1100 statute miles downrange.

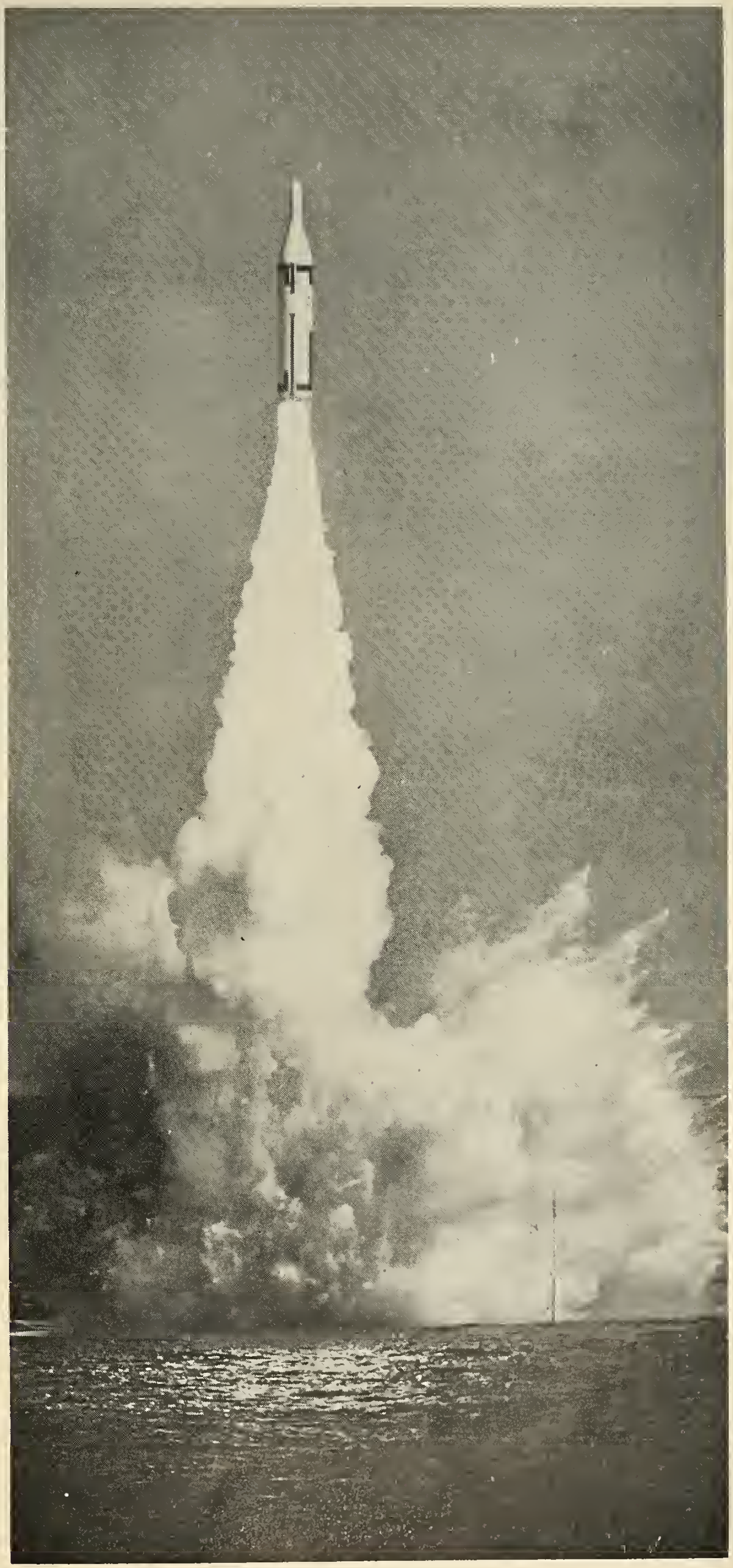
–The Navy disclosed that there would be no delay in constructing the two extra *Polaris* subs that Congress authorized and the Administration finally approved despite earlier objections. Long lead time items had not been previously procured for them—a possibly delaying factor. But the Navy said it planned to use the long lead time items ordered for two nuclear-powered attack submarines previously planned but later scratched by the Administration.

–Testing of the George Washington continued at Cape Canaveral. The George Washington and her sister ship, the Patrick Henry, are expected to launch more than a dozen *Polarises* from underwater before going on station later this year. The Patrick Henry, which has been undergoing testing at New London, sailed to Newport, R.I., to launch a Sabot slug as President Eisenhower watched.

• **Targets at issue**—One of the principal issues involved in the Air Force-Navy fight over a possible Joint Strategic Command is the so-called targeting issue. In effect, this is who is to be assigned to hit which target.

The Air Force contends that a Joint Command is needed to make these assignments and to make certain that targets will be covered when forces assigned to them are knocked out in an initial attack. The Navy contends target assignments can be made by the Joint Chiefs and that the *Polaris*

Control Issue



submarines can only operate at peak effectiveness as part of the overall fleet.

The Air Force is seeking to resolve the issue before the first *Polaris* submarine goes on station. This is scheduled to happen in October.

But even if the Defense Department were to reach a decision there is some question whether it would be upheld by the next Administration. Therefore, the chances that the decision will be allowed to slip are considered good.

The new Secretary of Defense and the White House probably then will face the question in January.

Pressing for Polaris Funds

Rear Adm. William F. Raborn said last week the Navy could develop a 2500-mile *Polaris* by 1964 if given the money. He said the increased range could increase *Polaris* submarines' hiding area from 3 million to 9 million sq. mi.

Asked whether he is seeking *Minuteman* money, Raborn replied; "The Navy is a poor service. We'll take money wherever we can get it."

Germany Bankrupt in Space Scientists

Migration of Rocket Talent to U.S. and Russia puts Bonn 10 years behind in space exploration

by Clarke Newlon

BONN, GERMANY—West Germany cannot make an important contribution to space exploration now and will not be able to for another ten years in the opinion of both government officials and the scientific community here.

While none were willing to be quoted by name, there was a general unanimity of opinion that West Germany had neither the scientific manpower nor the equipment essential to space exploration. Said one government official:

"There isn't a man in West Germany—not one—with the training and knowledge necessary to achieve any success in the space field. We had them once but now they are all either in Russia or the United States."

Asked whether any of the young German scientists who have migrated to the U.S., including some who have joined the Von Braun team at Huntsville, might return to form a space cadre, the official shook his head.

• **U.S. years ahead**—"They will stay in the States," he said, "because there is more opportunity there. Your country is 10 years ahead of us—even if we started now. And there is always the question of money—we do not have it."

England recently announced that she intended to enter the space exploration field, using the *Blue Streak* as a basic booster. The announcement said that Australia and Canada would merge their efforts with Britain and that probably France and West Germany would be invited to join the combine.

There was considerable doubt in the minds of German scientists that such an invitation would be accepted. Said one:

"Certainly we could build something for a space exploration vehicle. We could build, perhaps, a piece of guidance equipment or something in the electronics field.

"But it would be a hand-made article and the same device could be bought off the shelf in America much cheaper. We have not the tools. We have not done the research. We do not have the techniques.

"These things come with time, with study, with experience. Germany has none of these things and if we started now to acquire them it would take years and a great deal more money than our government has to spend on space."

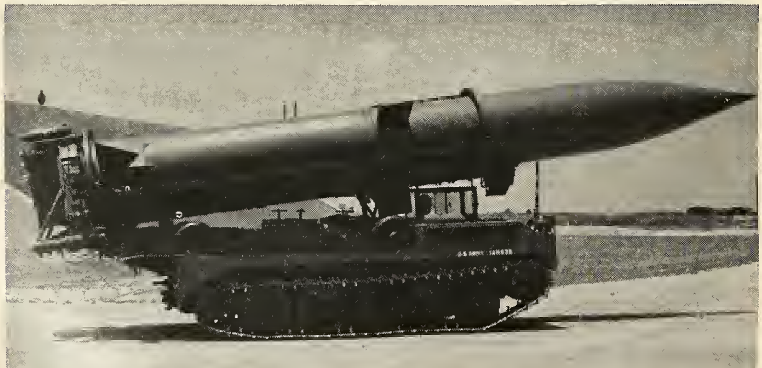
England's announcement indicated that she expected to spend 10 to 15 million pounds yearly on her program, for a total of perhaps 150 million pounds ($420 million). Presumably both Canada and Australia would contribute either money or equipment to the program.

• **French uninterested**—Political observers in Paris expressed doubt that the French government would be very interested in joining a combined space program headed by Britain and made up of Commonwealth nations.

"Any time Britain proposes a deal with the Continental nations she wants to control 51 percent of the stock," said one French politician. "France today is not in the mood to be a junior partner."

Notwithstanding these sentiments on the part of both France and Germany, there is little doubt that both governments would like to enter the space field in some manner. For, as the British government expressed it, any nation which does not must inevitably find itself a second class power eventually. Neither France nor West Germany is prepared to face this.

Launch from Tracked Vehicle



FIRST FIRING of Pershing from atop its tracked vehicle was a three-fold success. Selective range missile weathered "wind" variables thrown at it and TAPCO transporter-erector-launcher functioned successfully. 17-ft. long tracked carrier can travel at 40-mph over any terrain. Known as XM 474, vehicle is product of Food Machinery & Chemical Corp. of San Jose, Calif.

DOD's Secret Files Just Grow and Grow

A House Subcommittee has charged the Eisenhower administration with manipulating the "secret" stamp to its own advantage and creating a monumental pileup of classified documents.

Congressman John E. Moss (D-Calif.), chairman of the Government Information Subcommittee says the Pentagon has been a prime offender in withholding information vital to the public.

Summing up a five-year study of classification procedures, Moss found that "in too many cases, 'secret' was stamped on Pentagon information until the appropriate moment that the announcement would have the greatest propaganda effect on the American people."

He cites a case in which unclassified *Titan* ICBM pictures were withheld by DOD, claiming it wanted to avoid "ballyhoo" of untested missiles. However, the pictures were released "with political effect just before election."

In another instance unclassified *Nike-Zeus* photos were refused to the press with the explanation that no official pictures would be released until it was certain the missile would work. Result: pictures were released with "publicity fanfare 5 months after military declassification."

The committee's report came on the heels of Democratic Convention accusations that the Administration had purposely withheld non-security information which might discredit it in the eyes of the public.

Moss' committee studied 174 cases of classification by the Executive branch which were protested by outside agencies—mostly by Congressional committees and the press. In more than half the cases, the classified status was found to be unnecessary and harmful. These cases included the withholding of information to bidders on an unclassified *Nike* site for "security reasons;" and the refusal to release unclassified reports of conflicting testimony on DOD projects.

Classified documents are being stockpiled at the rate of 1373 feet a week, Congressman Moss found. A one million-cubic-foot stockpile of classified documents has been created since W.W.II—three times as much as that created from the inception of the system in 1907 until 1946.

PENTAGON DEFENDS CPFF CONTRACTS

The running battle between Congress and the Pentagon over the merits of negotiated contracts continued last week with DOD issuing a defense of its present procurement policies.

The DOD statement was precipitated by recent moves in both the House and the Senate to restrict the use of negotiated and incentive contracts in defense spending. Presently, about 85 percent of all defense dollars are spent through negotiated contracts.

Basically, the DOD argument was that:

–Competitive, formally advertised contracts are impossible in most cases;

–Negotiated contracts are the most effective and practical way to procure defense components;

–There is a great deal of competition in the negotiated contract method which Congressional critics have overlooked.

"Formal advertising," the DOD argument contended, "is inappropriate because it would require static specifications which would yield obsolete equipment. It would preclude placing contracts with companies offering the most advanced design."

The DOD argument also contends that competition is present in about 88 percent of all DOD negotiated contracts —usually at the design or technical level.

Cited as an example of the competitive quality of negotiated contracts was the procurement of *Mauler*, where the DOD statement points out that ninety-seven firms were briefed on the project, and thirty-one submitted proposals.

After intensive technical and military evaluation by defense agencies and non-government consultants, according to the statement a committee was formed which eventually picked four of the thirty-five companies to do feasibility study contracts.

Only after this entire process during which competition was present, was further evaluation and review conducted "which resulted in selection of a single contractor to handle the project."

Gas Generator Eliminated From Turbo-Fed Engine

Rocketdyne engineers have succeeded in eliminating the gas generator in turbo-fed liquid propellant engines.

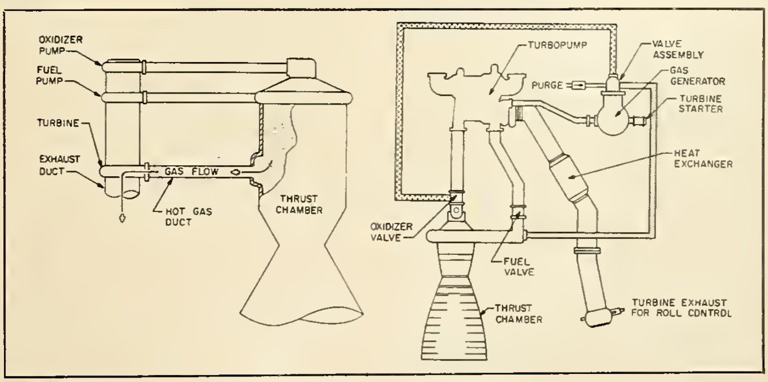
The simplification is obtained by tapping the main thrust chamber to get hot gases needed to drive the turbo pump.

Sixty-four tests with a modified MA-2 sustainer engine using liquid oxygen and RP-1 demonstrated the feasibility of the tap-off system. Performance of the modified engine was found to be comparable to a conventional propulsion plant.

The Rocketdyne system uses a solid propellant spinner to start the pump. After starter burn-out, the tapped gases take over.

The main benefit derived from the development is increased reliability. Removal of the gas generator is the equivalent of a 60% reduction in potential problems.

The work was performed under contract to the Ballistic Missile Division of the Air Research and Development Command.



SIMPLIFIED gas tap-off (at left) needs a solid-fuel starter.

Right Road to Rocket Reliability

Expert decries reliance upon flight testing—says 'Destructive thinking' dominates test philosophy

by Kermit Skeie*

With the tremendous expense of R&D and production of a missile or space system, why do we deliberately destroy it to prove that one inexpensive component will fail?

I understand this is called failure analysis. Broken down, it would be defined as "let something fail," then go back and find out what went wrong.

We spend millions on telemetry test equipment, so that after a $5 million missile explodes on the pad we can find out what went wrong. Then often we repeat the process for another part.

It appears that destructive thinking dominates our Space Age test philosophy—with destructive testing and failure analysis concepts.

• **Earlier tests needed**—under present design methods, certainly some failure is bound to result when 100,000 and more components must operate together. But isn't there some way that many of the failures can be predicted and prevented *before* flight tests?

In a recent issue of an industry publication, a reliability engineer in one of our largest missile companies wrote:

"Failure is the measurement of reliability—you cannot get any measurement of a device's reliability without some record of the number of failures as compared with the number of successes."

On the other hand, in a current issue of a trade journal, an advertisement by a leading component company caught my eye. It stated that destructive testing was the only sure way to determine fatigue characteristics. "Testing must be ceaseless . . . ruthless," the ad explained. "We must destroy enough of each lot so that we can be assured of the fatigue strength of the others . . ."

The paradox in these two viewpoints is quite fascinating. We can only insure absolute reliability through destructive means, but if we get "absolute" reliability—and we all know we won't—how can we get the failures to measure against the successes, to measure "absolute" reliability?

• **Development costs could drop**—The stated policy of the U.S. Air Force is to bring down the high costs of missile development, much of which is caused by the breakdown of individual components of individual parts. Justifying a $5 million explosion to prove the reliability of a part worth a fraction of the total cost of the weapon, is hard to swallow. I'm all for flight testing of the nondestructive type that accomplishes the planned objective. The announced Air Force policy and intent to bring down the fantastically high cost of missile development is extremely gratifying.

A flight test program should be planned to prove the concept of the design. Once a weapon system reaches the launch pad, the dependability of the components should already be established. The launch should be the final step to find how all components will work in relation to each other, as a system.

Component failure appears to be the principal cause of launch fiascos. These tiny failures—an airframe becoming unsoldered, a leak in a fuel hose, a cracked connector, a leak in a glass to metal seal that can turn a well adjusted guidance system into a neurotic circuit—cause the obliteration of thousands of man-hours, millions of dollars, and months of precious time.

These tiny failures do not suddenly develop on the launching pad. They may be designed into the individual components from the first line on paper. They may be born in the materials, passed on into the structures and explode in the system.

A concept is fine but it will never be a reliable system as long as basic defects are perpetuated. A concept is only as good as the sum of its parts.

• **Planned to fail**—Let me give you an example of how to design in failure. In this instance the engineers had actually designed in structure failure. The detail design had two guaranteed, built-in defects that could not fail to fail. In order to insure "reliability," the design called for far too much weld metal to be deposited, causing lack of fusion in the weld—a carefully engineered, man-made crack.

Not only that, but the design of this structure was such that it was virtually impossible to apply any known means of non-destructive testing satisfactorily at that late date—the only possible way to assure the absence of relevant defects.

The reliability engineer I quoted before would have ample factors for measuring reliability—he'd have more than enough failures for his measurements.

• **Specs a real goal?**—Is it possible we are more anxious to get past a component test requirement in a specification, rather than to assure ourselves that the part will perform its ultimate function?

The design engineer wants satisfactory performance—the military assurance of reliability—but both at any cost?

The designers take these failures to get performance, too often with reliability shelved until the goal is achieved. Then, with a lack of cost consciousness they try to design the reliability back into the system after performance is attained.

The present schedule in developing a system seems to me to be, all too frequently, this: design, develop, produce and then prescribe the test methods to insure reliability.

Tremendous economies can be realized and reasonable reliability of components achieved by developing test processes concurrently, rather than after, the conception of a design.

Design and flight test engineers want dependability but don't know how to get it without sacrificing the predictable performance—their basic objective.

**Mr. Skeie is Director of Services for Magnaflux Corp., a General Mills subsidiary.*

• **Need real approach to materials**—All materials are imperfect, full of irregularities. For instance, it has been noted experimentally that a single crystal of pure iron has a tensile strength of one million psi. This is pure, unalloyed iron.

So engineers start out on a foundation of imperfection and those imperfections are perpetuated on into a missile or space system. The design compounds those defects by making inadequate provision for those inherent irregularities or too much provision. This is called a factor of safety, but I call it a "factor of ignorance."

It's inconsequential whether this ignorance factor is 1.01:1 or 6:1 since the concept is a protective one.

The Aerospace industry has few standards on type and extent of irregularity that can be tolerated and practically no standards for the new exotic metals and alloys in use today—nor do they have methods to establish a code of standards.

• **Impact test for steel?**—For example, a measure of toughness utilized, historically, is an impact test and it is still prescribed. What is the use of an impact test on high strength steels, which has no need for purely impact properties?

How much money do you think could be saved if test methods—nondestructive test methods—were developed along with the design? How much time would be saved if minor modifications were made at an early stage to accommodate such testing, rather than complete redesign after the system is assembled?

• **Solution offered**—Design engineers should never call out the type of tests. They shouldn't be expected to know enough about the theories, the methods, nor the limitations of these tests. The function of the designer should be to prescribe the objectives he wishes to achieve by such testing and leave it to the quality control or nondestructive test engineer to meet those objectives.

Space technology has advanced much too far, too fast, for handbook concepts. The test procedures must be tailored to fit the exploding technology. The design engineer has stated objectives in his design criteria; let him leave the assurance of achieving them to those who know more about the performance of the materials.

• **New design-team member**—I urge that a quality control, specifically a nondestructive test engineer be added to the design team. Two or three major concerns in this industry who have adopted such an approach.

The designer is not looking for trouble. He assumes the homogeneity of the structure because the published or lab data are all he has to go by. But there may be trouble in the materials. We try to accommodate rigid test procedures from obsolete MIL Specs to a rigid design. We should expect inadequate performance.

The addition of a nondestructive test engineer to the design team might help fill that chasm between design, development and operational reliability. It would provide a system of checks and balances in the design of a space vehicle.

He can help bridge the communication problem. I have had conferences with high level design engineers who assured me they had no material problems. Then I met with reliability engineers who listed twenty-four acute problems in testing of materials and structures on the same missile project—existing hardware.

What can a mere nondestructive test engineer contribute to the knowledge of the designer? The answer may be nothing—but he does know something the designer doesn't—the design may be perfect on paper, but the materials aren't.

• **Not a new idea**—I confess there's nothing new about this concept. I've stolen it from the tractor industry, where test engineers have been kibitzing the designers for many years!

One manufacturer of steering parts inspects the same component three times, looking for one abnormality in 30,000. Why? One failure could result in a $500,000 law suit. One missile failure only costs $5 million, but then that's tax money.

I wonder what would be the result if DOD required just the same warranty you get with even a compact car—90 day or 4000 miles.

With 80% or so of a missile system on the ground, I should imagine that at least as much preventive maintenance is practiced on these facilities as is in the oil industry. Yet, I read this in the L. A. *Times:* "As the Atlas lifted off the pad the arm tore through the metal skin and ripped apart the pressure system tubing. Investigation disclosed two bolts in the arm had sheared from metal fatigue."

• **Thinking must change**—I've heard it said that we aren't interested in the measurement of moduli of materials dynamically because all our data and design criteria are based upon moduli obtained statically. Today it is possible to measure moduli dynamically on a structure itself, and survey the entire structure.

Or hardness testing—who needs it? Less than 5% of specs calling for hardness want hardness per se. Besides, it can't be nondestructive. Less than two months ago I encountered a requirement for hardness on a sintered beryllium alloy! The property this designer wished to measure was density, or homogeneity of structure. We stick to superficial hardness measurement of high strength fasteners because it's too much trouble to change the spec.

Or high strength steels for missile cases, thousands upon thousands are being spent in development of a repetitive destructive test to measure toughness on test sample of the material. All effort is put forth on developing the destructive test on samples and, to my knowledge, none on a nondestructive test on structures. True, no failure of a missile has been attributed to case failure, but how many thousands do they blow up on hydro test to achieve this record.

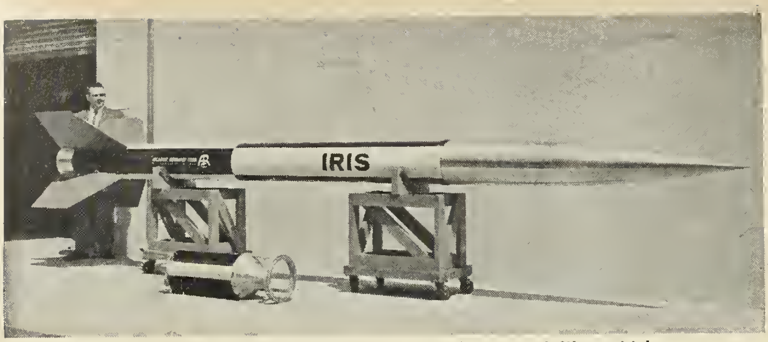
The hydrostatic test itself. Does this furnish the information we wish to know? Is it a liability in reliability? Most people say "it's the best we have." That's status quo thinking. One manufacturer of line pipe reduced hydro test failures from 15% to 0.3% by applying a nondestructive testing technique, that is not yet being employed as a production test to steel missile cases.

I feel that more than third of the failures can be prevented right on the design board. We know that nearly one-half of the missiles being fabricated, assembled and produced today can be counted out before the countdown.

Even if I'm half wrong—we'll still be 50% ahead of where we are today. Let's learn something from our biggest failure—the failure to recognize that we cannot afford failure analysis on complete systems.

Rules for Reliability

- **Develop test processes concurrently, rather than after the conception of a design.**
- **Stop trying to accommodate rigid test procedures from obsolete MIL Specs to rigid designs—tailor test processes to fit the design.**
- **Set up realistic standards for the new exotic metals and alloys**
- **Design non-destructive tests for structures.**



IRIS sounding rocket was developed at about ½ the cost of like vehicles.

NASA's Iris Rocket Lifts 150 pounds 140 miles

The National Aeronautics and Space Administration last week reported a highly successful first test of the Atlantic Research *Iris* solid-propellant rocket, a sounding vehicle designed to carry a payload of 100 lbs. to an altitude of about 200 miles.

In the test from Wallops Island, Va., July 22, the test *Iris* carried 150 lbs. of instruments to an altitude of 140 statute miles and impacted 210 miles from the launch site.

NASA said *Iris* was developed at a cost of about half of that for sounding rockets in its class used at present. The first shot in a series of three for the preflight rating test was a test of flight performance, acceleration, rotation, aerodynamic loading and aerodynamic heating of nose cone and fins.

Iris, which weighs 1216 lbs. exclusive of payload, is about 20 ft. long and has 12½ in. diameter, 46½ in. fin span and an 80 in.-long nose section. In the test, the rocket burned at an average thrust of 3800 lbs. for 62 seconds and lifted the payload to 28 miles altitude and a velocity of 6774 ft/sec at burnout.

Because of the slow-burning polyvinyl chloride propellant, a booster section was attached. The booster, which burned for about one second, gave an 18,000-lb. initial total thrust and then dropped off at burnout. The booster was a cluster of seven small rockets.

Iris was developed under a Navy contract, which was taken over by NASA last year.

Robert A. Wasel, acting chief of solid rockets, said NASA officials were surprised and pleased by the rocket's excellent performance on its first flight. He said the flight followed a series of six successful static tests.

The booster cluster was added to give enough initial velocity to overcome the problem of dispersion at Wallops, Wasel explained. The booster burns out before the *Iris* leaves the launch tower and drops off as a result of the continued thrust of the main stage.

Wasel said a low-thrust, long-burning rocket is preferred for sounding applications because the lower speed results in less atmospheric resistance and aerodynamic heading of the fins, and part of the burning takes place in a near vacuum, where the rocket is more efficient.

Scout Was Okay

Wrong Radar Signal Blamed for Failure

A sudden radar signal shift has been pinpointed as the reason for lack of complete success of the July 1 *Scout* launching.

The National Aeronautics and Space Administration said the all-solid vehicle did not actually change direction as indicated by the radar and the fourth stage could have been allowed to fire without danger.

The third and fourth stages reached an altitude of 860 miles and 1500 down the Atlantic Missile Range from the NASA station at Wallops Island, Va. With fourth-stage separation and burning, the instrumented payload would have gone to an altitude of 2300 miles and 4700 miles downrange.

Examination of telemetry data revealed three areas requiring detailed examination and possible modification in the *Scout* vehicle. They were:

- The protective covering of the third-stage motor, which normally would be jettisoned at third-stage ignition, came off as the vehicle passed through the transonic flight zone during first-stage burning. However, flight was apparently not affected by the premature loss of the shield.
- Vibration higher than had been anticipated was recorded toward the end of third-stage burning. No failures were known to have occurred as a result of the excessive vibration.
- Third-stage roll control was overpowered, probably by a torque just prior to burnout. The motor rolled beyond its limits during burning but roll, pitch and yaw control performed normally after burnout.

The July 1 test was the first powered flight of the third-stage *Antares,* a motor developed by Allegany Ballistics Laboratory, a Navy installation operated by Hercules Powder Co., especially for *Scout.* The three other stages are motors adapted from other programs.

NASA said the telemetry showed that performance of the first three stages was completely satisfactory except for the excessive third-stage roll. A spokesman indicated that the next *Scout* test will be held in the last quarter of the year.

General Electric Reduces Tunnel Diode Price 93%

The price of gallium arsenide tunnel diodes has been reduced 93% by General Electric.

At the same time, the company announced five new types of the gallium arsenide devices. The start of a volume market for the newly developed electronic components was cited as responsible for the price cut.

Two older GE gallium arsenide tunnel diode models previously selling for $55 and $85 are now $4.50 and $6 each in large quantities. Prices of the five new gallium arsenide diodes range from $7.50 to $18 each in large quantities.

GE predicted further price reductions as production volume picks up and estimated that tunnel diodes will be selling for under $1 each by 1962.

Production Run Completed For Canadian ASW Planes

The last of 33 Canadair CL-28 Argus antisubmarine airplanes built for the Royal Canadian Air Force under contracts totalling $170 million, rolled off the assembly line last week.

Argus airplanes have been in service with the RCAF Maritime Air Command since late 1957 and on July 1 had flown more than 4,700,000 miles.

On a recent routine mission an Argus was airborne for 26¼ hours and flew about 6000 miles. Developed to meet the increasingly serious threat of long-range submarines, the Argus mounts a highly sophisticated search and attack weapon system.

Dark Horse Douglas Wins 'Missileer'

Douglas Aircraft Co. emerged winner with the much sought-after Navy contract for "Missileer," launching aircraft for the *Eagle* long-range, air-to-air missile.

The award culminated a lengthy competition in which Chance Vought Aircraft and Grumman Aircraft looked by many to be prime contenders. Missileer is the only new military aircraft design proposed by the Pentagon this year.

Combined development costs for Missileer and *Eagle* have been estimated by Vice Adm. J. T. Hayward, deputy chief of Naval operations for development, to run as high as $3.4 billion. The development expert's figure differs with the official Navy forecast of $2.7 billion. Contract amounts for the Missileer development program has not been disclosed.

Missileer will be carrier-based, and although little has been made official, it is expected to fly a continuous air-alert around carriers and provide defense for Marines landing.

Two TF30-P-2 turbofan engines are now under development by Pratt & Whitney to power the subsonic aircraft.

Bendix is prime for the 100-mile *Eagle* missile. Subcontractors include: Grumman Aircraft Engineering Corp., air frame and propulsion; Litton Industries, computer; Bendix systems division, fire control system; Saunders Associates, missile seeker Aerojet General, propulsion and Westinghouse, radar.

mergers and expansions

CHANCE VOUGHT ELECTRONICS will establish a $3.5 million facility in the Great Southwest industrial district between Dallas and Fort Worth. An 80,000 sq. foot building to cost 1.5 million is now under construction. Special equipment costing approximately $2 million will be housed here.

GENERAL INSTRUMENT and GENERAL TRANSISTOR Corp. stockholders will vote on a merger agreement at separate meetings August 30. The agreement calls for the merger of General Transistor into General Instrument, with the issuance of .7 shares of General Instrument common stock for each outstanding share of General Transistor common.

SYLVANIA ELECTRIC PRODUCTS—Advanced Device Research Laboratory of the Semiconductor Division has been moved from Northlake, Ill., to Waltham, Mass. The move was made to bring the laboratory closer to the Woburn headquarters of the Semiconductor Division, where it is expected it will be relocated by 1961.

UNITED CONTROL CORP. adds its third firm this year with the merger of Smith-Florence Inc., a firm specializing in the design and manufacture of laboratory and field-service instrumentation. Smith-Florence, located in Seattle's Commodore Industrial District, will remain a separate organization and be headed by Robert E. Florence, one of the founders of the firm.

A. O. SMITH CORP. has acquired 50% interest in the Bissett-Berman Corp. of Los Angeles. Bissett-Berman was organized by Thomas B. Bissett and Bernard Berman, research scientists who had been associated with Thompson Ramo Wooldridge. The firm will offer advanced electronic equipment for military requirements and some commercial applications.

MB ELECTRONICS, a division of Textron Electronics, Inc. has established a laboratory for calibrating and certifying transducers. The facility reports it is geared to calibrate and ship transducers within two weeks.

HUGHES AIRCRAFT CO. has changed the name of its Airborne Systems Group to Aerospace Group. Included in this unit are engineering and flight test divisions at Culver City, the El Segundo manufacturing division, the communications division and

FIRST CONSTRUCTION contract for this 1000-ft. dia. radio telescope will be awarded this month by the Air Force's Cambridge Research Center. Located below Arecibo on the north coast of Puerto Rico, the $3.2 million mesh reflector will be built within a natural sink-hole to minimize earth removal. An elaborate cable network will maintain the spherical surface within ±0.1 foot. Funded by Advanced Research Projects Agency, Cornell University is prime for the overall program. Total cost for the observatory will exceed $6 million. It is due for completion by July, 1961.

field service and support division at Los Angeles International Airport and missile manufacturing division at Tucson, Ariz. Some 16,000 persons are employed in these divisions.

UNIVERSITY OF MICHIGAN will begin construction on a $1.1 million Cyclotron Laboratory on its North Campus. The laboratory will house a $1.8 million cyclotron, financed by the U.S. Atomic Energy Commission, in addition to the University's present cyclotron.

ELECTRICABLE INC. a new electronic and instrumentation wire and cable manufacturer has been formed in North Hollywood. It will concentrate on bulk production of wires and cables to both military and commercial specifications and specialty material.

DACOM CORP., professional computing service for engineering, research and industry has been established in Buffalo, N.Y. Dacom offers services in stress analysis, shaft vibration analysis, test data reduction, table generation (fans, compressors), structural analysis (two or three dimensional), pipe stress analysis (three dimensional) electrical network analysis. President William H. Mestler reports that the complete staff of MIT is available to the company for support research.

DEVELOPMENTAL ENG. CORP. revealed plans for construction of a new laboratory at Boulder, Colo. DECO's main plant and laboratories are at Leesburg, Va., with executive offices in Washington, D.C.

COOKE ENG. CO. opened new offices last week in Alexandria, Va. The building contains 10,000 sq. feet.

A. T. PARKER & ASSOC. has been formed by A. T. Parker, former chief engineer for Stoddart Aircraft Radio Co., Inc. The Hollywood firm will offer consulting electronic engineering services for manufacturers interested in Radio Frequency measurement and control, especially for those interested in complying with military requirements.

VERNISTAT DIV. of Perkin-Elmer, producers of precision electronic components for space and defense programs, has established facilities at Los Angeles.

MINNESOTA MINING AND MANUFACTURING has purchased Revere Camera Co. of Chicago. The 21-year old firm is a supplier of movie cameras, projectors, recorders and related items. Wollensak Optical Co., Rochester, N.Y. is a subsidiary of Revere.

PORTLAND INDUSTRIES' new president Ira Kamen unveiled plans to develop the Portland, Maine complex into a scientific center for the production of products in space technology and sonar and nuclear fields. Goals of 30 million yearly volume and employment of 3000 people have been indicated.

HYDRO-AIRE CO., producers of controls for aircraft, missiles and trucks, has become part of the recently formed Systems and Controls Group of the Crane Co. Other divisions in the group include Chapman Valve Manufacturing Co., Indian Orchard, Mass., and Swartwout Co., Hooksett, N.H.

VECTOR MANUFACTURING CO. has broken ground for a 25,000-sq.-ft. Space Instrumentation Center in Trevose, Pa. The electronics components manufacturer also has facilities at Southampton and Churchville, Pa., and Grand Prairie, Tex.

financial

Douglas Aircraft Co., Inc.—A net loss of $1.8 million for the second quarter of FY 1960 ending May 31 was reported. Six months loss was $8.8 million, compared with a loss of $15 million for the first half of FY 1959. Total sales for the first half totaled $556.5 million compared with $447.9 million the previous year. Backlog stood at $1.3 billion compared to $1.4 billion backlog May 31, 1959. Missiles and space systems accounted for $503 million compared to $281 million a year ago.

National Research Corp.—Net profit for the first half of 1960 was reported at $99,290, compared to a net loss of $100,534 in the corresponding period last year. Profit for the full year 1959 was $17,356. Sales and income for the 1960 first half totaled $4.5 million, an increase of 43% over the same 1959 period.

Hagan Chemicals and Controls—Six months sales and revenues reached $20 million compared to $18.2 million the same period in 1959. Net income rose to $901,822 from $857,691.

Sparton Electronics Div.—A backlog of $7 million in defense contracts is reported by the division. Approximately $5 million was acquired during the month of June.

Clevite Corp.—First half sales and other revenues were $51.4 million, compared to $42.8 million the previous year's first half. Electronics divisions accounted for 40% of sales and almost half of pre-tax earnings. Combined electronics sales were up 60% from first-half 1959.

Titeflex Corp.—The company, with a history of loss, is converting into stock $5.8 million of indebtedness to Atlas Corp., at the rate of one share for every $25 of principal and interest now owned by Titeflex. Encouraging although small profits were reported by the company in April and May.

National Aeronautical Corp.—Net sales for six months ended May 31 amounted to $3.2 million, compared with $3.34 million for the same period last year. Net income amounted to $316,000 for the 1960 half-year, which falls under the $370,000 reported for the six months ended May 1959.

Aircraft Dynamics International—Aviation Investors of America offers for the first time 99,000 shares at $3 per share. The company sells aircraft spare parts, supplies and equipment to domestic and foreign airlines and air forces. The proceeds of the sale will be applied toward repayment of current liabilities and expanding inventories.

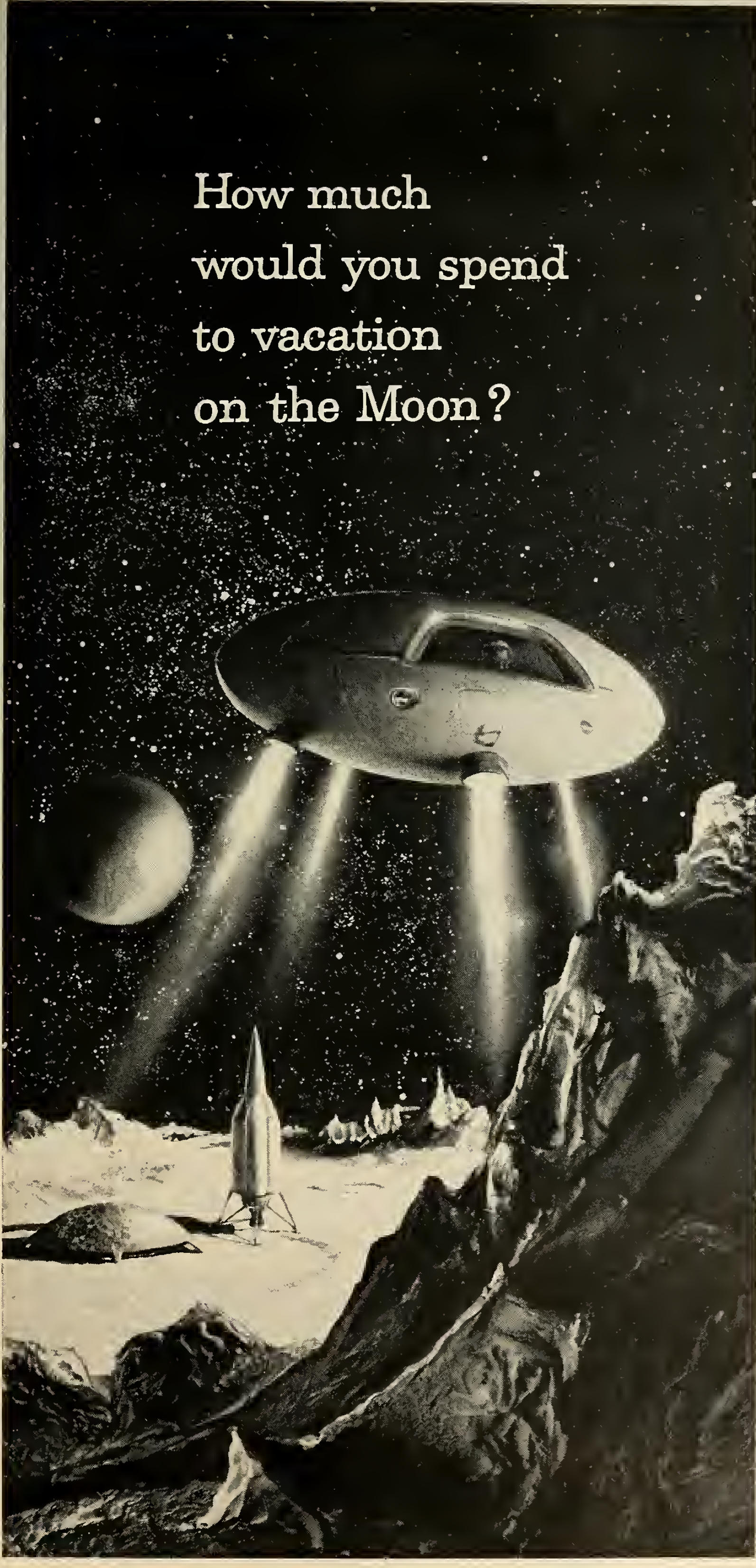
Aerojet to Earn $10 Million

Aerojet General will earn close to $10 million on sales of $425 million for the fiscal year ending November 30, according to vice president and general manager W. E. Zisch.

Zisch told a meeting of the Los Angeles Society of Security Analysists that the General Tire & Rubber Co. subsidiary would substantially increase its FY 1959 totals of $8.2 million income on $364.4 million sales.

Aerojet's six month's record showed a 29% increase in sales, but earnings rose only 16%. Zisch attributed this "profit deficiency" to the "closer competitive position into which all the companies in the aerospace industry are moving."

He marked the cost of sharing research and development work with the Government and emergence of many new companies into the missile field.



Out of today's space research come unexpected by-products —perhaps even space travel for the average citizen . . .

When only explorers dared cross darkest Africa, few foresaw it as a future vacationland. Outer Space now stands in a similar position.

What will Lunar vacations cost? When rocket development is written off and we have nuclear power, a traveler may go for about the present price of a tiger hunt or African safari!

At Douglas Aircraft, builder of the big DC-8 jets, practical steps to bring this about began 14 years ago when Douglas engineers designed and engineered a feasible space platform. Today, with more than 20,000 rockets under its belt—including the *Nike* series and *Thor*, reliable Space Age workhorse—Douglas is deep in a series of space age studies: the moon as a military base . . . compact space huts . . . how will man react to the space environment . . . what useable natural resources to expect . . . and, always, more efficient rockets for military, scientific, and peaceful needs.

The Douglas concept of a *complete* support system has resulted in space research ranging from nuclear rockets to nutrition for space travelers

DOUGLAS

MISSILE AND SPACE SYSTEMS • MILITARY AIRCRAFT • DC-8 JETLINERS • TRANSPORT AIRCRAFT • AIRCOMB® • GROUND SUPPORT EQUIPMENT

Technical Countdown

PROPULSION

Phoenix Goes to 200 Miles

Rocket Power/Talco's *Phoenix* rocket carried an 11-lb. payload to an altitude of 1,067,000 ft. on its fifth flight from Point Mugu last month. The two-stage vehicle was developed at a cost of $150,000 in 3½ months. Operational shots from Wallops Island are scheduled soon.

New High-Energy Solids Show Promise

Three promising high-energy solid propellants have been developed by United Technology Corp. in a company-funded program. Although UTC will not disclose details, one of the three is a polyurethane which, while not a great improvement ballistically, represents a physical step forward. The other two, more exotic, are said to be considerable advances if tests now underway turn out as expected. (See story p. 32).

Polaris Energy 5 Megapound-seconds

Total energy released during full-duration operation of both motors in the interim tactical *Polaris* is more than five million pound-seconds, says Dr. Werner Kirchner, *Polaris* program director at Aerojet. This would indicate booster thrust of something over 80,000 lbs.

Start-Stop Feasible for Hybrid

Marquardt and Grand Central researchers believe they have demonstrated feasibility of instantaneous start and stop in a hybrid solid-liquid rocket. A nitrile rubber binder with aluminum powder and a heavy liquid oxidizer is used. Ignition is hypergolic and shutoff is complete with interruption of oxidizer flow, since there is no oxidizer in the solid grain.

Liquid Stand Tests Solid Nozzles

Aerojet saves money on testing nozzles for solid rockets by using a liquid-rocket test stand. Aluminum powder and other bits of solid matter are fed into the propellant mixture to simulate a solid-rocket flame—thus postponing the cost of casting a solid grain until later in the test program.

ELECTRONICS

IR to Measure Atmospheric Temperatures

Laboratory instrumentation to study the feasibility of a satellite-borne infrared spectrometer that would measure atmospheric temperatures is being developed by Barnes Engineering. The nine-month job, to be completed next March, will be done under an $80,000 contract with U.S. Weather Bureau.

Low-Noise TWT Developed

A 2.8 db terminal noise figure is being claimed by RCA for a modified production-line traveling wave tube. Such a noise performance improvement would significantly increase sensitivity and range of systems using TWTs.

Satellite Weathermen Sought

A new breed of meteorologist is being sought by the U.S. Weather Bureau to do research on interpretation of data from *Tiros* and future weather satellites. Positions open for meteorologists and physicists at Suitland, Md., will pay up to $10,635.

Doppler Radar Weather Techniques Developed

A method of using doppler radar data to extract meteorological information has been developed by Cornell Aeronautical Laboratory. Statistical formulas applied to the doppler spectrum from weather targets yield data on wind velocity, air turbulence, and precipitation rates.

GROUND SUPPORT EQUIPMENT

VERLORT Radars for Mercury

Delivery has begun on VERLORT (very long-range tracker) radars for Project *Mercury*. The Reeves Instrument trackers are reported to be capable of much higher precision than any previous long-range equipment.

China Lake Tracking to be Improved

Navy will streamline and modernize its EDP and missile-tracking equipment at NOTS China Lake under a new contract with Cubic Corp. Primary improvement is addition of a data digitalizing system to operate with present missile intercept data acquisition equipment and provide almost-instantaneous performance information.

ASW ENGINEERING

Raytheon ASW Center Begins Operation

Raytheon's Antisubmarine Warfare Center at Portsmouth, R.I., began operations last week with about 450 employees. Work of this integrated industrial facility, among other things, will be "triple-threat" sonars going on Tullibee and Thresher. Raytheon also is managing the 9 NATO nation ASW research center at La Spezia, Italy.

ADVANCED MATERIALS

Ti Scrap Recovered in Unique Furnace

Single pours of titanium up to 550 lbs. in weight have been achieved in a helium-cooled furnace at National Research Corp. The unique furnace combines the features of skull melting by permanent electrode with vacuum melting by consumable electrode.

Powder Metallurgy Boosts Tube Life

Electron tube cathodes fabricated by compacting metal powders of closely controlled composition have increased reliability, uniformity, and life span, according to Sylvania Electric. The procedure permits a high degree of control over the reducing agents.

Moly Drilled Without Crumbling

Picatinny Arsenal engineers have been drilling perfect 20-in. holes in molybdenum using commercial electrical discharge equipment and a copper-tungsten electrode. The cavity races through the moly at one inch per hour but generates little heat in the workpiece.

Hydrogen Embrittlement Eliminated

Forty-five minutes in a tumbling barrel containing water, a promoter chemical, an impact medium, and a specially prepared metal powder will result in corrosion-resistant metal-plated parts. The ingredients were whipped up by Minnesota Mining and Manufacturing and aimed at the plating of small complete parts and assemblies.

Parachute Recovery Systems Being Refined

Cook Electric leader in competition to recover big Saturn space booster

by Charles D. LaFond

FROGMEN ASSIST in first recovery of a *Jupiter C* nose cone. Cook's recovery package is attached to base of cone.

THE DEVELOPMENT and successful operation of parachute recovery systems represent an indispensable ingredient in missile/space technological progress.

By far the acknowledged leader in this field is Cook Electric Company's Research Laboratories, Morton Grove, Ill. Its record of accomplishment is difficult to refute since every ballistic missile nose cone recovered in the Free World so far has employed a Cook recovery system.

Among the many "firsts" chalked up by Cook are recovery of *Jupiter C* nose cone (1957), *Thor-Able* ICBM range re-entry cone (1959), full-scale *Atlas* cone, and instrumentation cassette from *Titan* nose cone.

An outgrowth of its early parachute research and development work, recovery systems research has also spawned a flock of test missiles at the Center: *Skokie, Hopi, Sioux, Cherokee, Portland* and *Cree.* Cook's Tomahawk supersonic test sled is another of its offspring along with five other special-purpose rocket sleds.

Employing FIST Ribbon parachutes, single and clustered, deployment inflated bags, and many other types of chutes (ring slot, solid flat, equiflo, airfoil, torus, etc.), recovery system configurations can vary, depending on the particular need. Retro-rockets often provide extra deceleration capability, as does normal vehicle drag.

But, regardless of the configuration the essential requirement is that the system permit safe recovery.

• **Special test vehicles**—Early sled programs were started in 1950 to investigate sub-, trans-, and supersonic regimes. Later developments of a subsonic "whirl" tower and the unusual Tomahawk rocket sled contributed in no small measure to the division's rapid accumulation of parachute test data.

Located on a mesa, a unique monorail track permitted some of the first supersonic tests of parachute recovery by running the sled off a 1500-foot cliff before chute deployment. Track length is 10,000 feet.

The *Skokie* is a 32-foot near-sonic research vehicle loaded usually with cameras, electronic measuring and recording equipment. A free-fall missile, it is provided with a 3-in. diameter chrome steel spike on its nose to facilitate location and to minimize damage on impact.

Hundreds of B-29 dropped *Skokie* tests over the Mojave Desert have been made from Edwards AFB during recent years to test parachute stability and performance characteristics.

Cherokee, a supersonic, rocket powered, air launched missile, is a special-purpose vehicle designed for pilot ejection and recovery systems testing. *Cree,* is a high altitude, high mach JATO boosted vehicle used to test clustered parachutes.

• **Past successes**—The variety of parachute-type recovery system applications handled by CRL has been very broad. These include:

–Re-entry nose cones
–Missiles
–Missile-dropped cameras (from *Navajo*)
–Instrumentation and equip. drops
–Bomb stabilization and deceleration
–High-mach stabilization and deceleration
–Pilot ejection
–Radiosonde rocket air-launch platform stabilization.

One of the first major nose cone recovery packages developed by Cook was for the Army Ballistic Missile Agency, Huntsville, Ala. This started with a test system for a *Jupiter* scale-model nose cone recovery and climaxed with the first re-entry nose cone recovery ever made—the *Jupiter C* cone and its instrumentation in August, 1957.

Another early recovery system was one designed to retrieve a camera and instrumentation package ejected from the *Navajo* ICBM. The system was deployed by an aneroid at a predetermined altitude.

Later, during the IGY, seven *Nike-Cajuns* were used for obtaining upper-atmosphere data photographically. Carried in the nose cone, the sealed capsule was recovered after 73.6 mile drop. A dive brake and parachute were used to recover the 85-lb. nose section. Six successes were recorded.

Other major recoveries include 1 *Atlas* ICBM, and 2 *Thor-Able* re-entry nose cones and 2 *Titan* ICBM data capsules.

Also included in this recovery record is the now famous *Jupiter* nose cone carrying the two primates, Able and Baker. Both were recovered in May, 1959, in fine shape following their 1500-mile ballistic ride.

• **Future hopefuls**—Cook will need all of its past experience and then some for the many future recovery tasks it hopes to tackle.

With proposals out for *Titan* and *Minuteman* nose cones and *Saturn* first stage booster recovery systems, CRL at the present time must concentrate on immediate needs.

It is designing a *Redstone* booster recovery package and one for the *Pershing* nose cone is in the early stages of development.

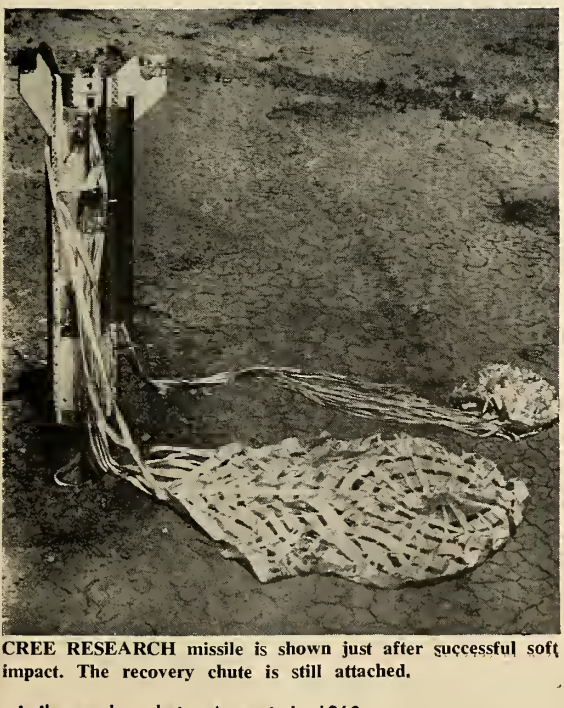
There is one recovery that still has never been made—the *Discoverer* stabilized space vehicle. Recovery system is a Cook product, but actual recovery involves an aircraft pickup in the air. After 12 attempts the score is still zero.

Probably the biggest system for the future will be that for *Saturn's* big booster. This will employ a balloon for initial stabilization, parachutes for deceleration and finally retro-rockets for zero-acceleration impact. It is not expected that the entire booster will be reusable, but that parts saved might make the effort worthwhile.

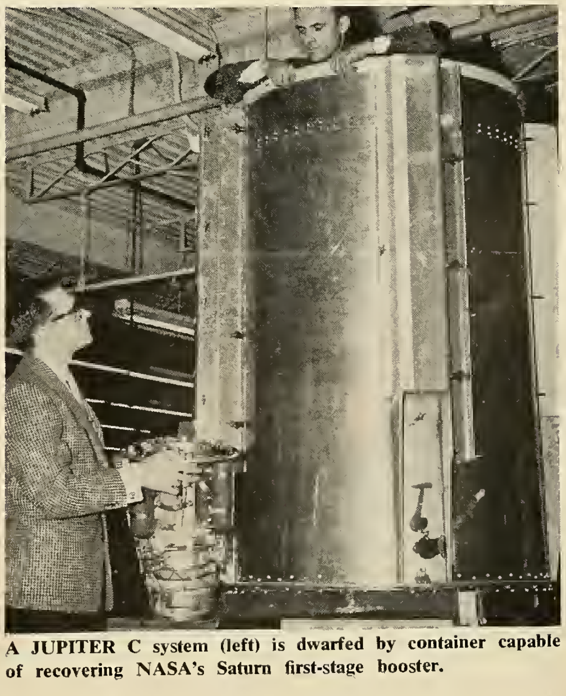
In NASA's *Mercury* project lies the toughest of all recovery problems—returning its human passenger safely. This is one recovery package that must function as designed. CRL has contributed much of its experience to development of this package.

A dual system is provided: one for ejection in case of malfunction during launch, the other for recovery after re-entry. Lift rockets will remove the capsule several thousand feet away before the drag and main chuts return the astronaut to Earth. Also included for recovery are retro-rockets for initial deceleration and a landing bag (inflated) for cushioning and buoyancy.

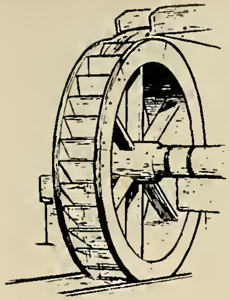
Primary drag for the capsule will be the capsule itself.

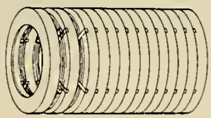


CREE RESEARCH missile is shown just after successful soft impact. The recovery chute is still attached.



A JUPITER C system (left) is dwarfed by container capable of recovering NASA's Saturn first-stage booster.





Solar energy conversion: Through recent advances in materials and electronics, we are on the threshold of a new era of energy utilization. By concentrating solar radiation into the cavity of a thermionic converter, electrical power is generated directly from sunlight without moving parts or circulating fluids. This freedom from earthbound energy sources promises far-reaching applications in space exploration. Artist's concept shows the unfolding of a solar collector mirror with its central power package which would be attached to various types of space vehicles. Lockheed's design of a thermionic converter operating model is shown at left. The water wheel depicts one of man's earliest known forms of energy conversion.

THERMIONICS

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

The development of new techniques in energy conversion is typical of the broad diversification of work at Lockheed Missiles and Space Division. The Division possesses complete capability in more than 40 areas of science and technology – from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists.

Exploration into unknown areas such as Thermionics, provides endless stimulation to imaginative scientists and creative engineers. Research at Lockheed's Missiles and Space Division covers the entire spectrum – from pure basic research to development work, in support of current projects. Thermionics is but one phase of Lockheed's complete systems capability in missiles and satellites. To maintain this position of leadership calls for an extensive research and development program – ranging from electrical propulsion research to advanced computer research, design and development. Typical current projects are: Man in space; oceanography; fuel cells; space station; space navigation; solid state electronics.

Engineers and Scientists: If you are experienced in work related to any of the above areas, you are invited to write: Research and Development Staff, Dept. H-29A, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / MISSILES AND SPACE DIVISION

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Missouri Town Makes Rocket Engines

Reliable Rocketdyne powerplant for Jupiter, Thor, Atlas produced at Neosho; plant employs 1100, purchases from 1500 suppliers; new alloy improves pumps

STEAM CLEANING of chamber is necessary to meet rigorous cleanliness requirements of Atlas engines. Workman tightens connection to chamber manifold.

by Jay Holmes

NEOSHO, MO.—One of the world's most reliable rockets, an engine without a name, is produced in undisclosed numbers at a plant employing 1100 persons outside a tiny community in southwest Missouri.

Rocketdyne Division of North American Aviation produces the liquid-propellant rocket that serves as powerplant for the *Jupiter* and *Thor* and as booster for the *Atlas* at a government-owned installation on the grounds of Ft. Crowder, a now inactive Army camp.

Military code designations are all the LOX-kerosene engine has for a name. As *Atlas* booster, the latest version is called XLR-89-NA-5. As engine for the Army *Jupiter*, it is the S3D.

Whatever the designation, it was rated originally at 150,000 lbs. thrust, with tanks for burning 160 sec. in the basic *Thor*. Recently, the engine has been upgraded to 165,000 lbs. to improve the *Thor* and give *Atlas* a longer range. A further modification, designated H-1, has been souped up to 188,000 lbs. thrust for clustering into the *Saturn* booster.

Rocketdyne performs research and development work on this and other engines at Canoga Park, Calif. When they go into production, activity shifts to Neosho. However, the 57,000-lb.-thrust, four-minute-burning *Atlas* sustainer is produced at Canoga Park.

Earnest A. Wright is manager of the Neosho plant, which has about 250,000 sq. ft. of floor area, a two-stand engine test area and a separate area for testing pumps, generators and vernier engines. Wright says the improvements developed in the engine recently have been introduced to production models, both of *Atlas* booster and *Thor* powerplants.

The improved *Thor* engine, which Rocketdyne designates "Block 2," will be used for space experiments. Further improvements have been made in the *Atlas* booster. Rocketdyne calls the latest version MA3.

• **Ameliorations**—Wright said the *Thor* improvements include simplified valving, substitution of a pyrophoric igniter for a pyrotechnic igniter and the increase of pump capacity to increase thrust. He explained that the new igniter uses tri-ethyl aluminum in the fuel line with a cartridge on either side.

When the pumps start, fuel pressure breaks one cartridge, and the igniter fuel flames up on contact with air. Regular fuel following behind the second cartridge is ignited by the triethyl flame. Meanwhile, LOX feed begins a few milliseconds later, at which time thrust has reached 90%.

The *Atlas* MA3 saves weight by using fiber glass wrapping instead of steel bands to reinforce the thrust chamber and reduces the number of components further. This is partly achieved as a result of a new control system that uses fuel from the missile itself to operate the engine sequences, instead of pneumatic and hydraulic sequences as in earlier models.

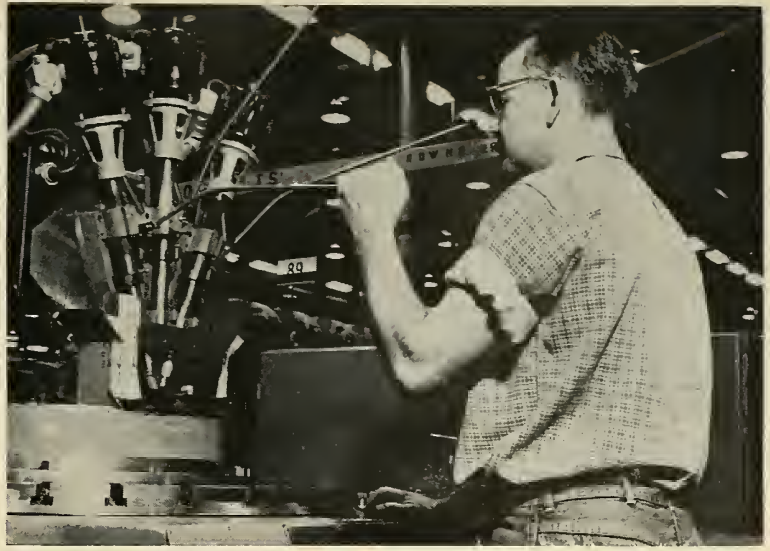
• **Many suppliers**—Production at Neosho begins in the receiving department. Rocketdyne bought $9,953,394 worth of parts, components and raw materials last year from slightly more than 1500 suppliers. More than one-third of the purchases were within an immediate four-state area (Missouri, Kansas, Oklahoma and Arkansas) within 150 miles radius. Of all purchases, 40.8% were from companies with fewer than 500 employes.

Much of the work given to subcontractors is on small metal parts, particularly when the plant machine shop is overloaded. Rocketdyne says many small machine shops in the area do extremely high quality work.

One example is Sibley Engineering & Manufacturing, a 19-employe firm in Sulphur Springs, Ark., whose chief product is a gizzard skinner used widely in the poultry industry. The owner, Milton Emanuel, is a former employe of a meat-packing company.

Another subcontractor, Claude Roderick of Monett, Mo., proprietor of Roderick Arms Tool Co., is in the rifle business, but does machine-shop, tool and die work for Rocketdyne.

A typical day's incoming shipments at Rocketdyne include: a lubricating pump from Pesco Products, forgings from Harvey Aluminum and American Brake Shoe, a valve assembly and an oxidizer check valve from Valley Bolt Corp., valves from H. W. Loud Machine Works, flex hose from Titeflex Inc., lubrication tank from Weldfab Inc. and servovalve and actuator from Moog Valve Co.



AUTOMATIC INDEXING machine used to drill holes in injectors, assures proper alignment, accurate angle. Tape control makes products identical.

Between 800 and 1000 different parts are manufactured in the Neosho plant machine shop, headed by General Foreman H. A. Eathorne. Many kinds of metal are machined.

• **New alloy**—One of the newest is an aluminum alloy developed by North American, called Tens 50. Castings of the new alloy are machined into the unusual shapes needed for the volutes in turbopumps. Tens 50 is harder and has greater strength than the aluminum alloy formerly used. This is a major factor in the uprating of pump capacity, which made it possible to increase thrust.

Another such change was a switch to Tens 50 from another grade of aluminum in the turbopump gear case. Also, the number of parts was reduced by switching from two pieces to one.

Hundreds of operations are involved in machining the complex gear case. The job takes weeks to complete. Work is programed so that different phases go on simultaneously.

"Tape-controlled machines come into their own on jobs like this," Eathorne says. "We get precision and repeatability. And we save on personnel costs."

In other changes in uprating the pumps, the inducer material went from plate 2024 aluminum to die-forged 2014 aluminum, and the impeller went to Tens 50 from another grade of aluminum. The inducer, which looks like a four-bladed outboard motor propeller, spins to maintain the flow of liquid into the pump. The impeller, inside the pump, does the main job. Alcoa supplies the aluminum forgings.

Other major parts machined in the Rocketdyne shop include a die-forged aluminum thrust chamber dome, the main injector of hand-forged 4130 steel, with its 3000 holes, and aluminum and stainless steel special fittings and crosses.

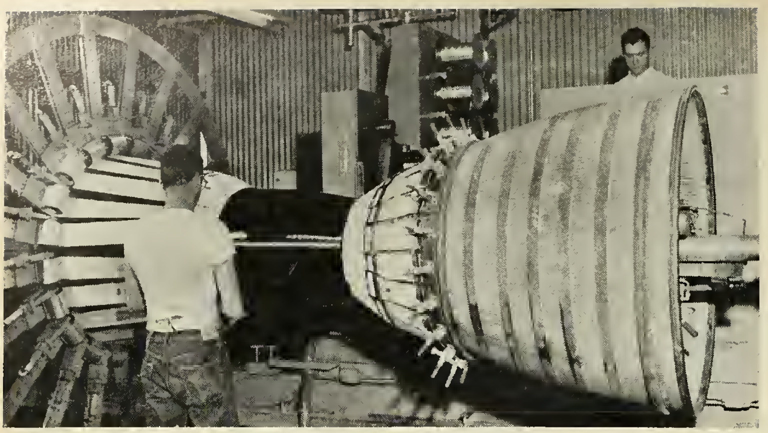
D. B. Gore, chief of engineering, says the Tens 50 alloy patented by North American was originally called T42. Variations of Tens 50 have 0.2% offset yield strength averaging 35,000 psi. Ultimate tensile strength averages 43,000 psi.

Tens 50 is the same as aluminum alloy 356-T6 except that it has 1% higher silicon content and a little beryllium. The composition is aluminum plus 7.6-8.6% silicon, 0.4-0.6% magnesium. 0.1-0.3% beryllium, 0.1-0.2% titanium and traces of several other elements.

The largest component of the engine, the thrust chamber, is produced in the metal fitting, welding and processing department, headed by General Foreman Frank Holkenbrink. This department also does all sheet metal work.

Assembly of the thrust chamber starts with 292 formed cooling tubes of pure nickel, chosen because it is very ductile and a good heat conductor. The tubes are stacked on a torch-weld jig and brazed together with silver solder. Silver was selected for its extremely high heat conductivity and relatively high strength.

In brazing, production workers start at the narrow throat and work both forward and backward, so that the combustion chamber and exit cone are reached simultaneously. To reinforce the tail cone, 4130 steel bands are used.



FIBER GLASS WRAPPING applied to the thrust chamber of Atlas MA-3 engines replaces heavy steel bands, reducing weight but keeping same strength as steel.

In the older design, 3/16 in. bands reinforce the combustion chamber and 11 bands 1/16 in. reinforce the tail cone. In the newer design, glass wrapping replaces all steel bands in the chamber area.

Holkenbrink outlined these subsequent steps in fabrication:

- Seal tube ends. At rear connect adjacent pairs. At front end, mill slot in every other tube and seal its end. Leave other tube open for feed to injector.
- Attach thrust ring to front end and machine it.
- Weld manifold on.
- Attach bands and ring to manifold.
- Pressure test to 1000 psi prior to glass wrapping.
- Insert expandable mandrel inside chamber.
- Paint seal coating on chamber to give good surface.
- Attach fiber glass strips, soaked in epoxy resin, lengthwise at 18° intervals.
- Wind fiber glass wrapping.
- Rotate 9° and attach another 20 lengthwise strips spaced between first set.
- Wind another layer of fiber glass.
- Cut off ends of strips.
- Attach fittings and wrap on with fiber glass.
- Bake in oven.
- Clean, paint and deliver to assembly.

In the assembly area, headed by General Foreman C. W. Bright, the first step is trimming impellers for the required power curve. Since thrust was uprated, the trim must be different from that in earlier models.

"From experience, we know within a few thousandths of an inch what the trim will be," Bright said. "One final trim is usually needed."

Bright listed these subsequent assembly steps:

- Mate impeller to gear case.
- Pressure-check and cold-check LOX line with liquid nitrogen.
- Hot-fire turbopump at test area.
- Leak-test and visually inspect pump on return.
- Test thrust chamber in water flow and calibrated for pressure drop.
- Calibrate and flow-check injector.
- Build up gas generator and test in hot-test area.
- Mount turbopump, injector and gas generator onto thrust frame.
- Link components with hoses and lines.
- Check out electromechanical connections.
- Test sequencing and for leaks.
- Hot-fire engine in test area.
- Make second electromechanical checkout at shop; optically verify that geometric center of thrust chamber is within prescribed tolerances.
- Inspect torque valves for leaks; verify complete procedures.
- Ship to customer.

A similar but less involved procedure is used in manufacturing vernier engines, the only other major item produced at Neosho. The vernier develops 1000 lbs. thrust that gives the *Atlas* and *Thor* their final velocity. Two engines are used on each missile; the *Jupiter* has none. The vernier weighs between 75 and 80 lbs.

The main difference between *Thor* and *Atlas* verniers is in the way the vernier is attached to the missile. In earlier models, designated Block 1, the vernier was ignited pyrotechnically. The Block 2 vernier uses a pyrophoric mixture of tri-ethyl aluminum and tri-ethyl boron.

Thor Engine Performance Data

Propulsion System	Actual (in qualification test)	Nominal
Thrust, lbs:	166,552	165,000
Specific Impulse, sec:	250.6	251.2
Mixture Ratio, o/f	2.308	2.300
Thrust Chamber & Propellant Feed System		
Thrust, lbs:	166,052	164,500
Specific Impulse, sec:	255.8	255.6
Characteristic Velocity, C*	5833	5848
Thrust Coefficient, C_F	1.411	1.406
Oxidizer Flowrate, lb/sec:	460.3	455
Fuel Flowrate, lb/sec:	189.0	188.5
Mixture Ratio, o/f	2.435	2.414
Chamber Pressure, psia	576	571
Fuel Pump Discharge Pressure, Total psia	879	830
Oxidizer Pump Discharge Pressure, Total psia	929	885
Verniers		
Total flow, lb/sec:	9.797	9.640
Mixture Ratio, o/f	1.725	1.800

Navy Builds Arc Furnace For Materials Research

Temperatures up to 27,000°F can be created with a new arc furnace being tested at the Naval Ordnance Laboratory, White Oak, Md.

The high-intensity arc will be used to study and develop new materials for missiles.

The furnace consists of a rod-shaped anode and a doughnut-shaped cathode surrounded by a plastic chamber. The plasma passes through the cathode. A stream of water whirled around the electrodes forms a core, or hollow vortex, which restricts the diameter and intensifies the electric arc.

The water also furnishes material to be heated and discharged through the hollow cathode as plasma. The hot gas is then directed against a material sample.

Noise levels up to 140 decibels are produced by the high-velocity movement of the plasma through the cathode orifice. Acoustic insulation will be used to reduce this to an acceptable level.

wanted:

engineers, physicists and mathematicians

FOR CAREERS WITH

GUIDED MISSILES RANGE DIVISION

PAN AM

in Florida

Pan Am's Guided Missiles Range Division (*GMRD*) is a technical organization with operations at Patrick Air Force Base, Cape Canaveral and the chain of down range tracking stations through the Carribean to Ascension Island.

For the past seven years, GMRD has been responsible for planning, development and operation of the Atlantic Missile Range—the largest and most complex test range in the world.

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PROPELLANT mixing station with 200-gal. capacity goes up at UTC's Coyote Calif., center. Control center is at left.

UTC Aims for Big Rocket Competition

Test stand for 2-million lb. thrust engines being built; careful R&D planning is basis of new company's 'catch-up' program

by William J. Coughlin

SUNNYVALE, CALIF.—A test stand capable of handling solid rocket motors of up to 2-million pounds thrust is scheduled for completion by the end of the year on United Technology Corp.'s test site in the mountains south of here.

The stand will be one of four at the 3200-acre development center. Of these, at least one will be for liquid engines.

With work well underway on its first rocket engine contract, UTC thus is setting the stage for rapid expansion in the fields of solid and liquid propulsion.

The new company is basing its move on a carefully-planned research and development program which it is confident will create the basic strength needed to make the firm a major competitor in the field.

"We think we will be strong competition to some of the folks who got started ahead of us," says president Donald L. Putt.

United Technology was set up as a subsidiary by United Aircraft to extend that company's interest in propulsion to the rocket field.

PUTT

ADELMAN

"We realized it took a whole new breed of cat," says a United Aircraft official. UTC's function is described as a research and development and pilot plant operation.

• **Contract from NASA**—Its first contract was announced last month with the National Aeronautics and Space Administration for demonstration of the feasibility of a segmented, conical-shaped, solid propellant rocket motor. (M/R, June 6, p. 15; June 13, p. 35).

Design, fabrication and testing of three experimental engines will be carried out at UTC's new research and engineering center here and its development center some 13 miles southeast of San Jose.

The first unit at the development and test center went into operation this month, a 200-gal. propellant mixer station and its adjacent remote control center. More than 60 structures are to be completed there by the end of the year.

Testing of small liquid and solid propellant rocket engines has been underway at the site since the first of the year. More than 71 such tests have been carried out.

Although interested in liquids, UTC has concentrated to date largely on solid propellants and solid propellant propulsion systems. It has developed some extremely promising high-energy propellants, but declines to give details of these other than to say they offer much higher specific impulse.

One of the three whose development appears promising is a polyurethane which is not a great improvement ballistically but represents a step forward physically. The other two are said to represent considerable advances and are more exotic.

"It's a big step from mixing these in the lab to mixing them for big motors," says executive vice president Barnet R. Adelman. "In four to six months, we may be justified in saying we have something pretty good."

Adelman says particular emphasis in the solid field is being placed on the synthesis of propellant ingredients, both organic and inorganic. In addition, he says, close attention is being given to development of advanced processing techniques.

• **Storable liquids**—UTC's interest in liquids is in other than cryogenic propellants, which will be left to Pratt & Whitney's Florida plant. Major attention in liquids is to storables and to systems using storables.

The effort in this field will include design and development of mechanical and electronic components for these systems.

According to president Putt, the firm will limit its work in storable liquid systems to those of not more than 25,000-lb. thrust. Larger applications will be handled by Pratt & Whitney.

"We think there is a market for motors of this size in upper stages, space boats and the like," says Putt.

The solid propellant plant at the test site, in addition to being a pilot plant, will also be what Putt calls a "manufacturing development" plant to work out manufacturing techniques.

This will give the company an incidental manufacturing capability of ½ to ¾-million lbs. per month of propellant. If a requirement for quantity propellant manufacture develops, present thinking is that it will be set up in Florida.

"But on large motors where the quantity is relatively small, say, one a month, we probably could handle that here," Putt says. The plant will have the capacity for casting and curing the largest rocket motors now contemplated.

• **Room for solids & liquids**—"We don't want to get typed as either a solid or a liquid outfit," the company president declares. "There are places for both of them. We want to remain flexible to propose and develop either one as needed."

UTC also is interested in other forms of propulsion and has carried out studies in the nuclear, ion and plasma fields. Efforts in these directions are expected to increase as the firm expands.

When United Aircraft made its move into the rocket propulsion field last fall, it lined up a top scientific and engineering staff to direct the effort, to be concentrated initially on research.

"We felt there was still a lot of fundamental research to be done and we wanted to have a strong research base," a spokesman says.

Putt, at the time of his retirement from the Air Force was Deputy Chief of Staff, Development, and a lieutenant general. He was chairman of the Scientific Advisory Board to the Chief of Staff and was president this year of the Institute of Aerospace Sciences. He was a former commander of the Air Research and Development Command.

Executive vice president Adelman was director of the Vehicle Engineering Laboratory at Space Technology Laboratories, Inc., before going to UTC. While there he had project management functions for development of the engines for the *Atlas, Titan* and *Thor* and was also responsible for establishment of initial solid propellant rocket engine development programs which led to *Minuteman*.

Chosen as vice president and director of the research division was Dr. David Altman, manager of the Vehicle Technology Laboratory for Aeronutronic Systems, Inc., at Newport Beach. He previously had served as chief of the chemistry and physics section of Cal Tech's Jet Propulsion Laboratories.

Herbert R. Lawrence, vice president and director of the engineering division, arrived at UTC from a position as associate director of the Astrovehicles Laboratory of Space Technology Laboratories, Inc.

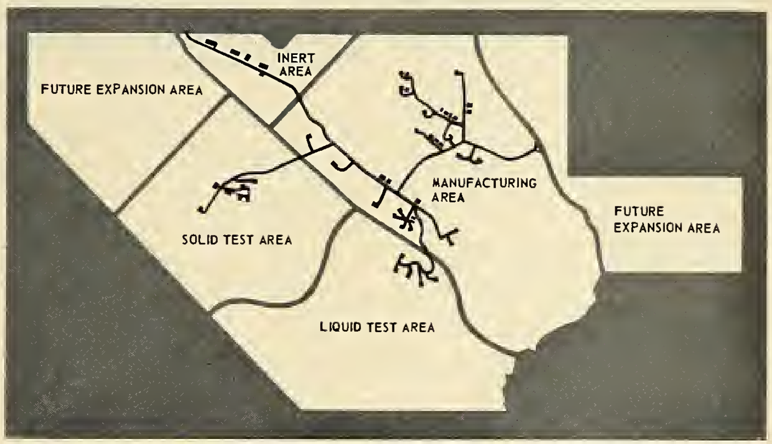
Around this team, UTC built its technical staff. Employment at the company now is approaching 300—more than half professional and technical people. Employment is expected to reach 1000 sometime late next year.

• **Initial research farmed out**—To get started quickly, United Technology contracted with Stanford Research Institute to do some of its initial propellant research. That arrangement still continues.

SRI has a 12-15 man group working exclusively for UTC on the development of new high-energy solids at its 14,000 sq. ft. Calaveras facility.

United Technology also is carrying out considerable basic materials research on nozzles, binders and other components of rocket propulsion systems. Extensive studies are being made of the physical properties of metal alloys, ceramics, plastics and plastic composites. Special basic research emphasis is being placed on thermodynamics and combustion of liquid and solid propellants.

The engineering division includes a strong organization for the analysis of complete weapon systems.



UTC will have constructed 60 buildings by '61 on this 3200-acre site.

"We probably will not be interested for some time in the development of complete weapon systems, if ever," Putt says, "but we need these studies to guide our efforts in the propulsion field."

In addition to its NASA contract, United Technology also backed its segmented concept with a bid on the Air Force's Project 3059 solid engine study which went to Aerojet-General.

The firm also has small proposals out in the research field, on materials, on new methods of vector control, and on new nozzle designs, particularly in regard to nozzle cooling.

From this relatively modest start, Putt and his colleagues are convinced United Technology Corp. will grow steadily, based on a combination of its own R&D capabilities with the hardware capabilities of United Aircraft's Pratt & Whitney division.

Data System Speeds Engine Development

Delivery of a new air/ground data acquisition and processing system to Edwards AFB, California, should result in a speedup of the Air Force's B-70 Valkyrie turbojet engine development.

Developed and installed by Radiation, Inc., Melbourne, Fla., for General Electric's Flight Test Center at Edwards, the new facility is expected to reduce significantly flight-test time and costs not only for the J93-3 engine but for other advanced GE jet engines.

With award of the contract to RI in early 1959, development was well underway by April and first elements of the giant complex were delivered in January, 1960. The installation although completed will undergo extensive testing over the next few months.

DATA PROCESSING CENTER developed by Radiation, Inc., for B-70 engine test and analysis is now completing test operation at General Electric's Flight Test Facility, Edwards AFB, Calif.

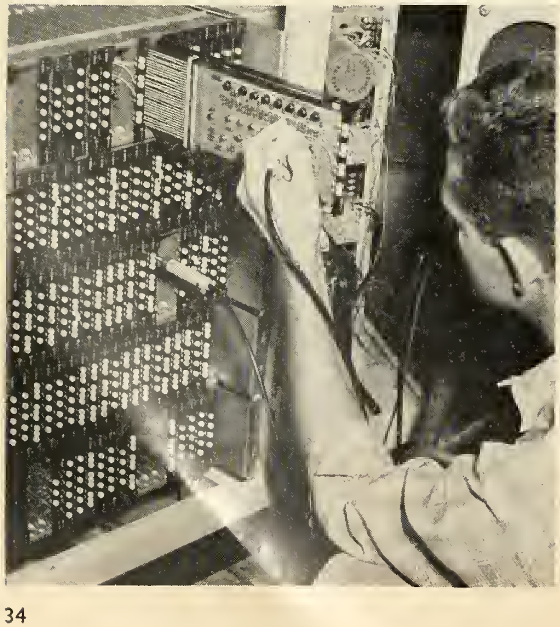
• **Mutt & Jeff contrast**—Size of the airborne data acquisition system is roughly 3.5 cubic feet and weighs about 180 pounds. It offers a startling contrast to its mate, the ground data processing center.

Occupying some 1600 square feet of floor space, the data processing facility is comprised of 26 rack mounted equipments and control consoles.

For high-speed and more accurate operation the system employs pulse code modulation (PCM) as the primary data recording mode.

A multiplicity of transducers will collect in-flight test data on magnetic tape. Critical fuel-flow, temperature, pressure, blade-stress, and engine-control-transient data are among the list of performance factors necessary to analyse GE's J93-3 engine.

During processing, selected data will be displayed visually at the ground complex. Others will be recorded for permanent readout on strip charts. Many of the data sequences will be translated automatically into formats for later analysis by the electronic computers.



SYSTEM FLEXIBILITY and reliability are achieved in ground facility equipment by the use of these standarized printed circuit cards and preprogrammed patchboards.

Both analog and digital techniques are employed. Analog wide-frequency data above 200 cycles can be recorded to an accuracy of 1% using frequency modulation techniques.

• **Two-speed collection**—Digital data can be collected and processed at either of two rates—10,000 or 20,000 samples/sec. with even finer accuracies, said RI engineers. Nearly 80% of test data to be collected will fall in the 0—200 cycle low frequency range.

The recorder in the airborne unit can handle 14 analog channels across 1-in. magnetic tape. It also permits substitution of 16 digital channels for 7 of the analog channels.

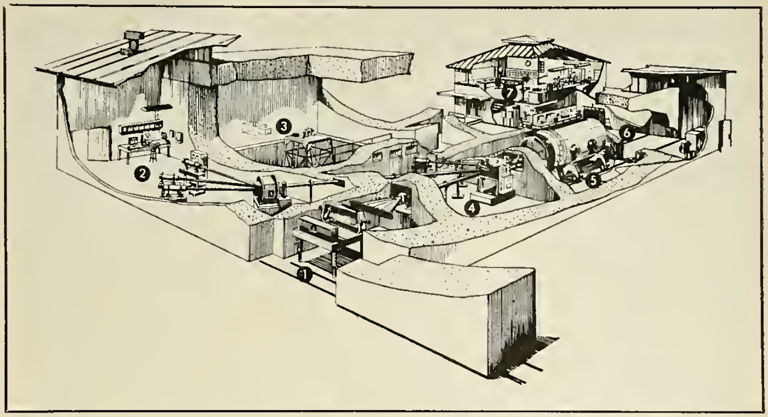
To eliminate the need for preamplifying low-level outputs before multiplexing, RI's advanced multiplexer (see M/R, February 22, 1960) is included in the airborne system. (This subsystem accurately detects weak signals and requires only one amplifier behind it.)

Designed for flexibility, the system will also be used to test other advanced GE high performance engines. For inflight tests GE's J79 and J85 jet engines will be among the first.

When the B-70 engines will be flight tested remains in doubt. However, it still will be installed in a pod beneath the fuselage of a B-58 jet bomber, but funding for flight-test program has been slashed.

For the future, GE's new test system might readily be adapted to missile flight testing with the introduction of telemetry units, say RI officials.

Industry Space Test Facilities Expanded



SPACE RADIATION research facility to be built by Convair will be equipped with 3-megavolt, 30-kilowatt electron/ion accelerator to study radiation effects on electrical components, guidance and control systems of nuclear propelled vehicles. Areas identified: 1) irradiation cell for conducting studies in radiation or structural damage to electronic components, and systems in nuclear vehicles; 2) nuclear physics experimentation area; 3) test area to investigate neutron interactions with nuclei; 4) steering magnet which directs accelerator beams to appropriate test cells; 5) accelerator; 6) accessory room for operation and maintenance of the accelerator; 7) control room.

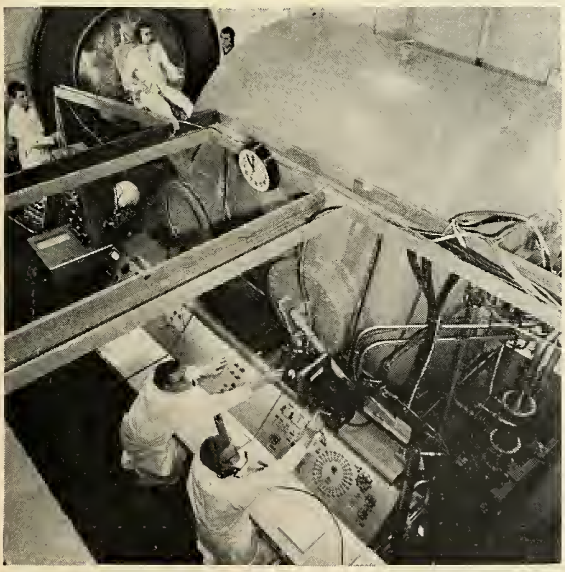
Convair, Boeing Sink Millions into Research On Space Hazards

NEW AND BIGGER space flight test facilities are the order of the day for the U.S. missile/space program. Industry and the military have recently announced several new facilities—much larger and of greater capability than anything previously available.

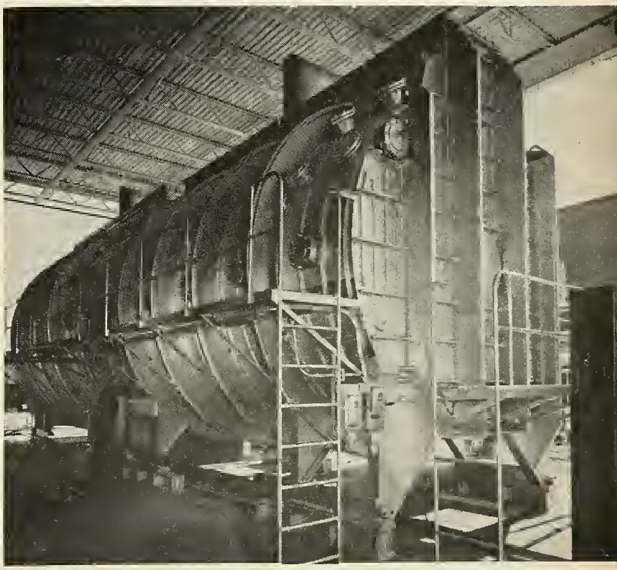
Convair has made two big additions to its space research facilities: high-performance vacuum chambers for simulated altitudes of up to 100 miles, and a space radiation research lab. A smaller tank capable of 250-mile altitude vacuum went into operation a short time ago (M/R, 7/25/60).

U.S. Steel will build for Edwards AFB an inertia-measurement platform capable of putting complete aircraft and missiles through yaw, pitch, and roll motions. Full-sized vehicles weighing up to 300,000 pounds can be tested on the 110 by 80-foot cruciform platform.

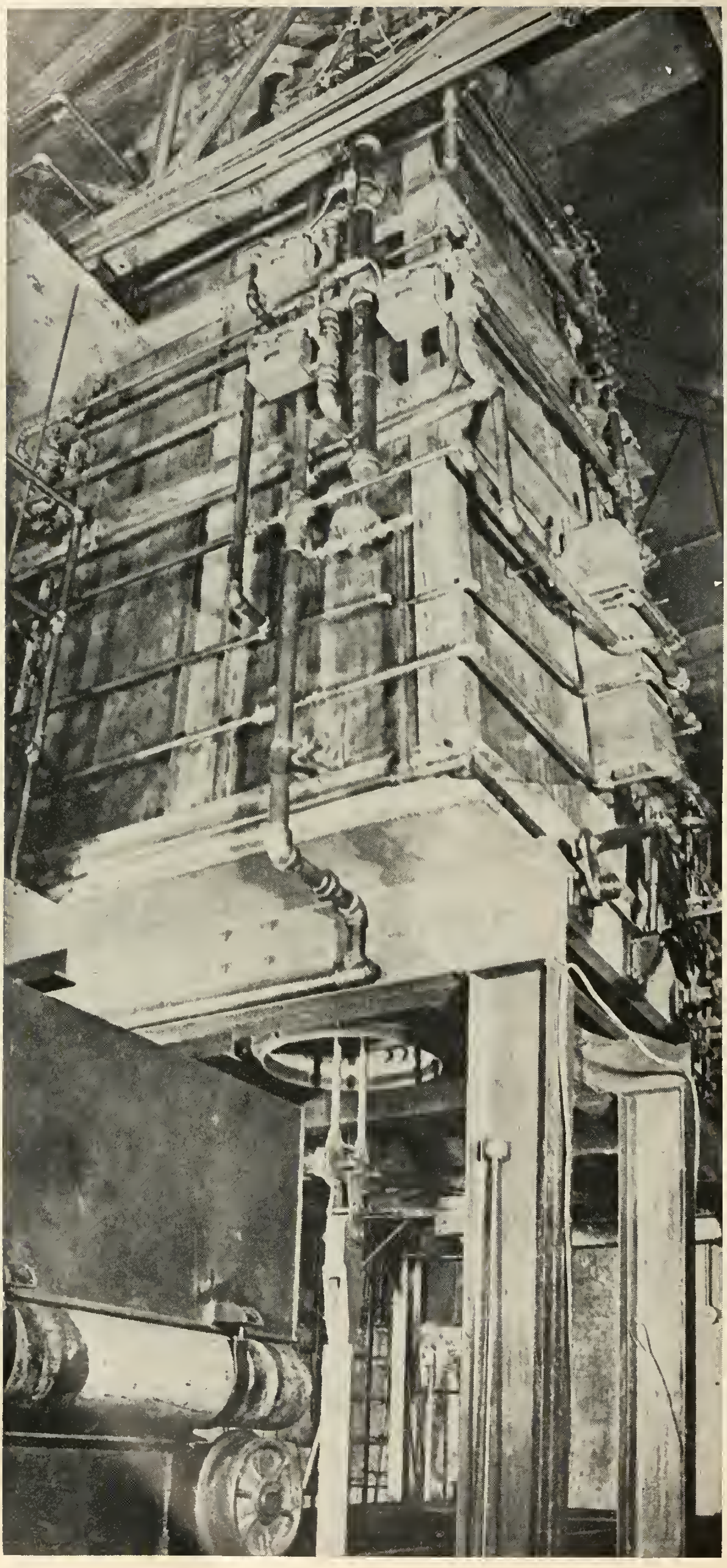
Boeing is near completion of a "multi-stress" chamber which will be used to determine human tolerances and equipment capabilities. The chamber can simultaneously simulate hypersonic flight conditions for *Dyna-Soar* and other manned-flight research.



BOEING'S "multi-stress" chamber will permit environmental control specialists to experiment simultaneously with six different space flight conditions: noise, intense light, vibration, and variations of pressure, temperature, and the composition of various gases.



LARGEST in the missile/space industry these 35-ton high-vacuum tanks at Convair Astronautics will be used to test small experimental rockets and satellite instrument packages. Tanks can simulate environmental extremes of heat and cold and altitudes up to 100 miles.



Heat

by Horace C. Knerr

Startling progress has been made in electronic controls and missile fuels in recent months.

But the men responsible for these singular achievements have been inclined to take too much for granted in the basic field of metallurgy, and in the most crucial aspect of rocket body production—heat treating.

The control and prevention of deformation within intelligent tolerances is entirely within the province of the skilled metallurgist and heat treater.

Yet the whimsical tolerances insisted upon by rocket engineers make an already difficult task almost impossible.

• **Heart of the matter**—The higher the tensile strength or yield strength specified, the more difficult it is to meet close dimensional tolerances. The following actual cases will aptly illustrate the prevailing conditions.

A body approximately 2 ft. diameter calling for heat treatment to 160,000 psi minimum yield strength specified a maximum total indicator reading (TIR) of 0.060 in. in its length of 11 ft. This included ovality (D-d) and camber (bow). The latter was required not to exceed 1/32 in. Since this cammer in itself would create a total indicator reading of 1/16 in. or 0.0625 in., there would be less-than-zero allowance for out-of-roundness! Realistic? Yet this is a prime example.

However, by the exercise of extreme skill, ingenuity and care, with special fixturing, the bodies were actually held by the heat treater within a tolerance of 0.070 in. TIR. Items frequently arrived from the fabricator with a TIR of as much as 0.125 in. In addition to holding these extremely close tolerances, the fabricating deviations were actually corrected by the heat treater. After several hundred bodies were so produced by the heat treater, he was rewarded by having an additional 1000 parts placed for manufacture and heat treatment elsewhere. Will the new contractors be required to conform to the extreme specifications or is it that the tolerances were

←
METLAB's 14 ft. inverted pit heat treating furnace. Work area is 3 ft. wide.

Treaters' Dilemma—Intolerant Tolerances

meaningless in the first place?

• **Excelsior**—A blueprint showing a body 6 in. dia., 8 ft. long, calling for 155,000 psi yield strength, specified bow and ovality to be less than 0.30 in. This seems to be generous but on further examination it appeared that ovality tolerance (D-d) was 0.190 in. If the fabricator so made the part, the heat treater would have to correct the ovality, or hold the body straight within 0.055 in. bow in its length—1 part in 1750.

A noteworthy instance, now understood to be obsolete, specified a spherical body 40 in. dia. with 0.048 in. wall made of 4130 steel to be heat treated to 180,000 psi minimum yield strength. For this high yield strength and thin wall a much more suitable steel would have been 4140, but even so the specified tolerance of ±0.010 in. in the diameter of 40 in. was clearly beyond obtainable limits.

First, the body could probably not be fabricated to such close dimensions even by drawing or hammering the two hemispheres over a spherical die and then very carefully welding and rehammering.

Second, no heat treater could assure this tolerance because volumetric changes in the metal itself due to heat treating transformations might exceed that amount.

Thirdly, there would be no further allowance at all for unavoidable deformation in the heat treating operation.

• **Teamwork needed**—Consultation by design engineers with a competent heat treating metallurgist might have avoided fruitless, costly and time consuming efforts to meet these requirements.

Another blueprint showed a body 14 in. dia., approximately 4 ft. long, calling for 180,000 yield point and demanding a bow less than 0.010 in. in 40 in. of body length, namely 1 part in 4000. Ovality was not specified.

More care and understanding in specifying strength values would be helpful. One blueprint submitted for

(*continued next page*)

Putting the Muscle in Metal

The heat treatment of metals is a very old art and a highly modern science, involving many variables depending upon the composition of the metal, the dimensions and shape of the work and the physical properties desired.

Basically, it usually consists of heating a metal part to a critical temperature range where profound internal changes take place, then cooling it rapidly to cause a transformation in the crystalline metal structure, and then a second reheating. For steels, generally known as ferrous metals, the quench hardens the material and the second operation, tempering, toughens it and sometimes softens it.

Aluminum alloys and certain others apparently reverse this behavior although the final effect, hardening and strengthening, is the same. They are soft after quenching (solution treatment) and then hardened and made strong during the second heating operating (aging).

• **Rocket application**—There are of course, many other forms of heat treatment for metals. The present discussion, for simplicity, is confined to the heat treatment of steels such as are used in rocket and aircraft manufacture.

Weight is the overriding consideration. By heat treating to high strength, steel is actually made "lighter" because less of it is required to support a given stress or load. By comparison, on a strength-weight basis, steels are actually lighter than aluminum or any other alloy.

Motor casings or containers for high pressure fuels, because of their extreme thinness, and lightness, present obstacles in the prevention of deformation during the hardening cycle. At the critical temperature, steel goes through certain plastic changes in addition to the natural softening caused by the high temperature—and is susceptible to deformation under its own weight. The rapid cooling or quenching operation unavoidably introduces further tendencies toward deformation because of thermal shock and severe contractional stresses. Small permanent changes in mass may result from metallurgical conversion, shrinkage may occur at welds.

The heat treater's principal task is to minimize deformation and thereby maintain the close dimensional tolerances required. In this respect the operation is as largely dependent upon the skills of the person as it is upon the character of the facilities.

• **Oils or nitrates?**—The quenching medium must be chosen with understanding and discrimination. No one is foolproof. Oil is usually preferable. Certain molten salts (nitrates, etc.) reduce the shock and tend to minimize deformation problems. But a salt bath is more sensitive to mass effects than oils—heavier sections do not fully harden. And we have consistently obtained the required high tensile properties with less deformation in oil quenching than with nitrate baths. Salt baths have their advantages—and we use them in other areas.

• **Treating styles**—The difficulties in quenching recalcitrant rocket bodies to high strength without disastrous deformation have led to the almost universal adoption of the "inverted pit" furnace.

Such a furnace consists essentially of a vertical, bottom opening heating chamber. A lifting device moves down inside the furnace and engages a spider supporting the charge. While heating, the charge hangs vertically, supported in such a way as to prevent sag.

When the heating cycle is finished, the charge is lowered directly into a quenching bath.

This system permits exact control of the quenching time and assures that every portion of the body has the same time of exposure from heat to quench. The bath can be made to circulate uniformly at a desired rate over the metal surface.

There are some disadvantages as to the idea of the gantry type furnaces. These travel back and forth over charging and quenching pits. It seems to be doubtful engineering to roll a tall hot furnace—made of refractory materials and carrying a delicate, suspended charge—back and forth during each operation.

(Continued from preceding page)

estimate to a heat treater specified "yield strength greater than 180,000 but less than 180,000 in." Plainly an error, but such mistakes in specifications can be wasteful and costly.

Another case demanded that yield strength should be held to 180,000 to 188,000 psi, in a body 5 in. dia., 5 ft. long. Any metallurgist will agree that, to hold yield strength within these limits, namely, ±2.25% would, if possible at all, require the most costly and protracted series of trial and error heat treatments for each individual piece. Steel varies in its hardenability from piece to piece in excess of this. A simple specification calling for a minimum of 180,000 yield with a maximum of 200,000 yield customarily specified would surely serve all practical purposes.

On this same body a TIR of 0.10 in. was called for, including both bow and ovality. A bow alone of 0.05 in. in 60 in. would require a straightness of 1 part in 1200—extremely close although obtainable with sufficient skill, care and time. In all probability, these were never achieved.

• **No decarburization**—Another "headache" presented to the heat treater is the requirement "no decarburization allowed". This is interpreted to mean zero decarburization. All rolled steel customarily has a slight amount of decarburization before it reaches the heat treater. A little more, making a total of 0.003 in. can be insured by special care, skill and good atmosphere.

To specify zero decarb required not only steels having this quality (practically unobtainable) but also very closely controlled artificial furnace atmospheres and sometimes the use of highly expensive special gases, such as helium, argon, etc. Such have even been called for.

But a prominent metallurgist in the rocket field (John M. Lynch, Aerojet-General, Sacramento, California) has shown that a small amount of surface decarburization, say 0.003 in. on a side, is actually beneficial since it reduces the surface tension, increases ductility and reduces the detrimental effect of surface notches.

• **"Ask the man who owns one"**—These comments are not made in a spirit of carping criticism but rather to illustrate the importance of closer collaboration between designers and competent metallurgists who understand the limitations of even the most skilled heat treaters with the finest equipment.

The metallurgist is only too glad to offer assistance and advice toward obtaining the very best performance in rockets, but requirements should not be set down unless they justify the expense involved in meeting them. But once such requirements are determined upon as necessary, they should be enforced.

In many cases, the dimensional tolerances are waived after it has been found that they are impractical and cannot be met. This is usually obvious to the skilled heat treater at the outset —before an expensive series of rejects. In some instances, stringent specifications are simply ignored and the purchaser does not receive as close tolerances as he might have, with consequently inferior performance. Obviously the heat treater who appreciated and allowed for the extra costs involved would lose out in the bidding.

Horace G. Knerr is the President of Metlab Co., Philadelphia, Pa. A veteran of 32 years in the heat treating of aircraft and missile parts, Mr. Knerr is the inventor of the inverted pit treating furnace (1928).

Furthermore, a certain cynicism regarding these "sacred little numbers" is generated.

Closer cooperation between the designer and the metallurgist would eliminate much of the retarding factors in such programs. Overemphasis on military secrecy in these areas add to cost, time and frustration, all out of proportion with intelligent security needs.

• **Are more furnaces necessary?**—The rate at which new and larger furnaces, capable of treating rocket bodies, are being built or planned is phenomenal. A short time ago there were scarcely six in existence.

At present there are more than twenty such facilities and more are anticipated. Seven of these are in the plants of commercial heat treaters, the rest belong either to the Government or to missile fabricators.

If all of these existing furnaces were to be utilized to their fullest extent, about 40,000 rocket bodies of all sizes could be handled annually. Yet more are planned!

Because there is little, if any, commercial application outside of the rocket industry for these specialized treating plants, the ultimate cost of this expensive equipment is borne by the taxpayer.

And the physical facility must be complemented with skilled personnel, possessing extensive metallurgical knowledge.

The practice of heat treating, while called a science, exhibits many of the characteristics of an art. Much of what happens to a metal being treated is only vaguely understood. The methods and techniques may be refined to a high degree but the understanding still lags behind.

One might suggest efforts toward a unification of specifications in the rocket field such as was carried out many years ago by the Army, Navy and Air Forces, including agreements as to steels to be used for certain strength values and other situations, the specification of tolerances within limits actually required and the question of surface decarburization, etc.

Furthermore, it would appear that more weight should be given to the value of experience and demonstrated ability in awarding contracts, especially repeat orders where a contractor has shown skill and resourcefulness in overcoming difficulties and meeting the highest requirements. Too often new orders are placed with a new source on price alone or possibly on local need for employment. A year's delay in production was reported in one such instance.

Other areas of endeavor also find this to be true. It seems that the business of defending the U.S. is just exactly that—a business, no more or less.

Travel Weary Electrons Measure Lowest Vacuum

Pressures down to 10^{-14} mm Hg can be measured with a cold cathode ionization gauge developed by P. A. Redhead, consultant to NRC Equipment Corp., Newton, Mass.

The instrument is reputed to be fifty times as sensitive as the current methods of measuring ultra vacuums. Its extremely high pumping speed will produce low pressures in small ultra-vacuum systems.

All ionization gauges measure pressure in terms of the very small current which is produced when gas molecules are ionized and attracted to a collector. The new gauge differs in the manner of ionizing these gas molecules. A few electrons traveling large distances form the ionizing medium. This offsets the usual X-ray background, which limits the effectiveness of current gauges.

Special models are being developed for inclusion in space satellites and probes to report on the densities and pressures of deep space.

Cornell Researchers Propose Flexible Space Radiator

Continuously rotating belt could be folded during launch to avoid high inertial loads; weight-saving a factor

Los ANGELES—A thermal radiator for space vehicles which consists principally of a long, thin, continuously rotating belt to radiate waste heat into space has been proposed by two Cornell Aeronautical Laboratory researchers.

They suggest that such a radiator not only will weigh considerably less than conventional tube-and-header radiators but also will avoid the high inertial loads during launching which cause severe design problems. A belt radiator, they point out, can be folded or rolled into a cylindrical shape and allowed to flex harmlessly during launch.

Details of their proposal were presented by Roger C. Weatherston and William E. Smith at the recent meeting here of the Institute of Aerospace Sciences.

Although admitting that a number of developmental problems remain to be solved, the Cornell engineers said the new type of thermal-capacity radiator is simple in concept and promises to be reliable in operation because it is not endangered by meteroids.

"It has been found that, for power levels above a few megawatts, the conventional radiator is the heaviest single component," their paper says. "In such cases, considerations for reducing the radiator weight are of paramount importance."

Meteoroid penetrations do not impair the belt radiator because it does not confine a fluid, the authors assert. Consequently, it can be made thinner and much lighter than a conventional radiator. A spare belt also can be carried with small weight penalty.

• **Heated by waste heat**—The belt radiator depends upon the thermal capacity and radiative ability of a solid, belt-shaped member or members to replace the header-and-tube assembly. Each belt element is heated either directly or indirectly by the waste heat from the powerplant and then follows a closed trajectory through space until it is cooled to some designated temperature.

Since the belt moves continuously, the paper points out, the heat addition process begins anew for each element as the cycle is repeated.

For operation at the same level of radiative power and mean temperature, the belt radiator requires the same radiation exposure area as the conventional radiator, the authors admit. But whereas the interior tube surface does not contribute to the radiation area of the conventional design, all of the belt surface is external and radiates effectively.

No lengthly headers are required because the cooled belt elements are being continuously returned for reheat to a position close to the powerplant.

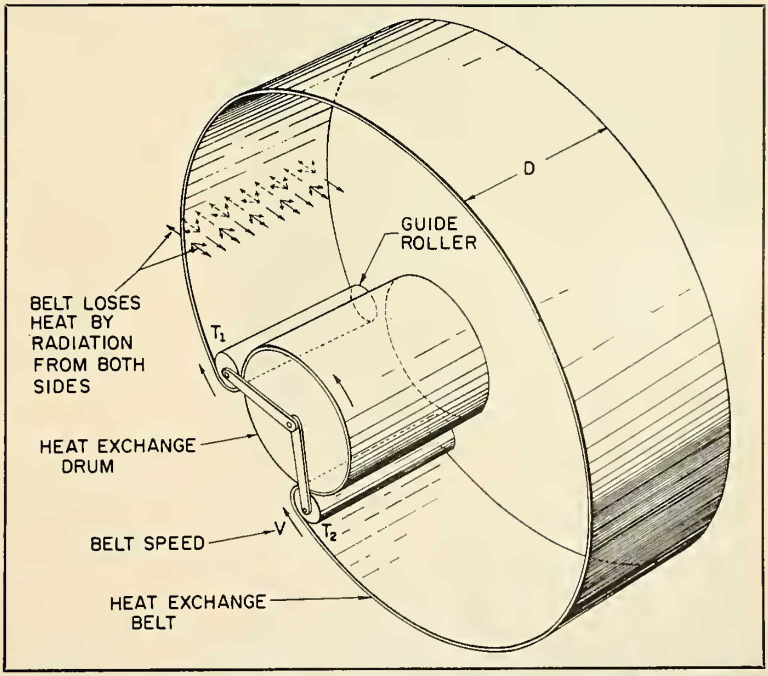
Two methods of transferring heat from the powerplant to the belt are suggested. One employs a long, flexible belt and a heat exchanger consisting of a rotating drum or other contact surface. The coolest portion of the belt contacts the hot drum to conduct heat from the surface of the drum.

In the other method, the contact surface is eliminated and the waste heat transferred directly to the belt by convection. In this method the powerplant working fluid, or another fluid if an intermediate heat exchanger is used, flows over the belt surface in an enclosed chamber.

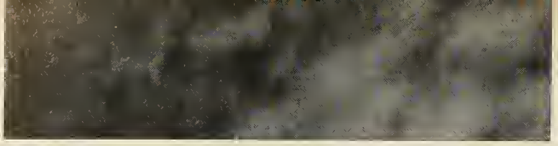
The Cornell researchers note that the nature of the belt radiator is such that it can easily be driven by electrical power. They propose that an electric current be passed through the width of the belt. Pairs of electromagnets placed on each side of the belt at several different positions across the width then would drive the belt without the wear associated with a friction drive. Their preliminary calculations show that electrical energy in the amount of one-half percent of the heat rejected would be required to drive the belt.

• **Low weight material**—While noting that the choice of materials or laminates for belt construction has not been extensively investigated, the two men suggest that stainless steel would represent a lower limit as far as temperatures are concerned. They suggest that use of beryllium might result in an extremely low belt weight.

For power levels in the megawatt range, the belt radiator might weigh only 15 to 25% of a tube-and-header radiator, it is estimated. The two researchers believe the problems involved in engineering a belt radiator appear solvable and would result in a big step forward in space propulsion.



POSSIBLE CONFIGURATION for a capacity heat exchange system for a space radiator.



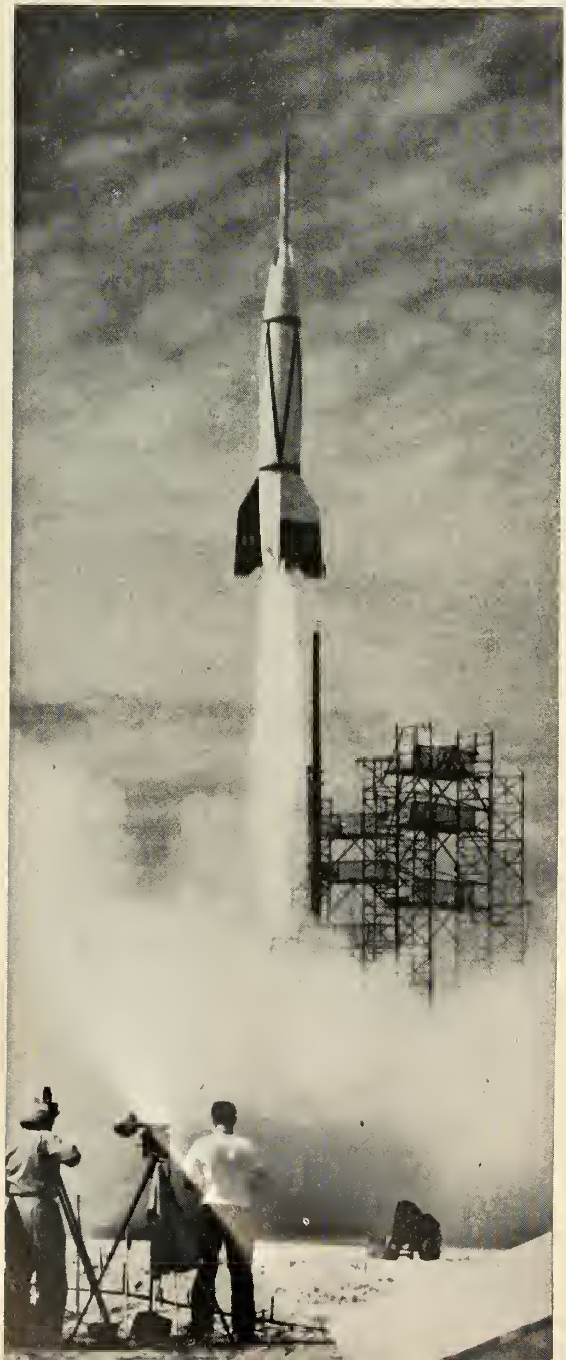
Second Decade Begins at Cape

TEN YEARS AGO—At 9:25 a.m. July 24, 1950—the first missile was launched from Cape Canaveral. The two-stage *Bumper*—A WAC *Corporal* sitting on top of a leftover German *V-2*—programed as planned and impacted in the sea 250 miles down-range. Five days later a second *Bumper* was successfully launched from the Cape. In October, a third launch—a *Lark*—completed the schedule for 1950.

The first decade of the U.S. missile/space program was underway.

When this first missile was fired, the Air Force Missile Test Center—then called the Long Range Proving Ground—had little more than 800 persons. Its capital plant was valued at around $150 million and annual operating expenses were about $3.5 million.

Just four days before the first launch, an agreement was concluded with the United Kingdom for establish-



←FIRST launch was Bumper.

A review of operational highlights during first decade of missile/space program at Air Force Missile Test Center (Cape Canaveral and Patrick Air Force Base, Florida.)

1950

24 July First missile launch from Cape Canaveral.
29 July Second missile launch from Cape.
1 Aug. Patrick Air Force Base, administrative headquarters for AFMTC officially dedicated.
25 Oct. First Lark missile launched by an Air Force Crew from Cape Canaveral.
Nov. Construction started at Grand Bahama Island for first downrange missile tracking station.

1951

1 Jan. The 4800th Guided Missile Wing established.
14 May AFMTC established, replacing Long Range Proving Ground Division, and placed under ARDC.
20 June First launch of the AF Matador from Cape.

1952

8 Dec. AF 1st Pilotless Bomber Squadron (Light) established at AFMTC for training on Matador.

1953

Jan. Construction of underwater cable from Cape Canaveral to Puerto Rico begins.

1954

Jan. Pan American World Airways takes over operation and maintenance of the Florida Missile Test Range.
9 Mar. 1st Pilotless Bomber Squadron (Light) transferred to NATO forces.
1 Aug. Maj. Gen. Donald N. Yates succeeds Maj. Gen. William L. Richardson as Commander of AFMTC.

1955

1 Jan. Four missile research and development flight programs underway at AFMTC: Matador, Snark, Bomarc, and Redstone.

1956

July X-17 test program begins at Cape to study re-entry problems by simulating re-entry velocities and conditions.
19 Sept. First Jupiter-C launched from Cape Canaveral. Modified Redstone carried 84-pound payload over 3000 miles.

1957

25 Jan. First attempted test flight of Thor IRBM. Flight not successful.
31 May First launching of Army Jupiter IRBM.
June First test flight of Atlas ICBM. Lift-off successful but malfunction in propulsion system occurred. Missile destroyed.
7 Aug. Nose cone from Jupiter-C test vehicle recovered from

lishment of the first tracking stations in the Bahama Islands for what was to become the more than 5000-mile Atlantic Missile Range.

• **Multi-million installation**—Today—over 800 missiles later—more than 20,000 persons make up the military-civilian team now working at AFMTC. The value of the capital plant, including Cape Canaveral, the AMR tracking stations, and Patrick AFB, now stands at almost $800 million. Operating costs for Fiscal Year 1960 were $230 million.

During the past decade, all of the long-range missiles of the Air Force, Army and Navy have undergone development flight tests at Cape Canaveral. The nation's major space experiments—except the *Discoverer* program—have used AMR facilities.

AFMTC's mission, under the Air Research and Development Command, is to operate and maintain the Atlantic Missile Range, conduct missile flight tests and collect and evaluate flight test data for the Air Force, Army, Navy, other governmental agencies, and missile contractors.

• **Space Age First**—Practically all the historic "firsts" in the nation's missile and space programs have taken place at Cape Canaveral—the first satellite, the first space probe, the first nose cone recovery, the first full-range ICBM flights, and many other significant achievements.

The second decade of missile launchings is off to a big start. Construction is being completed at the Cape on launch facilities for the *Minuteman* solid-fueled ICBM, the *Centaur,* and the *Saturn* 1.5-million-pound thrust space booster. And the first NASA Project *Mercury* man-in-space launchings are expected to begin in the near future.

CAPE CANAVERAL DIARY

the South Atlantic marking the first recovery of a re-entry body at long range.

20 Sept. First fully successful test flight of Thor IRBM.

Oct. Two Thor missiles successfully launched.

Oct. First full-range launch of Snark.

17 Dec. First successful launch of Atlas on 54th Anniversary of the Wright Brothers' first flight at Kitty Hawk, N.C.

1958

17 Jan. First launch of Polaris test vehicle in Navy's FBM test program at Cape.

31 Jan. Explorer I, Free World's first earth satellite, launched by a Jupiter-C.

5 Mar. Explorer II launched, but failed to achieve orbit.

17 Mar. Vanguard I, nation's second satellite, launched into orbit.

23 Apr. Thor-Able launched from Cape Canaveral to study re-entry problems at intercontinental ranges.

15 May Explorer III launched.

4 June Thor flight-tested for first time from a tactical-type launcher.

27 June All-Air Force crew successfully flight tested the Snark for first time.

June Recovery of the first data capsule at AMR after successful re-entry separation.

2 Aug. First full-power flight of Atlas using both sustainer and booster engines.

7 Aug. First launching of Bomarc interceptor missile on signal sent by SAGE control Center at Kingston, New York

17 Aug. First lunar-probe flight by Thor-Able ends when vehicle explodes 77 seconds after lift-off.

11 Oct. Pioneer I, nation's first space-probe, boosted by a Thor-Able launched. Re-entered earth's atmosphere on 12 Oct. after attaining altitude of 71,300 miles on a flight of 43 hours and 12 minutes.

28 Nov. First full-range (over 6000 statute miles) launch of the Atlas ICBM at AMR.

6 Dec. Pioneer III launched by a Juno II. Payload achieved altitude of only 63,500 miles before falling back to earth.

13 Dec. Jupiter carrying a live monkey in its nose cone launched.

18 Dec. Atlas launched into orbit. Known as Project Score, the experiment demonstrated feasibility of communications satellite.

1959

6 Feb. First test launch of the Titan ICBM from Cape.

3 Mar. Pioneer IV, a 13.4-pound satellite, launched into orbit around the sun by a Juno II. Signals were received from Pioneer IV at a distance of 416,000 miles from the earth.

8 Apr. Re-entry body of a Thor-Able recovered for first time after an ICBM-range flight.

23 Apr. First flight test of GAM-77 at AMR.

27 May First flight test of Bomarc-B long-range interceptor missile.

28 May Two monkeys, Able and Baker, launched in Jupiter to altitude of 300 miles and recovered alive.

5 June Start of construction at Cape Canaveral for Saturn 1.5 million-pound-thrust space vehicle.

2 July A Snark completed its third "round robin" flight at AMR.

21 July Full-scale Atlas ICBM nose cone recovered for the first time after a flight to far end of AMR.

7 Aug. Explorer VI, launched by Thor-Able III vehicle. "Paddle-wheel" satellite, measured earth radiation belts around the earth and carried scanning device to relay cloud-cover pictures.

25 Aug. First data capsule from Atlas ICBM recovered near Ascension Island.

27 Aug. First launch of Polaris test vehicle from the USS Observation Island at sea.

9 Sept. One-ton model of Mercury capsule launched on an Atlas to study design features of man-in-space capsule. Called "Big Joe I" the flight path of the missile carried the capsule to an altitude of about 100 miles to an impact point more than 1500 miles downrange. Capsule recovered.

18 Sept. Vanguard III launched into orbit to measure solar X-rays, environmental conditions in space and earth's magnetic field.

2 Oct. Major General Donald N. Yates, AFMTC Commander, appointed DOD Representative for Project Mercury support operations.

13 Oct. Explorer VII, a radiation-detection satellite launched into orbit by Juno II.

26 Oct. First AF Mace tactical missile test-launched.

26 Nov. Attempt to launch 372-pound satellite to explore space between earth and moon failed.

5 Dec. First transcontinental airlift of Atlas completed by C-133B aircraft, after seven-hour flight from California.

17 Dec. Final weapon system flight test of Thor accomplished.

1960

2 Feb. Ignition of Titan second stage at altitude occurred for the first time.

24 Feb. First 5000-statute-mile flight test of Titan. Data cassette ejected from re-entry vehicle recovered one hour and 13 minutes after launch.

25 Feb. First test launch of Pershing tactical-range missile.

11 Mar. Pioneer V, designed to investigate interplanetary space between the orbits of the Earth and Venus, launched by Thor-Able IV vehicle.

1 Apr. Tiros I, a 270-pound NASA meteorological satellite, launched.

13 Apr. Transit IB, designed to determine the feasibility of a satellite system for all-weather navigation, launched by Thor-Able Star vehicle.

20 May Atlas ICBM propelled its operational-type nose cone on a 9000-mile flight into Indian Ocean near southern tip of South Africa.

21 May Major General Leighton I. Davis assumed command of AFMTC succeeding Major General Donald N. Yates who became Deputy Director of Defense Research and Engineering (Range and Ground Support).

24 May Midas II, satellite designed to determine feasibility of a system for detection of missile launching with satellite-borne infrared sensors, launched by Atlas-Agena vehicle.

22 June Transit IIA, another in a series of navigational satellites, launched with Thor-Able-Star vehicle.

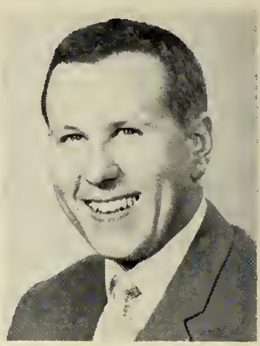
11 July Mace tactical missile launched from prototype "hard site" at Cape Canaveral for first time.

20 July First Polaris missiles launched from a submarine (USS George Washington) and fired 1200 miles down AMR.


TOWL


BEARINGER


DOOLITTLE


BUTLER

E. Clinton Towl, named president of Grumman Aircraft Engineering Corp. Towl has been administrative vice president since 1954. The Board of Directors also chose **William T. Schwendler** former senior vice president, as Chairman of the Executive Committee. **Llewellyn J. Evans,** former general counsel becomes a vice president. **Leroy R. Grumman** continues as Chairman of the Board of Directors.

Dr. Van W. Bearinger, appointed director of research for Minneapolis-Honeywell Regulator Co. He has been associate research director since 1956, and now fills a vacancy created a year ago by the promotion of **Dr. Finn J. Larsen** to corporate vice president in charge of research. Other appointments at M-H include **Dr. John N. Dempsey** and **Edward E. Rexer** to assistant directors of research.

Kent Doolittle, named general manager of the Western Operation of CTL Division of Studebaker-Packard Corp. The new plant is located in Santa Ana, Calif.

George D. Butler, International Resistance Co.'s Director of Marketing elected a Vice President. Butler will continue to be in charge of marketing activities.

George Havas appointed Vice President and Director of Engineering of Kaiser Industries Corp. Havas has been Chief Engineer of the Henry J. Kaiser Co. after 1935 and a vice president since 1945. In 1958 he assumed the position of General Manager of the company's Heavy Construction Division and international subsidiaries.

Arthur L. B. Richardson elected Senior Vice President of Sylvania Electric Products Inc. **William F. Rueger** named Secretary of the Company.

In appointments at Sylvania Electronics Systems division: Systems Engineering and Management Operation, **Hunter C. Harris** to technical manager; Buffalo Operations, **Robert C. Boe** to marketing manager.

Sylvania Semiconductor Division: appointed **Frederick S. Kerr** sales engineer for the New England area and **Chester J. Penza** sales engineer for lower Connecticut, New York and New Jersey area.

Edward H. Heinemann, appointed executive vice president of Summers Gyroscope Co. Heinemann is former corporate vice president of Douglas Aircraft Co. in charge of Combat Aircraft Engineering, Aircraft and Missiles.

Richard E. Palmer, named manager of The Garrett Corp.'s AiResearch Manufacturing Division of Los Angeles. Palmer has been associated with AiResearch for more than 18 years.

Emile F. duPont elected to the board of directors of the DuKane Corp., St. Charles, Ill.

A. M. (Tex) Johnston, veteran test pilot and former chief of flight test for Boeing, named an assistant Boeing program manager for *Dyna-Soar* manned space glider.

W. E. Giberson, tapped as chief of the newly organized Guidance and Control Division at California Institute of Technology Jet Propulsion Laboratory.

Dr. James W. Moyer, chosen research director of the Sperry Rand Research Center to be built later this year in Sudbury, Mass. Dr. Moyer has formerly been associated with the General Electric Co.

Leonard H. Davis, elected executive vice president of The Gabriel Co. Davis moves from vice president and general counsel. In another change, Gabriel president **John H. Briggs** also assumes the office of treasurer, relieving **Robert T. Hood** for full time duty as president of the Automotive Div. of The Gabriel Co.

Newly-formed Bell Aerospace Corp., former defense units of Bell Aircraft Corp. announces appointments in the Bell Aerosystems Co., (formerly Niagara Frontier Division.) **William G. Gisel,** (former vice president and treasurer of Bell Aircraft Corp., and general manager of Niagara) named to president. **Dr. Walter R. Dornberger,** vice president (former vice president of Bell Aircraft), and **John H. van Lonkhuyzen,** vice president (was Bell Aircraft's Avionics Div. manager).

Albert W. Brandmaier, selected as director of Consolidated Electrodynamics Corp., international operations for the Bell & Howell International Division.

Lee C. Pulsipher named by Perkin-Elmer Corp. to head its new Vernistat Division operation in Los Angeles.

William S. Aiken tapped as Director of Engineering at The Thompson-Ramo-Wooldridge Products Co. Aiken has been manager of the Project Engineering Department at the computer firm.

John F. Gardner, appointed plant engineer at Hughes Aircraft Co.'s ground systems group in Fullerton, Calif.

Bliss M. Bushman, John D. Gum and **James T. Sharpsteen** appointed director of systems engineering and assistant directors respectively at Consolidated Systems Corp., an associate company of Allis-Chalmers Mfg. Co., Bell & Howell, and Consolidated Electrodynamics.

Kenneth Duncan joins Gorham Electronics Laboratory as staff scientist. He was formerly with Gabriel Electronics Division.

Bernard Krieger moves into position of manager of Marketing for Manson Laboratories, Inc.

F. C. Milner appointed manager of the Los Angeles Area Field Office of the Military Sales Department of Librascope Division, General Precision Inc.

Thomas S. Hurley selected as supervisor of merchandising and advertising for CBS Electronics semiconductor operations. Hurley previously was a sales promotion manager for Raytheon Co.

soviet affairs

By DR. ALBERT PARRY

The Soviet computer program
is not in the best of shape. Plans are grand but their execution lags, and the quality of machinery is low. The Kremlin has appropriated large sums of money for the program: annually, until 1965, two billion rubles ($500,000,000 at the official Soviet rate of exchange) are to be spent to build electronic information processing digital computers. But on June 12 Academician Axel I. Berg complained in a front-page article in *Izvestia:* "The low quality of elements and details in our radio electronic instrumentation hampers the construction of more perfect electronic computing and guiding machines."

A conference on computer technology
held recently in Moscow presented rather mixed results. "We rejoiced at the plentitude of the already built mathematical machines," a Soviet engineer wrote in *Komsomolskaya Pravda* of June 11, "but their quality was no source of joy." As an example of the lag in quality, A. Musatkin, author of the article, stressed that some of the new Soviet computers discussed at the conference were using "old lamps" instead of transistors.

Duplication of effort
by too many Soviet computer-designing and building agencies was also decried by Comrade Musatkin. He urged, as a remedy, concentration of "specialized manufacture of standard elements of electronic computers" under the roof of just one agency. Such a concentration, he pointed out, would lead to a lower cost of the machines as well as their greater reliability. Savings in time required to build each new machine would also result, Musatkin wrote. He noted that "other countries, possessing a high level of development of computing technology, have not as yet adopted such specialized manufacture of standard elements." But this lack should not be an example to the USSR, he declared. "Such a transformation can be quickly effected only in our country which has planned guidance of industry."

Shortage of computer personnel
is another complaint in Russia. Some 200 graduate students are now being trained at the University of Moscow to be sent to Novosibirsk, there to work with large-scale computers. But it will be 1961 before they are finally on their way to their Siberian jobs. Meantime the existing Soviet roll of computer experts is deplorably sparse. Musatkin reveals that the Bauman Technical School in Moscow, one of the country's largest, has so far graduated yearly only some 40 engineers who know how to build electronic equipment and computing machines. He exclaims: "How can we be satisfied with such a quantity when, in order to create even a small electronic computer, no less than 20 engineers are needed!"

A friend who is a computer engineer
has told Musatkin that in the three years since graduation he changed jobs twice—an unusually high fluidity in the Soviet Union where a young graduate is supposed to be "frozen" to his first job, as his obligation to the state, for at least three years. Musatkin writes: "Don't think that he is a poor worker or can't get along with his associates. No, the matter is far more complex. It turns out that it isn't easy to find specialists in computing technology. The demands clearly exceeds the supply. "Men are being lured from job to job.

Some Soviet agencies
in this field try to solve the problem by supplying training in computer-building to the brightest of their engineers who did not study this work in their college years. But such retooling is held by Musatkin to be too time-consuming even if, in the long run, it does "bring the desired result." He calls on the Soviet Ministry of Higher and Middle Special Education to train such experts from a much earlier time of their lives and study.

when and where

AUGUST

Fourth Global Communications Symposium, co-sponsored by IRE, Professional Group on Communications Systems, and U.S. Army Signal Corps, Statler Hilton, Washington, D.C., Aug. 1-3.

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

International Symposium on Rarefied Gas Dynamics, University of California, Berkeley, Aug. 3-6.

University of Connecticut, Institute for Practical Research on Operations, Storrs, Aug. 7-13.

University of Connecticut, Third Annual Institute on Missile Technology, Storrs, Aug. 7-19.

Annual Meeting of the Association of the U.S. Army, Sheraton-Park Hotel, Washington, D.C., Aug. 8-10.

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

American Institute of Electrical Engineers, 1960 Pacific General Meeting, El Cortez Hotel, San Diego, Aug. 8-12.

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

XIth International Astronautical Congress, IAF, Stockholm, Aug. 15-20.

Cryogenic Engineering Conference, University of Colorado and National Bureau of Standards, Boulder, Aug. 23-25.

Western Electronics Show and Convention, Los Angeles Memorial Sports Arena, Aug. 23-26.

International Union of Pure and Applied Physics, International Conference on High Energy Nuclear Physics, University of Rochester, Rochester, N.Y., Aug. 25-Sept. 3.

The German Rocket Society, Annual Meeting, Hanover, Aug. 26-28.

University of Connecticut, Eleventh Annual Basic Statistical Quality Control, Institute, Storrs, Aug. 28-Sept. 9.

The Combustion Institute, 8th International Symposium on Combustion, California Institute of Technology, Pasadena, Aug. 29-Sept. 2.

10th International Congress of Applied Mechanics, Congress Bldg., Stresa, Italy, Aug. 31-Sept. 7.

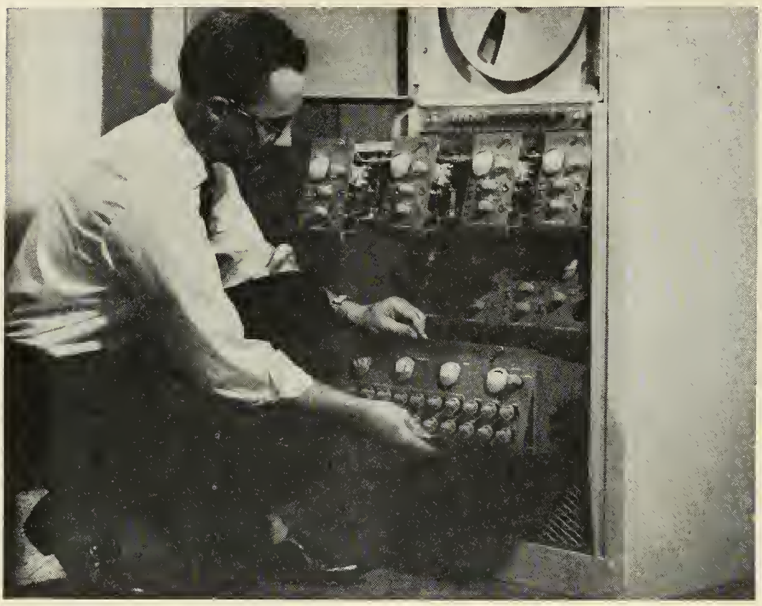
SEPTEMBER

Society of Instrument Technology and British Interplanetary Society, One-day joint symposium on Rocket and Satellite Instrumentation, Manson House, London, Sept. 1.

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

Society of British Aircraft Constructors Show and Flying Display, Farnborough, England, Sept. 6-11.

Electronics Industries Association, Second Conference on Value Engineering, Disneyland Hotel, Anaheim, Calif., Sept. 7-8.



Analog-Pulse Signal Rec/Rep.

A magnetic tape system capable of recording and reproducing both analog and pulse signals has been introduced by Mincom Division of Minnesota Mining and Manufacturing Company.

The model CM-100 video band recorder-reproducer which combines the capabilities of two machines in one is packaged in a single, standard-size rack. Each of the seven video tracks covers an overall bandwidth of 400 cycles to 1.0 megacycle.

The single ½-inch tape travels at any one of six speeds ranging from 7½ ips to 120 ips.

Highlight of application features of the CM-100 is the fact that in the megacycle range it can record at 120 ips one microsecond pulses spaced one microsecond apart and then, because of its versatile, instantaneous speed control, can increase the time axis of the pulses by 16 so that they can be assimilated by a computer to reduce the data.

Circle No. 225 on Subscriber Service Card.

Gaussmeter

Wrisley Engineering, Inc., announced the Model G/M-50 Gaussmeter for use in conjunction with electrodynamic vibration systems for measurement of stray magnetic field at critical specimen locations. No electronics nor external connections are required. Accuracy is better than ± 10% of full scale.

Circle No. 226 on Subscriber Service Card.

Tele-Signal Simulator

A precision telemetry Signal Simulator, the Model 145B, has been developed by Electro-Mechanical Research, Inc. The Model 145B combines in one versatile instrument the means for simulating PAM and PDM pulse trains for checkout, calibration, and evaluation of telemetry decommutation equipment.

Precision of the unit permits its use as a standard for evaluating either system or equipment characteristics such as linearity, stability, and crosstalk. It simulates all PAM and PDM signals specified in MIL-T-26985A (USAF) and IRIG standards.

Circle No. 227 on Subscriber Service Card.

High Tensile Shear Epoxy

A tensile shear of 2200 psi at 300°F on aluminum-to-aluminum for HYSOL 4322 adhesive has just been announced by HYSOL Corp.

HYSOL 4322, a smooth, thixotropic, 100% solid paste that will not flow during cure even when applied to vertical surfaces is ideally suited for bonding porous surfaces. It is also recommended for bonding metal, plastics, ceramics, glass and wood. The adhesive film has a slight resiliency insuring against cracking during thermal shock.

Circle No. 228 on Subscriber Service Card.

Adapterless Cable Plug

Sealectro Corp. announces a "Conhex" cable plug eliminating the usual adaptor necessary in running subminiature coaxial cables into BNC and TNC panel connectors.

The cable plugs minimize power loss and lower the costs of assembly through direct connection. Utilizing the patented "Conhex" design, the cable plug provides a vise-like grip on the subminiature cable with a strength greater than the cable itself. The cable plug is gold-plated to resist corrosion and to provide lower contact resistance.

Circle No. 229 on Subscriber Service Card.

Precision Angle Encoder

A BRL-5 high-precision angle-encoding system has been developed and is now available from United Aircraft Corporation's Norden division and Colorado Research Corp.

This new system divides a single revolution of a shaft into 360,000 parts and simultaneously provides parallel real-time readouts in three forms: electrical 8-4-2-1 binary coded decimal, electrical straight decimal, and visual decimal on NIXIE Tubes. Other systems also are available which provide pure binary resolutions of from 2^{18} to 2^{21} in a single turn.

An important feature of the new electronics is its repackaging and qualification to MIL E-5400 for airborne use a similar size ground-based package also is available.

Circle No. 230 on Subscriber Service Card.

Pressure Cartridge

Holex, Inc. is manufacturing a standard line of nineteen electrically-initiated pressure cartridges available in energy out-put ratings from 10 to 135 ft/lbs. These cartridges are specifically designed as power generators for the explosive actuation of piston-operated mechanical devices such as valves, cable cutters, actuators, stage separation systems, thrust reversers, etc. All cartridges feature ½-20 UNF thread-in pressure sealed configuration.

Circle No. 231 on Subscriber Service Card.

Wet Tantalum Capacitors

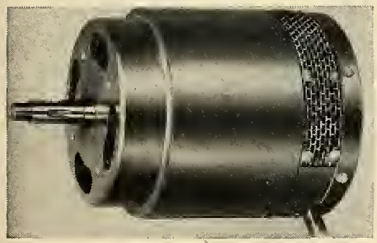
Production of a 100-volt dc hermetically sealed wet electrolyte, sintered anode tantalum capacitor series is announced by U.S. Semiconductor Products.

Immediate delivery of U.S. Semcor's new TSW line is available in ratings from 6 to 100 working volts and capacitance MFD from 270 to 4.7 at 85°C. Applicable MIL Specs are met or exceeded in leads, moisture resistance, temperature and immersion. Supplied with or without insulating sleeve, the bare tube case is 0.188 in. diameter, 0.525 in. length for TSW1 model, and 0.282 in. diameter, 0.720 in. length for TSW2 model.

Circle No. 232 on Subscriber Service Card.

Compact Induction Motor

Kearfott Division of General Precision, Inc. announced the availability of the F-25-2 induction motor. The motor has been tested and conforms to the requirements of MIL-M-7969A



and to the environmental requirements of MIL-E-5272A, Procedure I, including humidity, high and low temperature, explosion-proof, altitude, and vibration.

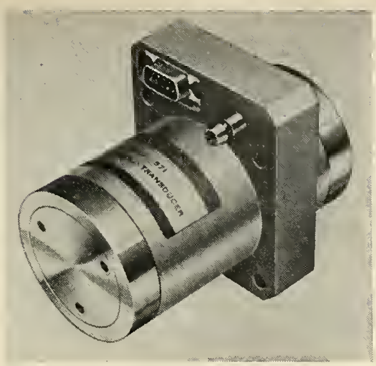
Circle No. 233 on Subscriber Service Card.

Glass Ceramic Cement

A glass-ceramic cement for the electronics industry has been developed by Corning Glass Works to seal glasses and other materials with thermal expansions between 80 and 92 x 10^{-7} cm/cm/°C.

Designated Pyroceram Brand Cement No. 89, it has electrical properties similar to those of Pyroceram Brand Cement No. 95, which seals materials with higher expansions. However, at elevated temperatures the 89 cement is stronger.

Circle No. 234 on Subscriber Service Card.



Altitude Transducer

Bourns, Inc. announces the development of a new instrument/system, the Model 571 Altitude Control Transducer.

The Model 571 employs a unique trapped air pressure design to provide an accurate altitude error signal. This instrument is referenced to the particular altitude to be maintained, and any change in this altitude results in an error signal that can be fed into the flight control system for corrective action.

Circle No. 235 on Subscriber Service Card.

Stable Ceramic Capacitor

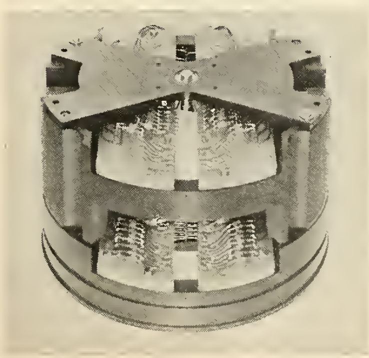
Mucon Corp. has available subminiature ceramic capacitors made low capacitance variation ceramic. The capacitance remains within +4% and –8% of the capacitance at 25°C over the whole temperature range of –55°C to +125°C.

Circle No. 236 on Subscriber Service Card.

Shaft Position Encoder

United Aircraft Corp.'s Norden division has developed a shaft position encoder capable of 100,000 counts in only 100 turns of the input shaft. It is designated the ADC-5-BCD (1000).

This new encoder is basically a 1000 count per turn device. It utilizes the patented Self-Selecting V-Brush technique, which provides a completely unambiguous output without the need



for cumbersome and expensive external logic circuitry, as well as a new split-bit technique, which permits incorporation of this high-resolution encoder into a small package.

Circle No. 237 on Subscriber Service Card.

Miniature Electron Tube

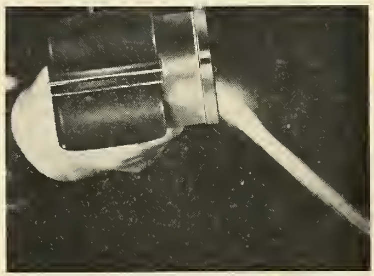
Sylvania Electric Products Inc. has announced the "Ten Pin," a construction in miniature receiving tubes which combines multiple circuit functions in a single bulb or envelope.

The "Ten Pin" uses the regular 9-base pin arrangement of the conventional T-6½ miniature envelope with an additional pin centered in the pin circle. The new design meets demands for improved miniature tube performance and flexibility.

Circle No. 238 on Subscriber Service Card.

Plasma Jet 45° 90° Heads

Newly developed Plasmatron electrodes, which divert the plasma jet 45° or 90° from normal, have been developed by Plasmadyne Corp., a Subsidiary of Giannini Scientific Corp., for use with Plasmatron "S" Series hand held plasma jet spray guns.



The conversion of any Plasmatron "S" Series spray gun from straight jet spraying to 45° angle spraying consists of replacement of the front electrode of the unit. To convert an "S" Series gun to 90° spraying, both front and rear electrodes must be replaced. All other components of the Plasmatron system remain unchanged.

Circle No. 239 on Subscriber Service Card.

Electron Beam Evaporator

A remote-controlled electron beam evaporating unit capable of vaporizing all metals, ceramics, refractory compounds and other non-metallics has been added to the line of EBV vaporizers available as standard products from The Alloyd Corp.

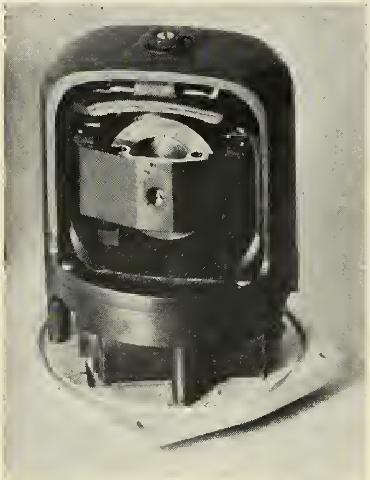
The Alloyd Model EBV-4 is a remote-controlled electron beam gun that, like the EBV-3, is suitable for installation in almost any laboratory or commercial vacuum equipment operating at 3 x 10^{-4} milimeters of mercury or lower. It may be used for either research and development of volume production of thin film coatings for microminiaturized electronic circuitry, optical filter films and similar applications.

Circle No. 240 on Subscriber Service Card.

Gas Driven Gyro

Lear, Inc., has developed a gas-driven displacement gyro with only four moving parts.

Its features are absolute design simplicity, a low drift rate, instantaneous start time and an inherently long storage life.



It can be produced at a fraction of the cost of convential gyros. Small quantity deliveries can be made immediately.

Circle No. 241 on Subscriber Service Card.

High Temp Foam Tape

TESAMOLL #763, a polyurethane foam plastic pressure-sensitive tape suitable for use in high-temperature operations, has been introduced by United Mineral & Chemical Corp.

In addition to being fungus- and mildew-proof, chemically inert and resistant to temperature and weather extremes and most oils—as all TESAMOLL tapes are—the new high-temperature tape will withstand temperatures up to 248°F.

Circle No. 242 on Subscriber Service Card.

Insulated Thermostat

Catham Controls Corp. is marketing a BW1/4 in. diameter insulated thermostat. It is produced with a patended wiping action and available with contacts that open or close with temperature rises. Any model can be factory calibrated or externally adjusted to obtain the desired actutaing temeprature, which is not affected by ambient temperatures.

Circle No. 243 on Subscriber Service Card.

new literature

ULTRA CLEAN FACILITIES—A three color, 8 page brochure entitled "Requirements for an Ultra Clean Facility" has been made available by Shielding, Inc. The brochure has index tabs for quick reference. The main subject headings are: Construction and Environmental Control Systems. Subdivision discusses: Modular Wall Panels, Non-Dusting Materials, Illumination, Floor Covers, Air-Showers, Pass Through Chambers, Pressurized Cabinets, Temperature-Humidity, Air Pressure, Air Replacement, Filtration, etc. A perforated application information form is attached which enables each potential user to get engineering information for Shielding on his particular application.

Circle No. 200 on Subscriber Service Card.

TUBE CATALOG—An illustrated 20-page catalog has just been released by Pacific Tube Co. This comprehensive manual details materials, size ranges, mechanical and physical properties, tolerances, lengths, specifications, material selection and applications of the mechanical, pressure and aircraft tubing produced by Pacific.

Circle No. 201 on Subscriber Service Card.

VIBRATORY MATERIALS HANDLING—A condensed catalog of vibratory materials handling equipment, vibrating parts handling equipment, power rectification equipment, mechanical shaft seals, paper joggers and portable power tools is announced by Syntron Co. It presents descriptions, data and specifications on all Syntron products, and shows products in operation.

Circle No. 202 on Subscriber Service Card.

LIQUIFIED GAS—A four-page booklet covering the principles and techniques of handling, storing and converting liquified oxygen, nitrogen and argon is now available from Air Reduction Sales Company. Entitled "The Liquid Story," the booklet features discussions of the history of the use of these gases, the advantages of storage in the liquid state, and the design and purpose of equipment used for their storage and delivery. Schematic drawings help to clarify points in the text.

Circle No. 203 on Subscriber Service Card.

FIFTH GROUP STEEL BONDED CARBIDES—A nine-page reprint available from Sintercast Division of Chromalloy Corp., translated from *Planseeberichte für Pulvermetallurgie,* December, 1959, reports the results of investigation on cermets performed at Sintercast by the authors. Vanadium, tantalum, and niobium carbides, bonded with carbon steel, were prepared by standard powder metallurgy techniques, and sintered in both hydrogen and vacuum. Resulting cermets were tested for hardness, density, transverse rupture, and machinability in the annealed condition. Illustrations include several photomicrographs showing grain structure of various cermets, as well as graphs correlating hardness of carbides with hardness of resulting cermets. In addition, several tables summarize the physical properties of carbides and steel-bonded compositions.

Circle No. 204 on Subscriber Service Card.

MAGNETIC LAMINATIONS—A two-color, 36-page catalog just released by G-L Electronics, contains an abundance of factual information, formulae and engineering data regarding each individual EE, EI, F, DU and W shape which is currently available from G-L. In this catalog, the manufacturer also introduces a new part numbering system which easily identifies each transformer lamination shape by its decimal equivalent. A handy cross reference index guide on the back cover shows additional comparison figures and specifications for individual shapes.

Circle No. 20S on Subscriber Service Card.

IMPULSE COUNTERS—A 6-page bulletin, describing Sodeco Ti Series Heavy Duty Electric Impulse Counters, is available from Landis & Gyr, Inc. Complete technical data is given including operating instructions, execution possibilities including several circuit diagrams, electrical information for both AC and DC models, and dimensional data.

Circle No. 206 on Subscriber Service Card.

NITRONEAL GENERATOR—A booklet of interest to industrial users of nitrogen or nitrogen-hydrogen mixtures has been published by the Chemical Division of Engelhard Industries, Inc. Titled *Nitroneal Generator,* the booklet provides detailed descriptions of equipment with capabilities ranging from 50-100 up to 2500-10,000 standard cubic feet per hour, including flow diagrams.

Circle No. 207 on Subscriber Service Card.

SILICON RECTIFIER DATA—Fansteel Metallurgical Corp. has published four separate data sheets helpful to any engineer or designer who specifies, uses or is concerned with silicon rectifiers. The sheets cover many of the technical aspects of application, heat sink requirements, surge voltage protection, parallel operation and series operation of silicon power rectifiers.

Circle No. 208 on Subscriber Service Card.

NAVY

Douglas Aircraft Corp., Santa Monica, for the development of the Missileer, the launching aircraft for the *Eagle*. Amount not disclosed.

Horkey-Moore Associates, Plastics Division, Torrance, Calif., for production of 400 rocket nozzles. Amount not disclosed.

The M. M. Newman Corporation of Marblehead, Mass., for the production of a special form of Heli-Tube, a cable-harnessing material designed for use in nuclear-powered submarines. Amount not disclosed.

$60,113,000—**The Electric Boat Division of General Dynamics Corp.**, Groton, Conn., for two nuclear-powered fleet ballistic missile submarines.

$32,405,000—**Newport News Shipbuilding and Dry Dock Co.**, Newport News, Va., for one nuclear-powered fleet ballistic missile submarine.

$28,000,000—**Northrop Corp.**, Beverly Hills, for the design, development and production of electronic components for the *Polaris* system, including automatic checkout systems, gyroscopes, type 11 periscopes and radiometric sextants.

$6,000,000—**RCA**, Moorestown, N.J., for production of mobile radar sets to be installed at the Pacific Missile Range.

$1,600,000—**Telechrome Manufacturing Corp.**, Amityville, N.Y., for communication systems for the *Tartar* and *Terrier* missiles.

$419,000—**Bulova Watch Co., Inc.**, Flushing, N.Y., for warhead safety and army devices for the *Terrier* and *Tartar*.

$208,497—**Computer Systems, Inc.**, Monmouth Junction, N.J., for services, labor, materials, equipment and facilities to design, develop, manufacture and furnish ballistic missile analog plotting board.

$198,767—**Northrop Corp.'s Radioplane Division**, Van Nuys, for target drones and parts.

MISCELLANEOUS

Micromega Corp., Venice, Calif., for the design and fabrication of low-noise parametric amplifiers to be installed in a satellite tracking radar. Amount not disclosed.

$150,000—**The Martin Co.**, Baltimore, for development and production of a radioisotope-fueled generator for use with an automatic electronic "sentry" powered by nuclear energy and capable of recording data and transmitting it from a remote ground location for at least two years without refueling or servicing.

AIR FORCE

$7,000,000—**Vitro Laboratories, a division of Vitro Corporation of America**, New York City, for operation and maintenance of the Eglin Gulf Test Ranges through June 1961.

$3,000,000—**Chance Vought**, Dallas, for extension of drone services for missile testing from Eglin AFB.

$1,700,000—**Vickers, Inc.'s Aero Hydraulics Division**, Detroit, for production of battery powered auxiliary power units for nozzle control units for all three stages of the *Minuteman*. Subcontract from Autonetics.

$1,665,336—**General Motors Corp., AC Spark Plug Division**, Flint, for depot level maintenance on the guidance sub-system of the SM-75 weapons system, its components and the related ground support equipment.

$1,150,118—**Fairchild Camera and Instrument Corp., Defense Products Division**, Syosset, N.Y., for photographic reproduction system and data.

$1,143,389—**Hughes Aircraft Co.**, Culver City, for spare components in support of the MG-13 fire control system.

$1,100,000—**Beckman Instruments, Inc., Systems Division**, Anaheim, for two high-speed data processing systems to be used with current satellite programs. Subcontract from **Lockheed Aircraft's Missiles and Space Division.**

$1,002,800—**ACF Industries, Inc., Electronics Division**, Riverdale, Md., for F-105D, type MB-7 flight simulator, spare parts, special tools, data and services.

$1,000,000—**Space Electronics Corp.**, Glendale, for the fabrication of the electronic systems for the AbleStar upper stage booster.

$571,000—**Electronic Specialty Co.**, Los Angeles, for a complete airborne missile tow target for the Century jet fighter series.

$445,120—**Douglas Aircraft Co., Inc.**, Santa Monica, for system engineering for *Thor*.

$417,347—**Melpar, Inc.**, Falls Church, Va., for development and fabrication of advanced trainer, *Bullpup*, ground pilot GAM-83 A/B, engineering specifications and data.

$360,000—**Dynatronics, Inc.**, Orlando, for PCM data conversion system.

$300,896—**North American Aviation, Inc., Rocketdyne Division**, Canoga Park, for research and development for fabrication and delivery of pressure storable propellant rocket engine.

$275,000—**The Bendix Corp., Eclipse-Pioneer Division**, Teterboro, N.J., for two propulsion monitoring systems and data.

$197,230—**Coleman Engineering Co., Inc.**, Torrance, for parachute test vehicle.

$183,600—**The Marquardt Corp.**, Van Nuys, for prototype multi-stage ejector diffuser.

$149,990—**Bell Aircraft Corp.**, Buffalo, for storable propellant data for the *Titan Mark II* program.

ARMY

Tracerlab, Waltham, Mass., for continued research on nuclear altimeter. Amount not disclosed.

$13,084,478—**Raytheon Co.**, Andover, Mass., for industrial engineering services, field maintenance, test equipment and ground equipment for the *Hawk*. (Two contracts.)

$10,935,410—**Motorola, Military Electronics Division**, Phoenix, for 12 radio communications central systems.

$5,263,650—**Minneapolis-Honeywell Regulator Co.**, Hopkins, Minn., for production of *Honest John* rocket warhead assemblies.

$3,353,466—**The Martin Co.**, Orlando, for *Lacrosse* engineering services.

$3,352,676—**The Bendix Aviation Corp., Redbank Division**, Eatontown, N.J., for *Nike-Hercules* warhead section, handling, checkout, repair parts and special testing of XM75 adaption kit quality assurance and stockpile reliability program. (Two contracts.)

$3,085,103—**Belock Instrument Corp.**, College Point, N.Y., for *Hawk* missile system training device 3-G-36 and repair parts.

$2,000,000—**ITT Federal**, Clifton, N.J., for *Nike* support equipment.

$1,749,322—**Raytheon Co.**, Andover, Mass., for repair parts, modification kits for CW acquisition radar for *Hawk* and services to incorporate CCM function in system. (Three contracts.)

$1,344,500—**Morrison-Knudsen Co., Inc.**, Seattle, for construction of control area facilities for *Nike Hercules* battery.

$987,500—**The Martin Co.**, Orlando, for launcher, helical rail, *Lacrosse* missile.

$980,768—**Western Electric Co., Inc.**, New York City, for *Lacrosse* engineering services.

$892,117—**Raytheon Co.**, Andover, Mass., for modification kits and maintenance test equipment for *Hawk*.

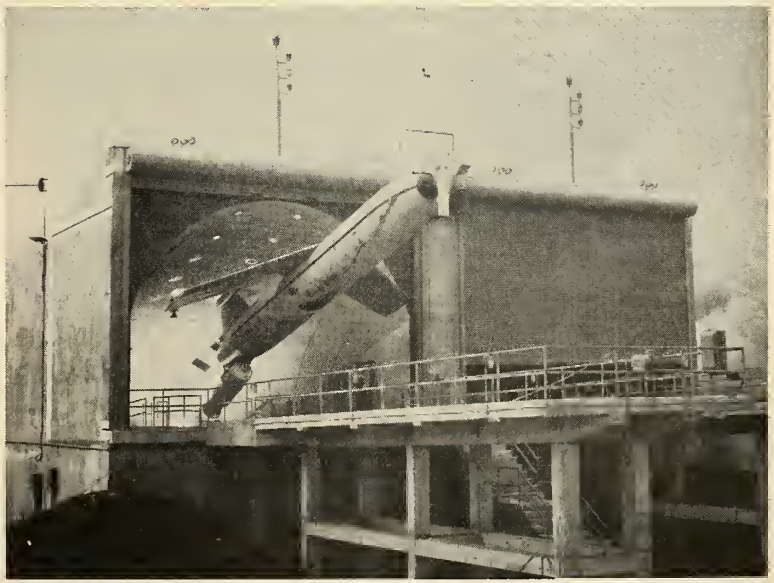
$727,375—**The Budd Co.**, Philadelphia, for development of high performance rocket motor cases.

$235,000—**Lockheed Aircraft Corp.**, Marietta, Ga., for fabrication and assembly of components for *Saturn*.

$176,000—**Hayes Aircraft Corp.**, Birmingham, Ala., for engineering, design and specialized services for manufacture of special tooling and fixtures for *Saturn*.

$149,984—**Atlantic Research Corp.**, Alexandria, Va., for necessary services to conduct a research study in the field of "Flexible Polymers to be Used as Thermal Insulation in Solid Propellant Rocket Motors".

Mace Goes From Hard Site



PROTOTYPE OF MACE B hardened launcher was proved out in a July 11 shot at Cape. Sites will be used in West Germany. The Martin tactical missile was kept on "hot hold" for several hours before firing.

Converted Drones

To the Editor:

I feel you have overlooked an important segment of Aerial Target capability by failing to include Converted Drones in your otherwise excellent special report on drones (M/R, June 27).

We at Sperry point with no little pride to the fact that we have, with Air Force guidance and support, contributed significantly to the successful conversion of the *QF-80, QB-47* and *QF-104* drone aircraft. As a point of fact, developments of the Microwave Command Guidance and "SEE" Systems (both of which were well described in your article) were an outgrowth of our work on converted drone systems.

The Converted Drone, represented at present by the operational *QF-80* and *QB-47* and the developmental *QF-104*, is a significant segment of the Aerial Target capability now in existence and programed for Air Force use in the next few years. In their respective performance classes, these drones provide a payload capacity, endurance, and cost-per-mission capability not approached by any other type of Aerial Target, expendable or recoverable. Operational experience with the QF-80, for example, shows an average record of better than 60 unmanned missions flown per drone prior to loss from any cause other than missile kill.

The unique capability of the Converted Drone will keep it in inventory for some time to come. No general treatment of the drone field can be considered complete without including it.

P. C. Story
Dept. Head
Drone Systems Eng. Dept.
Aeronautical Equip. Div.
Sperry Gyroscope Co.
Great Neck, N.Y.

M/R's encyclopedia covered only powered aerial targets and surveillance drones. Hence it did not include Sperry's highly regarded converted drones.—Ed.

Where It Began

To the Editor:

The "horse and buggy days" of a half century ago blended with the "space age" in the Solar Furnace article and photo in the April 11, 1960 issue of MISSILES & ROCKETS.

The history of these units goes back to 1912 when Blasius Bart developed and patented the Bart Lectroform process, consisting of electro-forming copper over sprayed low melting alloy molds for the reproduction of art objects. In 1929, Blasius Bart developed a bright rhodium process which resulted in a brilliant heat and corrosion resistant surface.

A combination of these processes produced the key item in the solar surface; a 60 inch diameter parabolic mirror electroformed from copper and nickel with the front reflector surface electroplated with bright rhodium. This enabled the production of successful anti-aircraft searchlights and naval search and signal lights.

The advantages of the Bart metal mirrors were published on by the then Major G. B. Robinson, U.S.A.C.A.C. in the December, 1931 issue of the Coast Artillery Journal. The contracting officer in liaison with Bart Labs was Lt. Leslie R. Groves, who is now best known for his great accomplishment on the Manhattan Project.

These reflectors replaced other types and are standard for allied countries as well as ours. Bart Labs helped to establish its production processes at the U.S.A.E.C. plant near Cincinnati, Ohio, which was run by the then Colonel Frank Forney of the Engineers Corps. The searchlights were extensively used during WW II and Bart Labs was congratulated by General Douglas MacArthur for their continuous and outstanding performance on Bataan.

The fact that these mirrors still provide very high reflectivity enabling their use as high temperature (3500°C) research apparatus is a demonstration of the significant protective properties and qualities of the rhodium electroplate and copper and nickel electroforming.

Surplus searchlights were suggested as possible tools in solar studies in '54, and an article was published on this topic in the February '57 issue of Chem. & Eng. News.

This technique developed by Bart about 50 years ago, has now become an important tool in the space age. An improved Lectroform process is now used for the production of wave guide structures, antennas, missile and rocket nozzles, linear electron accelerator structures, hyperthermal, hypersonic tunnels, nozzles, liners, reaction control thrust chambers, plasma gun apparatus, venturis, and many others.

Melvin H. Ehrenberg, Ph.D.
Bart Laboratories & Design Inc.
125 Manchester Pl.
Newark 4, N.J.

Questioned Record

To the Editor:

We were most interested to read in your issue of May 9th this year (Page 25) about the record duration rocket firing made at Rocketdyne's Propulsion Laboratory, Canoga Park, Calif., when their *Atlas* vernier engine ran continuously for over 32 minutes.

We were, however, surprised that this achievement was considered to be a record breaking run, since as early as 1956 we ran a *Spectre 1* engine of our own design (see photo) for 74 minutes

continuously over a range of thrust which included a high proportion at its maximum output of 8000 lb. st. thrust.

The controllable thrust version of the *Spectre* first ran in 1953, and this type of engine may well have been the first type of rocket motor to have a thrust output fully variable between idling and max. output. A distinctive feature of our *Spectre* series of rocket motors is that they all use a topping or "no-loss" turbine where the turbine exhaust gases are used to supplement the main flow in the combustion chamber, a system inherently more efficient than its separate turbo pump counterpart.

We trust that you will understand that we wish in no way to belittle the considerable achievements of our friends at Rocketdyne, but thought that our own achievements as detailed above are at least worthy of note.

J. E. Scott
Public Relations Manager
The De Havilland Engine Co. Ltd.
Leavesden Hertfordshire

For the Record

To the Editor:

In the M/R account (page 17, July 4) of my Colorado Springs speech, I gained the impression that it implied a certain amount of "brittleness" in *Polaris*. I just hope that others won't be led to believe, for example, that a five ft/sec. zephyr along the trajectory will cause a wild shot with this highly accurate system.

Actually, my intent was to convey the message that the *Polaris* system is designed to produce a trajectory of such accuracy that it will be as nearly free of errors—even small ones—as current technology can make it. Upon reading over my speech now, however, I see that I did not use exactly those words. At the same time, I feel that the words I did use could not reasonably be interpreted in any other way.

Incidentally, my remarks were not repeated with quite the same precision we require of *Polaris* guidance! In my comments on errors I did not name *Polaris*. While drafting the speech I was careful to avoid *Polaris* numerical data because of their security classification. Thus, instead of *Polaris*, I said "a typical missile" and, having paid particular attention to that item, I was careful to give extra emphasis to those words when I said them at Colorado Springs.

Please do not interpret my comments as "nitpicking." This is just an attempt to set the record straight in connection with a subject in which I have a greater than normal interest just now.

J. A. Jaap
Rear Admiral, USN
Dept. of the Navy
Washington 25, D.C.

Why Bases Slip

To the Editor:

Your editorial in the July 11, 1960, issue of MISSILES AND ROCKETS inadvertently omitted to mention the most important single factor responsible for the loss of time, and, incidentally, also for excessive costs of *(Atlas)* missile base construction.

Under the existing regulations, missile base projects must be treated as they were simple roads, and construction contracts are awarded to the lowest bidders without sufficient evaluation of their technical and engineering qualifications to handle complex projects.

Encouraged by outmoded procedures, the profit motive very often predominates, and the essential requirements of providing adequate engineering field supervision and coordination of subcontractor's work is not given sufficient emphasis by the construction contractor.

It would appear that the responsible Government Agency has difficulties in discharging its managerial responsibilities, as witnesses by the amount of rework due to inadequate inspection and resulting delays.

Since, under the existing regulations, neither the Air Force nor Convair have full jurisdiction over missile construction contracts, they cannot be responsible for the delays.

There is only one way to eliminate the slippage and that is to have a single qualified agency, preferably the prime contractor, responsible for the entire weapons systems program.

Dr. Alex J. Paszyc
Professional Engineer
San Marino, California

Truth About Polaris

To the Editor:

On Thursday July 21, 1960, a newspaper columnist wrote a story about *Polaris* missiles based upon half truths, and misinformation.

First of all let me state, and the Navy will substantiate this, that there has not once been a delayed firing of a *Polaris* missile due to Aerojet's failure to have the motors ready. There have been some close calls in this respect, but those have been occasioned by the Navy's pushing the schedules ahead. It should be remembered too that the *Polaris* program is currently running three years ahead of its original schedule and that this is in a great part due to three "technical breakthroughs" by Aerojet. These are:

(1) Dr. Karl Klager's development of higher impulse propellant with superior physical properties that permitted its early application to *Polaris* motors. For this he received the Navy's distinguished service award for civilians.

(2) Resolution of the thrust termination problem at a much earlier date than anticipated. This problem concerned the determination of range and was at the beginning considered one of the toughest problems surrounding the successful evolution of the missile.

(3) The guidance problem utilizing thrust vector control had never before been done in solid rocketry, but here again an earlier than expected breakthrough by Aerojet scientists was accomplished.

When the original Navy specifications were written they called for a 1500 nautical mile missile. At that time the design of submarines and the state-of-the-art of propulsion systems would not permit planning for a missile with greater range.

As a matter of fact, the 1500-mile missile even then was considerably beyond the state-of-the-art; however, it was decided to go ahead anyway and shoot first for an interim missile in the 1000 to 1200 nautical mile range and that is precisely what is being made operational today.

Following close on the heels of the A1 *Polaris* comes the A1a, the A2 and the A2a. These missiles are not behind schedule at all but are currently being test fired from the pads at Canaveral. And contrary to the columnist's allegation, in the development of these advanced *Polaris* missiles Aerojet has happily experienced only a minimum of difficulty. Actually, the A1A *Polaris* will be capable of 1500 nautical miles and this has been occasioned by the fact that additional space has been made available in the submarines to accommodate a slightly larger missile.

The A3, which has not as yet been funded, will have a range of 2500 nautical miles, a range that was not even conceived when the Polaris program got underway. Considerable technical and background work has been done already on the A3 which will result in a speedup in its development time.

Walter G. Winslow
Public Affairs
Aerojet-General Corp.
Washington, D.C.

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Money—For Weapons and Time

THE successful double launching of two *Polaris* missiles from the nuclear submarine George Washington off the coast of Cape Canaveral last week was the best news on the American defense front for a long time.

The sub-based and launched *Polaris* gives the U.S. arsenal a new weapon that will add both strength and versatility to the U.S. defense posture.

For the first time it makes the Navy a real part of the U.S. deterrent force, presumably with assigned targets in event of war.

And the sea-going *Polaris* will complicate immeasurably the defense problems of the Soviet Union, which is another way of saying the Russians will have to think even longer about attack as it becomes more and more difficult to neutralize our retaliatory forces.

The schedule for building the nuclear submarines to carry the 1200-mile missiles is as follows: nine under present construction; five authorized, for a total of 14. In addition, the Navy is authorized to contract ahead for the long lead time items necessary in the likely event that seven more are authorized, bringing the possible grand total up to 21.

Of these, two will be operational during 1960, two or three more in 1961 and the others about as rapidly as a new administration feels they are important.

Each sub will carry 16 missiles, a total of 224 for the 14 authorized, representing somewhere in the neighborhood of 200 megatons—that is 200 million tons—of explosive power.

It is a rather terrible thought—just as terrible, we hope, to the Kremlin as it is to us.

Last week on this page we wrote that in the present temperature of the not-so-cold war it is almost impossible for the United States to be too strong; that visible brute strength is the one elemental factor in world politics the Communist leaders respect and bend to; that we cannot be equally as strong as Russia—but we must be stronger.

In the last session Congress voted over half a billion dollars more than the Administration asked for weapons and space exploration. Much of this half billion was marked for missiles and missile-carrying aircraft.

There is considerable doubt—and Congress shared this doubt—that the additional money voted will be spent by the Eisenhower-Stans decision. A better reason for voting the money was so that it would be available for the new Administration in January.

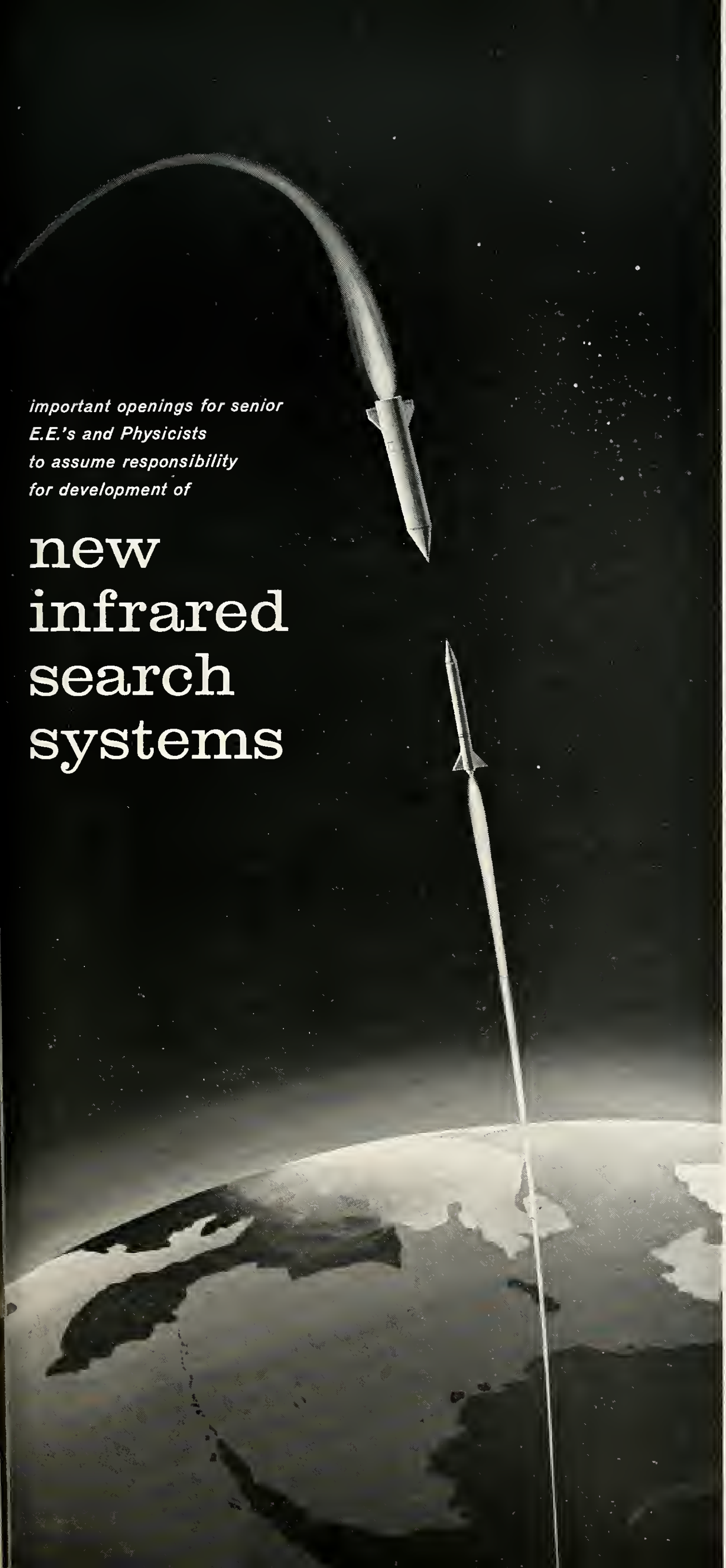
WE DO not believe the defense of the non-Communist world falls *wholly* on the United States, but we do believe that it falls *mainly* there. This includes the arms, supplies, transport and even troops for any United Nations force employed anywhere, from Africa to Cuba.

The half billion voted by Congress will buy hardware. More important, perhaps, it will buy time—time that we may find very precious one of these days.

The *Polaris* is a welcome and powerful addition to the arsenal of the free world. But *Polaris,* like SAC's bombers and ballistic missiles, is just one side of the defense picture. Strength means tactical forces as well as strategic, conventional weapons as well as nuclear. It means mobility—for distances of five miles or five thousand.

The money which Congress added to the budget (plus more they would doubtless vote if requested) and the weapons and time that money would buy may not be the entire answer to Khrushchev's belligerence but it certainly could be a good part of it.

Clarke Newlon



important openings for senior E.E.'s and Physicists to assume responsibility for development of

new infrared search systems

Progress of the Hughes Infrared and Guidance Department reflects Hughes overall growth. In the past ten years, employment has risen from under 2,000 to over 34,000 in the several semi-autonomous divisions of Systems Development, Research, Commercial Products, Ground Systems, Communications and Manufacturing. The infrared activity includes these typical projects:

---

1. **Air-To-Air Missiles**
2. **AICBM**
3. **Air-To-Air Detection Search Sets**
4. **Satellite Detection & Identification**
5. **Infrared Range Measurement**
6. **Detection Cryogenics**
7. **Detector Application Physics**
8. **Optical Systems Design**

These activities have created a number of new openings for graduate engineers and physicists with analytical and inventive abilities.

You are invited to investigate these openings if you have several years of applicable experience in infrared, optics or electronics, and can assume responsibility for systems analysis and preliminary design.

The importance of infrared development at Hughes is shown in substantial development contracts and in the fact that Hughes is investing its own funds in further exploration.

We invite your earliest inquiry. Wire collect, or airmail resume directly to:
Mr. William Craven, Manager, Infrared
Hughes Systems Development
Laboratories, Culver City 32, California

We promise that you will hear from us within one week!

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AIRBORNE SYSTEMS GROUP
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USAF