CONRAD LAU

Conrad Albert Lau, aeronautical engineer, inventor, executive, known to his friends and business associates as "Connie", was born on February 8, 1921 in Port of Spain, Trinidad, British West Indies to Mr. and Mrs. Egbert Lau. He was one of a family of four, all boys. His brothers were Neil, Roy and John. He and his wife Nancy Page Lau had three children, Conrad, Jr., Sally and Michael.

Conrad attended school in Trinidad through his sophomore year at Queen's Royal College. He entered Massachusetts Institute of Technology in his junior year. He received his B.S. Degree in 1942 and his Masters Degree in Aeronautical Engineering in 1943. While at MIT he was on the Dean's List for high scholastic achievement, and he was elected to membership in TAU BETA PHI, National Honorary Engineering Fraternity. Also, at MIT, in recognition of his Christian leadership, he was elected Secretary of the Technical Christian Association, a student organization of all Christian denominations dedicated to practicing and encouraging the Christian life.

Conrad joined Chance Vought Aircraft, Division of United Aircraft Corporation, upon graduation from MIT in 1943. He devoted his entire professional career to the Company that had become Ling-Temco-Vought, Inc. at the time of his untimely death, April 18, 1964. Through his initiative, superb intelligence, and human warmth, he had advanced rapidly from the position of Junior Aerodynamics Engineer to Director of the U. S. Navy VAL Light Attack Aircraft program for LTV.

OCTOBER 27, 1958

MINUTEMAN—Second Generation ICBM

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

News and Business Edition

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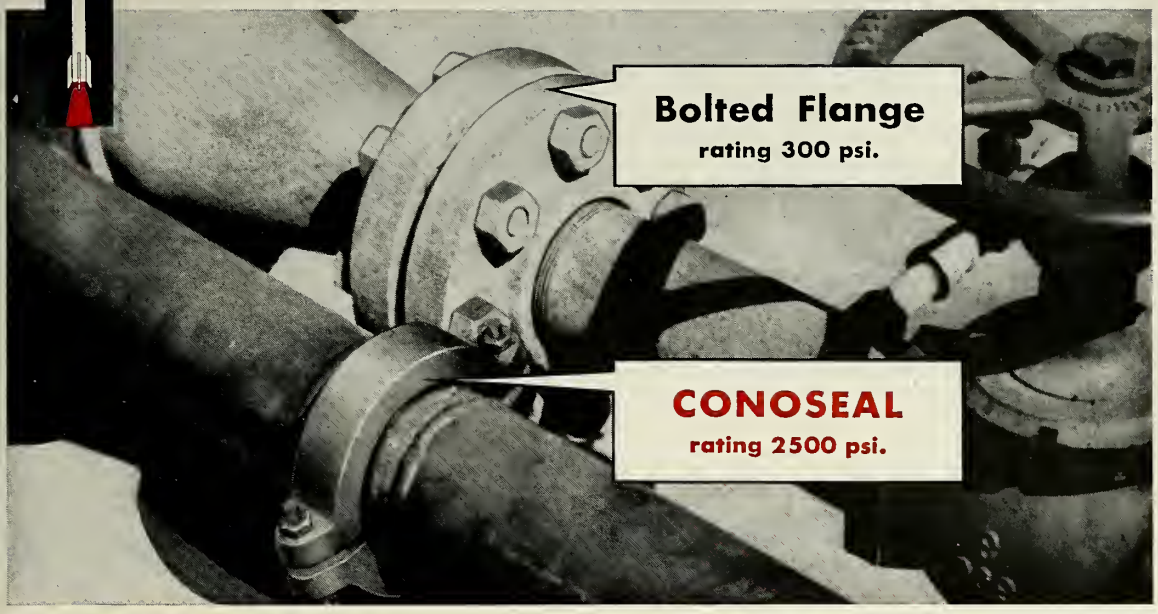

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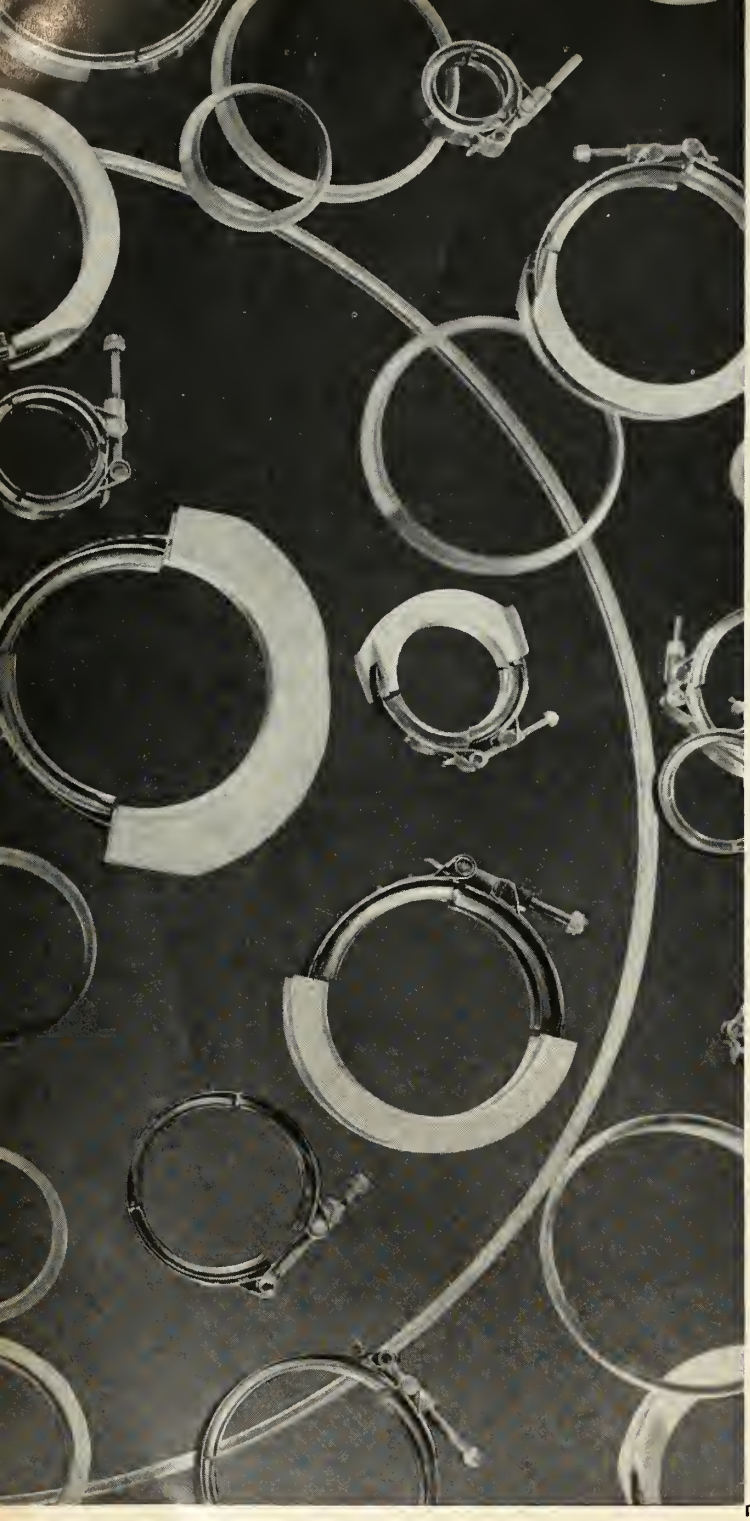

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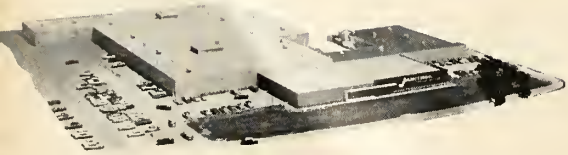

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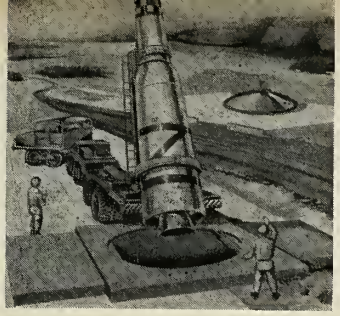

COVER: *An ICBM* Minuteman *is lowered into its "sunken silo" hardened base. The* Minuteman *system—which will be deployed in 1961-62 along highways, roads, and railroad tracks—should have easy maintenance and be a minimum target risk. (See p. 20)*

missiles and rockets **Vol. 4, No. 17, Oct. 27, 1958**

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in this issue

OCT. 27 HEADLINES

ASTRONAUTICS ENGINEERING

MISSILE ELECTRONICS

DEPARTMENTS

Missile Metal Machining

The picture below shows a guided missile component of A-286 alloy being machined on a 48" Monarch Air Gage Tracer Lathe at Diversey Engineering. Nowhere else can you get such extensive facilities for contour machining of Titanium, Inconel, A-286, Haynes Stellite and Zirconium.

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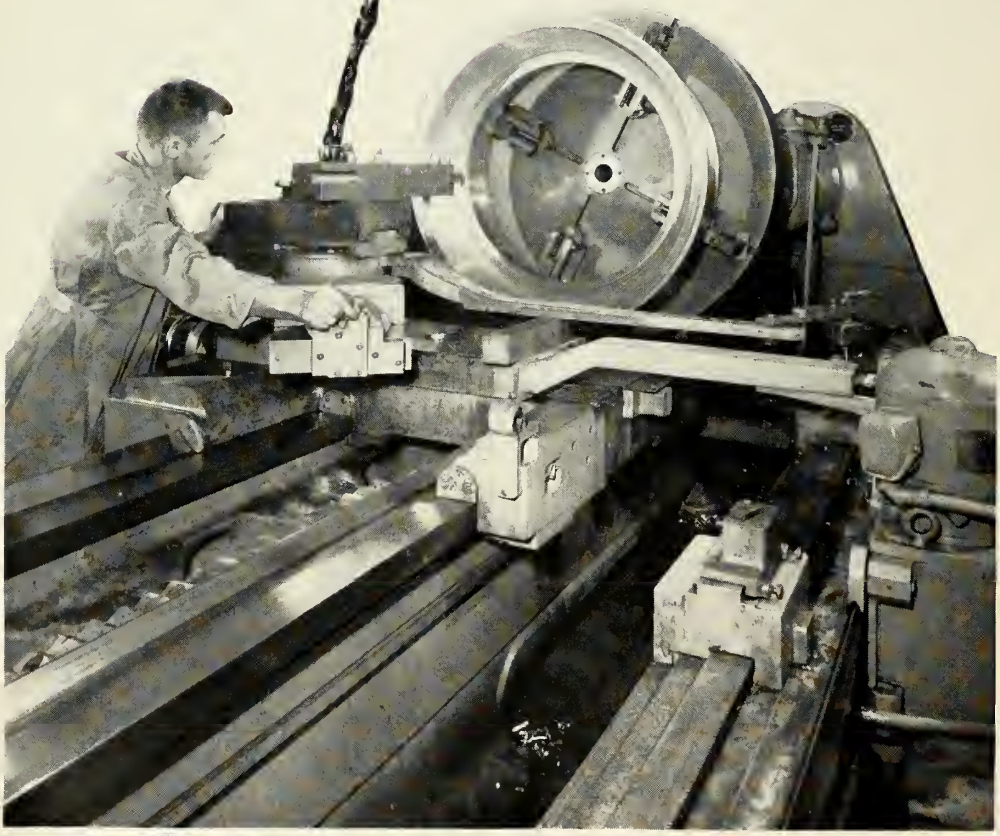

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FROM NOSE TO NOZZLE, FROM FIN TO FIN, CONTOUR TURNED PARTS—WITH PRECISION BUILT IN

In My Opinion . . .

. . . the nation's missile and space flight progress is in grave danger of being slowed down again. Once more the spirit and morale at Redstone is at a rock bottom low. Once more Wernher von Braun has been forced to tell his scientists to keep up the good work, to ignore the political footballing, to avoid any let-down—in spite of the fact that the axe is again being lowered over their heads.

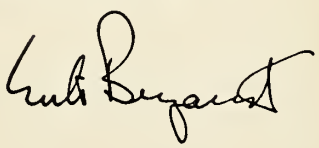
It will take weeks, and more probably months, for the Administration to finalize the decision to transfer the ABMA rocket science team to NASA, although the decision probably will be made before the end of the year. This is the statutory time limit and the only way the President can take such action without approval of Congress. But in the meantime—while the future of the nation's greatest rocket development team is being determined by election-minded Washington politicians—this same team is expected to advance successfully a major share of our most important missile and astronautics work.

In addition to the accelerated *Explorer* program, which represents this country's only worthwhile satellite program so far, the ABMA team is preparing two lunar shoots which the entire world is awaiting anxiously—a series of *Juno* IV communications satellites, the *Pershing* ballistic missile, ballistic freight and manned rocket carriers, an anti-ballistic missile, and other highly secret and crucial projects—projects that play an important role in this nation's cold-war struggle with Russia.

For many years, the Army missilemen have been given one blow after another—in fact, we cannot think of any other defense development group that has had better reason to become discouraged, disillusioned and distressed in their efforts. Yet this team, under the brilliant leadership of von Braun, has continued to pursue the goal of putting this nation ahead. The progress of this team is unparalleled—ranging from development of the first IRBM to this country's first satellite. And there have been other important break-throughs—less publicized—such as the ballistic missile nose cone development for less than $4 million (other missile builders spent $400 million doing the same thing later).

At the present time—since we do not know the details of the proposal to transfer the ABMA team to NASA—we cannot voice an opinion as to whether the proposal is good or bad. However, it can be stated that every effort must be made to back up the ABMA morale and spirit. This team must know that every man and woman in the Free World is thankful for the team's efforts. The ABMA scientists must be told that the nation will demand that only the very best decision is good enough for them. They should also be reminded that the current Administration has only a short time to go—and that in the end, free men and women will have the final voice in electing better people if the right decisions are not made.

Finally, let us appeal to Army Secretary Brucker to show his old vigor in this battle! The ABMA team needs your support, Mr. Brucker. Why not show them that you are determined not to let Army technology go without a fight?
fight.



Think small

Mechanical brains for missiles must be as tough and tiny as possible . . . a design problem that calls for experts skilled in both electronic computers and miniaturization.

ARMA's computer group has shrunk a digital computer module until it's the size shown above . . . a feat comparable to squeezing the contents of a steamer trunk into a cigarette package.

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washington countdown

Third AF moon shot . . .
will be ready on schedule, according to General Bernard Schriever's Ballistic Missile Division. BMD doesn't share any Pentagon doubts that alterations to beef up guidance and propulsion systems can be completed by Nov. 7.

Watch for a fight . . .
on hard bases for *Titan*. One faction feels that the job can best be done by large engineering firms with construction work integrated into the various local economies. But the *Titan* feud will be largely academic. The real plum will be the many hard bases required for *Minuteman*.

Turning the tables . . .
the Navy has announced testing of a new research rocket, *Arcas*, developed by Atlantic Research. Designed for a low acceleration rate, it is used for atmospheric research. The low speed eliminates need and expense of ruggedizing instrumentation.

Despite two failures . . .
Navy spokesmen are talking up putting *Polaris* missiles on all types of surface vessels plus submarines. Arming with *Polaris* conceivably could put many ships now in mothballs back into service.

Secretary of the Navy . . .
Thomas Gates probably will make known his intentions—whether to stay or resign —within the next two weeks. Reason: election. If he leaves, the job could go to one of the GOP entries who placed well but did not win, or to a governor completing a term whom it would be desirable to keep in the public eye until 1960.

But the job's up for grabs . . .
with Undersecretary Franke the unknown factor if the post is vacated. Franke wants the job. Or he may swap for Asst. Defense Secretary W. J. McNeil's comptrollership, with McNeil taking top Navy spot. Best bet for an outsider is James Smith of ICA. Rep. Wigglesworth, once a possibility, may become ambassador to Canada.

International space plan . . .
advocated by House Astronautics and Space subcommittee will bring no objection from military—but Pentagon says it wants to be sure nothing but pure science is involved. All are for freedom of science, but don't want the Russians to cut themselves into a one-way clearing house.

Transfer of projects . . .
to NASA is looked upon much more favorably than transfer of personnel. While the proposal that the Huntsville team should go to NASA stirred controversy, many military figures like the transfer of purely scientific programs such as *Vanguard* which were nearer pure science, but came out of military money.

Ironical missile paradox . . .
is that many conscientious U.S. R&D scientists are quietly hoping Russia will at least equal many of our space developments in near future. Otherwise—complacency, smaller appropriations, and lack of urgency may result on our part.

Boeing had to win . . .
the *Minuteman* competition, some wag remarked. Otherwise the company backlog might have dropped considerably below the two billion mark.

Another U.S. satellite . . .
was being readied as m/r went to press. Reports were that the Army would use a *Jupiter* C to launch NASA's 12-foot inflatable sphere.

X-15 roll out . . .
coming closely on heels of the 80,000 mile lunar probe, sent spirits soaring in Washington. Optimistic predictions are that first glide tests of the X-15 will be in December with a first rocket-powered flight late in the month. Full scale tests are still many months away.

RCA added . . .
another department to its large Defense Electronics Products Division with the dedication of its Missile Electronics and Control Department in Burlington, Mass., active in the *Nike-Zeus* program.

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industry countdown

AMC has been accused . . .

by the International Association of Machinists, AFL-CIO, with "coercion at the collective bargaining table" in the aircraft and missile industries. IAM states that DOD policies and actions amounted to illegal wage control—the fixing of ceilings on wage rates without authority from Congress or the White House. AMC told m/r that its procurement follows instructions issued by DOD to all services and it does not become involved in negotiations between management and unions. However, the Air Force will not necessarily adjust payments to meet agreements made by union and contractor after contracts are made.

New contracts . . .

for "Jack Blade and his Green Mountain Boys of Huntsville," (American Machine & Foundry). AMF has landed a contract for $1,685,000 with Republic for flight calculators and $1,768,000 with GE for radar antennae.

More mergers . . .

with Jetronic Industries of Philadelphia acquiring two Florida concerns in a transaction designed to insure a larger share of the missile market. Jetronic, producers of electronics test equipment, with plans for a major expansion in missile instruments, purchased Centronix, Inc., and the Atlanta Land & Manufacturing Co., both electronics component manufacturers.

Large grain solid lag . . .

is indicated in the recent disheartening launch failure of the second full-size *Polaris*. Instability in burning of the first stage was observed in the latest firing—a major problem area of past years. Last two firings have been operational configurations produced by Aerojet-General. The series of earlier test vehicles were lash-ups of the reliable *Sergeant* tactical missile produced by Thiokol.

Industry investment . . .

of tremendous R&D money for civilian goods could also be channeled into defense R&D if there were a climate of adequate profits. GE points out the constant glare of publicity on all non-classified projects in defense R&D and the inevitable technical troubles tend to lead to public discouragement and a loss of confidence in a company and its products. The pronounced effect on U.S. economy is illustrated by the fact that 1958 R&D expenditures will be about $10 billion, representing only 2.3% of the gross national product predicted for the year.

Promising market awaits . . .

the metals industry if and when a suitable means of processing beryllium from its ore is found. Forming and machining is a minor problem report the companies now producing such beryllium items as jetavators for solid propellant rocket control, and nose cones for *Atlas* and *Thor*. Its high heat resistivity would make it ideal for leading edges and high-drag surfaces on future space vehicles as the *Dyna-Soar* and manned satellite re-entry vehicles.

X-15 subsystem . . .

manufacturers announced at the roll-out of the first vehicle include: General Electric supplying two hydrogen peroxide APUs for providing electrical and hydraulic power; Sperry Gyroscope, inertial flight data system for providing data enabling the pilot to control the research craft during the critical period experienced at launch through the high acceleration period and at re-entry into the earth's atmosphere; Lear, Inc., a three-axis indicator showing attitude of the X-15 in relation to the earth during exit and re-entry; Bell Aircraft, control rockets for control above the atmosphere; and the Garrett Corp., responsible for a liquid nitrogen air-conditioning and pressurization system.

Target missiles . . .

demand heavy share of defense budget as indicated by the size of contracts awarded to Lockheed for its *Kingfisher* missile evaluation system. Latest award of $2,786,953 by Army Ordnance brings the total for this system to more than $10-million since the original contract was executed last June. *Kingfisher* is loaded with highly complex electronics instrumentation, including a firing error indicator for ground control intelligence of the proximity and approach angle of interceptor missile and radar device for simulation of attacking aircraft.

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special m/r survey . . .

Missile Mergers: Brains Are Target

by E. E. Halmos, Jr.

WASHINGTON—The increasing number of mergers within industries serving the missile field during the past year is sparked principally by the need for technical know-how.

And while the mergers promise better stability for the field, they emphasize the desperate shortage of technically trained people and technical knowledge in a field that is of vital importance to U.S. safety and progress.

That's the key to an m/r survey of business activity in the diverse industries that serve the missile field.

Other factors, turned up in m/r's partial survey indicate that:

1. The mergers, combinations and acquisitions between companies in the missile industry have resulted in practically no loss of top scientists, although some management skills have undoubtedly been pushed out.

2. Physical assets such as machinery or overall plant area in most cases apparently are minor considerations when one organization considers acquiring another.

3. A majority of the mergers are in the electronics and telemetry fields, reflecting again the need for small capital investments—but with large investments for technological "capability."

Transactions Increase—

The m/r study was prompted by the voluminous reports over the past year—and increasing during the past three months—of new alignments among manufacturers. The accompanying table, (p. 13) for example, lists some 30 such changes, and represents only a skimming of the actual transactions that have been concluded, or are in process.

In addition to the actual mergers, outright purchases (or stock exchanges), there have been dozens of other activities that indicate the strength of the trend: The establishment of special divisions within companies to handle special phases of missile work; joint ventures between companies for missile work, such as that announced recently by Vitro Corp. of America and the Koppers Co.; licensing agreements with foreign manufacturers, and the like.

To business observers, there's nothing new in the trend—except possibly the speed with which it has become apparent. Nearly every other major industry in U.S. history—and the missile industry today is a formidable one—has started in the same way, with thousands of small manufacturers, "tinkerers and individuals," getting in at the start, developing some facet of the technology, then by combination or absorption (or poor business practice) being welded into a stronger, larger organization.

But it took the automobile industry, for example, 40 years or more to achieve its present monolithic state. The aircraft industry has been strengthening itself for more than 30 years.

And in missiles, the trend is coming within two years, as nearly as anyone can set boundaries on the actual start of the business.

Canada Fears Loss of Specialists to U.S.

Canadian manufacturers and government leaders are frankly afraid that U.S. firms will make a serious dent in Canada's reservoir of electronics specialists.

Delegates to the Institute of Radio Engineers convention at Toronto officially warned the government that when the Avro CF-105 jet program is terminated next year, some 475 specialists on electronics will become prime targets for U.S. firms —some of which have already sent interviewers into Canada.

Merger Considerations—

The reason for the speed, of course, lies in the reason for the mergers.

The great rash of consolidations that hit U.S. industry shortly after World War II was dictated by three major considerations: An attempt to diversify the product line in order to keep alive in the expected let-down from wartime economy; the need to acquire physical plant and distribution facilities at a time when heavy industry was still aligned for war production; and—most attractive of all to many a company official—possible tax loss to be claimed through assuming the obligations of a faltering organization.

But in missiles, the spark continues to be the need for quick acquisition of technical know-how. The physical assets possessed by many of the small companies which have disappeared into the maw of larger ones are often hardly worth considering—a small shop, a few machines. In many cases, their financial position has also been sound enough.

Official Opinion—

A concensus of the top officials contacted by m/r could be put in such a statement as this:

"This business is only a couple of years old—yet it is already expanding into so many fields of highly specialized knowledge and theory that we haven't had time to develop the people or the technical libraries that should be available if we are to meet the fantastic requirements made of us.

"But such knowledge does exist in many places—in out of the way companies, and corners, in the minds of men who have been working away at some special phase for some years.

"We could, of course, attract some of these men and some of this information with high salaries, extensive search, body-snatching. That costs a lot of money, takes a lot of time. And we don't have the time.

"So the simplest thing to do is to buy the whole thing, wherever we can get it, at the best price we can negotiate."

An example is The Martin Company, which has been openly looking

around for an electronics company for some time. Martin has manufacturing capability, considerable know-how built up over years in the aircraft field and experience over many years in missile work. But it has not had time to develop enough electronics specialists in its own shop.

Why Electronics?—

The heavy emphasis on electronics is of course further evidence of the direction in which missile work must go, and where its weakest link lies.

There have been some consolidations on the side of manufacturing operations—but in general, manufacturing techniques haven't changed so much that old-line machining techniques and knowledge can't be applied. The materials are often newer, harder, or have other characteristics that differentiate them from more conventional industrial components. But the techniques for handling them are general refinements of long-known methods.

But electronics is a new business, and it calls for methods, materials, production techniques and knowledge that was unheard of two years ago. Often, it calls for methods that are apparently not economically possible for a large concern.

And of course, the electronics end of missiles is as close to mass production as the field can offer. While only 50 or 60 of any particular model of the big ballistic missiles may ever be built—each of these monsters may include more than 300,000 parts, many of which fall into the electronics area.

As things stand now, the major prime contractors are forced to subcontract much of this work. It has been estimated that more than 70% of all missile money goes out from the prime contractors to subcontractors. And the electronics and telemetry items are the "high markup" items in the business. It makes sense, business-wise, for the prime contractors to want to keep some of this business under their own roofs.

Exceptions—

There are exceptions, of course, to this general picture. Probably most typical was the acquisition early this summer of the engineering firm of Haller, Raymond & Brown by the Singer Sewing Machine Co., of Hartford, Conn.

The situation here was more typical of business mergers: Singer had a plant at Hartford—an area where skilled labor was then in oversupply—which had been set up specifically to turn out custom-made machines for special purposes, as opposed to its other plants which produce consumer-market machines on an assembly-line basis.

Singer management decided that missiles—or at least missile components—could be manufactured in this plant, to take advantage of existing facilities and skills. A major consideration, also, was diversification of the company's long-established product line.

Obvious answer—buy the capabilities the company didn't possess.

Another answer to the need for technical know-how has been the joint-venture operation. Well known in some industries—such as the construction field, where as many as eight contractors have joined forces to bid in and build a major job—it is relatively new to other industries.

But the demands for technology and special knowledge—and the heavy emphasis on research and development—have almost forced combinations of companies, in order to provide the needed pool of information and capability.

Recent Missile Mergers

Some idea of the speed and size of the company mergers that have occurred in the missile field can be obtained from the following list. This compilation is limited to larger deals as reported in the columns of MISSILES AND ROCKETS over the past three months. It includes only actual mergers or acquisitions, not joint ventures or establishment of special departments or divisions.

In chronological order, here are the transactions:

Litton Industries, Beverly Hills, bought Airton, Inc., Linden, N.J. (July 7).

Singer Sewing Machine Co., Hartford, bought Haller, Raymond & Brown, State College, Pa. (July 7).

Tennessee Gas Transmission Co. and Food Machinery Co. acquired Grand Central Rocket Co. (July 14).

U.S. Chemical & Milling Co. bought in four other companies: Missile Air, Hydro Metal Spinning Co., Foto-Etch Circuits and Paul Omhundro Co. (July 14).

Diversey Engineering Co., Chicago, purchased Warrior Tool & Engineering Co. (July 14).

Underwood Corp. bought Canoga Corp., Van Nuys, Calif. (July 21).

Houdaille Industries Inc., bought in Provincial Engineering Co., Niagara Falls, Que. (July 28).

National Tool Co., of Cleveland, purchased AutoVac Co. of Bridgeport, Conn. (July 28).

Mandrel Industries, Houston, purchased Hall-Scott Electronics of Burbank, Calif. (Aug. 4).

Advanced Industries, of Cambridge, Mass., purchased The Electrolizing Corp. and two smaller firms (Aug. 4).

Pyle-National Co., Chicago, bought in Steber Mfg. Co., Broadview, Ill. (Aug. 11).

Accoustica Asscociates, Inc., bought in General Ultrasonics Co., of New York City. (Aug. 11).

Ling Electronics, Culver City, Calif., absorbed Calidyne Co. of Winchester, Mass. (Aug. 18).

Olin-Mathieson Corp., joined Aluminum Ltd. and two French firms for ore exploitation and chemical work. (Aug. 18).

Beaver Precision Products, Inc., Detroit, licensed Armstrong-Siddley Motors of England to produce electronic products. (Aug. 18).

Acme Precision Products Inc., Dayton, bought in Cal-Tronics, Inc. of Los Angeles. (Sept. 8).

Air Logistics Corp., Pasadena, purchased Polaris Engineering Co. of Inglewood. (Sept. 8).

Chromalloy Corp. of New York, bought Propellex Chemical Corp. of Edwardsville, Ill. (Sept. 15).

Marquardt Aircraft Co. purchased Associated Missile Products Co. (Sept. 22).

General Transistor Corp. of Pasadena, merged with Barnes Engineering Co., Stamford, Conn. (Sept. 22).

Electronics Assistance Corp. of Red Bank, N.J., bought the electronics division of Mack Truck. (Sept. 22).

Litton Industries bought the Westrex Corp. (Oct. 6).

Jetronics Industries of Philadelphia, acquired Centronix, Inc. of Cocoa, Fla., and the Atlanta Land & Manufacturing Co. (Oct. 13).

Thompson Products and Ramo-Wooldridge merger approved by stockholders. (Oct. 13).

USC Operates New Type Hypersonic Tunnel

The University of Southern California has begun operation of a wind tunnel designed to test missile models under simulated conditions of Mach 20 at 60 miles altitude.

The tunnel, said to be the only one of its kind in the world, has the appearance of a large steam boiler and does not operate in the method of conventional wind tunnels.

Instead of using pumps and fans to blow air over models, the tunnel creates a vacuum at one end by refrigeration. This sucks nitrogen gas from the other end of the chamber and over the missile model. Pure nitrogen is used because it eliminates the necessity of removing moisture from the gas.

Designed by Dr. Raymond L. Chuan, director of USC's Engineering Center, the tunnel was built on a research contract from Air Force Office of Scientific Research and the Office of Naval Research.

A helium refrigeration system designed and installed by Arthur D. Little Inc. employes a method of cryopumping to achieve temperatures ranging from –450°F to +750°F inside the tunnel.

The vacuum pulls the test gas in a fraction of a second, through a tiny aperture, then into an 18-inch-wide tapered throat where it expands and accelerates to speeds around Mach 8. When this tapered throat is opened to a diameter of 40 inches, the tunnel will test at Mach 20.

Due to gas cooling during expansion, electric heating is applied to the nitrogen when it first enters the tunnel and again just before it flows over the subject model. Proper research findings from the tunnel depend on the model being the same approximate temperatures as an actual missile would be.

The second heating, applied just before the gas passes over the model, is done by a new method invented by Dr. Chuan. A small transmitter in the tunnel beams radio waves at the gas, resulting in heat similar to that of radar cooking.

The only moving parts in the tunnel are in the refrigerator, which operates on a 50-horsepower motor. A comparable unit, based on a gaseous diffusion pump, would require about a half million horsepower. Contrasted to the operating time of a fraction of a second for most wind tunnels, the USC unit can function for ten hours.

The space administrator said the advisory group would represent "the best men we can find from industry, educational and research organizations." The OPPE will work closely with Defense Department in the planning of immediate and long-range space programs.

Dr. Glennan made the announcement concurrently with the disclosure that Homer Joseph Stewart, professor of aeronautics of the California Institute of Technology, will head the newly organized planning office.

The newly appointed planning director, who was chief of the liquid propulsion systems division of Caltech's Jet Propulsion Laboratory, has been well-known in American rocketry circles for many years. He played a major role in the pioneering of such rocket projects as the *Wac Corporal, Corporal, Bumper, Sergeant* and *Jupiter C* and later, in the development and launching of the *Explorer* satellites.

Stewart joins NASA November 1.

Ion Engines May Adjust Chemical Vehicle Errors

Ion propulsion may be the answer to trajectory and orbital error in missile and satellite flight, according to Dr. Ernst Stuhlinger, director of the Army Ballistic Missile Agency's Research Projects Office.

Stuhlinger, who has gained recognition for his feasibility and design studies of electrical propulsion systems for space ships said it is possible that smaller scale systems may in the future make the delicate corrections necessary to keep chemically propelled missiles and satellites on course.

Electro-Optics, Inc. of Pasadena, Calif., is under contract to ABMA to conduct research in the fundamentals of ion propulsion, Stuhlinger said. Other contracts are in the works.

The Air Force Office of Scientific Research has let 34 contracts involving ion and plasma studies to the following companies and institutions: North American Aviation, Giannini Plasmadyne Corp., Avco Research Labs, Litton Industries, Ramo-Wooldridge, General Electric, Vitro Lab, Aerochemical Research, Aerojet General, Reaction Motors, Sperry Gyro, Sylvania Electric Products, University of Michigan, Temple University, Johns Hopkins University, Cornell, Princeton, New York University, MIT, University of Maryland, Stevens Institute of Technology University of Illinois, University of Minnesota, University of Oklahoma, University of Southern California, Stanford University, and Polytechnic Institute of Brooklyn.

Advisory Group to Aid NASA Program Plans

An advisory group to assist the Office of Program Planning and Evaluation will soon be set up for the National Aeronautics and Space Administration, according to Administrator T. Keith Glennan.

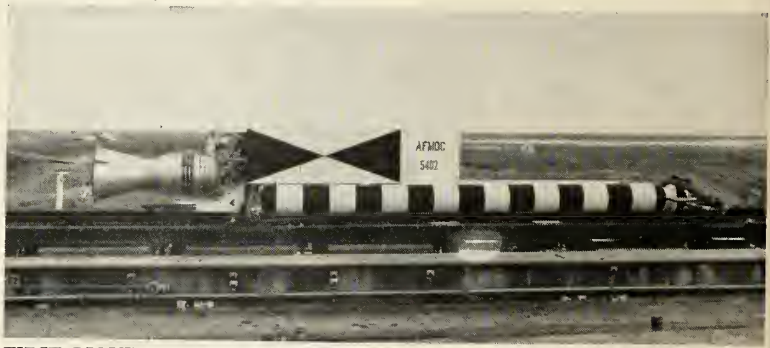
AFOSR's General Gregory Retires After 30 Years

Brig. Gen. H. F. Gregory, commander of the ARDC Air Force Office of Scientific Research will retire October 31 after two-and-a-half years in that post and 30 years of military service. He will be replaced by Col. Benjamin G. Holzman, present assistant deputy commander for research at ARDC Headquarters.

General Gregory, whose first assignment in the research and development area was with the Air Materiel Command at Wright Field, Ohio, in 1938, is considering several offers from private industry.

Col. Holzman, author of 32 scientific papers on geophysics, meteorology and atomic energy, served as staff officer for the 1946 and 1948 atomic tests in the Pacific.

Holloman Liquid Rocket Sled



FIRST LIQUID oxygen propelled sled to run on captive missile test tracks is this 50,000 pound thrust development of Rocketdyne. The sled weighs 3,000 pounds; can carry payloads up to 1,000 pounds; and travels the track at 1,100 feet per second.

Details Emerge on Soviet's Large Rocket Program

Technical Literature Coming from Behind Iron Curtain Giving Valuable Information on Developments Since End of World War II

by Donald J. Ritchie*

In the past few years there has been a rush of conjecture in this country on the efforts of the Soviets in the fields of rockets and guided missiles. Their success in placing satellites in orbit should leave no doubt as to the success of their efforts.

In the past year many Russian technical publications have found their way from behind the Iron Curtain into the United States. From the material contained in these books, journals, and pamphlets it is possible to construct a rough picture of the development of the rocket engine in the Soviet Union. The early years—through 1940—are fairly clear. However, the postwar years remain a relative blank.

Soviet Rocket Engine Development

Soviet Designation	Designer	Date	Thrust (Lb.)
OR-1	Tsanders	1930-31	11
OR-2	Tsanders	1932	110
ORM-1	Glushko	1931	
ORM-5	Glushko	1932	
ORM-12	Glushko	1932	
ORM-50	Glushko	1933	
ORM-52	Glushko	1933	662
ORM-65	Glushko	1936	342-386
RD-1	Dushkin	1943	651
RD-1X3[1]	Lavochkin	1946	
RD-2	Dushkin	1945	1320
RD-3	Dushkin		1980
R-14	(Team)	About 1950	220,000

[1] Shown at Tushino, August 18, 1946

• 600,000-lb.-thrust engine — But more details are emerging, particularly on a three-stage liquid fuel engine which probably is in the 600,000 pound-sea-level thrust class. A Soviet technical book, for example, illustrates that dual fuel pumps are used in the first stage powerplant, with one on each side of the oxidizer pump. The fuel pumps empty directly to the nozzle where passages bring the cooling fuel back to the combustion chambers which appear to reach almost to the nozzle.

A "guesstimate" as to the nozzle diameter would be about 25 inches. Assuming a combustion chamber pressure of about 800 pounds per square inch, it appears this unit is definitely in the 600,000-pound-thrust class.

The upper stage engines, with their combustion chambers and nozzles, are completely buried in the fuel tank. This is an excellent method to shorten each stage. All stages use jet vanes for steering following the V-2 principle.

The atomic rocket engine also is receiving much attention in the Soviet literature. Considerable effort is expended in the Soviet Union to reduce the physics, technology, and problems to be understood by the Soviet lay reader. As a result, many fine expository books have been published in the area of atomic energy and aviation.

• Rocket background—The first gunpowder rocket factory in Russia was opened at the close of the 17th century for the purpose of producing sky-rockets and other pyrotechnic displays for holidays and celebrations. These factories and workshops constituted the technical basis for the development of rocketry in Russia. Subsequently, for 150 years Russian troops used the signal rocket which underwent almost no change since its appearance in 1717.

The Russian military engineers Alexander Zasyadko (1779-1837) and Konstantin Konstantinov (1818-1871) made the greatest contributions toward the development of the gunpowder rocket in Russia as a weapon.

Zasyadko designed and tested a war rocket in St. Petersburg in 1817. The first rocket company was formed in St. Petersburg in 1826. Zasyadko's rocket was first used for war purposes during the Russo-Turkish war of 1828-29. Thousands of these rockets were also used during the war in the Caucasus. The war rocket designed by the British engineer Congreve was used in quantity in the war of 1812.

K. Konstantinov is claimed to be the founder of experimental rocket dynamics. He recognized the need for standardization so that his rocket was in all respects identical with the one manufactured previously. Konstantinov was aware of the necessity of scientific experimentation for perfecting rockets. He worked out in detail the methods of stand-testing of rockets by means of a ballistic pendulum of his own design.

Soviet writers are all pretty much in agreement, however, that Konstantin Tsiolkovsky is the father of modern rocketry. Tsiolkovsky (1857-1935) was a school teacher who, in his spare time, delved into the problems of aerodynamics, dirigible construction, reaction propulsion, and space flight.

Tsiolkovsky grasped the principle of reaction propulsion as early as 1883 but it was not until the close of the century before he created a mathematically precise theory of rocket propulsion. Many of the equations developed by him are still in widespread use today in the rocket field.

The most important contribution to science is his theory of the rocket relating to the mechanics of bodies with variable mass. The first type of long range rocket was described in Tsiolkovsky's work entitled "Investigating Space with Rocket Devices," published in 1903.

• Other developments—Comparable developments in the United States took place in 1916 when Dr. Robert H. Goddard, of Worcester, Mass., conducted his rocket experiments under the sponsorship of the Smithsonian Institution. Dr. Goddard published the results of his work in 1929 in a paper entitled, "A Method of Reaching Extreme Altitudes." He started work on a liquid fuel rocket engine in 1920 and the first flight of his liquid rocket vehicle took place on March 16, 1926.

The Russian efforts in rocket technology were accelerated in 1929 by the invention of a combustion chamber which would withstand high temperatures.

The Soviet rocket enthusiast, engineer F. A. Tsander, started to deal with rocket engines in 1908. Many interesting ideas on the improvements of rocket engines were proposed by Tsander in his book "Problems of Flight by Means of Reactive Apparatus," which was published in 1932.

In 1930-32 Tsander constructed two rocket engines—the OR-1 and the

*Research Laboratories Division, Bendix Aviation Corporation, Detroit, Mich.

OR-2. The letter O comes from the word opytovyi meaning experimental, and R from the word for rocket or jet.

The OR-1 was constructed in 1930-31, and consisted of a combustion chamber, nozzle and pressurized feed system. The propellants employed were benzine and gaseous air which produced a thrust of 5 kg. (11 pounds).

The OR-2 was constructed by Tsander in 1932. The OR-2 used benzine and liquid oxygen for propellants with a nitrogen pressure feed system. The liquid oxygen was gasified before injection into the combustion chamber by means of a counterflow heat exchanger using hot water as a heat source. This unit produced 50 kg. (110 pounds) of thrust and was one of the first in the world to use liquid oxygen and petroleum fuel.

• **Propellants**—The Soviets did not overlook the importance of propellants in rocket propulsion. Yu V. Kondratyuk in his work "The Conquest of Interplanetary Space," Moscow, 1947, considered the question of using improved fuels such as lithium oxide and horon coupled with hydrogen and the metallic elements.

V. P. Glushko, who started work in the rocket field in 1929, suggested as early as 1930 the use of nitric acid, nitric tetroxide, tetranitromethane, hydrogen peroxide, colloidal fuels containing beryllium, and others as oxidizers and fuel.

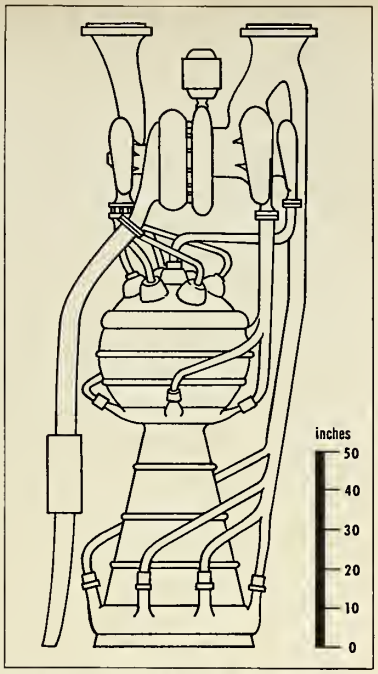
In the period from 1930 to 1936, the Soviet engineer Glushko designed and built a large number of liquid fuel rocket engines. In 1930 Glushko constructed and tested the ORM-1 liquid rocket engine. The designation ORM stands for opytnykh raketnykh motorakh or experimental rocket motor.

The ORM-1 used nitric tetroxide for the oxidizer and toluol for fuel. In subsequent years Glushko produced many versions of his first design. In 1933 he designed and constructed the ORM-52, a 300 kg. (662 pounds) thrust unit using nitric acid and kerosene. An official test stand was designed for this motor.

The culmination of Glushko's efforts was the ORM-65 which he designed in 1936. This engine also used nitric acid and kerosene and produced a thrust of 155 kg. to 175 kg. (342-386 pounds). A specific impulse of 210 seconds was achieved with the ORM-65 unit.

The ORM-65 engine was used in a soaring glider designed by S. P. Korolev and flown by F. A. Fedorov on February 11, 1939. It was also used in a winged pilotless vehicle, rocket 212, in the period 1937-1939.

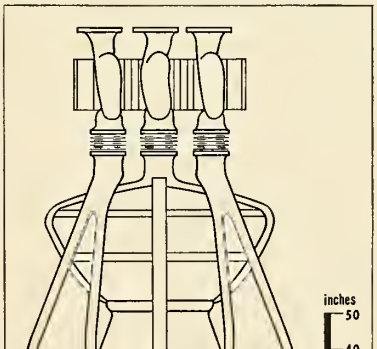
Following the successful designs of V. P. Glushko, the Soviet engineer L.



THE R-14 220,000-LB.-THRUST ENGINE. Note V-2-type spherical combustion chamber.

S. Dushkin produced a series of rocket engines in the period 1943 to 1945. These carried the designation RD and produced thrusts which varied from 651 pounds to 1980 pounds.

• **Post-war years**—The picture now gets cloudy. After the close of World War II, very little concrete information filtered through the Iron Curtain as to the efforts of the Soviets in rocket engine design. However, it is a good bet that the Soviets utilized to the utmost



HOW RUSSIAN 600,000 pound thrust engine may look with dual fuel pumps.

the German technology that they took over at the close of the war. A few pictures showing the German V-2 rocket being used by the Soviets have reached the press which bear out this conjecture. Undouhtedly, the Soviets have taken over and improved the V-2.

A further source of information as to the Russian efforts hehind the Iron Curtain has heen provided hy the German rocket technicians and scientists released from their stint of forced labor for the Soviets. These returnees have hrought a few details on their own project activities from which it is possihle to piece together a hazy picture.

Of great interest is the information on the R-14 rocket engine. Information has been provided on the R-14 rocket hy German rocket collectives, who worked for the Soviets from the end of World War II to 1950. From this information it is possible to deduce the Soviet philosophy towards rocket engine design.

At the close of the war the Soviet's immediate goal was to standardize on propellants and gain performance through high-thrust rocket motors, high comhustion-chamher pressures, and simplicity of design. The nozzle exit and throat dimensions of the R-14 have heen calculated from the stated thrust and chamber pressure.

The R-14 engine would produce a thrust of 220,000 pounds with a combustion chamher pressure of 900 pounds per square inch. The 60-atmosphere system was to operate via a two-stage turbopump, while higher pressures would he developed hy a three-stage system.

Fuel for cooling the nozzle walls, probahly hy transpiration, as used in the V-2 engine, comes directly from the fuel tank. The comhustion chamher itself was cooled by fuel from the first stage pump, while the comhustion chamher head was cooled by the output of the second stage pump. LOX as oxidizer and either kerosene or watered alcohol for fuel were probably the propellants.

Sources of information indicate a keen awareness hy Russia of the importance of the rocket engine not only as a propulsion unit for meteorological rockets, IRBM's, ICBM's, and space vehicles, hut also as adjuncts to fighter and homber aircraft to achieve super performance.

The prohlems of liquid fuel rocket engine control are covered in Soviet text books which discuss not only the theoretical aspects hut also the practical hardware aspects as well. The stress, placed by the Soviets, on the engineer's education in mathematics and especially non-linear mechanics, allows the design of extremely reliable and simple rocket engine control systems.

when and where

OCTOBER

1958 National Metal Exposition and Congress, American Society for Metals, Public Auditorium, Cleveland, Ohio, Oct. 27-31.

IRE 1958 Electronic Devices Meeting, Shoreham Hotel, Washington, D. C. Oct. 30-31.

NOVEMBER

Fifth Institute on Electronics in Management, American University, Washington, D. C., Nov. 3-7.

13th Annual Symposium on Applied Spectroscopy, Hotel New Yorker, New York, N. Y., Nov. 6-7.

Fifth Annual Meeting, Institute of Radio Engineers, Professional Group on Nuclear Science, Villa Hotel, San Mateo, Calif., Nov 6-7.

National Defense Transportation Association, 13th Annual Convention and Logistics Forum, Sheraton-Jefferson Hotel, St. Louis, Mo., Nov. 9-12.

School of Aviation Medicine, International Conference, Physics and Medicine of the Atmosphere and Space, Hilton Hotel, San Antonio, Texas, Nov. 10-12.

Society for Experimental Stress Analysis, 1958 Annual Meeting, Hotel Sheraton-Ten Eyck, Albany, N. Y., Nov. 12-14.

Conference on Scientific Information, AFOSR/Directorate of Research Communication, NAS, NSF and the American Documentation Institute, Mayflower Hotel, Washington, D. C., Nov. 16-21.

American Society for Quality Conference, Sixth Annual Aircraft and Missile Division Conference, Biltmore Hotel, Dayton, Ohio, Nov. 17-18.

American Rocket Society, 13th Annual Meeting and Astronautical Exposition, Hotel Statler, New York, N. Y., Nov. 17-21.

Eighth National Plastics Exposition, International Amphitheatre; and Plastics Conference, Hotel Morrison, Chicago, Ill., Nov. 17-21.

Northeast Electronics Research and Engineering Meeting, Mechanics Hall, Boston, Mass., Nov. 19-20.

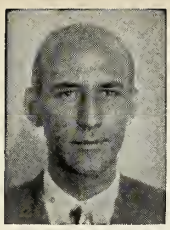
The Convertible Aircraft Congress, Franklin Institute, Philadelphia, Penna., Nov. 28.

First Electronic Computer Exhibition and Symposium, Olympia, London, England, Nov. 28-Dec. 4.

DECEMBER

Third EIA Conference, Reliable Electrical Connections, Dallas, Texas, Dec. 2-4.

Eastern Joint Computer Conference and Exhibit, Bellevue-Stratford Hotel, Philadelphia, Pa., Dec. 3-5.



propulsion engineering

by Alfred J. Zaehringer

Chemical-nuclear "hybrid" systems might allow a breakthrough in rocket performance before a practical all-atomic rocket arrives. Chemalco, a Pasadena, Calif. firm, suggests a slurry of a hydride (lithium, beryllium, or boron) in hydrazine. The slurry could be fed into a low temperature (2700°F) nuclear reactor to vaporize and exhaust the metal-fuel combination. Performance is estimated on the order of 350-450 sec.

Hot water rocket developed by German IPS has an I_{sp} of 50-60 sec. Water is electrically heated to a temperature of about 500°F under a pressure of 7,000 psi. When the water is released, the resulting steam expands to a velocity of 1,700 ft/sec. Dr. Saenger sees many ground-based RATO applications in Europe, since the system is cheap. A large hot water rocket developing 110,000 lb. thrust is planned.

Cryogenic liquid propellants will have to be tolerated, believes NACA, because they appear to offer the near ultimate in chemical performance. Much work, however, has to be done in storage and handling techniques before they can seriously be considered for operational use.

Plasma jet has been put to new use: depositing metals on various base surfaces. The jet developed by Giannini Plasmadyne Corp., for example, creates a plasma of 25,000°F with a velocity of 13,000 ft/sec. Tungsten coatings have been deposited on steel in this process.

Moly-coating process developed by Chromalloy Corp. appears to give an oxidation-resistant coat for molybdenum that may make the clad material a good bet for rocket motors. Chromalloy's subsidiary, Propellex Chemical, is reported testing the material for new, high combustion temperature composite and double base solid propellants.

Dispersions of metals and hydrides in plastic fuel-binders may be the answer to processing new high energy solid propellants. Such systems are safe to handle and use techniques long employed in the paint industry. One firm has already produced a dispersion of 50% solid high energy fuel material in a commonly used composite fuel-binder.

Solid propellant auxiliary power systems (SPAPS) are going into two solid rockets. Standard Oil Co. of Ind. has a thermoplastic fuel-binder composite that goes into the SPAPS on the *Falcon* rocket. AiResearch is to supply a SPAPS for the new *Nike-Zeus*. Solar Aircraft is studying SPAPS for use in 1000°F and in nuclear environments.

Nitration of ethylene glycol to form double-base solid propellant ingredient, DEGN, has been accomplished in a continuous flow-tube reactor by Hercules Powder. Scale-up of this system may be possible and may result in a new class of double-base solids.

Liquid monopropellant work at NARTS has hit an I_{sp} of over 200 sec at 300 psi. Composition of the high-density propellant was not disclosed. However, it is cheap, can serve as a coolant in regenerative motors, and is easy to store. Big problem appears to be high shock sensitivity.

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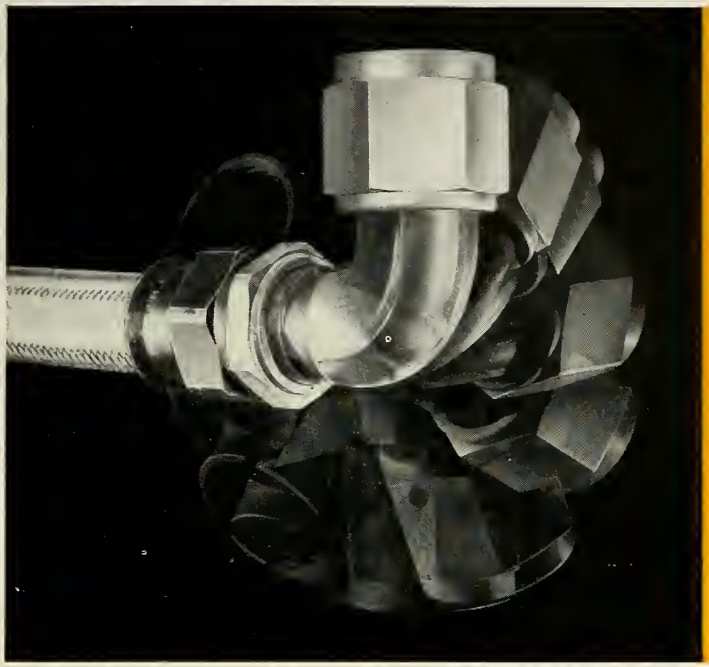

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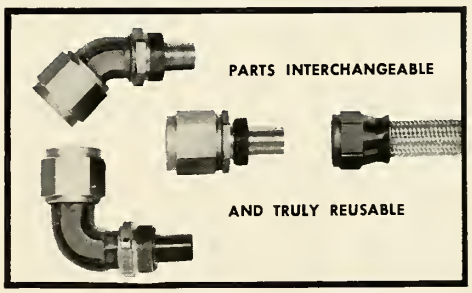

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Boeing Starts Work On ICBM *Minuteman*

Half-billion dollar missile replacing B-52 production; bolsters U.S. defense concept

by Clarke Newlon

WASHINGTON—Last year when Boeing lost out to North American in the competition for the long range supersonic bomber (Weapon System 110, later designated the B-70), President William Allen's wrath shook the big Boeing complex from assembly line to executives' row.

At the time Boeing entered into the competition for the second generation ICBM *Minuteman,* it was generally understood that heads would roll if Boeing lost. With the B-52 phasing out and only commercial aircraft on the horizon, Boeing was in the missile business up to its apogee and the *Minuteman* contract conservatively would run half a billion dollars before production.

When the Air Force announced the winner of the competition (m/r Oct. 20, p. 14) Boeing heads were safe. The Seattle Company had won the assembly and testing contract over 13 major competitors, reportedly by a narrow margin but by unanimous decision.

Boeing started work immediately in production preparations for another project in a long history of company "majors." However, a problem: shop space. With the B-52 program apparently ending in February, the high bay areas which formerly accommodated the towering tail assembly of the SAC bomber would be available for the 50-plus foot height of the *Minuteman.*

Boeing officials went into swift huddles with executives and production people from subcontracting companies named months ago—Avco for the nose cone; Autonetics Division of North American for guidance; Thiokol and Aerojet, who are backing each other up on first, second and third stage engines; and Hercules Powder, which is exploring a double-based propellant potential, probably ammonium perchlorate.

By February the assembly line reportedly will be laid out and the contracted components, let last July under a source-selection competition, will arrive at Boeing to be run through the line in mockup.

Competition Schedule

Seventeen companies invited to bid Spring of 1958. Fourteen bids received, late summer. Bids went to Source Selection Board (including AMC, ARDC, SAC) in September. Board deliberations completed about September 30. Command briefings held September 29-October 3. Board and Command recommendations returned October 6. Recommendations made to AF Chief of Staff and AF Secretary, October 7. Recommendations made to Deputy Defense Secretary Quarles, October 9. Unanimous decision reported for Boeing, October 10, 1958, with Boeing officially notified that date.

Air Force considers its first two intercontinental ballistic missiles—the Convair *Atlas* and the Martin *Titan*—to be first generation weapons, the "Model T's" of the family. Compared to previous aircraft-type weapon systems for the U.S. retaliation-defense concept, they are more expensive to build and each new change—there are many as the state of the art progresses—means major revisions. This includes launching and maintenance equipment and perhaps a retraining of personnel manning the weapon.

Therefore, missilemen believed that if developments came along particularly in the guidance and propulsion, it conceivably would be simpler to create a new weapon than to try and convert existing ICBM systems. That's the why of *Minuteman.* However, this does not mean *Atlas* and *Titan* will not be used; they are hardware in being, available—or almost—now. *Minuteman* promises to be ready in the 1961-62 zone.

Quick development—

In its short history, *Minuteman* is one of the fastest drawing board developments of any major military vehicle. Considering the first two ICBMs, the Air Force wanted these requirements for the follow-on:

(a) Simplicity, little expense and so basic in design it could assimilate new developments for the next 10 to 20 years without altering the original concept. It should be able to accept new fuels as developed, an improved guidance system or a multiplicity of shapes and sizes of warheads;

(b) It should eliminate countdown with a solid fuel able to fire like a rifle;

(c) It should have no on-site maintenance with the missile dropped into its "sunken silo" base, to be serviced by automatic (or semi-automatic) checking apparatus, where it would stay for its operative life, perhaps as long as a year before it would be replaced and returned to the factory for disassembly and/or rebuilding;

(d) Launch sites would be hardened to 100 pounds pressure per square inch or more; the control points further hardened, missiles cross-controlled from at least three points and the entire complex so dispersed that one nuclear hit would not knock out more than one site. Ideally, the sites might be strung along a highway, as in this week's m/r cover conception, or along a railroad.

Military objective—

The man who came up with the answer to these requirements was Colonel Edward N. Hall, of the AF Ballistic Missile Division in Los Angeles. He later was made project officer, and his vocal, firm opinions pushed the project through in short time. The accompanying "timetable" box amply confirms this. The "Father of the Minuteman" is now assigned as the staff missile advisor to the U.S. Mission to NATO.

Back of the *Minuteman* program is the military planning concept that Russia will start hostilities when she is convinced that she can destroy the American capability to wage war and

still sustain the losses the U.S. and her allies would inflict.

Suppose, for example, that the USSR could reach the point where her forces were capable of knocking out two-thirds of America's retaliatory force.

The one-third which remained could still devastate the Soviet. But it might not be able to knock out the Soviet offensive force to the extent ours had suffered, because Russia would have had the initiative—surprise—on her side. In a continuing struggle, Russia would eventually win because of remaining superior military forces, especially true even if Russia would disperse her military forces and civilian populace outside target areas.

U.S. concept—

It is possible to visualize a situation where the Soviet government, with this obvious military superiority, would simply invite observers, point to her overwhelming military force, dictate her terms and win a total victory without firing a missile or sending a plane aloft.

But the U.S. concept is inherently tied to the present massive struggle of cold war, with both countries fighting for supremacy, first in manned bombers, and now in missiles—whether sea or airborne, and whether land, sea or air-launched. And preparations today will decide the future in a contest on whom will be first with military machines in space.

All U.S. military planning—NATO strength, dispersed SAC bases, Army atomic capability, *Polaris* submarines—has this objective—to be sure that Russia does not reach a point wherein she feels strong enough, vis a vis the U.S. military team, that she could accept the losses of an all-out war. This is the present strategic concept and posture of the U.S. and her allies.

This concept and posture is relatively simple—to have retaliatory forces so strong, so varied and so dispersed that Russia cannot hope to knock them out effectively.

The retaliatory concept is the reason for SAC bomber bases in Spain, North Africa and Britain and for Britain's own atomic bomber capability. It is the reason for nuclear-capable fighter bases, with ranges far behind the Iron Curtain. It is the reason for ground forces with atomic artillery in the NATO line from Turkey to Norway. It is the reason for nuclear-capable fighter planes on our aircraft carriers, for atomic submarines, for *Jupiter* and *Thor, Atlas* and *Titan, Polaris* and *Minuteman*.

There undoubtedly have been attempts for good reasons and obvious misjudgment errors—to make the four major U.S. missiles—*Atlas, Titan, Polaris* and *Minuteman*—competitive with each other. But military planners do not so regard them. True, *Atlas* and *Titan* are in a sense competitive, but only because one is likely to enter the inventory, according to present planning, as the other fades out. Neither, again according to planning, is really competitive with *Minuteman* because it is designed for different atomic-capability targets. (*Atlas* and *Titan* have much larger warheads).

Polaris and *Minuteman* have a common characteristic—solid-fueled—and a dual role in the U.S. strategic concept. One to be fired 1,500 miles from dispersed and possibly submerged submarines. The other is designed to be fired from dispersed holes in the ground and will cover a range of 5,500 miles.

ICBM value—

Minuteman's value to the strategic picture lies in its relative cheapness (reportedly one-seventh of *Titan* or *Atlas*); the reported ease of hardening its sites and the reported low personnel requirements (20 per site as opposed to several hundred for *Atlas* or *Titan*). Time will prove the concept right or wrong.

But in *Minuteman* studies, literally hundreds of situations and presumptions have been theoretically evaluated, taking into account multiple changes in the basic factors, i.e., numbers of weapons, force of weapons, probably target error and the degree of hardening possible or desirable. Paramount consideration has been that in a few years the Soviet will possess a ballistic missile force of multi-megaton power, capable of 4,000 or more miles of flight with a two-mile radius of target error. (Four thousand miles probably is all Russia needs to cover the U.S. The U.S. however, needs another 1,000 miles or more to cover the Soviet).

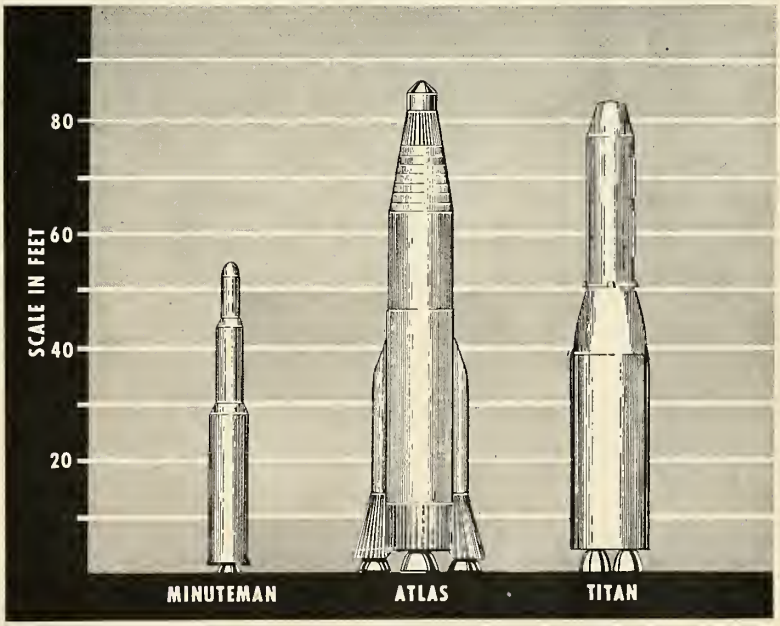
Other studies show that Russia would have to assign a relatively small (say X number) of missiles to be reasonably sure of achieving 90% destruction of any "soft" U.S. ballistic launching site.

But the Russians would have to send over some 30 times as many missiles (or 30 times X) to be sure of neutralizing a missile site which was both dispersed and hardened to the point where it could withstand a blast force of 100 pounds psi.

Multiplying this 30X figure by 100 or perhaps 1,000 or more sites in this country indicates the difficulty of delivering an effective knockout blow.

And while Russia is knocking out *Minuteman,* she has to deal with *Polaris,* with the *Jupiter* and *Thor* sites in Europe, with SAC's nuclear strategic bombers and fighters, with the Navy's nuclear fighters and the Army's atomic capability—all strong, varied and dispersed. While the U.S. problem is great, Russia's is not easier.

How ICBM's Compare



TOMORROW'S MINUTEMAN seems small in comparison beside *Atlas* and *Titan*.

Focalized Facilities

FOR MAJOR WEAPONS SYSTEMS

• RESEARCH • DEVELOPMENT • MANAGEMENT

Providing a new systems approach that follows through from initial plan to final production, the Bendix Systems Division serves as the *focal point* for the twenty-five strategically located divisions that constitute the Bendix Aviation Corporation. The new building, designed for engineering and managing of major weapons systems, is adjacent to the Graduate Engineering School of the University of Michigan in Ann Arbor.

This structure and its additions will accommodate a staff of 1,000 including engineers and scientists who will explore new concepts in communications, guidance and control, infrared, data processing, aerodynamics and propulsion, radar, acoustics, and countermeasures.

Weapons systems now being developed by this Bendix division include air defense network improvements, global weather reconnaissance, special radar applications for detecting ballistic missiles and low-flying aircraft, underwater surveillance, mission and traffic control, and a supersonic aerial target system for testing operational capabilities of the latest weapons.

Bendix Systems Division

ANN ARBOR, MICHIGAN

Bendix AVIATION CORPORATION

Precise Measurements Sought For Space

by Raymond M. Nolan

WASHINGTON—Now that the U.S. has finally gotten an object farther out in space than the orbiting satellites, the measurement of things once taken for granted—time, the meter bar, kilogram, and temperature scale degree—is assuming new importance.

Probably most important is the measurement of time. The U.S. Naval Observatory in Washington, responsible for the official determination of time in the U.S., now determines time by counting the vibrations of crystals kept in a scientifically-designed location. The vibrations are then checked on a daily basis against the earth's rotation.

However, this unit of time, while adequate for most things, will not be precise enough for space travel when a fraction of a second of error might mean that a resupply vehicle would miss its rendezvous with an orbiting station or another vehicle.

The variations in the length of a second, almost imperceptible, are caused by measuring methods. Since the length of the solar second depends on the time it takes the earth to make one complete revolution and since the earth is gradually slowing down, the second, as seen by scientists, is a shifting value. At least shifting in a sense that a variation of one-millionth of a second might someday become intolerable.

Because of this problem, quite a bit of attention has been given in recent years to an atomic method of determining time. This work has resulted in a commercially-available atomic clock manufactured by the National Co. of Malden, Mass. and various atomic timekeepers developed by companies for their own use. Actually, it goes even farther than that—the Naval Observatory now makes daily comparisons of its time determination with an atomic clock in the Naval Research Laboratory in Washington.

• **Measurements**—The atomic clock operates on the principle that the cesium atom gives off waves of energy with a constant frequency over a period of time, regardless of outside influences. This radiated energy can be counted to a high degree of accuracy. Scientists are measuring time with atomic clocks with an error in the neighborhood of 5 ten-billionths of a second, or one second in 60 years.

However, there is hope that this accuracy can be increased by a whole order of magnitude in the next few years. Solar time at the present has a maximum accuracy of plus or minus one second in 30 years.

The National Bureau of Standards' Boulder, Colo., facility has been using an atomic clock for a year to measure time and standard radio frequency. Time signals are set by the atomic device.

Time is not the only measurement under scrutiny. The National Bureau of Standards and many commercial firms are seeking ways to more accurately measure other standards. Besides the solar second, the other three primary standards from which all other measurements are taken are: the national meter bar (a copy of the international meter bar kept in France), the national kilogram, and the international temperature scale degree.

Weights and lengths used now are derived from long-standing Congressional Acts. The National Bureau of Standards is responsible for determining the conversion factors between the units we use and the four primary standards. Other standards for radio waves, electricity, atomic radiation and magnetism are kept by the Bureau, but while it is possible to measure these by conversion from one or another of the primary standards, the Bureau, in fact, does its measurements with a set of instruments that reproduce the derived standards.

Temperature measurements have been of interest to the Bureau for many years and some outstanding work has been done on measurement of extremely high and extremely low temperatures. Some discussion of this problem appeared in Congressional testimony this year and was probably responsible for this year's direct appropriation of $11.5 million, up $2 million from fiscal year 1957.

• **Pertaining to missiles**—Experiments underway at the Bureau and throughout industry are aimed at the redefinition of the meter by means of the length of certain wavelengths of light. Since light waves are now being measured down to something like a ten-millionth of an inch, the national meter bar could have its length checked ten times more accurately with light than is possible now.

This determination of length is important to the missile industry, where tolerances now are "intolerable," in the

***Sidewinder* Production Line . . .**

GUIDANCE AND CONTROL sections of the *Sidewinder* missile in final checkout before shipment by Philco. This is first *Sidewinder* production view released by the Defense Department. Missile is used by Navy's Sixth and Seventh Fleets and by AF F-104A.

words of one missile maker's production manager. In the guidance field particularly, gyros have become so precise that they are designed to be built with more accuracy than any available laboratory measuring instrument. Weight is a serious problem with gyros because of their dependence on mass for gyroscopic action.

Standards laboratories are becoming a necessity for almost all large corporations because of the multitude of precise measuring instruments that must be kept in perfect calibration for precision manufacturing. Some companies have gone even further and are doing basic research in standards determination. Much of this is concerned with the determination of length but several laboratories also have tackled the weight and temperature problems.

• **Space Age measurement**—Some of the larger corporations active in the standards field are American Telephone and Telegraph, International Telephone and Telegraph, Radio Corporation of America, Sperry Rand Corporation, Minneapolis-Honeywell, General Electric, and Westinghouse.

Electronics Field Soars to Worldwide 5th Place

The future of electronics as a science is "forewritten," and it has grown twelvefold since World War II. Today, it is the fifth largest business in the world, surpassed only by petroleum, automotive, meat packing and aircraft. These facts were cited by Maj. Gen. J. B. Medaris of Army Ordnance Missile Command recently.

Of the $39.1 billion defense expenditures in FY 58, the estimated almost $41 billion this year and $44 billion in 1963, a good percentage will be in the electronics field. Last year's more-than $7 billion in electronics expenditures is expected to double by 1963, with considerably more than half going to defense electronics expenditures. Importantly, these figures do not include R&D where electronic laboratory and test equipment will add an impressive amount to the totals.

Propellants and propellant checkout systems now account for a good part of the missile bill, but when ion and plasma propulsion schemes become a reality, then these too can be counted as electronics, fattening the amount still further, General Medaris said. Initial nuclear propulsion units cannot rightfully be included in any electronics totals, but when controlled thermonuclear fusion becomes the power source, it too will probably fall within the description of electronics.

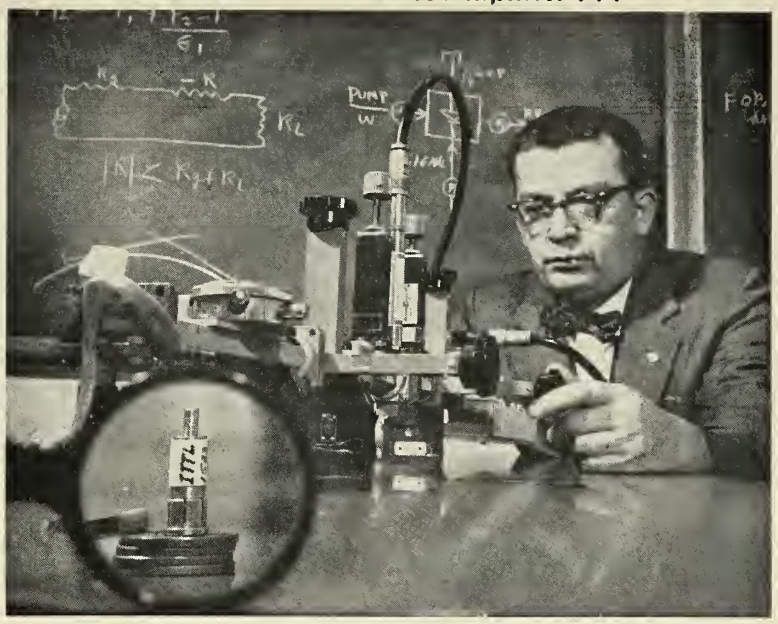
His remarks are significant because the most important area for large expansion in the electronics business hinges on a yet-to-be realized breakthrough—new ways to develop electrical power. Every plan for manned and unmanned spaceflight today has the drawback of almost impossible to achieve power requirements. Many scientists feel that, until power can be obtained from other than conventional sources, exotic forms of propulsion and crew environment will remain as major stumbling blocks.

Conversion of solar energy to electrical power is a reality, but the amount of power developed in relation to the size of the required equipment does not make solar conversion attractive in its present state. Another method being investigated by quite a few companies is the Peltier effect (m/r October 13 page 39), where different temperatures of dissimilar metals produce a flow of electricity. But here again, efficiencies are low and capacity is limited by size requirements.

If and when the breakthrough occurs, it will almost certainly come as a result of research and development in space technology, but its applications will be so universal that some observers feel it will more than justify any amount of money pumped into it.

At any rate, the electronics industry is riding pretty nicely on a healthy growth curve and can expect to remain in this position for some time. But, if a breakthrough in power development occurs, throw away the old figures—they'll be meaningless.

Silicon Diode Used in Parametric Amplifier . . .



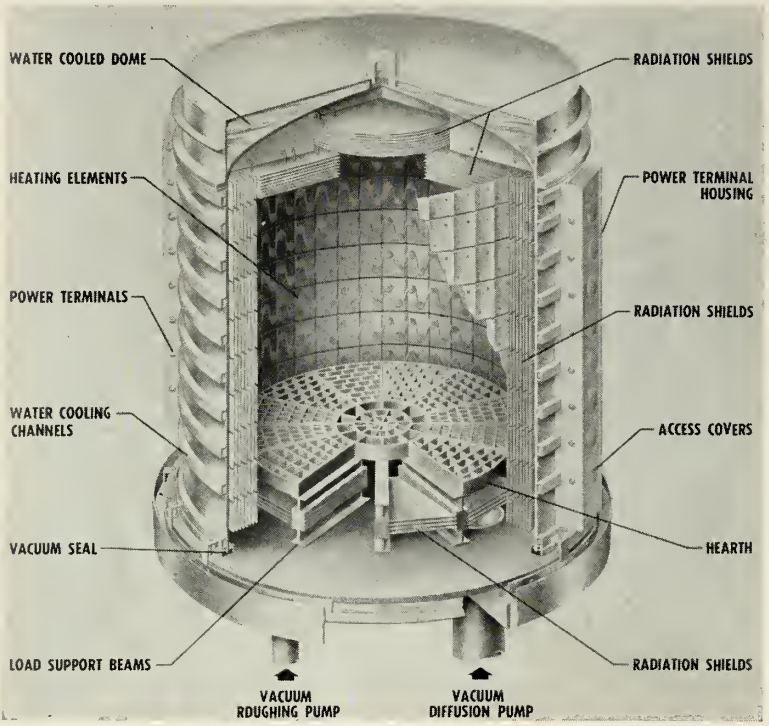
A sub-miniature silicon diode (magnified section of photo) is the heart of a recently announced parametric amplifier developed by the International Telephone and Telegraph Corp.

Immediate application of the new low-noise amplifier will be the extension of scatter and microwave radio links by 25 or 30% or the lowering of transmitter power for the same distance by as much as 90%. Combinations of decreased power and increased distance also may be used.

ITT sees eventual applications of the amplifier providing substantial savings to commercial and military users of over-the-horizon communications by reason of lower power consumption, less expensive equipment and greater distance per link.

In a technical description of the amplifier, William Sichak, director of the Radio Communication Laboratory at ITT, said that a received microwave signal with a frequency of 900 megacycles is modulated in the amplifier with a 9900 mc output of a local oscillator, producing a resultant 9000 mc output with a conversion gain of 18-20 db. This 9000 mc signal is then mixed with a 9070 mc local oscillator signal in a standard crystal converter, producing a 70 mc IF output. The overall noise figure is less than 1 db, compared with a figure of somewhere around 8 db in existing systems.

The first use of the new amplifier is for telephone conversations, television programs and communications systems but future uses for long range radio links in the missile field are in the offing.



GE Vacuum Furnace Insulated with Metal

Quick heat-up and cooling cycles for heat-treating super alloys of stainless steel and refractory metals, such as titanium and zirconium, is possible with a new electric bell-type furnace developed by General Electric Company.

Cylindrical metal shields instead of brick insulate the inside walls. The furnace casing is water-jacketed to keep it cool, making it possible to retain strength to withstand atmospheric pressure with high-temperature work loads. Losses due to convection are reduced by the vacuum in the furnace. A protective gas atmosphere can be used in the furnace while it is in operation.

The metal radiation shields form a complete enclosure around the material being heat treated, retarding radiation heat losses. The alloy shields are arranged in several layers of concentric cylindrical shells on the inside walls of the heating chamber, and the top and bottom have separated layers of alloy sheets in a horizontal position.

New Radio 'Scope Has High Resolving Power

A new type of radio telescope, believed to be the largest of its kind in the world, is in partial operation at Stanford University even though construction is only at the half-way point. The telescope, which has been under construction for the last three years and is expected to be completed in about six months, is financed by grants from the U.S. Air Force Office of Scientific Research.

On completion, the telescope will possess the highest resolving power, or focal clarity, of any radio telescope in the United States. The resolution is expected to be equal to that of a steerable paraboloid with a diameter of 375 ft.

The completed portions of the telescope include sixteen solid aluminum "dish" antennas, each 10-feet in diameter and mounted on a concrete pedestal, lined up in a 375-foot row across Stanford campus.

The antennas are synchronized to move in unison, probing the sun's blazing atmosphere with what is described as spectacular precision.

The system is expected to play an important role in the study of other planets in space which some day will be probed by man from space vehicles. When completed, the telescope's beam will be only 1/15th of a degree in both dimensions.

Computer Symposium Programmed for Chicago

The fifth annual Computer Applications Symposium, sponsored by Armour Research Foundation of Illinois Institute of Technology, will be held at the Morrison Hotel, Chicago, October 29-30.

The conference will have a different emphasis each day. On the first day, business and management applications will be the subject in sessions, and on the following day, the symposium will deal with engineering and scientific areas.

On the morning of the first day, Col. D. E. Ellett, chief of the data development division, directorate of plans and programs, Headquarters, Air Materiel Command will have as his subject, "Information Systems Modernization in the Air Materiel Command."

On the second morning session, the program lists "Scientific Uses of a Medium-Scale Computer with Extensive Accessory Features," R. A. Haertle, AC Spark Plug division of General Motors; "Optimizing Designs with Computers," D. D. McCracken, Institute of Mathematical Sciences, New York University; "Computer Applications in the Numerical Control of Machine Tools," R. B. Clegg, Kearny & Trecker Corp.

In the afternoon session, the program includes "Computer Sharing by a group of Consulting Engineering Firms," E. M. Chastain and J. McCall, Midwest Computer Service Inc.; "Current Developments in Computer Programming Techniques," F. Way III, Case Institute of Technology; "The Future of Automatic Programming," W. F. Bauer, Space Technology Laboratories.

Fred J. Gruenberger, mathematician of the RAND Corporation will chair the October 29 session and C. B. Tompkins director of numerical analysis research in the department of mathematics at the University of California at Los Angeles will be chairman for the October 30 session. At the close of the program each day, the chairman and speakers will conduct a roundtable discussion.

Two lunches are scheduled. On the first day, C. A. Phillips director of the data systems research staff of the Assistant Secretary of Defense (Comptroller) will have as his subject, "Problems and Prospects of Data Processing for Defense." On October 30, the speaker will be R. W. Hamming of the Bell Telephone Laboratories technical staff, who will speak on "Frontiers in Computer Technology."

A welcoming speech to registrants will be given by Dr. Haldon A. Leedy, director of the Armour Foundation.

missile business

There are no panaceas in the Pentagon now to cure the ills of small percentage participation by small businesses in the $6 billion-plus missile field.

But under the powerful watchdog eye of the Senate Select Committee on Small Business, the pressure is on for DOD to do more than just say it is aware of the problem.

The problem is basic: Small concerns can make valuable contributions to the nation's missile progress, but they are not being effectively utilized under the weapons system concept. In the field of research and development, small business participation is particularly needed.

The committee has recommended that the still-to-be appointed DOD Director of Research and Engineering designate an individual in his office to assist small firms in R&D contracting. If this is done, it should provide a healthy atmosphere with direction coming from the top, which the committee says is necessary. But, according to the committee, there are other areas that need correcting:

1. Lack of adequate specifications and drawings which can be "farmed out" to insure maximum open bidding.

2. A dearth of DOD-sponsored information on missile programs at the prime-contractor level available to the small supplier. Areas not sufficiently stressed include procedure for security clearances, types of contracts being utilized, end items desired, and what funds will be expended.

3. Less tendency of missile primes to consolidate their subassembly requirements and the subsequent placing of orders with large or medium-sized contractors instead of small business.

Speaking of small concerns, before Congress adjourned it voted a change in the Tax Code that will be important. Under certain circumstances of Public Law 85-866, small concerns can get the benefits of a corporation without getting double taxation of profits.

"There's a definite need for the government to distinguish between good and bad performance of contractors," Lt. Gen. E. R. Quesada (USAF Ret.), said. "Both continue to receive contracts and there should be," Quesada added, "some criteria established between good and poor performance."

Advanced Research Projects Agency—with a budget of some $420 million in fiscal year 1959—wants, and is anxious to do business with anyone who has a good military space proposal. That's the word from Rear Admiral John E. Clark, deputy director, who spoke last week to the National Rocket Club. Clark explained that ARPA—which has far-reaching contract authority—wants to insure that any industry gets a fair hearing.

Industry Roundup: Genisco, Inc., of Los Angeles, manufacturer of missile components and testing equipment, has acquired all of the capital stock of the **Eldema Corp.** of El Monte, California . . . A construction contract will be let next month for an $8-million addition to **Lockheed Missile System Division's** Sunnyvale plant. The facility will be used for WS-117L satellite development . . . **Bristol Aeroplane Co.** and **Aerojet-General** have formed a subsidiary company—Bristol-Aerojet, Ltd., with a factory in England, and will pool their solid rocket motor techniques . . . **Telemeter Magnetics, Inc.** of Los Angeles has leased additional space and plans to expand employment by 20% before the end of the year . . . **Titeflex, Inc.,** of Springfield, Mass., has established a Pacific Division in Santa Monica, Calif. . . . Dow Chemical Company has reported net income of $11,175,730, or 43 cents per share of common stock outstanding, for the first quarter ending August 31.

contract awards

ARMY

By U.S. Army District Engineers, Los Angeles Corps of Engineers:

Noxon Construction Co., Los Angeles, received $126,022 for facilities for launch control and safety (IRSS) Skyscreen Roads, camera pads and utilities at Vandenberg Air Force Base.

By Cleveland Ordnance District, Cleveland:

Norman Noble, Inc., Cleveland, received $43,755 for nozzle support weldment for *Jupiter* missile.

By Headquarters, Quartermaster Research & Engineering Command, U.S. Army, Natick, Mass.:

Princeton University, Department of Chemistry, Princeton, N.J., received $32,800 for study of the preparation and properties of monodisperse polymers.

By District Engineer, U.S. Army Engineer District, District Albuquerque, N.M.:

George A. Rutherford, Inc., Albuquerque, N.M., received $246,731 for White Sands Missile Range, N.M.

By U.S. Army Ordnance District, Los Angeles, Pasadena, Calif.:

Douglas Aircraft Co., Inc., Santa Monica, Calif., received $41,611 for repair parts.

General Electric Co., received $168,591 for computation facility operation.

Aerojet-General Corp., Azusa, Calif., received $49,964 for design and study.

Aeronutronic Systems, Inc., Glendale Calif., received $134,883 for orbit determination.

Aerophysics Development Corp., Santa Barbara, Calif., received $74,932 for feasibility study.

By U. S. Army Ordnance:

Telecomputing Corporation, Los Angeles, has received an add-on contract of $1,510,637 for nuclear warhear test equipment.

By Redstone Arsenal:

Firestone Tire & Rubber Co., Guided Missile Division, Los Angeles, received $34,627 for furnishing 24-man-months of technical services of engineers, for training groups of military and other personnel.

Teleprompter Corp., New York, received $200,000 for providing technical assistance in operation, maintenance and supervision of closed circuit television and teleprompter equipment, and producing and telecasting programs for the training schedule of the Ordnance Guided Missile School.

AIR FORCE

By Commander, Headquarters AMC, Wright-Patterson Air Force Base, Ohio:

Extrusions, Inc., Caldwell, N.J., received $85,780 for development of a process for the extruding of titanium and steel alloys by use of explosives.

By Air Force Cambridge Research Center:

Sylvania Electric Products, Inc., Waltham, Mass., received $48,707 for study of electromagnetic and magnetohydrodynamic properties of ionized gases associated with high-speed missiles.

ABMA Transfer to NASA: Good or Bad?

by Erik Bergaust and
William O. Miller

WASHINGTON—A move by Administrator T. Keith Glennan of the National Aeronautics and Space Administration towards exercising transfer powers authorized by the National Aeronautics and Space Act without advice of a still-to-be appointed civilian-military liaison committee has touched off a controversy extending to the White House.

The controversy—as forecasted by m/r (Oct. 13, p. 9)—developed when Glennan reportedly proposed to Army Secretary Wilber M. Brucker that the Army Ballistic Missile Agency's team of scientists, headed by Dr. Wernher von Braun, be transferred to the administrative control of NASA.

The request was made without the prior knowledge of the Army's top missile men, both in Washington and in Huntsville. The Space Act specifically calls for appointment of a civilian-military liaison committee, which if it had been operating when Glennan made his proposal, would undoubtedly have obviated much of the confusion and protest. It is expected that the next meeting of the National Aeronautics and Space Council on October 28 will see the belated appointment of this committee.

The President will appoint the committee chairman. Defense Secretary McElroy will name representatives from each of the three military services and Glennan will make a like number of appointments from his agency.

Much of the controversy stemmed from the lack of details of the NASA proposal. Glennan will not comment on it and the President has declared that he will make the final decision. Key questions unanswered are how many and what personnel are to be involved, what facilities will be transferred, and, most important of all, how will the transfer affect Army missile programs?

However, time enters into the problem. The power of the President to transfer facilities and manpower will be subject to approval of Congress after December 31. The question arises whether the lawmakers will stand still for action taken by the Space Council.

In fact, Congress has a club if it wants to use it. Of the nine members appointed to the Council, two were recess appointments and must be confirmed by the Senate. They are William A. M. Burden, New York investment banker, and Lt. Gen. James H. Doolittle, retired. Doolittle will become chairman of the board of Space Technology Laboratories January 1. Doolittle's appointment may be debated for possible "conflict of interests," because of his STL position.

Two other members appointed were Dr. Detlev W. Bronk, president of the National Academy of Sciences, and

NASA's KEITH GLENNAN—his move angers Army scientists.

Dr. Alan T. Waterman, director of the National Science Foundation.

Other members are the President as the chairman; the Secretary of State, the Secretary of Defense, the Chairman of the Atomic Energy Commission, and Glennan. These men will assist the President in making the decision regarding transfer of the Army team.

• **Army indignant**—The Army brought in its big guns in an attempt to block the move, or at least to find out what actually is involved in the proposed transfer.

Maj. Gen. John B. Medaris, commander of the Army's Ordnance Missile Command, flew from Chicago to Washington, reportedly to seek an appointment with the President. While he did not see him, he conferred with Secretary Brucker.

Even though they would not be quoted, top Army officials voiced fears that their missile agency might become nothing more than housekeepers supplying support to the civilian agency. This, they said, would undermine the Army's missile program to the detriment of the national defense.

• **German scientists speak**—German scientists, heart of the Huntsville team, spoke out in no uncertain terms:

"Such a transfer would seriously damage the Army's capability to fulfill its weapon systems requirements," one scientist said. He pointed out that replacement of weapons would require a period of several years and would cost over $100 million. Splitting the team up would not be effective utilization of personnel, who have repeatedly proved their ability to carry out missile and space programs, he added.

Army's major concern is that transfer of part of the team, which has a strong group loyalty, would result in many leaving the Army and NASA for higher paying positions in industry.

As one German scientist put it: "The proposal would involve transfer of U.S. citizens who have verbally stated their opposition to it. There is no logical reason for the transfer since the Army organization is willing to support NASA in the same way it has supported the Advanced Research Projects Agency in DOD."

Another said: "The interconnection between missile development and space exploration activities at ABMA is so intimate that both could come to a screeching halt if the existing team is broken in two. If this happens, it would do the most serious damage to the defense effort of our country and our attempts to regain technical superiority in the space age.

"Our work has been most important for tactical purposes in the military field and in the technical and scientific fields and we feel we have contributed to both. Such a split would be extremely inadvisable and undesirable. Our country cannot afford to do this at the present time."

• **Thousands involved**—"The core of ABMA is the development operations division, headed by von Braun. The division has 3,925 employees led by a team which has no equal in the world," an Army spokesman explained. "They have worked together as a team in this country since 1945, and in their firsthand knowledge in developing, assembling and firing over 400 ballistic missiles they have ten times the experience of any other U.S. missile group. Of the total number, 1,249 are scientific and professional personnel, the Army spokesman added.

AUSA Avoids ABMA Transfer

by Donald E. Perry

WASHINGTON—The two most significant impressions coming from the 1958 meeting of the Association of the United States Army (AUSA) were gained from things that weren't officially said. There was absence of any mention of the proposed transfer of Army Ballistic Missile Agency (ABMA) to the National Aeronautics and Space Administration (NASA) and the discussed possibility that Army may be on its way to losing its coveted missile capability.

All discussions avoided the ABMA transfer. But it was the most popular subject wherever two or more people met—in the hallways, in hospitality suites and even the exhibit hall where conventional weaponry was heavily stressed. As one observer jokingly commented: "There are too many vacancies open in Panama."

Both the opening speech by Vice Chief of Staff General Lyman L. Lemnitzer and the remarks of JCOS Chairman General Nathan E. Twining, low-rated missiles and other new weapons as factors in increased Army mobility and firepower.

General Lemnitzer said that while the layman considers the missile age as basically altering the conduct of war, missiles have their shortcomings. "While they contribute to meeting aggression, they do not, however, improve our ability to maneuver, to exploit firepower and to occupy and deny ground," he said.

"New weapons will justify reductions on Army firepower only in those types of forces where the primary function is to achieve destruction by heavy firepower," he continued. "Army forces benefit only from missiles to a limited degree, through the replacement of heavy non-atomic artillery and reduced close air support requirements. Army forces gain nothing from these particular items in terms of mobility or of the ability to occupy and deny ground."

General Twining told his audience that he thought Army emphasis should be on firepower and speed with the majority of combat equipment capable of movement by air or fast ship.

"When I speak of mobility," he said, "I am thinking of both rapid movement and fast reaction. The *Redstones, Corporals* and even *Honest Johns* of today are not really mobile in the sense of rapid movement in a battle area. Nor do they yet possess the capability for fast reaction. Firepower is not much good unless it can be applied quickly and flexibly. Emphasis must be placed on insuring improvements in these characteristics in the follow-up models such as *Pershing* and *Sergeant.*"

Both Twining and Lemnitzer said the answer to successful development of the weapons needed is in the close cooperation between the services and industry. Lemnitzer added that science and industry are basic to the process of research and development, test, standardization and procurement.

A panel discussion of the Army's achievements in larger missiles and in space research included such participants as Lt. Gen. Arthur Trudeau, Army Chief of Research and Development, chairman; Maj. Gen. John B. Medaris, AOMC; Dr. Ernst Stuhlinger, ABMA and Brig. Gen. Frederick W. Gibb, commander of the Combat Development Experimentation Center.

In prepared texts, no mention was made of the proposed transfer of ABMA. Discussions were general, with emphasis on the research and scientific achievements made by the Army's team—that portion of the Army program NASA would like to have transferred to the civilian agency.

De-emphasis of missiles and rockets apparently was not accidental, but came from action of the AUSA board which reviewed speeches. Search for a new Army theme was said to be the motivation.

If the AUSA 1958 convention is any yardstick, the Army is far from leaving the infantry concept behind. The meeting reinforced the Air Force claim that the Army can take care of tactical situations with a combination of men and small missiles, while the USAF concerns itself with strategic policy.

New Hot-Cold Light Panel Has Space Use

PITTSBURGH—The first experimental model of a three-purpose combination hot-cold light panel was revealed here last week by Dr. J. A. Hutchison, vice-president in charge of engineering and research, Westinghouse Electric Co.

The experimental panel combines into a single operating unit two of man's newest technological advances—thermo-electric refrigeration and electro-luminisent lighting. Thermo-electric refrigeration produces cooling in special solid materials directly from the flow of an electric current. Electro-luminisent lighting is produced by glowing panels, no thicker than a sheet of ordinary windowglass.

The new foot-square hot-cold light panel, composed entirely of solid state materials, has no moving parts. It produces as much light as a 25-watt light-bulb, can maintain a surface temperature approaching that inside a house-hold refrigerator and can raise the surface temperature to about 130° F—a temperature suitable for radiant heating.

Dr. Hutchison told m/r he could visualize that the hot-cold system might be used in satellites and space vehicles for cooling and heating electronic machinery in space.

United Aircraft Forms Research Sudsidiary

United Aircraft Corp., which recently took the full plunge into the missile field (m/r July 7, p. 5), last week announced a further step—formation of United Research Corp. to "sponsor and support" basic research in fields pertinent to the company's interests.

First assignment will be research in advanced propellants for missiles and space craft, in cooperation with Stanford Research Institute.

Lt. Gen. Donald L. Putt, recently Deputy Chief of Staff for Development, Headquarters, USAF, has been named as president of the new corporation. Other top men in the new firm include Dr. Isidor Rabi of Columbia University; Dr. C. Richard Soderberg, dean of engineering at MIT; Dr. H. Guyford Stever, assistant dean of engineering at MIT; Dr. Bernard Lewis, of Pittsburgh, and S. Allan Kline, president of Sierra Metals Corp.

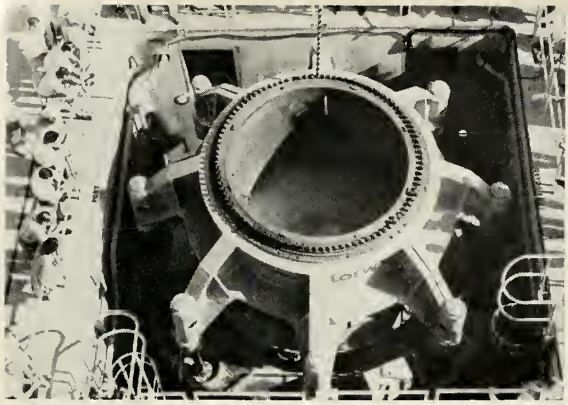
Rocket Mail Flight to Mark End of IGY

The largest demonstration of rocket post yet conducted will take place December 31 when six letter-carrying rockets flash across the Nevada-California border to commemorate the end of the International Geophysical Year.

Six thousand special rocket envelopes from stamp collectors will be aboard the sleek, fourteen-foot long by three-inch diameter rockets which will be launched by the Rocket Research Institute from Clark County, Nev., to Nipton, a small mining town in San Bernardino County, California, two miles away.

B-52G to be tested

The B-52G strategic bomber designed to carry two GAM-77 *Hound Dog* missiles will undergo flight tests at Edwards AFB starting this month. The new version of the long range bomber has increased range of 25%, speed in excess of 650 mph., and reduced weight. In addition to the two missiles, the plane will carry nuclear weapons in its bomb bay.



SIMULATOR CAN DROP 14 feet as it rolls and pitches.

Polaris SMS Equipment Undergoes Cape Tests

by William O. Miller

CAPE CANAVERAL—The Navy has spent upwards of $3 million to make sure that when *Polaris* is put into a submarine, it will be thoroughly acclimated to the roll, pitch and heave of its underwater environment.

A movement simulator, now undergoing final acceptance tests at Cape Canaveral, was put through its paces for the first time a few days before a full scale, two-stage *Polaris* test vehicle failed in a second firing from the Florida test center.

The SMS (Ships Motion Simulator), popularly known as the "Shaker," was designed, built and installed by the Loewy-Hydropress Division of Baldwin-Lima-Hamilton Corp. It will allow the Navy to study actual conditions under which the *Polaris* will have to be stored and fired. It also will pre-test the missile.

The "Shaker" will enable engineers to study the influence of ship movements on the structure, the guidance system, safety elements and overall characteristics of the fleet ballistic missile; and equally important, in developing handling and servicing techniques.

There are six directions in which a ship moves. However, only three have any appreciable effect on launch characteristics and missile structure requirements. These are roll, pitch and heave.

The "Shaker" can accurately simulate all of these motions by means of two large diameter and concentric cylindrical rings which are gimbal-mounted to permit angular motion of the longitudinal axis of the inner cylinder in roll and pitch or in any vertical plane. These gimbals are mounted on a crosshead assembly which is connected to a series of guides located on the walls of the pit, which will move in a vertical direction only. This vertical movement is equivalent to the heave motion.

The entire assembly is supported by four hydraulic cylinders. Two of these are working cylinders controlled by hydraulic valving, while two are uncontrolled and considered counterbalances to part of the platform weight as it is lowered, thus saving power.

Roll and pitch motion is provided by four additional cylinders arranged in opposing pairs. The planes are at right angles to each other. The cylinders are ball-ended at both ends to permit oscillatory motion of the platform.

• **Simulator use**—It is planned to record on board a submarine the actual ship movement, which then can be brought back and programmed into the simulator. While the *Polaris* is primarily designed for underwater firing, where movement is a fraction of surface movement, the surface firing of the missile is not ruled out.

First use of the simulator will be in a series of pop-up test shots of the ejection system that launches the *Polaris* by hydraulic pressure. Once on the surface, the first stage solid-propellant engine will be fired.

A forced vibration system is used in which fluid pressure is applied alternately to opposing cylinders in each pair, and roll and pitch oscillations are set up and maintained as long as hydraulic fluid is provided. The upward heave is by fluid pressure to the vertical actuating cylinders, with downward movement gravitational.

When demonstrated, the simulator went through a plus and minus eight-degree pitch motion, a plus and minus eight-degree roll motion, and a plus and minus seven-foot heave motion. The combined roll and pitch was within an eight-degree cone. Time per cycle is 6-14 seconds.

The upper and lower surfaces of the inner gimbal ring are equipped with flanges and bolting to accommodate the *Polaris* launcher (DPL-2) made by Westinghouse, launch contractor. Lockheed Missile Systems Division operates Complex 25 for the Navy and conducts the flight test program under Navy supervision.

• **Subsurface installation**—The subsurface installation of the 400,000 lb. launcher and simulator posed special construction problems due to the necessity of digging a 55-foot pit into sandy Florida soil, totaling 23,000 cubic yards. Proximity of the ocean and the Banana River necessitated a dewatered sheet pile cofferdam. Original water table is eight feet below grade. The 47-foot deep by 33 foot square rests on a seven-foot thick plug within four-feet thick sidewalls. Construction required pouring of 3,800 cubic yards of concrete.

The simulator, as part of the Fleet Ballistic Missile program, has a DX priority, the highest that can be awarded. The entire program is under the supervision of the Navy's Bureau of Ordnance Special Projects Office, Rear Admiral William F. Raborn, director.

A series of tests of the ejection system in the launching tube has been carried out on the West coast. The dry-land tests were called Operation Peashooter. The submerged tests Pop-up. This was the second test firing from a dry land base. The first test firing of the *Polaris* at sea will be from specially equipped surface vessels. Then the missile and the submarine will be put together for the first complete Fleet Ballistic Missile system.

Five FBM submarines have been ordered. Congress has made money available to the Department of Defense for two additional boats, but Secretary McElroy has declined to give the green light. It was explained at the time of the decision to hold back money for the two boats, that seven boats were all that could be considered desirable

until the entire system had reached a higher state of development.

Availability of both the submarine and the *Polaris* missile has been set for 1960. Latest reports (prior to this second unsuccessful firing) were that development of both the submarine and the missile were progressing abreast each other.

• **Bridges the gap**—*Polaris* is the first IRBM designed to be launched from a moving platform. To bridge the gap between the earlier stable dry-land launches and the specially-equipped surface ship is the purpose of the ships motion simulator.

For the East coast tests of the *Polaris*, the Navy has taken over a corner of Cape Canaveral to develop the special complex of some 36 acres. There are some 5,000 square feet in buildings in the pad area. Hangar Y nearby, has an additional 60,000 square feet. It is in Hangar Y, the main building, that *Polaris* test missiles are assembled.

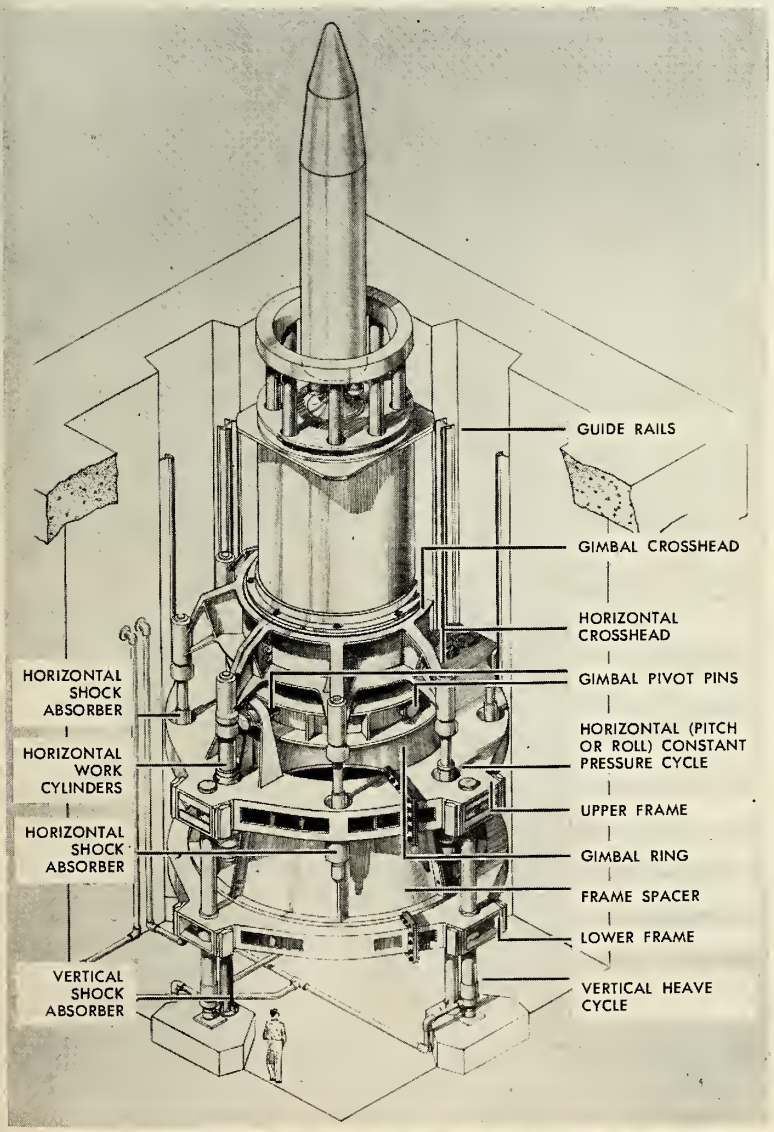
The systems are checked and final adjustments made for the launching. Other facilities making up the *Polaris* complex include several laboratories, receiving and recording equipment and an engineering laboratory.

• **Power specifications**—Just to the east of the SMS and also underground are the power units which enable the simulator to go through its gyrations which are somewhat reminiscent of an elephant doing a cake walk.

The major source of power is a 2,250 horsepower pump and a second pump with the capacity for another 700 horsepower. Control of the three desired motions to be simulated is done through specially designed, servo-positioned hydraulic throttle valves. This permits very close control independently of each of the three motions.

The electronic control system facilitates quickly setting up the separate or combination of motions desired. The introduction of actual ship movements recorded at sea is done by means of three channel magnetic tape.

Total maximum power of the simulator is 3,000 horsepower. Hydraulic drive pumping capacity is 2,000 GPM. The working pressure of the hydraulic system is 3,000 PSI.



SHIP MOTION SIMULATOR without the launcher and artist's conception of *Polaris*.

Third *Polaris* Firing Probable Within Month

CAPE CANAVERAL—Despite the highly successful tests of individual components, the Navy's top-priority *Polaris* seems to be running the normal course in the first phases—tests, failures of various systems, and disappointing but knowledge-yielding firings.

The major cause of failure in last week's firing apparently was in the solid-propellant first stage. After some seconds, the second nipple-like stage ignited and, separating itself from the booster, climbed in an arc for seven seconds to explode on impact about one and one-half miles away.

The first stage, continuing its faulty programmed sequence, never left the pad and continued to chug and puff 20-foot columns of flame at half second intervals—a familiar symptom of combustion instability.

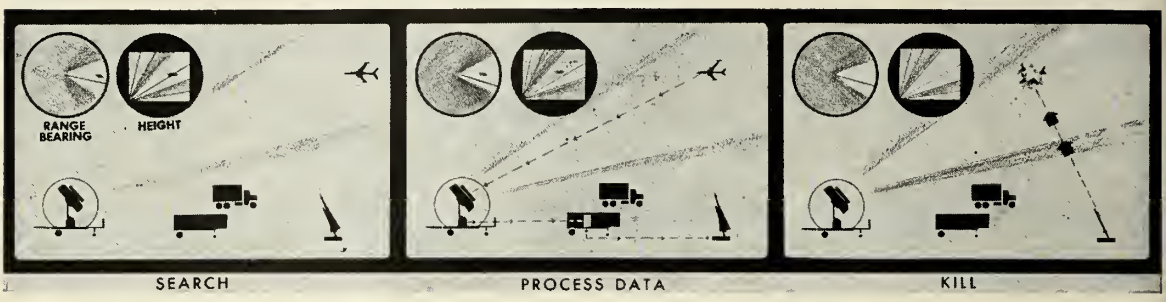
The Navy offered no explanation as to what caused this second failure. One spokesman did say: "It was a disappointment but we can take solace in the fact that we are discovering weaknesses through these failures in the early phase."

The first test shot several weeks ago was destroyed by the range safety officer when it failed to tilt over into the planned angle. Until that time, the vehicle performed beautifully, according to Rear Admiral William F. Raborn, head of the Navy's Special Projects Office.

The Navy declined to estimate when the third in the series of shots would be carried out, but one estimate is it will be about a month before another firing could be tried.

The last major change in the *Polaris* components was the changing from earlier Thiokol propulsion units to those manufactured by Aero-jet for the first stage.

Missile Monitor to Use 3-D Radar

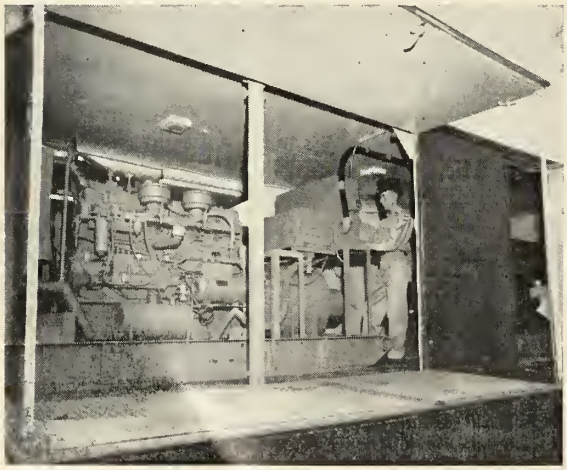


New unit, called Frescanar, to provide eyes for Missile Monitor, Army's tactical air defense system. Radar plots range, speed, direction, and height of multiple air targets simultaneously. Army to order several for testing.

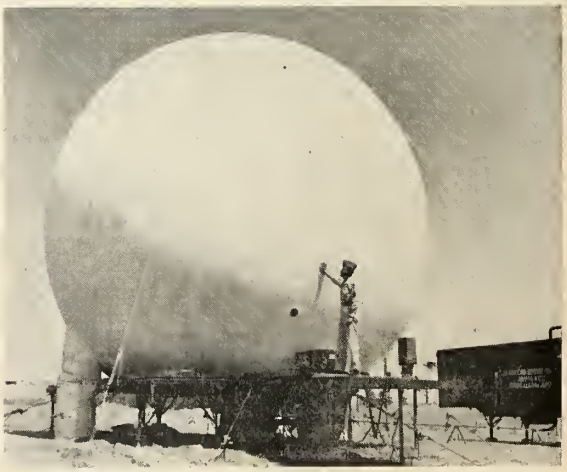
This new army radar—described by Brig. Gen. Earle F. Cook, U.S. Army Signal Corps as the eyes of the Missile Monitor System—is a completely mobile unit which uses a new technique in the detection of multiple air-borne targets by electronic means.

Missile Monitor is a mobile air defense fire distribution system for a field Army's missiles. Gen. Cook describes it as the tactical counterpart to Missile Master, the Army's electronic coordination and control system already operational for the *Nike-Ajax* and *Nike-Hercules* missiles.

The radar, originally developed by Hughes Aircraft for Navy shipboard use, scans a volume of space electronically by moving the antenna beam up and down. The pointing direction of the beam is sensitive to the frequency of the

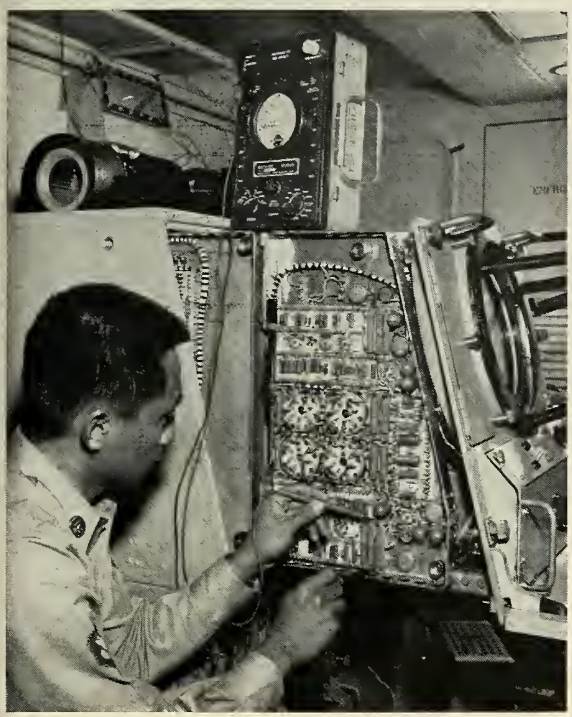


POWER VAN with side flaps raised. At Army's demonstration, two vans were used—one on standby.



PLASTIC BALLOON houses Frescanar antenna. Bag on left is a pressure hatch for entering balloon.

CONSOLE SECTION of the new "3-D" radar slides out for easy maintenance. The unit uses printed circuit cards extensively for quick replacement.



OPERATORS' POSITIONS. Scope on left shows target range and bearing; that on right, altitude. Date is transmitted instaneously to missile batteries.

applied energy to the antenna, so by varying the beam frequency, the new unit can scan up and down at the speed of light with a different scan angle for each applied frequency.

The unit, called the AN/MPS-23 frequency scanning radar and dubbed "Frescanar" by Hughes Aircraft, has been under extensive test and development since 1952, although a Hughes spokesman says that the frequency scanning principle was first investigated about ten years ago.

The inflatable radome is made of rubberized nylon, vulcanized to two layers of neoprene-coated fabric. It weighs about 600 pounds and can be inflated in a matter of minutes after an operating location is selected. The system is similar to Martin's Missile Master.

FRESCANAR SYSTEM set up and ready for operation. At left is the plastic radome housing 15-ton antenna which obtains information and sends it to radar van on its right. Only physical connection between radar van and antenna is waveguide for transmission of the microwave energy. Two units on right are active and standby diesel generator vans.

missile people in the news

New Planning Chief Named by Melpar

Dr. George E. Valley has been appointed Director of Development Planning at Melpar, Inc., Falls Church, Va. Dr. Valley, formerly Air Force Chief Scientist, was instrumental in the development of the SAGE radar early warning system.

Engineering

James H. Reid was appointed chief engineer of the Subsystems Division, Servomechanisms, Inc. Reid was in charge of Electronic Systems Predesign at the Convair Division of General Dynamics Corp., and prior to his association with Convair, he was a project engineer with the A. B. DuMont Laboratories. Reid has had extensive experience in electronic research and development of airborne systems and instrumentation, and in the administration of scientific programs.

Top Brass

John C. Cain of Greer Hydraulics, Inc. has been named treasurer of the corporation. He will continue in his present position as controller of the corporation, a post he has held since November, 1957. Prior to joining Greer, he was manager of Cost Accounting and Estimating for American Bosch Arma Corp., and assistant treasurer of Wallace and Tiernan, Inc., according to a company announcement.

Leonard J. Fletcher, (vice president of Caterpillar Tractor Co., retired) has been elected a director of Holex Inc., Hollister, California, producers of PEP (Packaged-Explosive - Power Units). Fletcher joined Caterpillar in 1927 in a sales capacity, later holding the posts of assistant general sales manager, director of training, and assistant to the chairman and president.

R&D

J. L. Shultz has joined Stavid Engineering as senior scientist. Schultz, an expert in military electronics, was responsible for the design and development of Airborne Early Warning Radar projects at General Electric in Utica. Schultz is a senior member of the Institute of Radio Engineers and a member of professional groups on Engineering Management, Information Theory, Military Electronics, Computers and Communication Systems.

Industry

Appointment of **E. C. Karnavas** as manager of the Capacitor Department of Texas Instruments Inc., Semiconductor-Components Division, has been announced. Karnavas joined Texas Instruments in 1952 as one of the first employees in the semiconductor products group, and was project engineer on the first grown junction transistors manufactured by TI.

William G. Alexander has been named general manager of Stromberg-Carlson-San Diego, a division of General Dynamics Corp. Alexander has been chief engineer since joining the organization in January, 1957. He will continue in that capacity, in addition to his new responsibilities.

The appointments of **Donald F. Wentzler** as director of planning and organization and **Edward J. Felesina** as director of public relations and advertising at ITT Laboratories, Nutley, N.J. division of the International Telephone and Telegraph Corp., have been announced. Wentzler, formerly manager of professional staff relations at Federal Telecommunication Laboratories joined ITT in 1956.

Lockheed's R&D Growth Creates New Post

Growth brought on by several new classified projects, in addition to the X-7 test vehicles and the Q-5 target missile systems, has caused Lockheed to name a top manager for research & development at the Missile Systems Division, Van Nuys, Calif.

Appointed to the new post is **Thomas P. Higgins,** formerly missiles and spacecraft manager in preliminary design at Lockheed's California division plant, Burbank. Previously the plant's R&D was directed from Lockheed's Palo Alto plant.

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