JULY 6, 1959

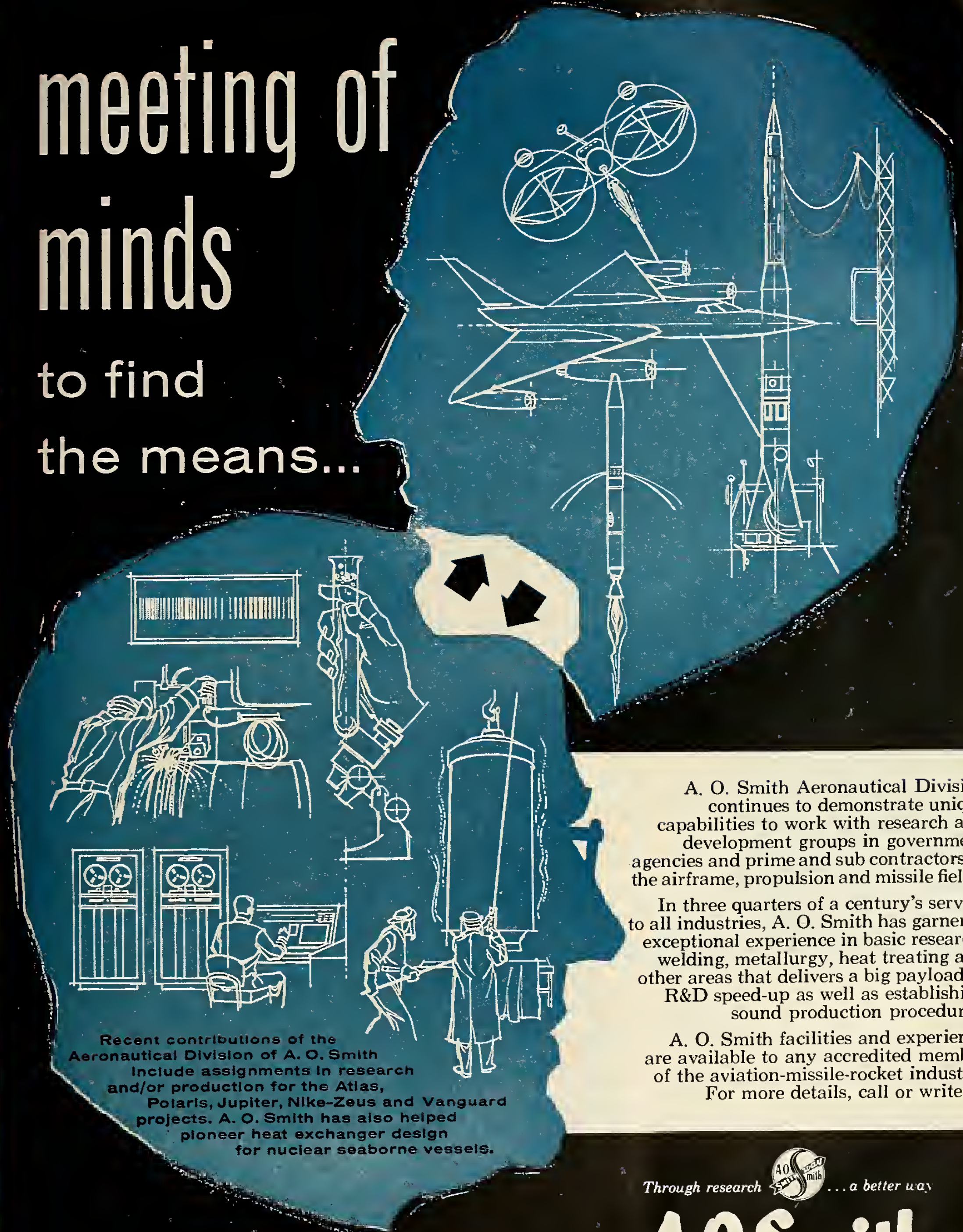
HAWK NOW OPERATIONAL

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

meeting of minds

to find the means...



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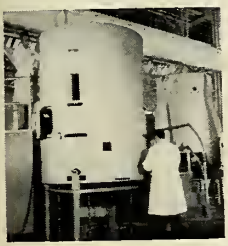
missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

COVER: Raytheon's *Hawk*, like Martin's *Lacrosse*, is going to Army's units (see p. 28).

YANKEE Ingenuity in missile field is reflected in wealth of new plants (see survey, p. 13).



ALUMINUM shells for *Redstones* are formed at Reynolds plant. (see aluminum story, p. 18).

ARTILLERY units are receiving Martin *Lacrosse* solid-fueled guided missiles (see p. 29).

DEMON Automatic checkout system built by Curtiss-Wright is used on *Nike-Ajax* (see p. 33).

JULY 6 HEADLINES

ASTRONAUTICS ENGINEERING

ASTRIONICS

SPECIAL SECTION

THE MISSILE WEEK

DEPARTMENTS

Who Owns Man's Brain?

In the Constitution of the United States, a sometimes almost forgotten document in these regimented days, is a paragraph which reads (Article 1, Section 8):

"To promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

We bring this up in connection with the important controversy over patent rights accruing under contracts to the National Aeronautics and Space Administration. Hearings were held in Washington recently (M/R, June 1) to permit industry attorneys to express their opinions of, and objections to, patent regulations laid down under the Congressional Act which set up NASA—particularly the manner in which they differed from the regulations governing patents under military contracts.

Briefly, under the military regulation an inventor or a company is entitled to the rights to any invention achieved under a military contract, with the Government holding license rights. That is, the company owns the patent but the Government gets free usage.

Under the NASA regulations, with a few minor exceptions, the Act provides that any invention achieved during work on any NASA contract is the exclusive property of the Government. This applies to prime and subcontractor alike, no matter how far removed.

Further, any person inventing an article which may have a utility pertinent to the conduct of aeronautical and space activities—whether he is a NASA contractor or not—must declare under oath that his work was not related to any contract with NASA before he can get a patent on his invention.

Although this is a nutshell version of the two regulations, we think it shows that the NASA Act opposes completely the principles of both the Constitution and fair practice. We cannot believe that government has an automatic and complete right to the fruit of the by-product labors of its employees, direct or indirect. Nor do we believe that the burden of proof should fall upon the individual—in this case the inventor.

That NASA itself is not entirely in agreement with the law may be judged from a statement by Administrator T. Keith Glennan regarding the conflicts between the rules of NASA and the military. He said:

"Two such contrary patent policies followed by Government agencies working in closely related fields of research and development, can be detrimental to the kind of cooperation that we must have from industry, if our joint effort is to go forward with effectiveness and dispatch. We are well aware of the attitude of industry toward this question. On the other hand, it must be recognized that these rules are written into the law, and we cannot ignore them."

Congress has made it clear that it wants the National Space Act to operate for a while before it makes any changes. We suggest that this should be among the first alterations—and that industry must take the lead in making the situation clearly understood by the law-makers.

Indemnification—Another Problem

While we are on the subject of Congress, industry and space, let's consider another problem which the country must face up to, and fairly quickly—indemnification legislation.

Very shortly we shall have ICBM bases in this country equipped with missiles designed to carry nuclear warheads. Nuclear-armed IRBM's are already on station in England and soon will be in Italy. Very shortly also we shall be testing and launching atomic-powered rockets for spacecraft and atomic-powered aircraft.

It is not inconceivable that in all this monkeying around with a power we really know little about, and even less how to control, some horrendous accident could occur.

Who is responsible? The Government? The prime contractor? And to what limit? Any corporation could easily be wiped out by the claims which might accrue. And suppose the fault could be traced to some gadget, made by a small subcontractor and in itself harmless—except that it malfunctioned. Insurance companies will touch no such case.

Two measures have been introduced in the House which cover the situation to some extent by limiting the responsibility of both Government and industry. But they do not really cover all of the aspects—and they appear unlikely to come up at this session.

This is another problem on which the aircraft/missile/space industry must unite to push for a solution.

Clarke Newlon

3 EAG

AEROJET-GENERAL CORP.

THE GENERAL TIRE

A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

Engineers, scientists—investigate outstanding opportunities at Aerojet. (Plants at Azusa and near Sacramento, Calif.)

Industry Countdown

STRUCTURES

Project Rambler is scratched . . .
NASA rejected the proposal of $1 million-plus high-altitude sounding rocket as duplicating capability of other already well-advanced research programs, such as *Scout*. Embodying new concepts in fibreglass construction and new launching techniques, *Rambler* was submitted recently by a team composed of the **University of Michigan, Vickers, Lear, Sparton Electronics, Wyandotte Chemical** and **Curtiss-Wright.**

• • •

Amputated in DOD's . . .
"master defense plan"—two *Bomarc* bases at Winooski, Vt., and Madison, Wis.

• • •

Don't throw away industrial . . .
security regulations. The program struck down by a Supreme Court ruling last week probably will be reinstated shortly either by Presidential executive order or rush Congressional action. Regulations may be changed to allow alleged security risks to confront their accusers.

• • •

Co-op NATO missile/aircraft . . .
production lineup which appears imminent probably will see Italy making airframes and MSE; France—airframes and assembly; Britain—engines; Holland—electronics; Germany—electronics and heavy equipment; Belgium—support equipment and parts.

• • •

Great Britain is dickering . . .
for purchase of the **Martin** *Bullpup* air-to-surface missile. Whether it will be manufactured in England under license or exported still remains to be decided . . . France is getting ready to spend a reported 16 billion francs over the next six years on space research; may be in the market for hardware. Program, if funded, will be run by National Fund for Scientific Research.

• • •

PMR operating contract . . .
will be awarded by Navy to **Bendix Aviation** and **Texas Transportation Co.** (a new corporation reportedly set up by retired military men.) Contract is similar to **Pan American's** at Cape Canaveral.

• • •

Just revealed . . .
Martin *Titan* skin structure is about 40% magnesium-thorium sheet and extrusions, accounting for about 2000 of the ICBM's total poundage. **Dow Chemical**-developed HM21A and HK31A sheet is used in transitional sections, between fuel and oxidizer tanks and between second stage and nose cone. HM31A extrusions are used for external conduits between fuel and oxidizer tanks in both stages and for internal stringers, longerons and hinges.

PROPULSION

Advancing technology bypassing . . .
boron compounds is apparent reason for Navy's sudden cancellation of $13.5 million sodium borohydride contract with **Metal Hydrides Inc.,** Beverly, Mass. Other materials are offering higher I_{sp} without the handling and oxidation problems of boron compounds. MHI, which had produced 1.7 million pounds of the missile/aircraft propellant under the contract originally due to expire in May, 1960, plans to go into commercial production.

• • •

Powerplant for first *Mercury* . . .
capsule has been delivered by **Rocketdyne** to ABMA. The *Redstone* liquid-fueled rocket engine delivering 75,000 pounds of thrust will lift a capsule carrying animals down a 100-mile course.

ELECTRONICS

Really hot competition . . .
can be expected for **Douglas'** ALBM guidance contract. While early version may be simple command system, inertial is certain to be an eventual requirement. Specs probably will demand a complete digital system for stellar acquisition, interpretation and readout measured in seconds rather than minutes. Manufacturer who produces quickly, therefore, has a lucrative opportunity. Secondary requirement probably will be for versatility in stellar acquisition both in the bird and the launch aircraft.

• • •

Won by RCA . . .
Boeing *Minuteman* electronic subsystem contract . . . and insiders say RCA also will get multimillion-dollar Project *Mercury* tracking due to be announced by NASA July 15.

• • •

Advanced infrared detector . . .
utilizing photosensitive semiconductor energized by microwave electromagnetic fields has been developed by **General Bronze Electronics.** Wide bandwidth unit (infrared through ultraviolet) with parametric amplifier claims sensitivity approaching the theoretical limit.

SPACE MEDICINE

Space-environment chamber . . .
being installed early next year at **Republic's** astronautics research center to simulate conditions for humans 150 miles up, will cost $500,000 and be built by **Tierney Engineering Inc.,** Union, N.J. Chamber will be 14 feet in diameter, 30 feet long.

the missile week

Washington Countdown

IN THE PENTAGON

Navy's plans for own ALBM . . .

as broken exclusively in M/R (June 22, p. 9) have come under "roles and missions" fire with the order presumably given to the Navy to keep its hands off because it is a "strategic" weapon. Many industry sources say the project has been driven "underground" and Navy now is busy adjusting for "new requirements" which will permit it to enter the ALBM picture. Original Navy thinking, sources told M/R, is that Navy had planned to get its own ALBM into production at least a year before the AF-**Douglas** version by using prototype hardware of some of the companies edged out in the AF competition.

• • •

Demotion of William Holaday . . .

onetime U.S. missile czar, is now all but complete. Holaday has been "released" from his post as special guided missile assistant to Defense Secretary Neil McElroy and the post has been abolished. But he remains as chairman of the somewhat strengthened Civilian-Military Space Liaison Committee. Holaday's removal strengthens the hand of R&E Director Herbert York.

• • •

A Far East AF missile base . . .

is being planned for Okinawa. Cost estimated to date: Nearly $10 million. The one-time Japanese base is within easy IRBM and ICBM range of Peiping, Shanghai and the big Soviet industrial and military centers in eastern and central Siberia.

• • •

Next *Discoverer* launching . . .

may be held up while ARPA and Air Force scientists try to find out why *Discoverer IV* failed to go into orbit. *Discoverer V* normally would have been launched toward the end of July. Whenever it is launched, it will be used to check out the *Discoverer* system before any new attempt is made to recover mice after putting them into orbit.

• • •

French nuclear-tipped missiles . . .

may be carried by the Mirage IV—the new French fighter-bomber now under development. The bomber, capable of carrying a nuclear bomb, will have a range of more than 1350 miles—great enough to reach Moscow. Production is 27 months away.

Reconnaissance satellite tests . . .

are nearer than some think. The Air Fo is already constructing test stands for **Lo heed's** *Sentry* at Vandenberg AFB. It se $14.4 million for *Sentry* facilities. Many c sider the U.S.-Soviet race to develop a rec naissance satellite one of the great battles the Cold War.

• • •

U.S. wants to construct . . .

installations for **Lockheed's** *Midas*—the mis warning satellite—somewhere in Great Brit The Air Force wants more than $19 mill for *Midas* facilities in FY 1960.

ON CAPITOL HILL

Be starred ex-military officers . . .

will not be called to testify for awhile the House investigation of the alleged "mu tions lobby" gets underway. (See M/R Ju 29) First witnesses during the next week so will include Defense Secretary Neil M Elroy, Attorney General William Rogers a members of Congress.

• • •

Congress is expected to grant . . .

an extra $137 million for **Western Electri** *Nike-Zeus* program. That will put a total $437 million in the FY 1960 budget for *Zeu* The extra funds will be used for productio facilities and pre-production planning. (S page 25)

• • •

Behind NASA's First Real Fight . . .

with Congress over the $68 million cut their budget is an effort to keep on schedu Project *Mercury's* attempt to put man space. By contacting newspapers, science ar civic groups, and friendly Congressme NASA hopes to re-instill Congress's pos *Sputnik* fervor for space projects.

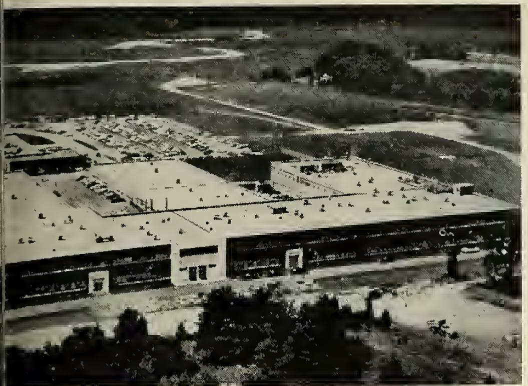
AROUND TOWN

Some of the reports. . .

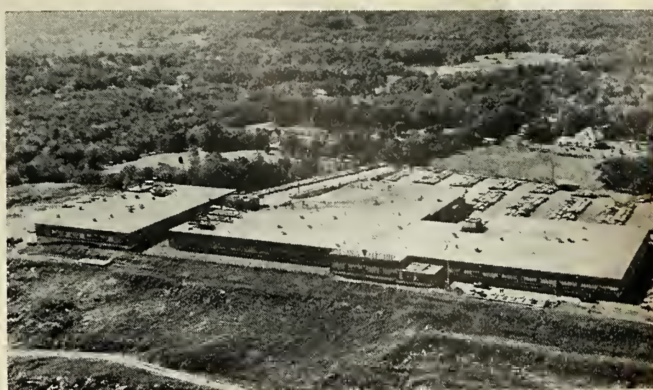
that are being passed as the "latest" in th nation's capitol:

. . . Governor Nelson Rockefeller of Ne York will emerge in his struggle with Vic President Nixon for the GOP presidentia nomination as the foremost advocate for "Bi Defense."

. . . The long-range tide in defense plan ning is turning away from massive retaliatio in favor of greater preparation for limited wa



THEON'S plant at Wayland, Mass. This company, prime ractor for *Hawk* and *Sparrow*, is area's top missile employer.



SYLVANIA'S engineering and research facilities at Waltham, Mass. Firm also has one plant location in New Hampshire.

New England's Missile Boom

The Northeast's $1 billion-a-year-plus business —first in a series of regional surveys

by William E. Howard

Boston—A missile/space manu-ıring boom born of scientific ı-power is surging through New land's economy.

All over the six-state area, hard-t few years ago by a mass exodus extiles, there is a fever of activity. region now has more than 600 ronic manufacturing firms with a uct value topping $1 billion— of the entire nation's output. e are an estimated 76,000 elec-ics employees receiving $290 mil- annually in wages.

Approximately 2600 firms are en-d in missile/aircraft component uction, supplying parts and sub-ms for virtually every missile/-e project. The work force in this runs into the tens of thousands.

n addition, New England houses 600 basic research and develop-t firms, big and little, which have tional thousands of scientists and nicians intently exploring new hori- in astrionics, propulsion, nucle-s, astrophysics and related sciences ned in the driving new missile nology.

• **One billion and growing**—What's scope of the missile industry, as ? Experts on the New England ncil for Economic Development estimate that the Northeast's missile volume is well over $1 billion and the figure is still growing.

So fast has the growth been that officials are hard put to come up with any definite figures. But their estimates indicate that upwards of 150,000 persons throughout New England are hard at work in the field.

Eighty percent of the $1 billion electronics manufacturing in the region is believed to be missile-related. Pinpointing where the activity lies, though, is difficult. Many companies are strictly components producers supplying both consumer and military markets.

From wave-scoured shores of Maine to the exclusive exurbanite sanctuaries of southern Connecticut, new plants are sprouting behind scenic old fieldstone fences and in dozens of brand new industrial parks. Around Boston, hub of electronics and R&D, carpenters and masons are rushing to complete more than $50 million of new construction to meet a seemingly never-ending demand for more space for production and laboratories.

Not to be overlooked are New England's clanging shipyards. They are turning out missile cruisers and frigates and *Polaris* submarines under contracts running into the hundreds of millions of dollars. The region is also heavily dotted with defense installations—SAC, SAGE and Navy bases and other facilities that keep a legion of suppliers busy.

Under construction way "Downeast" at Cutler, Me., for example, is a $64 million VLF Navy radio station for *Polaris* FBM submarine communication.

• **Raytheon largest**—The area's biggest single missile employer is **Raytheon Mfg. Co.,** which has two prime contracts—the Army *Hawk* and Navy's *Sparrow III*. This week it was awarded a $161 million contract for more *Hawks*. More than half of the company's 35,000 employees in New England are in defense production and more than 3000 are working in the Missile Systems Division plants located at Lowell, Tewksbury and Billerica, Mass. This Raytheon division alone farms out an estimated $10 million to more than 600 Massachusetts subcontractors.

As the nation's only electronics company with two prime missile contracts, Raytheon going into 1959 had a backlog exceeding $300 million. The company has added 6000 employees since Jan. 1, 1958, and is preparing to hire another 1,500 to 2,000 to man a new ASW plant to be constructed at Portsmouth, R. I.

growth reported in six states . . .

Across the Bay State in Pittsfield, **General Electric's Ordnance Division** of 3500 employees is pushing development of *Polaris* inertial guidance and fire control under a multi-million dollar contract. This division also has an $8 million development contract for the huge *Talos* magazine, feeder and checkout systems to go aboard the nuclear cruiser Long Beach. The cruiser, incidentally, is being built by **Bethlehem Steel** at Quincy, Mass., under a $100 million contract. This shipyard also is commencing work on a $108 million nuclear frigate which will be armed with *Terrier* missiles.

GE is in the process of negotiating a $10 million follow-on for the *Talos* system and is working at Pittsfield on a $10 million *Atlas* tracker. Missile contracts in the division total over $50 million. At Lynn, Mass., GE is turning out engines for *Quail* decoy missiles and a complement of missile support equipment including leak detectors, electronic strip chart recorders, insulation test equipment, switchboard instruments and inertial systems components.

Looming large in the region's missile industry is **Avco,** which last month opened a $23 million research center at Wilmington, Mass. Holder of a $111 million contract for development of the *Titan* nose cone, Avco employs 1700 and is also deeply involved in shock wave research.

Just off Boston's "Golden Industrial Semicircle"—a congregation of companies along Route 128—**RCA** is producing miniaturized electronic missile controls and components in a spanking new $3 million plant. Other leaders of the area are **Sylvania Electric, CBS Electronic** and **Transistron.**

Recently this important new industrial area saw the formation of **Goodrich-High Voltage Astronautics Inc.** to research, develop and manufacture ion propulsion engines for space vehicles.

• **Connecticut supplies parts**—In a figurative sense, much of the work being done in Massachusetts is to supply the electronic "brains" for missile and space projects. By the same token, Connecticut is caught up in a big effort to provide "innards"—the hundreds of thousands of metal parts and subsystems.

Precisely how important missiles are to the Nutmeg State's economy is evident in a recent report of the Connecticut Development Commission. A survey by that agency shows 224 firms providing parts or services to prime and major subcontractors. These firms employ a total of 11,000—including 27,000 technical workers—but the precise percentage actually engrossed in missile work is not known.

However, it is believed to be substantial, even when stacked up against the state's total manufacturing work force of nearly 400,000. The CDC says 57 of the state's 169 cities and towns have missile operations underway.

In addition to parts, the state is showing a steady growth in missile electronics and related research.

At Groton last month, the George Washington, first nuclear fleet ballistic missile submarine which will fire its first **Lockheed** *Polaris* next year, slid down the ways at the **Electric Boat Division** of **General Dynamics Corp.** The sub cost $100 million and the company is working now on a sister ship, the Patrick Henry, and will soon start a third, the Ethan Allen. Employment at EB is up over 8000 and the company has scores of suppliers and subcontractors through the Northeast.

A few weeks ago the Office of Naval Research handed Electric Boat the managership of an industry-Navy team working on SUBIC (submarine integrated control system) aimed at reducing FBM sub crews from 100 to 12 men. Concept of the project is to create "balanced man-machine partnership" utilizing greater electronic sensing and data processing equipment and a television-type visual display of information.

Largest Connecticut missile employer is the **Pratt & Whitney Division** of **United Aircraft** at East Hartford. Many of the division's 35,000 employees are producing J-57 and J-52 engines for *Snark* and *Hound Dog*. **UA,s Hamilton Standard Division** at Windsor Locks with nearly 12,000 employees is producing *Nike* parts, secondary power packs, air conditioning systems, fuel controls, pneumatic valves and starters for other missile systems.

Other large companies with important missile assignments include **Kaman Aircraft,** Bloomfield, which is studying electronic countermeasures for *Polaris* missiles; **Landers, Frary & Clark,** New Britain, producing 2.75 rockets; **Naugatuck Chemical Division, U. S. Rubber Co.,** R&D solid propellant rocket liners; **Norden-Ketay,** Stamford, analog-to-digital converters for *Atlas;* **Lycoming Division of Avco,** Stratford, nose cones for *Nike-Hercules Polaris* rocket case compo[nents,] *Talos* forward-sleeves and *Titan* [...] bodies, cylinders and heat sinks.

A recently-issued CDC report [sho]ws 358 Connecticut firms employing [...] 000 scientific and technical work[ers in] research labs—nearly all inv[olved in] electro-mechanical, metallurgical, [chem]ical and aerodynamic work, much [of it] related to missiles. Interestingly en[ough,] Connecticut has one researcher [for] every 25 production workers.

• **New Hampshire**—Electroni[cs is] the fastest growing industry in [New] Hampshire, with employment [...] numbering 8750—more than 10[% of] the state's 83,000 total work [force.] More than 25% of the electronics [pro]duction is missile-oriented, chief[ly in] the component field.

Leaders include **Sanders Assoc[iates],** Nashua, which started out with a [...] dozen employees in 1945 and [has] grown to around 1000. Sanders [...] won a subcontract from **Bendix** [...] **tion** to develop the guidance "se[...]" for *Eagle*.

Transistors and capacitors are [...] produced at a **Sprague Electric** [...] in Concord; **Sylvania,** with one [tran]sistor and diode plant at Hillsbo[ro,] looking around the Granite State [for] another plant location; **Rayth[eon's]** Hookset facility is manufact[uring] power suppliers and transformers [for] its other divisions.

At Manchester, precision resi[stors] are coming off the production lin[es of] **Tel-Labs Inc.** and in Concord, **Richard D. Brew Co.** is making [...] lines. With an in-house-developed [ma]chine tool, **Ber-Kit Industries,** [...]chester, is finding a profitable m[...] market for precision screws.

A fourth FBM submarine, the [...] Lincoln, is being constructed at P[orts]mouth Navy Shipyard.

State development officials re[port] that employment is "tight" in [New] Hampshire. As textiles have decli[ned,] electronics have taken their place.

• **Vermont**—Across the state [line] in Vermont, firms are busy suppl[ying] machine tools for the missile indu[stry.] **IBM** has a large plant at Burlin[gton] making relays for data processing [de]vices, and at Bennington **Sprague [Elec]tric** is producing electronic com[pon]ents and ceramic sheathed wire.

• **Maine**—Only a few Maine f[irms] are turning out missile parts, acc[ord]ing to the state's Department of [Eco]nomic Development. **Alloy Prod[ucts,]** Sanford, **Portland Machine Tool** [...] **Maine Metal Finishing,** Gorham, [are] the principal ones supplying spec[ial] items to various weapons contract[ors.]

But the DED says the Pine [Tree] State is "getting ready for the mi[ssile] age" by becoming an important [...] in the nation's defenses. In addi[tion] the VLF Navy radio facility, a *narc* base is being built at Bangor the first *Snark* squadron to be- e operational in the nation is now y for action at Presque Isle AFB he potato-growing north country Aroostook County. SAC bases are ated at nearby Loring AFB and estone AFB.

Four hundred technicians are work- at a $20 million SAGE control er—New England's first—located opsham, Me.

Rhode Island—The Rhode Island elopment Council reports there are 30 small electronic firms—many hem engaged in defense produc- **Speidel Inc.**, Providence, which a total work force of 1000 has a ing electronics division which as- bles components for missiles, ac- ing to RIDC.

Also in Providence is **Federal Prod- Inc.**, a gauge maker employing which is firmly established in the le component field.

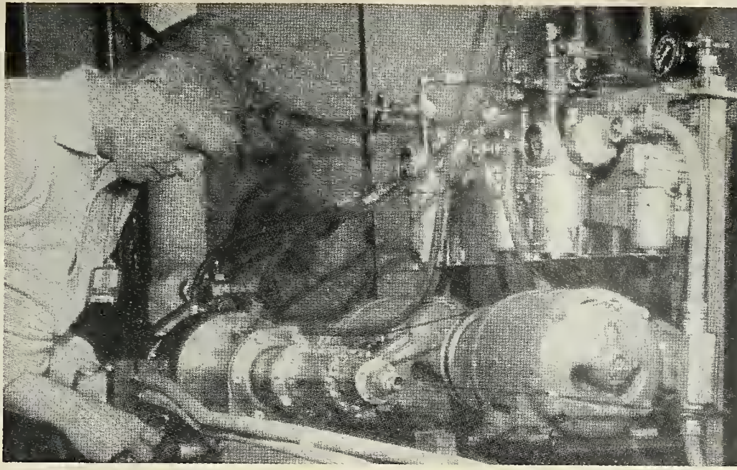
Brainpower factor—Traditionally ervative New Englanders are still what awestruck by the young mis- space giant rearing up in their t. Where did it grow from? The ronics industry founded after d War II, some experts will tell But other researchers probing into uestion of why New England sud- has a booming new industry be- the answer lies in the areas top ural" resource—the wealth of power generated from its long- lished universities, technical ols and research centers.

The New England Council notes one-sixth of the nation's entire rch facilities are clustered in the n, along with 13% of the universi- and colleges which award higher es. "There is a very definite cor- on, in our opinion," says one al of the agency, "between educa- l facilities and the growth of our science-based industry."

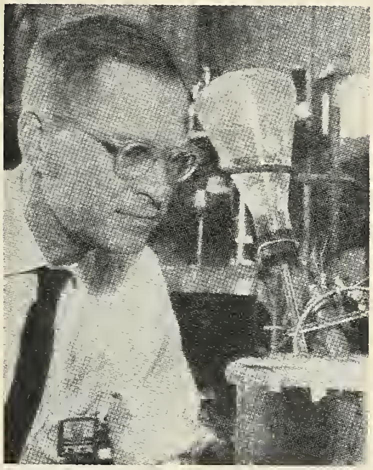
Many new companies are being d and founded by the graduates I.I.T., Harvard, Yale, Worcester echnic and scores of other New and institutions of learning. And of these newer firms lean heavily sic research and specialized areas issile/space technology.

When **RCA** opened its new **Missile ronics and Controls Department,** urlington, Mass. In the "Golden trial Semicircle" company Presi- John L. Burns commented, "Few y areas in the country offer a er stimulus to intellectual curiosity original research."

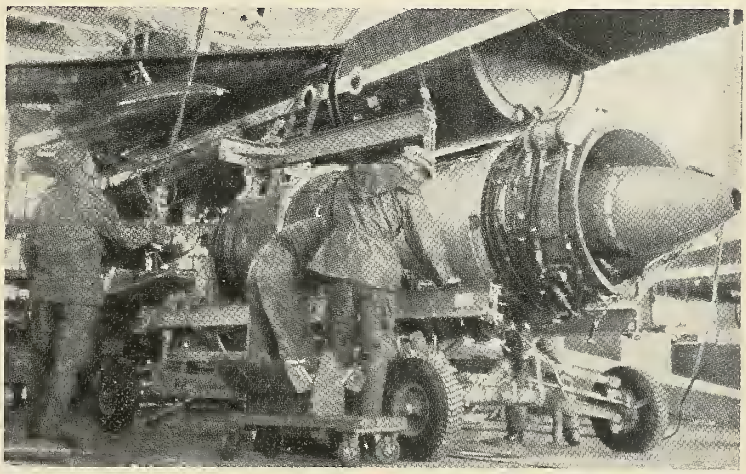
Week:
Closeup of Boston's "Golden Semicircle"



TYPICAL OF developmental research work being carried out by numerous New England companies is this fatigue testing of high temperature bearing material.



INSPECTOR at work in Pratt & Whitney laboratory, East Hartford, Conn.



FIRST OPERATIONAL *Snark* squadron in the nation is ready for action at Presque Isle AFB in the potato-growing north country of Aroostook County, Maine.

Interview With General Sessums

"He is the rare kind of commander who always seems to know exactly what everyone under him is doing . . . and regardless of how occupied he may be with important decisions, if he feels someone has done a good job, he always finds the time to put it in writing in the man's record."

The words were tinged with regret as they came from an officer the other day. For he was speaking unhappily about the retirement of his boss—lean, nimble-witted Maj. Gen. John W. Sessums, Jr., as vice commander of ARDC, a post he had held for the past five years.

Mechanical engineer-trained (University of Tennessee, Air Corps Engineer School) Johnny Sessums has been intimately associated with aircraft and, in recent years—missile—research and development throughout his 30-year career. And his firm guidance will be missed. In the early '30's while in the Canal Zone he flew—and crashed on its second flight—a homemade monoplane with an engine he had constructed from outboard motor parts. During World War II, he headed up the AF's Aircraft Production Division for three years then shipped overseas as chief of plans for the 22nd Tactical Air Command.

Returning in mid-1945 to the U.S., he promptly was made assistant to the chief of R&D at AMC, Dayton. Six years saw him rise to deputy commanding general of ARDC at Wright-Pa son AFB, and in 1954—to vice c mander of the entire ARDC comm Along the way, in addition to his w personality, silver-haired Johnny sums has earned the reputation mechanical genius. His associates he is "conscientious in everythin does."

ARDC Commander Lt. Gen. l ard M. Schriever noted Sessums one of the earliest advocates of listic missiles and called the ret general "a voice in the wildernes the late '40's and early '50's." A was in the process of stepping back civilian life last week, General Ses was invited by M/R editors to over the missile development hor

Q. The next 10 years hold promise of big things. Let's take ballistic missiles. We're pushing ahead with *Atlas* and *Titan*—the so-called first generation ICBM's—and in a few years will come solid-fueled *Minuteman*. What do you believe will be the third generation?

A. If I had to bet on it, I would say the pre-packaged liquids. And it is my firm belief that we are going to find the air-launched ballistic missile is really the pay-off.

Q. You mean strategically and from a cost standpoint, too?

A. Yes. The overall cost of defending the country can be greatly reduced with a system using CAMAL, the nuclear-powered, continuously airborne, missile-launching, low level airplane, and the ALBM. With a fleet of these planes, you would need only a few bases. The planes don't have to be accommodated on the ground all at one time—they stay in the air most of the time. On patrol, they could be a terrific deterrent. Not only can they get closer, which helps solve your targeting problem, but by getting closer the magnitude of the problem of detection and destruction reduces very rapidly. Such a force operating on a global basis would be able to strike at all enemy target complexes. It would be a most difficult task for any enemy to locate the constantly moving patrol. I think that with such a force it would be very difficult for any aggressor to launch a surprise attack on the U.S.

Q. Letting your imagination go a bit, how feasible is the CAMAL-ALBM as an anti-missile missile?

A. Of course, the CAMAL concept of operations is not defensive in nature, rather it is a weapon system designed to deter the enemy from launching his ICBM's. It is true that CAMAL would be able to assume tasks of a defensive nature because it will be a very versatile airplane capable of carrying very high payloads. We are talking now, for instance, of intercepting missiles at 18,000 miles an hour and 700 miles high. This is quite a problem—the defensive missile which may be going even faster than that will always have the disadvantage of taking off last. So, you can't assume you are going to get him half way; you are going to have to get him somewhere between half-way and home plate. CAMAL would put you out to where this half-way business becomes the ocean—instead of the U States.

Q. That certainly is desirable. would CAMAL have a capabilit combatting a number of ICBM's ing in; a capability superior ground-based system?

A. The Kitty Hawk of the launched missile business is the mile type that we are developing The studies that were carried o **Martin, McDonald** and **Convair-l heed** in competition for the A contract indicate that an airplan CAMAL's size ought to be ab carry several.

Q. And the size can be expect diminish with future developmen

A. Certainly. With the first bomb, you may remember, we l terrible time folding the thing int biggest airplane we had. Compar now to atomic artillery shells now can be shot from a gun. Yo expect increased efficiency in ALBM's propellants, which will r the size of the missile. So, you c we are either going to come do the size of the missile or be al shoot it further with a bigger if we keep it roughly at 10,000 p size.

Q. Visualizing an airplane out over the ocean hunting missiles, i going to be a devilish compu problem. The airplane would l computer.

A. You may be right; you ha a problem. But it seems to me th to lick it is by building your det in the plane. This would elimina need for the ground communi rol system we have now, with s of large capacity computers and munication relays for detecting tracking. If you have the weapon oard and the detection equipment oard, all the computer does is put ignals in the missile, and the plane can fire instantaneously, assuming have the authority to launch. All need is a signal, like SAC now or the positive control system.

). It is still going to take a big air- to carry it all.

. Well, it is going to take a big ne to carry a nuclear reactor and ding. This is another point: you say if you have a fleet of these s patrolling the perimeter of an y country, they will just send their rs and shoot them all down. It is to be a long time before there are ic fighters—when you start out 60,000 to 100,000 pounds of ling before you start to fill in the e and the airplane. So, I would he any counter weapon would be issile. It might be submarine-hed. But, if your CAMAL has rity to defend himself—take on s—then I would think that as as a missile was launched at him, ould be able to get the missile whomever launched it.

. This looks like an interesting ect to tie in the Air Force early ing system, and possibly with the task of anti-submarine warfare.

. There are a great variety of pos-ies. And the thing that appeals is that it offers a chance to save money by reducing some of the weapons systems we have now, offensive and defensive.

. Of course, any saving with a like this would be very far in ture. We wonld still have to go with ICBM base building, cost- enormous amount.

Yes. It is just like General Le- says. He will take any new n that is proven. This is true of and *Titan*. He's not about to take -52's off the line, until *Atlas* and have been proved. You have to them in the hands of trained and with a demonstrated capa- first. Target selection (planning of attack and all these things) o a factor and poses a much er problem than the average in- al realizes. The CAMAL airplane new development—it hasn't been own yet. The ALBM is a new pment. It will be some time be- we get a really satisfactory air- ned ballistic missile. Before you ne built, you can see another is going to be a big improve- n

On the point of training. In opinion, how many years will it be before we can muster a 15-minute ICBM retaliation system?

A. Well, the nucleus of the capability will start when the first *Atlas* becomes operational. That means crews have been checked out on the mechanism. But just having a group of men trained in the mechanics alone is not enough. You are going to have to build up all the accouterments—targeting is a problem we are learning more about every day. I would say soon after we kick off, we ought to have some capability. That capability should increase at a rapid rate as facilities and additional personnel become available.

Q. Let's switch over now to what's ahead in propellants and materials. On improving the specific impulse of solid fuels, what's the outlook on aluminized perchlorates?

A. They have shown considerable improvement—something like 20 per cent. I think we are going to see other additives that will be very effective. A great deal of research is going on in the boron field, both as a fundamental fuel and additives, which may produce even better results. We have gotten higher than 260 I_{sp} with solids. But with perchlorates, you must remember they are extremely sensitive and the higher specifics become, the more sensitive they get. This creates a problem in making them meet storage and handling requirements. If they are so sensitive that if anyone just tapped a rocket accidentally and it went off, it wouldn't have much military use.

Q. Where are you having heat problems with solids—just in the nozzle area?

A. In the nose cone, of course.

Q. How about the casement side?

A. Well, we aren't having any particular problem, other than trying to get the weight down.

Q. And with liquids?

A. The big problem here is the motor chamber pressure. A number of people are working on chambers of up to 1000 psi. And with this order of magnitude they are getting into entirely new developments to keep the engine from blowing up.

Q. Actually, most ARDC work is strictly related to materials. What are the goals in this area of an applied research nature?

A. Beryllium development is a good example of our applied research efforts. It is really a wonder metal, but it is very hard to extract from its ores and not too many exploitable sources have been discovered. Furthermore, we have brittleness and joining problems. Substitution of beryllium for steel has provided us with an extremely sensitive, light weight gyro. Many other specialized applications, such as brake systems, nose cones, satellite structures, are visualized which could reduce their weight by 50% or more.

Q. Has the toxicity problem been licked?

A. No, but the beryllium industry and the AEC over a period of years have developed many safeguards from which we and our contractors are learning.

Q. Are we trying to build an industry, like we did with titanium? Everyone knows how titanium slumped. Now, are we building up the beryllium effort at the expense of other important metals such as the refractories—like columbium—so all our eggs will be in a beryllium basket?

A. Not at all. We are also concentrating on applied research in the refractory metals. As for building an industry, you will recall that, initially, aluminum and magnesium were primarily aircraft materials. Both have become a boon to the civilian economy. I expect the same pattern for titanium. But money is always a problem. With the J57 Pratt & Whitney engine, there was a large premium for the titanium in it—so large a premium, in fact, that a decision was made at higher levels to cut the percentage of titanium to where it would cost only $150,000 or so premium over the price of the engine. It would have been fine if we could have afforded to create a terrific market for titanium.

Q. What about "whiskers?"

A. Research in "whiskers" is one of our longer-range programs. Such studies may shed new light on problems, such as fatigue, which have long plagued the Air Force. A string of iron molecules making up one of these "whiskers" is out of the ball park for anything we've known in the past for strength—over 2,000,000 psi, many times the strength of any known steel.

Q. What would you say will be the basic material for space vehicles of the foreseeable future?

A. Obviously, it is going to be a long time before we can grow molecules into sheet sizes. So, I think you will see stainless steel alloys, with their terrific strength properties, particularly in honeycombs, being used for quite some time. ARDC, of course, is investigating all approaches of the entire spectrum of basic materials. And you never know what will be coming up, because there are literally billions of possible combinations. In the high-temperature area, we are looking into the refractory metals, ceramics, and graphite and trying all types of cooling tricks—evaporative, porous, ceramic-coating and regenerative systems. Any of these could be a real answer if we come up with ways of improving their characteristics—either by alloying or protective coatings, or both.

Missile Aluminum Uses Increase

The lightweight workhorse of the aircraft industry proves to be a versatile metal for missiles, with support equipment offering the greatest market

by Paul Means

WASHINGTON—Aluminum, long the economical lightweight workhorse of the aircraft industry, is now proving to be one of the most versatile materials for missile and rocket development.

The metal is used in almost every type of missile component and support equipment—from solid propellants to warheads, from the largest missile hull to the tiniest electronic component. Aluminum parts carry, fuel, launch and track today's missiles and space vehicles.

Aluminum accounts for approximately 10% of the average missile's weight—second only to steel. The amount of aluminum used is increased in the newer missiles, and as missiles advance from the R&D stage to production.

With more and more missiles moving along the production line, a vast new market is opening up for the aluminum industry.

In 1958—the first year that missiles were produced in any quantity—the Department of Defense purchased 342,202,000 lbs. of aluminum, 24,451,000 lbs. of which were specifically designated for the A-2 missile program. In 1959, DOD expects to purchase 307,492,000 lbs. of aluminum, 19,199,000 lbs. of which are earmarked for missile use.

Much of the aluminum not specifically designated for missile development finds its way into missile checkout, ground support, tracking and electronic equipment. Also not included in the totals are National Aeronautics and Space Administration aluminum uses not specifically purchased from one of the services.

Expectations are that DOD and NASA aluminum purchases for missiles in 1960—when IRBM's, ICBM's, and space vehicles go into quantity production—will skyrocket, offsetting declining aluminum purchases for military aircraft.

The number of primary aluminum producers, which expanded from four to six in 1958, are: **Aluminum Company of America, The Anaconda Company, Harvey Aluminum Inc., Ka[i]ser Aluminum & Chemical Corp., Or[met] Corporation,** and **Reynolds Metals**. The new producers were Harvey [and] Ormet, which is jointly owned by [Olin] **Mathieson Chemical Corp.** and Re[vere] **Copper & Brass Inc.**

In back of these companies [are] over 26,000 firms—including most [of] the major missile contractors—[which] have the capability to fabricate alu[mi]num into its desired forms.

• **Myriad applications**—A comp[lete] list of missile parts made wholly [or] partly out of aluminum would be [al]most impossible to compile. A par[tial] list would include: light and he[avy] gauge sheets for hull and nose co[m]ponents; rod, bar, wire, and sc[rew] machine stock for electronic con[trol] and guidance units; angles or extru[ded] shapes for internal bracing; foil in el[ec]trical components; forgings for fi[ns;] honeycomb aluminum for wing a[nd] tail assemblies; powder for ignition s[ys]tems and solid propellants; and alu[mi]num in many forms for brackets, f[uel] tanks, motor heads, rocket motor tub[es]

ALCOA integrally stiffened, extruded aluminum plate forms the *Titan's* hull.

Representative Uses of Aluminum in Missiles

MISSILE	WHERE ALUMINUM IS USED	OVERALL WT.—LBS. (Takeoff)	WT. OF ALUMIN USED—LBS.
AEROBEE-HI	nose	231	100
ATLAS	powerplant	200,000	3500
BOMARC	hull, skin, wings, tailskin, fuel tanks, motor components	8500	1500
BULLPUP	major parts	600	300
CORVUS	inner hull, motor fins	not available	not available
CORPORAL	booster components	12,000	4000
DART	motor head, wing spars, wing spoilers, wing bobbin rods	100	5
FALCON	fuel tank, body, fins	100	49
GENIE	not available	104	
HAWK	midsection body, propellant	1200	170
HONEST JOHN	skin, bulkhead, fittings	6000	960
JUPITER	skin, fuel tanks, fins, powerplant	100,000	17,500
JUPITER-C	skin, fuel tanks, fins, powerplant	60-80,000	3,500 (powerplant)
LACROSSE	wings, tail surfaces, structural body, brackets, frames	500	250
MATADOR		13,800	5000
MIGHTY MOUSE	motor, tube, fins	19	2
NIKE-AJAX	skin, bulkhead, fins, fittings	1000 (without warhead)	460

-propellant core molds; and spin chers for satellite launchers and e probes.

luminum uses in support equip- include: shipping containers, ries for loading and unloading; way carriers, field loaders and car- field liquid oxygen producers; ge units and trailers; lightweight r generators, launching towers, devices, photomapping vans, ing radars, acquisition radars, ronic control vans, fire control pment, and even portable field ers for personnel.

t is in the latter area—missile sup- equipment—that aluminum com- es feel they have their greatest ex- ing market.

wo of the most attractive qualities uminum are its weight, of course, its cost.

luminum has a specific gravity of 7 (one third the volume of steel). ht savings in structure allow for weight in propellants and pay- . Aluminum also has a great ver- ty of uses, requires little mainte- e, resists corrosion, is non-toxic, has a tensile strength of 13,000 per square inch—a factor which e raised to 90,000 lbs. per square with alloys and special heat treat- s.

Low cost gains attraction—Alu- m's economy as a structural metal mes important when the missile is uced in volume. Prototypes are lly handicrafted and time and labor utshadow material costs. Materials is stage are not necessarily picked conomy.

ut as missiles move into full-scale uction, time and labor costs drop, he proportion of materials cost to verall cost goes up. It is then that inum's low basic price, easy ma- bility, and light weight will recommend its use wherever possible to cut unit costs.

And the price of aluminum has been lowered somewhat in recent years by improved methods and foreign competition. It presently sells for about 24.7 cents a pound.

Another advantage of aluminum is that it is in plentiful supply. Major expansion has taken place in recent years in primary aluminum production facilities. This was done partly by the producers to meet expanding demands of commercial and industrial aluminum users, and partly with guarantees from the government to meet military requirements.

The Federal government gave contracts to the aluminum producers after the beginning of the Korean War to expand aluminum facilities under which the government, for a period of 5 to 6 years following initial production from the facility, is required to purchase metal from the new facilities which the producer is unable to use or market in its normal operations.

• **Capacity swells**—The capacity for producing primary aluminum more than doubled between 1950 and 1958. Additional capacity of 433,000 tons was installed in 1958, representing a 24% increase during that single year.

New facilities installed during 1958 included Kaiser's hot-line at Ravenswood, West Va., the installation of two 16 million-pound plate stretchers, one by Alcoa and one by Reynolds, and a 6000-ton extrusion press installed for the Navy at their Hannibal, Ohio, plant by Reynolds.

Major facilities to be installed during 1959 include Olin Mathieson's new rolling mill at Hannibal, Kaiser's 30 million-pound plate stretcher at Ravenswood, and Alcoa's 14,000-ton press at its Lafayette, Ind., plant.

One drawback of aluminum for missile use is its comparatively low heat resistance. The metal melts at 1220°F, and begins to suffer measurable loss of strength above 400°F.

Though other metals and alloys have a higher heat resistance, very few can withstand surface temperatures created at very high Mach numbers for any length of time.

Much of this problem has been overcome by research into the effects of high temperatures for short periods on aluminum, and with newer missile designs and flight paths.

Almost every major form in which aluminum is available is used in missiles and missile support equipment: sheet, plate, castings, extrusions, forgings, rod, bar and wire, electrical conductors, insulated wire, foil and powder.

And the fabrication of aluminum in these various forms for complex forced aluminum fabrication companies to devise new special handling techniques and very careful quality controls.

• **Tight controls**—An example of this is the extreme tolerances that Reynolds must meet in fabricating the aluminum shells for *Redstone* and *Jupiter-C*.

To insure quality, Reynolds, which has been fabricating missile hulls since 1952, employs one inspector for every four technicians working on rocket casings. Each of the more than 20,000 parts, and each stage of assembly, is checked before joining.

Quality control starts for Reynolds, as it does for the other aluminum producers, when the aluminum sheet and plate is produced for missile parts. The metal must be perfect, devoid of scratches and blemishes. Electronic instruments search for possible weak spots that might fail under pressure. Width and thickness of the sheets and plates are measured to tolerances within a few thousandths of an inch, and samples are chemically analyzed.

The sheets are then taped to protect the surface from dirt, scratches, and fingerprints. This tape is not removed until the final assembly is ready for cleaning and finishing.

Reynolds then trims the aluminum sheets to their required length of 220 inches fitting a tolerance of 0.002 inches.

The trimmed sheet is then rolled to form a cylinder, then the ends are welded. Next, the shell is strengthened by spotwelding an aluminum reinforcing bar along the longitudinal weld.

Then the shell is trimmed to exact length, fitting a tolerance of plus or minus 0.015 inches. Aluminum stiffener rings, shaped on a radial draw forming machine, are spotwelded into the shell. There are approximately 24,000 spotwelds on a *Redstone* shell. The shells

S E	WHERE ALUMINUM IS USED	OVERALL WT.—LBS. (Takeoff)	WT. OF ALUMINUM USED—LBS.
K HERCULES	skin, bulkhead, fins, fittings	2000 (without warhead)	750
L IS	not available	28,000	25 (known)
S L	wings, fins, hull skin, motor, wing roots, wing components	13,000	3200
D NE	nose, fuel, body, engine housing, tail fins, hull	40,000	4500
R ANT		22,000	1320
DE INDER	power tube, hull	155	75
IA	skin, fins, frame	36,000	3900
A OW I	midsection, body	300	95
A OW III	midsection, body	350	260
L	fins, inner hull	3000	500
R R	shell, structurals, fins		19%
RF R	structural parts, outer skin	3300	528
TA	skin	220,000	not available
IC	skin, tanks, bulkheads, power plant	100,000	11,025
ANUARD	skin, fins	22,600	3700
JN	rocket motor tubes	107	not available

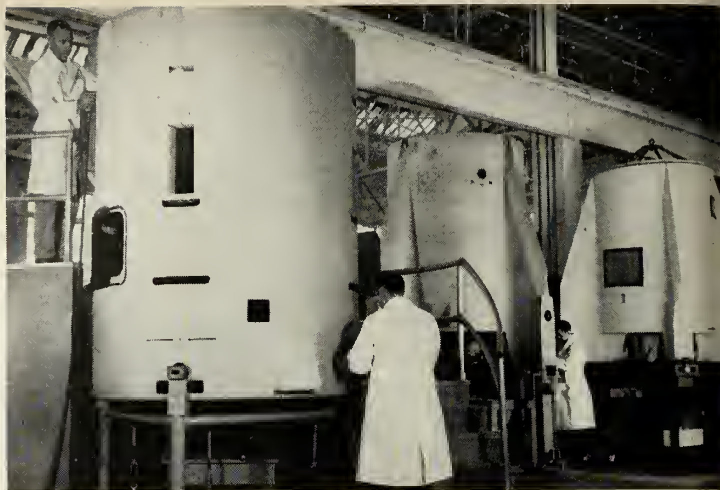
Source: Kaiser Aluminum & Chemical Co.

are then welded into sections, which require tolerances of 0.031 for a 34-foot section.

After the sections with the bulkheads are welded together, with X-rays checking the welds and extremely high tolerances demanded throughout, the piping and tanks are hydrostatically tested for leakage, pressurized to make sure the metal and welds withstand pressure, and optically inspected by instruments to check alignment of all assemblies.

These rigid quality controls follow the shell through final finishing for delivery to **Chrysler Corp.,** the prime contractor.

Other large missiles using aluminum plate or sheet as their frame and covering include *Thor, Jupiter, Titan, Snark, Bomarc, Polaris* and *Minuteman.*



REYNOLDS fabricates the aluminum tail sections for the modified Project *Merc* *Redstone* **scheduled to take the first American on a ballistic rocket flight.**

•**Milling and aging**—The *Titan* uses integrally stiffened, extruded plate produced by Alcoa's 14,000-ton press at Lafayette. The 20-foot shapes emerge as inverted vee's. They are flattened into 34-inch widths, and shipped to **The Martin Co.,** at Denver for stretch-forming, chemical milling and welding. Mechanical milling reduces the skin to a uniform thickness. The two faces of the aluminum skins are milled to required dimensional tolerances including the flat surface of the web between the ribs.

After inspection, they are stretch-formed in sections as large as 5 feet wide and 24 feet long, inspected for contour, and aged for final strength. Heat treating to a final T-6 condition follows and after additional aging, the panels are finally chemically milled.

Alcoa Aluminum plate is used for *Thor* and aluminum sheet is used for *Jupiter.*

Smaller missile shells can be made of a single precision aluminum cold forging as **Hunter Douglas, Division of Bridgeport Brass Co.,** does for the *Sidewinder* motortube. This tube is typically straight within .020 inches, its inside diameter within .006 inches, wall thickness within .0015 inches. It has a yield strength of 72,000 psi minimum.

• **Use in solids**—Another not too widely known application of aluminum in the missile industry is as a component in solid-fuel systems.

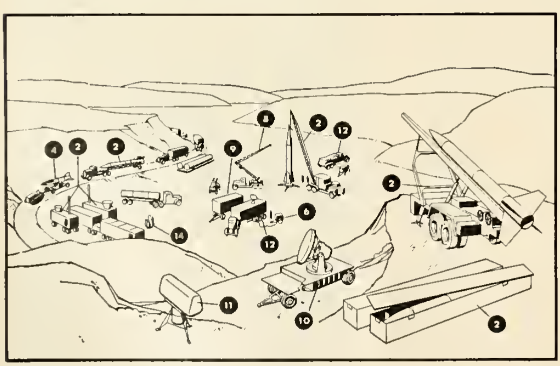
Polaris' solid-fuel motor, for example, uses a composite fuel made up of very fine aluminum powder in combination with conventional polymer bondings. The fuel is encased in aluminum firing chambers to increase the heat.

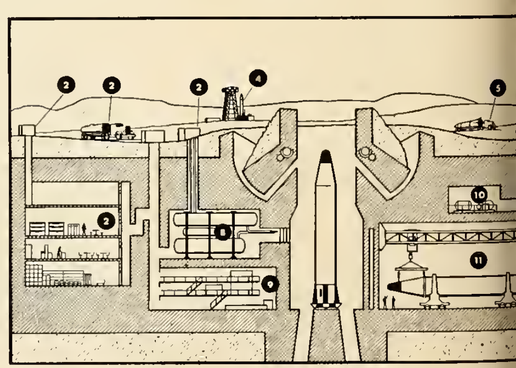
Powdered aluminum constitutes 15% of the propellant by weight used in the Army's *Hawk.*

• **Promise in support**—But according to a recent study by Kaiser, missile support equipment offers small and medium-sized aluminum f cators their greatest opportunity. the case of tactical missiles, alumi will gain widespread application cause of the entire missile bat must be readily portable and, in cases, capable of being airborne.

Aluminum's light weight, dur ity, and ease of maintenance in storage make it a favored metal t used in ground transport equipm designed to take the missile not from factory to test or installation but also from base to base as assig

Small missiles make wide use aluminum containers for shipm The *Sidewinder* is shipped in aluminum container 18 inches sq by 35 inches long. The *Falcon* shipped in an aluminum case measures 88 inches overall. The to-surface torpedo *Petrel* uses an minum case that telescopes into a for reshipment.





SUPPORT equipment aluminum uses include: 1—shipping container; 2—gantry; 3—highway carrier; 4—special loader, carrier; 5—LOX producer, storage and trailer; 6—power generators; 7—launch tower; 8—firing device; 9—photomap van; 10 & 11—track and acquisition radar; 12—electronic control van; 13—fire control equipment; 14—field showers. Fixed base uses clude: 1 & 6—personnel access; 2, 3 & 8—fuel transport, int and storage; 4—static testing; 5—missile transport; 7—qua and storage; 9—control room; 10—power generation; 1 warhead loading. Drawings supplied by Kaiser Aluminum C

A Bright Future for Cryogenics

Their advantages should enable them to stand off challenges of exotic systems at least until 1970

by Frank G. McGuire

Los ANGELES—The outlook for cryogenics? Bright and clear. That's the opinion of propulsion experts, and they make a convincing argument to support their optimism. Despite the approach of nuclear rockets, ion and photon systems, and other exotic propulsion devices, it seems the chemical systems will be with us for a long time.

Part of the key to the future of cryogenic propellants lies in the definition of the term, from a scientist's point of view: "As they exist in a normal atmosphere on earth, cryogenics are liquified gases whose boiling point is considerably below vapor pressure at ambient temperatures . . . and which must be refrigerated in order to be stored under normal conditions." Storable propellants, on the other hand, do not have the characteristic of boiling off in a normal atmosphere on earth.

The significant words in both cases are "on earth." According to Robert S. Kraemer, group leader in **Rocketdyne's** preliminary analysis department: "When we get out into space, the environment is completely different, and we find that what is 'storable' in space is not 'storable' on earth."

This environmental difference eliminates (or greatly reduces) a major disadvantage of cryogenics and adds a handicap to the storables. The low-temperature nature of such high-performance propellants as LOX (−297°F), ozone (−169.5°F), liquid hydrogen (−423°F), and fluorine (−306.3°F), itself, may lend itself very well to making these chemicals storable in space. Propellant combinations with higher, non-cryogenic boiling points, such as nitrogen tetroxide and hydrazine, will have great usefulness in immediate-retaliation missiles, but will not dominate the space flight field and may even yield to cryogenics in some missiles.

(There is evidence that almost anything will boil off in space—even solid propellants and possibly metals. It has been felt necessary to place a diaphragm over the exit nozzle of solid-propellant rockets that will coast for a long time in space, to prevent excess vaporization of the material.)

● **Stressing insulation**—Despite low temperatures in space, it will be necessary to insulate cryogenic propellents against direct solar radiation to prevent boil-off, and to insulate storable propellants to prevent freezing. Either boil-off or freezing would abort a mission. One method, proposed by Rocketdyne, features the use of lightweight plastic foam which acts both as insulation and as a load-bearing structure. The fluorine/hydrogen tanks in Rocketdyne's suggested space vehicle are mounted directly in the rigid foam, which insulates the tanks and provides support for the vehicle's outer walls. (The outer walls will be painted with a reflective coating to minimize solar radiation effects.)

To reverse the insulating action, the foam "umbrella" that protects the propellants from solar heat is rearranged to provide a reflecting surface to focus solar heat on tanks containing storable propellants to prevent freezing. It was calculated that just about as much insulating foam would be needed to prevent storables from freezing as to keep cryogenics from boiling off. The difference is merely in the design of the foam shield around the tanks. As a result, fuels and oxidizers formerly thought too touchy for space flight—such as fluorine and hydrogen—are just as storable for space missions as nitrogen tetroxide and hydrazine.

The new insulating powder recently developed for propellant tanks was not used in the Rocketdyne design because of the need for structural strength to support the vehicle walls. Actually, slightly larger amount of foam is needed for cryogenics than for storables, but the amount is "negligible," according to Rocketdyne.

● **Looking away**—A further step taken to control solar absorption by space vehicles is the technique of orienting the vehicle so that it presents as small a surface as possible to the Sun. While the vehicle is pointed nose-first at the sun, reflectors are extended from the sides at the nose to form a shaded area over the propellant tank area. Known as making the vehicle "solar statically stable," the technique is an easy one to carry out and involves keeping the solar-pressure-center aft of the center-of-mass. This method keeps heat away from the cryogenic-propellant tanks. When the reflectors are extended from the sides at the tail, they focus heat onto storable-propellant tanks to prevent freezing.

The Linde Company, manufacturer of cryogenic liquids, also has considerable confidence in the future of cryogenics as rocket propellants. According to C. T. Fallon, manager of cryogenic engineering, the firm expects to begin operation of its liquid hydrogen plant at Torrance, Calif., about April of 1960. This facility is designed to produce over 360,000 pounds of liquid hydrogen per month, 300,000 pounds of which goes to NASA under option. Linde will then truck the propellant to NASA's facilities for use in various programs.

● **Gains in storability**—The new insulations presently being developed, notably Linde's SI-4, assure almost complete storability of cryogenics. Although few details on SI-4 (Super-Insulation #4) have been released by the company because of pending patent proceedings, its weight and thermal conductivity have been announced. Compared with other standard insulations, SI-4 stacks up as follows:

Santocel thermal conductivity is between room temperature and 90°K, recorded as BTU/Hour-Foot-°F. This

'Specific Impulse Is King!' . . .

reads as 120 x 10^{-5}. Perlite, another standard insulation, has a thermal conductivity of 90 x 10^{-5}. This compares with a straight vacuum, which has a rating of 78 x 10^{-5} (with highly polished surfaces).

The SI-4 insulation rates at 3 x 10^{-5} in thermal conductivity, an obvious improvement of 30 times over Perlite, and 25 times over a vacuum. It weighs about 6.8 pounds per cubic foot, compared with the 8-pound-per-cubic-foot weight of Perlite. The figures established by Linde laboratories have been verified by the National Bureau of Standards.

Evaporation losses have also been considerably reduced by SI-4, and in the case of liquid hydrogen protected by the material, amount to 9.3% per year. Normal tankage using Perlite would lose about 200% per year. A LOX tank protected by SI-4 could be expected to lose 2½% to 3% per year through boil-off. The difference is due to the lower boiling point of hydrogen.

The cost of the SI-4 depends not only on production and availability, but also on the technique of application, which is very important. It would however, be a premium product, somewhat more expensive than Perlite. It would unquestionably pay its own way where the colder cryogenics are concerned, such as hydrogen or helium, but the low cost at which liquid oxygen and nitrogen are distributed make it questionable whether the premium cost would be justified in a ground installation. In an airborne vehicle, however, SI-4 has distinct advantages because of its light weight.

• **Limits of fluorine**—Linde feels that with the high specific impulse of a fluorine/hydrogen system combined with the storability of such cold fluids now possible, there is no great barrier to their use in space vehicles. However, when asked if they thought fluorine would ever be able to compete economically with liquid oxygen, company officials thought not. Agreeing with Rocketdyne spokesmen, they said fluorine would probably be used where specific impulse is the prime factor, but that it is very unlikely that fluorine would get down to the neighborhood of LOX in price-per-pound.

Until the advent of systems with higher specific impulses, there seems an excellent possibility that a cryogenic fluorine/hydrogen system will be the workhorse of our space programs where large payloads are used.

• **Comparisons**—The future of cryogenics in space flight as compared with other propulsion systems has been studied by Rocketdyne, which came up with some interesting results. Starting from a common point, that is, takeoff from a 300-mile orbit around the earth at a gross weight of 25,000 pounds, each vehicle or system was to complete a simulated mission to Mars. Payload delivered to Mars was the determining factor of usefulness.

The solid-propellant system delivered a gross payload of 1600 pounds, exclusive of any propulsion system or related items. Such a vehicle would be available in the early 1960's and a "fairly optimistic" solid propellant was assumed. In addition, higher motor-case strengths were assumed than those of other systems, and more staging was used.

In spite of this, says Rocketdyne, both the storable systems (hydrazine/nitrogen tetroxide bi-propellant liquid rocket) and the hybrid system (liquid chlorine-trifluoride/solid lithium-hydride) came out considerably higher in payload capability—about 2800 pounds, compared with the 1600 pounds for the solids. The pure liquid system (liquid fluorine/hydrogen) outperformed all the previous systems with a gross payload capability of 4000 pounds.

• **King Cryogenic**—"Regardless of complications," said Rocketdyne's Kraemer, "we found that higher specific impulse would always pay for itself . . . you might say 'Specific Impulse is King!' "

This criteria therefore establishes cryogenic liquids as the most efficient system for a number of years to come. Even with the advent of nuclear and ion rockets in the late 1960's or early 1970's, there will be a need for efficient large chemical boosters to get these low-thrust or radioactive rockets off the ground and away from earth.

The fluorine/hydrogen system will be available in the early 1960's, as will the large solid-propellant system, and other large cryogenic-chemical systems will be on hand even sooner. Advanced nuclear systems expected to be ready for flight by 1970 will bring the payload capability up to 6300 pounds, from the 4000-pound-capability obtainable with the F_2/H_2 system (still using the basic premise of a 25,000-pound-gross-weight vehicle leaving a 300-mile orbit). These advanced nuclear systems have a design I_s of 1080 seconds.

The future of one particular cr genic propellant—liquid oxygen— been questioned because of the po bility that liquid fluorine or oz might completely displace it. The u mate theoretical cryogenic combi tion is ozone/hydrogen, but ozone not yet reached the state of devel ment that allows its use as a stand propellant.

The ultimate practical combinati therefore, is fluorine/hydrogen, witl specific impulse of 398 seconds (th retical maximum specific impulse, lb-sec/lb. frozen equilibrium). Liq oxygen/hydrogen holds a spot ab ten seconds behind at 388 secon With the extremely low cost of L (less than a penny per pound) and high availability, it is an excellent for use in many vehicles where extreme performance of fluorine is mandatory.

• **Trend toward simplicity**—Spe equipment for handling LOX is of greater complexity (and in some ca less) than equipment for other cr genics. Rocket engines show a c tinuing trend toward simplification . witness the engine used in *Th Jupiter*: components reduced from in 1955 to 5 by 1960.

The turbopump problem is s to be greatly exaggerated, with b **Aerojet-General Corporation and Ro**etdyne defending it against advoca of pressurized systems. The reliabi of tubopumps in cryogenic systems much better than generally believ both companies say, and they emp size that the added structural weight a pressurized propellant tank is a mu greater penalty than the questiona gain from elimination of the turl pump system.

In upper stages that operate extreme altitudes, it is possible—a sometimes desirable—to almost co pletely eliminate moving parts, but i claimed there is no valid reason removal of turbopumps from boos stages. Even with the near-absolu zero temperatures of liquid hydrog (−423°F) there should be no probl of reliability with pumps and valves the equipment is properly designed.

• **Pleasing figures**—The cost propellants is a major factor in t large booster systems now in the desi stage. With the $900/pound price t on the cesium propellant of an i rocket in mind, it is nice to note t 10¢/pound cost of LOX/RP1, or t storable combinations at 70¢/pou or even the solid propellants that r up to $3/pound. These figures take a tremendous significance when o considers the three million pounds propellant that will be used in just t first stage of the *Nova* vehicle of on-pounds thrust, for example. For these reasons, economy, performance, availability and relative simplicity of handling, LOX takes a back seat to almost no other propellant. Where the utmost I_{sp} is needed, or where density is a consideration, Fluorine will be used. (It is about one-half again as dense as LOX.) When economy is the prime factor, LOX/-Hydrogen will hold its own. As noted previously, the insulation problem with cryogenics varies with the environment, and appears to be an almost minor problem.

Interplanetary t r a v e l possibilities with LOX and other cryogenics varies with the area to be covered. In terrestrial space and closer to the Sun (Venus, Mercury areas) there is a varying definition of the storability of propellants, and the scale tends to shift toward those propellants with a fairly high boiling point. Therefore, in the region of earth and the Sun, cryogenics are not going to show up to their best advantage in long-term storability, but if it is just a question of a few days on the moon, there is no real problem with cryogenics.

The feasibility, of course, depends on the length of time required before return to earth. The lunar temperatures during the night would aid in the storage of cryogenics while daytime temperatures would hinder storage. Once a vehicle leaves earth's environment, however, the scale pretty nearly evens out among cryogenics, storables and solids, because of the insulation needed for all of them.

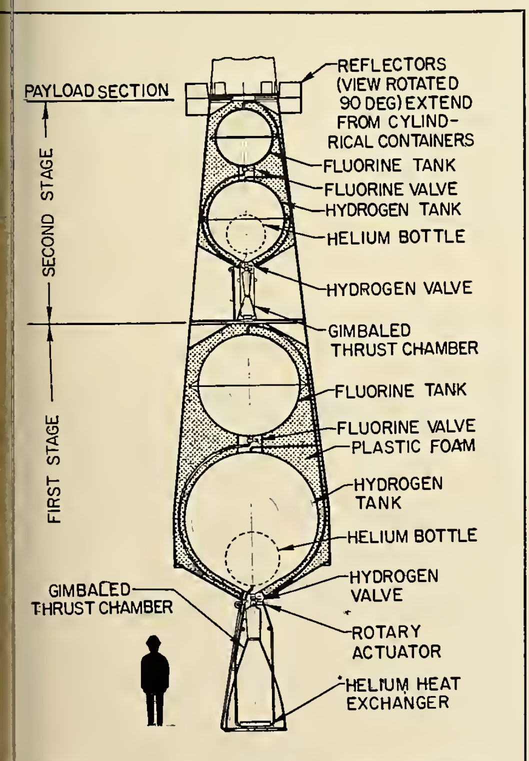
• **Backing and filling**—Evidence has been seen lately that various planning agencies like the theoretical performance of a new propellant combination and try to work it into a program. Once a closer look is taken, however, at things like costs, availability, handling characteristics, etc., a slow backward movement is begun that results in a final choice like LOX/RP1 to fill the requirement. Even though faith in the storables is expected to be borne out by increases in specific impulse to 400 seconds at high altitudes, the cryogenics are likely to be at 460 seconds by the same time.

It has "disturbed" some liquid-propellant experts to see that the government has established research funds for the advancement of solid-propellant chemistry, but has not established any funds for development of storable liquid propellants. The potential of these non-cryogenic liquids has been demonstrated on a small scale, they note, and all that remains to be done is to develop them for full-scale operation.

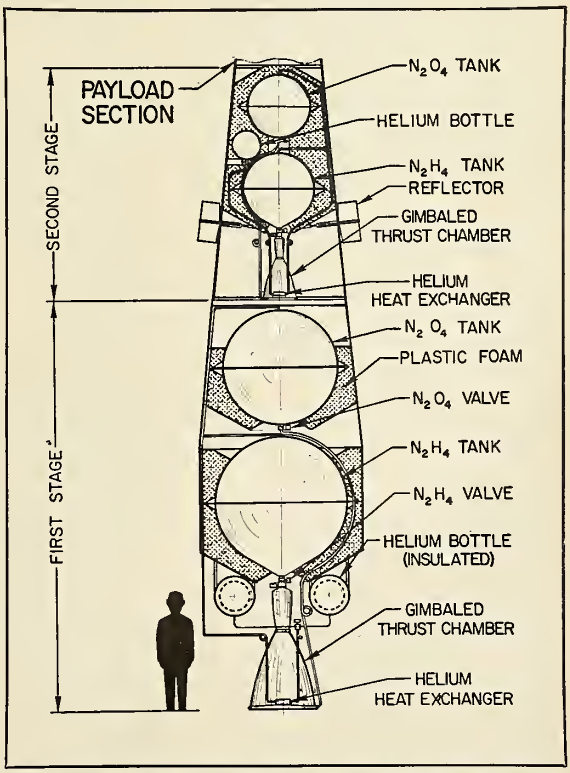
Combustion-wise, there is a greater efficiency in cryogenics than in other propellants. Smoother and more stable combustion results from cryogenically-liquified gases; the best being two cryogenics, next best is a cryogenic and a non-cryogenic liquid, then two non-cryogenic liquids, and so on down into the more stable states. The more easily vaporized the gas, the easier it is to achieve and maintain a smooth, stable combustion.

So, although ozone/hydrogen is ultimate, it is not practical and fluorine/hydrogen takes over. But this is expensive and requires special handling, and so reverts to economical, available, high performance LOX/-Hydrogen, which has no radioactivity, toxicity or other highly undesirable characteristics.

In the final analysis, therefore, we find that large payloads will be necessary in order to carry out significant space missions, but that they can be put into orbit most efficiently by a cryogenic combination of fuels—the specific choice depending on a number of factors. This situation will probably remain unchanged until at least 1970.



FLUORINE/HYDROGEN propulsion system depicted by Rocketdyne. Spokesmen see it as the space program workhorse.



STORABLE PROPELLANT space propulsion system, also as pictured by Rocketdyne. Near-complete storability is at hand.

Nike-Zeus Decision Is Looming

Slated to cost $1.5 to 2 billion in FY '61 alone, the nation's only anti-missile missile under development could be cut back

by James Baar

. . . Thunderer Zeus, who all dominion hath.—The Odyssey

WASHINGTON—*Nike-Zeus*—the nation's only anti-missile missile under development—faces a life or death crisis within the next six months.

Billions of dollars and the future strategic posture of the United States ride on the outcome.

In simplest terms, the Eisenhower Administration in its final days must answer this two-part question:

Shall the **Western Electric** *Zeus* system be put into production so that it can become operational on schedule in 1963?

Or:

Shall the billions that it will cost be spent elsewhere—if at all?

There is also a third possible choice: The Administration can temporize.

The price tag on this question for FY 1961 alone is about $1.5 to 2 billion. The total price for *Zeus*—all payable within the next few years—is almost anywhere from about $5 billion up. It depends on how much defense you want to buy.

To appreciate the awesomeness and complexity of the problem you should begin by bearing in mind three basic facts:

• The United States today does not have any defense against an attack by Russian ICBM's.

• *Zeus*, for better or worse, is the only foreseeable defense that the United States can have against ICBM's for at least the next eight to 10 years.

• Russia is expected to have enough ICBM's for a major attack beginning about 1962. And that capability is expected to mount rapidly thereafter.

• **Family resemblance**—Now, let's look at *Zeus*, itself.

Basically, it is a huge direct decendant of the Western Electric *Nike* family of anti-aircraft missiles—the *Ajax* and *Hercules*. It was designed from the same general concepts: command guidance, acquisition radar, ground battery computers. And it bears a strikingly similar appearance. However, the advances have been tremendous.

Zeus has three solid-propellant stages. The **Thiokol** booster engine, which has a 450-thousand pound thrust, delivers its power in about four and a half seconds. The **Grand Central Rocket** second-stage engine is powered by what the Army describes as "special high-energy propellants." It has a newly-developed plastic nozzle made by **Douglas Aircraft.**

Both the first and second-stage engines have been static fired successfully. The first-stage engine was first fired at Redstone Arsenal last August; the second-stage engine at Beaumont, Calif., this spring.

The *Zeus* system has huge radars and computers designed to find and track oncoming warheads and direct missiles to the right areas for interception within minutes. In the final seconds of flight, a precise tracker guides the *Zeus* to its target.

Major system components are scheduled to be tested later this year at the White Sands Test Range.

• **Funding history**—The Army, Western Electric and **Bell Telephone Laboratory** began studies on the system in the mid-1950's. In Jan of 1958 the Pentagon directed Army to proceed with the prograr an urgent basis and scratched the s what similar **Convair** ***Wizard*** **that** being developed for the Air F However, the Pentagon directed Air Force to proceed with rapid d opment of BMEWS—the ballistic sile early warning system.

So far, well over a half-million lars has been spent on *Zeus*. than 80 companies are engaged i development in 17 states from York to California.

This brings us down to the pr slugging match over money for in the FY 1960 budget.

Originally, the Army recomme putting $1,003,000,000 in the bu for *Zeus*. This included about million for R&D and more than million for tooling and other pr tion facilities as well as some for *Zeus* bases.

Later the Army reduced its request to $626 million—$300 m for R&D, the rest for production f ties. But this figure also was una table to the budget-minded Adn tration. Only $300 million for R& mained in the Army budget by the it reached Congress.

The net effect of this would been a sizeable delay in the *Zeus* table. As one Army source put it: production money is needed for lead time items. When you pr dinner, the roast takes just so lo cook. If you delay putting it i oven, the whole meal is delayed.

• **Change of mind**—The Adr tration explaination was that it did not feel *Zeus* was advanced e for production. However, as the

Part One of a two-part series on anti-missile missiles.

n-fighting in congressional commit- passed, the Administration re- ed itself. It included an extra $137 ion for *Zeus* production facilities he so-called "master plan" for anti- raft defense.

The $137 million is conceded gen- ly to be just barely enough to keep *s* on schedule. It also leaves the ninistration with the painful decis- to be made all over again in the ing months as the nation heads a presidential election year. Only time the sums involved are billions ead of millions.

At the very core of the problem is question of just how good *Zeus* Army experts will tell you fervently: y good. A number of other Penta- experts will tell you: Yes—and no. h in a sense are correct. It's a mat- of premise: What do you want an -missile missile to do?

Of course, you want it to knock n ICBM's. But how many? And re? And at what cost?

• **Half a loaf**—Ideally the answers simple. You want an AICBM that knock down all ICBM's fired at in anger—even when the sky is vded with possibly dozens of war- ds and scores of decoys. All of this vity is to take place outside the osphere where explosives of multi- aton warheads will do relatively damage. And the whole show ld cost about $1.98.

This isn't *Zeus*. Nor is it anything known to be feasible at this time.

The Army contends—and most ob- ive experts agree—that *Zeus* will able to provide adequate spot de- e of vital targets.

This means that if a dozen or so heads or warheads and decoys are led at a particular target—say a . ICBM base—*Zeus* will be capable preventing the target from being royed.

Very good. However, here comes rub. In the case of a city like New York or Chicago, *Zeus* might also make a perfect score. But some of the interceptions might take place not far overhead causing widespread fires. And if *Zeus* were to bat down nine out of 10 ICBM's, one five megaton warhead on Chicago would be enough.

Finally, *Zeus* will be able to do some discriminating between warheads and decoys. And the Army contends the system is sufficiently flexible so that even if Russia becomes capable of filling the sky with warheads and decoys, *Zeus* will become capable of dealing with the problem. However, this contention is open to argument outside the Army.

Obviously all of this adds up to a weapon that is not the ideal anti-missile missile. But the Army contends that to reject it on those grounds is like starving to death because the only food in the house is ham sandwiches and you want pressed duck.

• **Strong points**—Moreover, these arguments weigh heavily in *Zeus'* favor:

• No matter how powerful a deterrent force the United States can build, the nation is powerless to prevent an ICBM attack once a war begins unless it has some anti-missile missile system.

• At a very minimum, *Zeus* would provide a guarantee that a significant part of America's retaliatory force could not be destroyed on the ground by a surprise attack.

• The very existence of *Zeus* increases the cost of an attack for Russia and raises one more doubt as to whether one could succeed.

• Finally, if the United States were to scratch *Zeus* and put its cost into offensive weapons such as more ICBM's, how much better off would the United States be if Russia developed an AICBM like *Zeus*?

"Put it this way," one Army spokesman said. "No defense is perfect. If the enemy wants to get through badly enough, he always can by paying the price of admission. What we're doing with *Zeus* is boosting the price of admission."

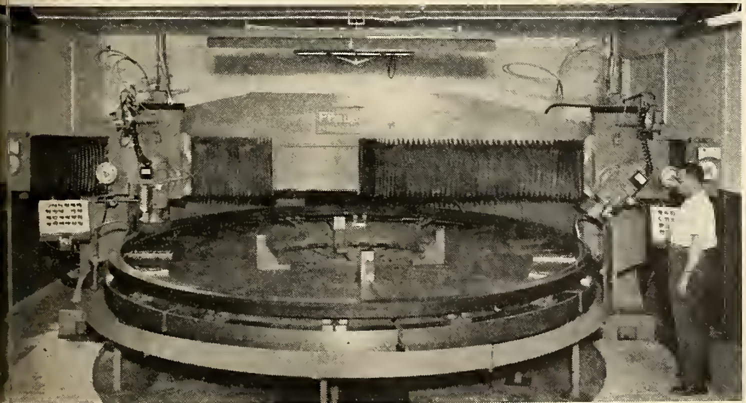
• **Trouble ahead**—It is difficult for many to conclude other than that the *Zeus* program should be pushed ahead on schedule. However, powerful opposition to it is certain. The root of much of this will be the money problem.

Given no worsening in the Cold War between now and January, the Administration will be even more eager than it was this year, as the presidential campaigns get underway, to call for a balanced budget.

This can mean only one thing: A defense budget frozen somewhere around the present $40 billion. Nearly $2 billion for *Zeus* will be hard to find, indeed.

Therefore, the Administration may be greatly tempted to marshal opposition against *Zeus* to try to kill it. Or, since it would be easier, postpone costly production and thereby put off having an operational AICBM until 1964—two years after Russia is expected to be in a position to, in the words of Defense Secretary Neil McElroy, "cream the country."

TESTING OF the Thiokol booster engine used in *Nike-Zeus*. The solid-propellant engine delivers 450,000 pounds of thrust in about four and a half seconds.



RLD'S LARGEST ultra-precision hardened bearing was ground by the Kayden E ineering Corp. for production of giant radars needed for the *Nike-Zeus* system.

NASA Wants Small Business To Get Its Share

Civilian agency has good record in letting contracts to small firms and wants more on its buying list

by Paul Means

WASHINGTON—A new man at NASA intends to make it his business to see that small business gets its share.

But first he needs to know the names of small firms having the interest and ability to perform NASA contracts and subcontracts.

Jacob M. Roey, recently appointed Small Business Adviser, will start by screening a list of small businesses (those with under 500 employees) supplied by the Small Business Administration.

This is only the beginning. As Roey points out, "there are hundreds of small research organizations with competent staffs that have come into being almost overnight. It is our job to locate them and catalogue their interests and capabilities."

He asks any small business interested in having its name added to his list to contact him at NASA's Washington headquarters.

Roey views his job as one of education and information. He informs NASA procurement officers and large contractors of small businesses, singly or in teams, capable of performing certain contracts. He also informs small businesses of upcoming NASA contracts for which they might be capable of being contractor or subcontractor.

• **High batting average**—NASA's record of letting contracts to small businesses during their first six months of operation has been very good. The last quarterly report from NASA's Ames Laboratory shows over twice as many procurements going to small businesses as to large, and almost twice as many dollars.

Most of the Ames Laboratory procurements were for supplies and services, an area in which small businesses have greater capabilities. But the record indicates NASA's desire to give small business all the work they can handle.

NASA contractors also have a good record of subcontracting to small business. E. W. Brackett, NASA Procurement Director, points out that the **Rocketdyne Division** of **North American Aviation,** which has the NASA contract to produce the *Nova* million and a half pound thrust single chamber engine, placed 79.4% of its total subcontract work by volume with small business firms in 1958. Total dollars showed $40 million going to small business subcontractors and less than $28 million to large business subcontractors.

Roey's job, then, is to systemize the process, so that NASA and prime contractors know what small businesses are able to perform specific jobs, and so that the small businesses know what jobs are available.

• **General aims**—Though he is still drafting a policy statement outlining the goals of his job, Roey says the general programs he intends to institute are the following:

1. To compile a well-indexed file of small businesses.

2. To screen proposed NASA contracts to determine what portions could be performed by small businesses.

3. To invite small businesses to participate as members of the audience when details of NASA-proposed contracts are explained to potential bidders.

4. To give big business contractors names of interested small firms with subcontracting potentials.

5. To urge big business contractors to set up their own files of potential small business subcontractors.

6. to urge small businesses to pool their resources so that they can jointly bid on larger NASA contracts.

• **Some targets**—The evils in the contracting process detrimental to small businesses which Roey hopes to overcome include:

1. The natural tendency on the part of some procurement officers and technical staffs to award contracts to large firms of proven reliability.

2. The practice on the part of so[me] large contractors to set up a stable [of] subcontractors who then get most [of] the subcontracts without competiti[on] from the outside.

The area in which small firms [re]ceive a lot of NASA contracts p[re]sently is supply and services. But t[he] area which Roey feels holds a gr[eat] future for small business is resear[ch] and development.

The Congress recently went on r[ec]ord as favoring the letting of contra[cts] to small business in this field. Unli[ke] the military program, NASA nee[ds] R&D work on many small systems a[nd] components which small busines[ses] could handle.

• **Made to order**—The very natu[re] of the space program indicates th[at] many opportunities exist for small bu[si]nesses in this field.

One shot, custom-made spa[ce] probes lend themselves ideally to sm[all] business development, since volu[me] production line capabilities which f[ew] small businesses possess are not neede[d]. Payloads on top of space probes a[nd] satellites vary from shot to shot [as] NASA scientists attempt to increa[se] their knowledge about the univers[e]. Much NASA payload contracting as[ks] the company to extend the state of t[he] art in a specific field, and individu[al] theoretical ability counts.

On the large space projects, such [as] *Mercury, Vega, Centaur, Saturn,* a[nd] *Nova,* no one company is big enou[gh] to do the entire job. In these case[s] small electronic, engineering, researc[h,] construction, and many other types [of] firms become valuable junior partne[rs] on a competing team for the contra[ct] and after the contract is won.

Many small handmade items, tr[e]mendously important in relation [to] their size, can best be done in a sm[all] intimate shop, where decisions can [be] made orally across the shop floor rath[er] than routed through the chief engine[er] up to the executive vice president.

Another reason small business[es] should get their share of NASA co[n]tracts is that the space administratio[n] does not intend to adopt the system[s] concept of procurement, used to som[e] extent in DOD. In the systems co[n]cept, all contracts for a complete pr[o]gram, including support equipmen[t,] training aids, spare parts, and oth[er] items are placed with one contracto[r]. In such cases, small business can ser[ve] as subcontractors, but are shutout [as] principal contractors.

Brackett states that NASA will u[se] such a system only in crash program[s] where "time is of the essence;" th[at] the usual procedure will be to "procu[re] various items, or segments, separatel[y] from different contractors, and int[e]grate and assemble them ourselves

Pressing the Search for 'Whiskers'

Five to 10 years may bring usable materials with six times the strength of steel

by Jay Holmes

WASHINGTON—Metal "whiskers," a headache for handlers of electronic equipment, may some day be a boon to makers of missile structures, in which high tensile strength is vital.

Some of these tiny metal fibers, which grow out of bits of metal under heavy electron bombardment, have a strength up to six times that of the strongest modern steel. The problem before researchers is to form the whiskers into a material that can be fabricated.

The strongest whiskers, which can have a tensile strength as high as 2,000,000 pounds per square inch, have diameters of less than a 10,000th of an inch. Their strength compares with a maximum of 350,000 psi for modern steels.

Metal whiskers were discovered a short time after World War II when engineers sought the cause of mysterious short-circuits that developed in electronic equipment after long use. When they took the black boxes apart, the investigators found tiny wiry strands jutting from areas of metal surfaces under heavy electron flux. The strands are formed when atoms boil out the metal and deposit themselves in a regular crystal structure, sometimes in the form of a spiral.

Why are whiskers so strong? A more pertinent question would be why aren't most metals as strong as whiskers. For physicists have calculated—from the difference between electrostatic repulsion and bonding energy of metal atoms—that the tensile strength of a perfect crystal theoretically should be on the order of several million pounds per square inch. The difference between this figure and the much lower measured strengths of ordinary crystals bothered physicists for many years. The discovery of whiskers' high strength confirmed the theory. The weakness of ordinary metal is due to imperfections in the crystal structure.

The National Aeronautics and Space Administration is sponsoring metal-whisker research at California's Jet **Propulsion Laboratory** and at the Lewis Research Center in Cleveland. Work is also under way at several industrial laboratories, including those of **General Electric Co., Bell Telephone** and **Union Carbide Metals Corp.**

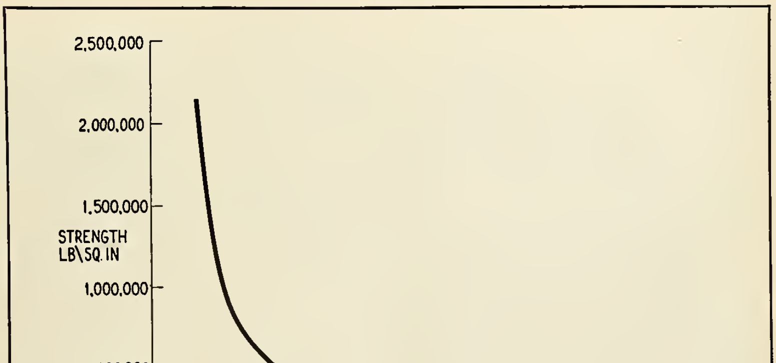
● **Five years at least**—Dr. Harold Hessing of NASA's Washington headquarters told M/R it might be possible to make usable materials from metal whiskers in 5 to 10 years. "I would say five years at a minimum," he said.

A great difficulty, Hessing explained, is that only one metal whisker in 10 has unusually great tensile strength. So far, he said, no one has devised a simple test of whiskers' strength other than to pull each one individually. "If we can pull it up to a certain load, then we know we've got one of the good whiskers," Hessing commented.

Joining the whiskers is another problem. Bonding material must be ductile and able to carry a shear load. Hessing said it may be possible to devise a method similar to one under NASA study in Cleveland for bonding wires together. The wires, immersed in molten copper, are forced through a funnel-shaped piece of metal. After the wires are forced together and the copper freezes a material of very high strength is formed. NASA scientists at Cleveland have made a package of ordinary steel piano wires ¼ inch in diameter with strength of 320,000 psi, compared with 150,000 psi for unpacked piano wire. There is no reason why such packaged wire cannot be made indefinitely long, Hessing said. The effect of the copper surface on the metal crystals is less than had been feared, he added.

● **Search for strength**—Tungsten is commonly used in experiments with whiskers because it is one of the strongest of the pure metals. Pure tungsten is stronger than pure iron. Steel, of course, is stronger than both but no one has offered any plan for growing iron whiskers with just the right amount of impurity to make high-grade steel. The accompanying graph shows maximum strengths of pure iron whiskers plotted against diameter. The curve for tungsten would have the same shape and would be a little above that for iron. A graph for tungsten wires bonded as in the NASA experiments at Cleveland would be a little below.

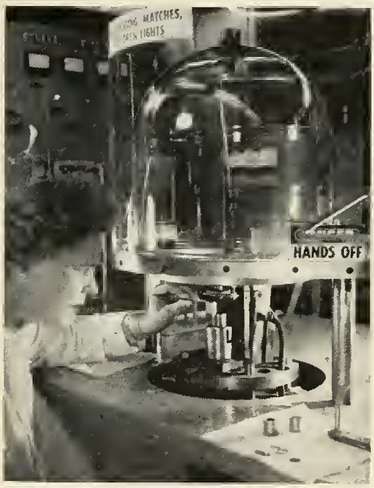
While some scientists are trying to grow longer and thicker whiskers, others are trying to eliminate or reduce them to eliminate short-circuits in electronic equipment. Several investigators report that alloys form fewer whiskers than pure metals. Nickel and tin are popular ingredients of such alloys.



MAXIMUM STRENGTHS of pure iron whiskers. Tungsten curve would be higher.

Hawk and *Lacrosse* Join Armory

Both highly mobile missiles will be deployed overseas in the next year to U.S. and NATO forces



HAWK RATE GYRO is silver brazed at 1300°F in two minutes under controls.

WASHINGTON—The Army this month added two powerful new missiles to its armory—the **Raytheon** *Hawk* and the **Martin** *Lacrosse*.

The first home of the *Hawk* is Ft. Bliss, Tex., where the 5th *Hawk* Missile Battalion of the 57th Artillery has been organized. The 300-man unit will train future *Hawk* missilemen for deployment in the United States and overseas.

Two *Lacrosse* units—the 5th Missile Battalion, 41st Artillery, and the 5th Missile Battalion, 42nd Artillery—have been organized at Ft. Sill, Tex. Each has about 170 officers and men.

The Mach 2.8 *Hawk* is designed specifically for intercepting enemy planes and air-breathing missiles flying from tree-top to medium altitudes in an attempt to dodge radar. It complements point defense provided by the **Western Electric** *Nike-Ajax* and *Ni* *Hercules*. Its range is about 22 mi

The *Hawk* has two stages—b powered by solid-propellent mot developed by **Aerojet** and **Thiokol.** T warhead is a high explosive. Raythe homing guidance in the missile dire it to its target.

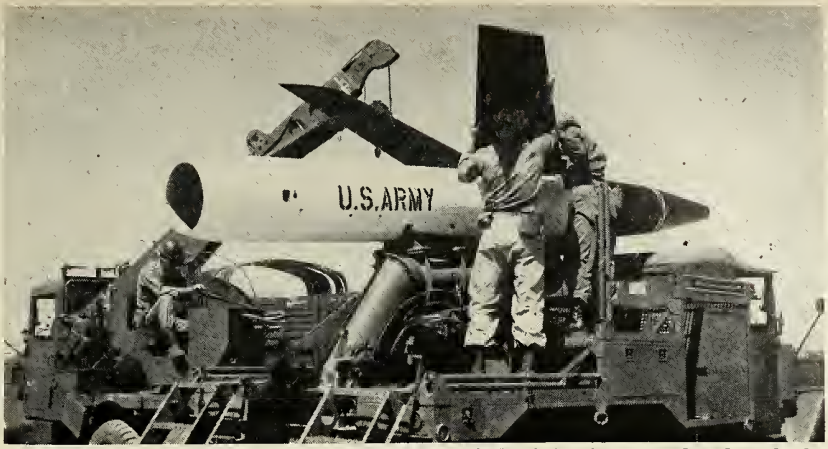
The 1250-pound *Hawks* are hig mobile. They can be rapidly tra ported either by road or by helicop and aircraft. *Hawk* launchers ca three missiles which can be fired rapid succession.

The Mach 2 *Lacrosse*—a nucle tipped artillery missile—also is hig mobile. The entire system can mounted on a standard two-and-a-h ton Army truck. The system also c easily be airlifted.

The 19.5-foot missile has a rar

THREE *HAWKS* ready to go are mounted on mobile launcher at White Sands Test Range. They can be fired in rapid succession.

ASSEMBLING *HAWKS* at the Raytheon's Missile System sion, Andover, Mass. *Hawks* may soon be manufactured in Eu



LACROSSE, **the Army's new surface-to-surface tactical missile, is mounted and ready for launching from standard 2½-ton truck.**

o about 20 miles. Its warhead can be ld ded with a variety of explosives and s ped charges. It can pack a nuclear wrhead or a variety of conventional e plosives or shaped charges.

Lacrosse is powered by a solid mo- t developed by Thiokol. Its guidance i terminal and provides a high degree c accuracy, making it possible to hit s all targets such as bunker entrances.

Millions of dollars worth of *La- cosses* and *Hawks* are scheduled to b deployed overseas during the next yar both in the hands of U.S. Army uits and NATO troops. Marine units ao will be equipped with *Hawks.*

Five NATO nations are moving tward production of *Hawks* in Europe f their own forces through an agree- ment with Raytheon.

The *Hawk* and *Lacrosse* are among t first of the new highly mobile fast-reacting tactical weapons being developed for the Atomic-age Army. Among those still under development: the **Martin** *Pershing, Davy Crockett,* **Aeroneutronics Systems** *Shillelagh* and **Convair** *Red Eye.*

The 500-to-700-mile *Pershing* will succeed the liquid **Chrysler** *Redstone*.

Red Eye is a tube-launched guided missile for use against low-flying aircraft by troops in the field. It is equipped with an infrared homing system.

Shillelagh is a lightweight surface-to-surface missile designed for use against armor, troops and field fortifications. It is expected to be operational by mid-1960.

Davy Crockett is a light nuclear-tipped rocket designed to be fired by one or two men in the field. It is being developed as a family of missiles.

BLAST OFF for a *Lacrosse.* **It can carry a warhead an estimated 20 miles.**

READY TO GO from its mobile launcher, *Lacrosse's* **terminal guidance enables it to strike enemy positions with pin-point accuracy.**

What's New in Fuzing and Arming

Remarkable achievements have been made in a field that is shrouded in secrecy and remains largely government-controlled in the hands of a small group

by Hal Gettings

WASHINGTON—The primary function of a missile is to deliver a warhead to a target. Consequently, the warhead—with its arming and fuzing system—is a major subsystem of a missile. All the other subsystems operate only to enable the warhead to perform its function. The design and manufacture of an arming and fuzing system thus becomes a large and important part of a missile program, demanding the utmost in efficient design and reliability.

How do you make an explosive device so safe that it's practically impossible to detonate it accidentally—even if the missile carrying it blows up on the launch pad, or the jet bomber carrying it crashes on take-off? How do you guard against a technician inadvertently putting a voltage on a fuzing circuit? And, after making it this safe, how do you get the thing to detonate without fail at exactly the time and place it's supposed to?

These are some of the problems that face the designers of arming and fuzing systems for both nuclear and conventional missile warheads. That they have solved these problems, at least to a remarkable degree, is evidenced by the fact that we have never had a premature nuclear warhead explosion—even when the weapon was involved in a bomber crash.

The safety factor is considered at least 1000 times more important than any other aspect of reliability. Designers actually shoot for a minimum of 100% reliability so far as safety is concerned.

Detonation reliability must then become a little less than 100% perfect. Design goal is aimed at what is sometimes called the "wooden bomb" concept. This means that the warhead must be capable of being dropped, stored for long periods under changing conditions, mishandled—in short, subjected to practically any sort of maltreatment—and then be ready to go on a minute's notice.

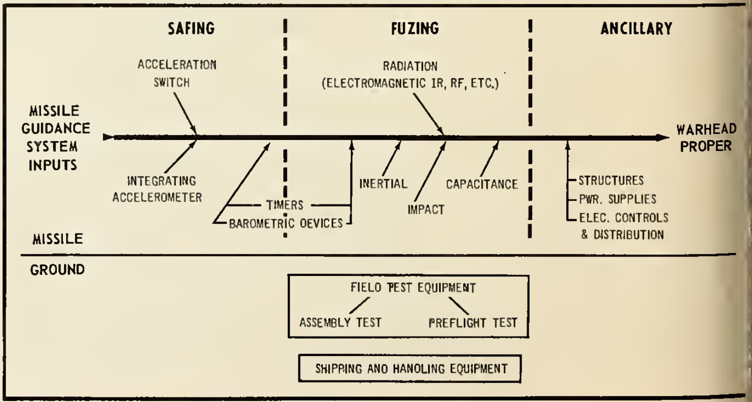
• **Shroud of secrecy**—A great deal of secrecy surrounds arming and fuzing systems—some no doubt justified, and some perhaps not. Of course, an argument for tight security is the fact that knowledge of the characteristics of a system can lead to second-order deduction of facts about the warhead itself. Knowing the sensitivity range of a proximity fuze, for instance, one can tell much about the size and capability of the nuclear payload. More important, knowing details of the system would allow an enemy to prematurely detonate the warhead.

Several manufacturers have stat[ed] privately that some of the governme[nt] agencies involved are chiefly interest[ed] in keeping fuzing systems in the cat[e]gory of government-furnished equi[p]ment—so that they may either pr[o]duce the system or handle the subco[n]tracting.

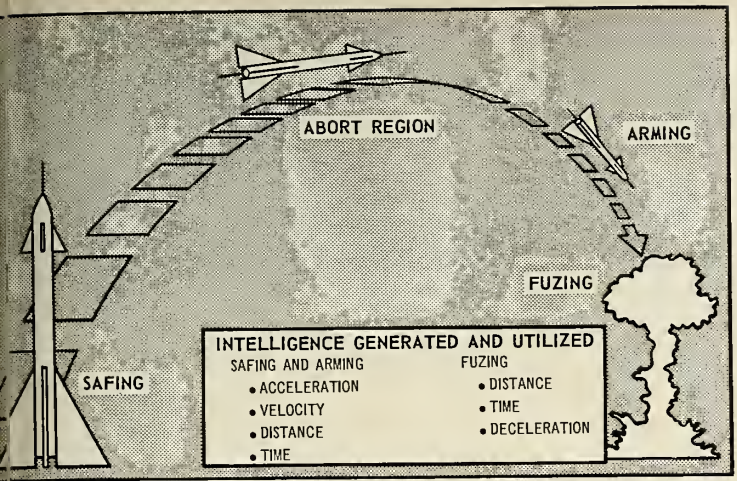
Whether this charge is true or n[ot] is a moot question. It is a fact, how[ever], that there is no central clearin[g]house for industry information. It [is] conceivable under such circumstanc[es] that the state-of-the-art cannot a[d]vance at a rate comparable to that [in] related fields.

Accepting the need for tight s[e]curity in this area, some sort of centr[al] agency for coordination of past d[e]velopments and of work in progre[ss] would help to provide answers f[or] those with a need-to-know.

The arming and fuzing industry



INPUTS and components of a typical fusing and arming system.



UCTIONS OF TYPICAL MISSILE SAFING, ARMING AND FUZING SYSTEM
AING is defined as handling and launching safety for own personnel facilities and itory; the abort region is the area where the bird may be self-destructed without enation of warhead; arming prepares warhead for fuzing signal.

hole is in the hands of a small rup. In addition to the restrictions n limitations mentioned, there is r one customer—the military—for h business, and developments do not e to profitable commercial products.

• **Growth of participation**—Arming r fuzing of a nuclear warhead was le entirely by the Atomic Energy Commission until, in 1953, they agreed o transfer some of the responsibility o the armed forces. **General Electric** v the first industrial contractor to oak the barrier and produce a comple system from design through hardwe production—for the *Lacrosse* msile. GE is currently working on—o has completed—nuclear ordnance ojects for eight major missiles.

Bulova's Research and Development Labs have been in the business fc a long time and are currently w king on their 17th system. They recently were awarded a multimilliondcar contract for the Army's *Pershin* missile.

Besides GE and Bulova, there are perhaps three other companies with a mor interest in this field: **Minneapoli Honeywell, Maxson,** and **Avco-Crosle** Others involved to a lesser extent inude **Bendix, Philco, Farnsworth, Clins, Emerson, Eastman, Melpar, Westinghouse,** and **General Mills.** There are at least 30 major component suppliers.

Several government agencies are in the picture to a greater or lesser degree. Army's Diamond Ordnance Fze Lab worked in the field for many yrs. They were in at the beginning o the proximity fuze development ir 1941, and have maintained their wk in this and related fields until they probably now have the most complete in-house capability of any agency. DOFL has also done considerable work in electronic miniaturization for fuze circuitry and other accessory areas.

The Navy, too, was concerned with proximity fuze development in its early stages. Naval Ordnance Labs at Corona, Calif., and White Oak, Md., as well as Ordnance Test Station, Inyokern, are today involved with arming and fuzing development.

Other government agencies involved include AEC, Air Research and Development Command and Air Force Special Weapons Command.

Picatinny Arsenal has prime responsibility for all Army missile warheads. Their Special Weapons Ammunition Command acts as specifier, buyer, and technical consultant to system contractors. They may also procure components or subassemblies for the prime. Picatinny's Atomics Lab conducts periodic symposia on arming and fuzing for industry contractors.

• **Tricky requirements**—Due to security restrictions, the problems and design criteria for A and F systems can be discussed only in principle. Several major problems confront the designer: extreme reliabilities, high accuracies, extreme environments, and tactical utility.

The d o u b l e -barrelled reliability problem puts the designer on the horns of a ticklish dilemma: the safer he makes the fuze, the harder it becomes to make it operate at the proper time. This factor is overcome, to an extent, by use of redundancy in the firing circuits. An oversimplified example would be a circuit such as shown in the diagram. Switches A, B, and C would have to be closed to complete the circuit; the failure of any one would make the system inoperable. If parallel switches were added, then the likelihood of failure is reduced (assuming 100% reliability of the switches themselves). Redundancy has its limits, however, since space and weight are at a premium.

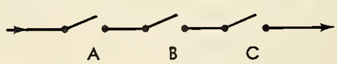
The high accuracies required in an arming and fuzing system are another problem source. The warhead must explode at a precise point in altitude or proximity to the target. It therefore must be sophisticated (almost intelligent), sensitive, and fast. Such complexity further adds to the reliability problem.

This complex and sensitive device must ride a missile through a wide range of extreme environments. It must maintain its integrity through the shock of initial blast-off, a gamut of temperature extremes, acceleration and deceleration, atmospheric re-entry (in some cases), and other shock and vibration.

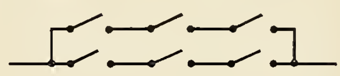
Tactical utility requires a unit that can be stored for long periods, quickly assembled, easily tested and immediately available. It must be capable of all this in the hands of field-level personnel with training roughly equivalent to that given an ordinary field artillery crew.

The so-called "adaption kit" allows missiles to have a dual capability. Battlefield generals, fleet or air force commanders can choose between either conventional or nuclear warheads—and the missile can be so armed at a split-second command.

• **Complications**—The most simple fuzing system, of course, is the basic "hammer and nail" type—a pistol firing pin, for example. Starting with this concept, a system steadily grows more complicated. A "safety" is added to prevent premature firing . . . and further equipment is then needed to bypass or remove the safety at the proper time—for instance, a propeller must revolve



SIMPLE set of series switches are closed to allow fuzing signal to go to warhead.



PARALLELING second set of switches provides alternate path for B signal (redundancy).

a certain number of times or the projectile must rotate fast enough to throw out the safety. Then we can add acceleration inputs, barometric devices, radiation (or other electromagnetic) transducers, or any amount of complicated gear to make our system more sophisticated and safe—and potentially less reliable. It is one of the most complex devices in a missile.

The basic elements and optional control inputs of a typical arming and fuzing system are shown in the diagram. The choice of the various inputs, would, of course, depend on target characteristics, location, altitude, and any number of other factors. The more of these considered necessary, the more sophisticated the system.

A system's components include timers, accelerometers, integrators, gear trains, power packages, amplifiers, a maze of switches and electronics, logic panels, and unique sensing elements—all acting on programmed and sensed inputs to set in motion a chain of events leading to the final "moment of truth." All components must be of a precision and quality not required in other areas. Although designed to be used only once, they must be ready at all times to perform their assigned function with no question as to readiness and reliability.

Little is heard—or can be told—of the actual techniques and mechanisms developed to enable a missile warhead to do its job. Their importance must be judged not by the publicity they receive but by their extremely important part in successful missile systems.

Hoffman Acquires New Data Processing Machine

MENLO PARK, CALIF.—Capable of performing 480,000 decision-making operations per minute and storing up to 6 x 10^8 characters of information, a new data processing machine recently was purchased by Hoffman Laboratories Div. of **Hoffman Electronics Corp.**

First of its kind to be built, the $800,000 computer, called a Datatron 220, is a digital system with full magnetic-core memory.

To be employed in the performance of the U.S. Air Force electronic reconnaissance system, "Tall Tom," the giant computer was built by **Electro Data Division** of Burroughs Corp. Hoffman is directing the team of seven companies involved in the program for the USAF Aerial Reconnaissance Laboratory.

The system was dedicated formally here at **Stanford Research Institute,** during a recent meeting of the Tall Tom management policy board.

reviews

STANDARD SAMPLES FOR GASES-IN-METALS, U.S. Department of Commerce, National Bureau of Standards, Summary Technical Report.

Eight bars of ferrous materials whose oxygen and nitrogen content have been precisely determined comprise a new type of standard sample now available from the National Bureau of Standards.

In providing these reference materials for the calibration of commercial apparatus used to measure the gas content of metals, the Bureau has inaugurated a program of standard samples for gases-in-metals covering a variety of metallurgical products.

RESEARCH ON FIELD EMISSION CATHODES, E. E. Martin and H. W. Pitman, Linfield Research Institute for WADC, 69 pp., $1.75, available from OTS, U.S. Department of Commerce, Washington 25, D.C.

This program was undertaken in two phases, one of which led to improvement of stability of the field emission cathode and the other involving study of the electrochemical behavior of refractory metals used to make field emitters.

In the first part, methods were developed for greatly improving stability of the cathodes by avoiding changes in surface electric field and work function. Experimental testing of fixed voltage operation of a cold tungsten emitter was extended beyond 3000 hours. In other cases current drift rates less than 5% per 100 hours of operation over several hundred hours were observed at currents of the order of 10^{-4} amperes.

Improvement during repetitive, microsecond, pulsed operation at pulse currents up to 0.1 ampere was demonstrated. Techniques included careful vacuum practice, envelope material nearly impervious to atmospheric gases, and thoroughly degassed refractory metal shaped to minimize encroachment of secondary electrons on tube envelopes.

In the study of the electrochemical behavior of refractory metals, formation and dissolution of oxide layers appeared to have a major influence on surface smoothness and emitter geometry. Developed were an automatically controlled method of emitter shaping and a technique for removing material uniformly from small parts such as small cathode structures. The effect of variation of polishing cell parameters such as temperature, voltage and electrolyte concentration was also investigated.

HIGH TEMPERATURE MATERIALS, Edited by R. F. Hehemann and G. Mervin Ault, John Wiley & Sons, Inc., New York, 544 pp, $17.50.

This book is based on papers presented at a conference sponsored by the High Temperature Alloys Commitee, Institute of Metals Division, Metallurgical Society, American Institute of M[ining,] Metallurgical and Petroleum Engi[neers.] It delves into all classes of material [for] use at temperatures over 1500°F [and] many of the related problem areas. [Well] illustrated and indexed, the book inc[ludes] research paper reports on such sub[jects] as refractory metals, dispersion harde[ning,] gas metal interaction and oxidation [re-]sistance. Contributors to the volume [are] top men in the field from govern[ment,] industry, research institutes and uni[versi-]ties.

MAN IN SPACE, Edited by Lt. Col. Ke[nneth] F. Gantz, USAF, Duell, Sloan and Pe[arce,] New York, 303 pp, $4.00.

Every facet of the problems inv[olved] in man's survival outside the atmosp[here] is covered by pioneering research g[ains] in the bio-medical aspects of space fl[ight.] Human factors from the general to [the] specific problems as weightlessness, [con-]ditioning, escape, time dilation, and [hu-]man performance under space condi[tions] are analyzed on the basis of past ex[peri-]ments and projected into future n[eeds.] Papers presented include contribu[tions] from Col. John P. Stapp on biodyna[mics;] Dr. Hubertus Strughold, "father" of s[pace] medicine and M/R contributor, on [ecological] factors; Lt. Col. David G. Simons on h[igh-]altitude experiments; Dr. Hans G. [...]mann on the engineering environm[ent;] and Dr. Siegfried J. Gerathewold [on] weightlessness. Some of the Pentag[on's] top strategists go into the military asp[ects] of manned space operations and the [need] for long-range planning. The appe[ndix] includes a 14-page glossary of term[s,] reading list of astronautic books, [bio-]graphical notes on the authors and a [de-]tailed rundown on Project *Mercury,* [the] nation's first manned space vehicle pro[gram.]

AIR RESEARCH AND DEVELOPM[ENT] COMMAND TECHNICAL SYMPOSI[UM,] JULY 1958, WADC, U.S. Air Force; 502 [pp.,] $7, available from OTS, U.S. Departmen[t of] Commerce, Washington 25, D.C.

Technical papers and discussions of [the] Air Research and Development Comm[and] symposium on materials for space vehi[cles] and propulsion systems, held in J[uly] 1958, in Dallas, have been published.

Attending the symposium were [rep-]resentatives of the major Air Force [re-]search and development establishme[nts] including ARDC, Office of Scientific [Re-]search, Air Materiel Command, C[am-]bridge Research Center, and the Wri[ght] and Rome Air Development Centers.

Among papers presented on structu[ral] materials were those dealing with alu[mi-]num, magnesium, beryllium, steels, su[per] alloys, adhesives, graphites, plastics, [and] surface treatments.

Reports presented on electronic [ma-]terials included such topics as synth[esis] and application, energy transforming [ma-]terials, insulation and dielectric materi[als,] magnetic materials, and transistors.

Other papers were presented on [ma-]terials research, materials application [and] processes, and propulsion materials.

Automatic Checkout Systems Compared

Curtiss-Wright's DEMON and Nortronics' NORSCAN are representatives of the fully transistorized development trends in the checkout field

by Charles D. LaFond

WASHINGTON—For those who have followed the rapid development of automatic checkout, the evolution to solid-state systems was logical and mandatory to achieve the desired very-high-speed and data-handling capabilities.

Last week's issue of M/R summarized the results of an industry survey of checkout systems. It was evident that solid-state systems are well past the dream stage.

To better understand just how much has been accomplished with these newer checkout systems, a close-up of two systems is presented: the **Curtiss-Wright** DEMON and the **Nortronics** NORSCAN—both fully transistorized, modularly constructed, completely self-checking, and extremely flexible in application. Although the two are similar in overall design, each has certain unique attributes. It is important to note that there are other similar systems, but DEMON and NORSCAN appear to be representative of the development trends in tomorrow's automatic checkout industry.

• **Design goal**—Both DEMON and NORSCAN were designed to achieve one principal goal: a broad system capability (1) not limited to any existing weapon system, (2) incorporating sufficient functional groups to accommodate many future weapons systems, and (3) adaptable to all levels of testing. In other words, the system design had to be such that the inherent capability might permit module deletion, but not require addition, when adapted to a particular weapon system checkout.

• **Limitations**—The one limitation foreseen by both manufacturers in their respective systems is the ability of the system applications engineer responsible for determining the programming for each checkout program.

Curtiss-Wright DEMON

DEMON was formally introduced at the Benesia Arsenal in Benesia, Calif., in March of this year. It also has been in continuous use at the Santa Barbara Division of Curtiss-Wright Corporation since December, 1958.

In a current demonstration setup, DEMON is shown (Fig. 1) checking a *Nike-Ajax* missile system; however, this application utilizes something less than 5% of its total in-being system capability. There are no existing weapons systems today that would require or use the total capability of DEMON, according to Curtiss-Wright.

Company engineers believe that had DEMON been available when the *Nike-Ajax* was introduced operationally, considerable savings in time and dollars would have resulted. For example, utilization of that portion of DEMON which is now being used to check the *Nike* missile would cut by more than half the number of personnel required for tests. The skill level of those persons remaining would be several grades lower than previously required. One skilled operator still would be required for each repair crew, mainly to assure the physical quality of the repair.

Another important consideration, they believe, would be a considerable decrease in time and experience required at the Ordnance Guided Missile School, Huntsville, Ala., where Army missile maintenance crews are trained. As an example of the slash in test time required, DEMON now takes less than one minute to locate a faulty component in the missile power supply—as contrasted with several hours on a manual basis. Further, upon location of the fault, detailed visual repair information could be made immediately available to the operator.

Editor's Note: The reference to the use of a "trend index" by Curtiss-Wright in Part I of this series last week was in error. The Nortronics "confidence index" is the only such trend-type comparison standard that M/R has found employed in any checkout system.

• **Major subsystems**—Referring to Fig. 1, the DEMON system consists of a Flexowriter and the three adjacent equipment racks. The fourth rack contains various stimulus generators used in checking the *Nike,* including an analog-tape stimulas generator. The missile shown was supplied as Government-furnished equipment (GFE) by the Department of Army (certain pieces of test equipment have been removed from the missile depicted for security reasons).

The following is a brief description of each of the major DEMON subsystems as shown in Fig. 2:

• Input-output—Handled by a Model FPC Friden Flexowriter, modified slightly to meet system requirements. Standard 8-channel tape is used. Information can be fed into the system by either punched tape or direct "typing" of coded signals into the file memory. System output is also handled by the Flexowriter. Output signals result in punched tape. This is fed into the receiving mechanism and automatically typed, thus permanently recording the data.

• File memory—Consists of magnetic tape and handling mechanism (paper tape can and has been used), which provides storage of programmed information necessary to perform the following: (1) switching to apply stimuli to injection points; (2) delivery of appropriate max. and min. values for each test for comparison with measured values; (3) execution of address functions based on go-no go response; (4) delivery of any of the test-block stored contents into the system.

• Buffer memory—Provides time-scale changing from the 12,500-character/sec. rate of the file memory to the random rate with which the stored information normally is utilized without significantly delaying acquisition of the information contents when needed.

• Decoder matrix—Accepts stored instructions from the buffer memory, and translates the instructions into an executed pulse delivered at the address specified by each instruction.

• Encoders—Convert all quantities (voltage, frequency, elapsed time) to be measured into binary-coded decimal form. Measurements are performed by comparing numerical data representing the function to be measured with numerical limits programmed by the control system.

• Search control—Supervises the movement of the magnetic-tape file memory, in response to signals arising elsewhere, to prepare for or actually to transfer one test block between file memory and buffer memory.

• Comparator—Evaluates encoded test results with respect to programmed tolerance units. Using simple logic circuitry (subtraction method) the comparison is accomplished in bi[…] coded decimal form. A voltage-s[…] detector is used as an "ON-OFF" c[…]parator and to detect simple switc[…] functions.

• Clock—Used in the testing ([…] in effect, the controlling) of l[…] complex systems. A synchronous c[…]trol logic was chosen in the interes[…] safety and economy in preference [...] a nonsynchronous technique. [...] clock controls transfer of informat[…] between all internal subsystems [...] for all input-output operations.

• **Features**—A summary of [...] principal features will best illustr[…] the capabilities of DEMON.

Storage capacity is greater than 1[…] x 10^6 bits. The system also include[…] "table lookup" for simultaneous eva[…]ation of dependent variables (from [...] functional subsystems) over a gi[…] range. Buffer capacity is 1792 bits.

Programming is digitally control[…] by magnetic tape (patch boards [...] not employed). To minimize physi[…] test equipment, the system utili[…] magnetic tape for an analog in[…] stimulus to the system under test.

Servo-stimulus control is provid[…] for all high-frequency test signals t[…] cannot be programmed on the ana[…] tape. The output of the signal genera[…] is precisely controlled through the [...] of error feedback circuits which co[…]pare the signal generator output agai[…] the desired output, independent [...] knob position. Thus signals are ref[…]enced to the standard against whi[…] the system responses are measured.

A time sharing system is so [...]signed that it can time share the ce[…]tral control subsystem for a number [...] maintenance work stations simultan[…]ously.

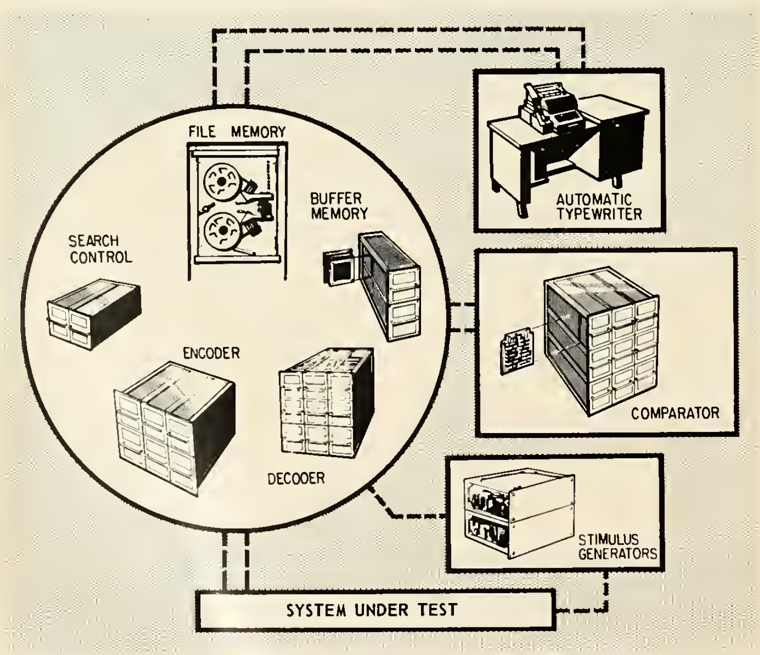
Readout for the test results is pr[…]vided in terms of distance from g[…] distance from no-go, or distance fro[…] any arbitrary given point.

The present DEMON Flexiwrit[…] will print out any information desire[…] from complete test data to select[…] failure data. This is recorded [...] punched tape, and if desired can [...] transmitted via teleprinter to stimula[…] a logical supply system and thus i[…]sure that a proper balance of stor[…] is maintained.

A new visual readout system, em[…]ploying a view screen, is being deve[…]oped by Curtiss-Wright. The system w[…] be driven by the DEMON control sy[…]tem and will display actual photograp[…] of the malfunctioning area of the sy[…]tem under test, the procedure to [...] followed in repair (or replacement[…] and the next step to be taken by t[…] operator after repair.

No operational failures have bee[…] experienced in the DEMON, accordin[…]

CURTISS-WRIGHT'S DEMON checks out a *Nike-Ajax*. DEMON—along with Nortronics' NORSCAN—represent solid state technology for automatic checkout. (Fig. 1)



SUBSYSTEMS of DEMON. Fully transistorized, system is modularly constructed, completely self-checking, and extremely flexible in application. (Fig. 2)

ica company spokesman. All circuits have been designed for maximum independence of component tolerance, which permits the use of 10% components (resistors, capacitors, etc.) throughout the system.

Nortronics NORSCAN

Nortronics, a division of the Northrop Corporation in Hawthorne, Calif., just recently completed its first prototype of NORSCAN, acronym for Nortronics System Computing Analyzer (see Fig. 3). But, according to a company spokesman, the system is founded on thoroughly developed and proven concepts.

Principal memory device in NORSCAN is its magnetic drum, having a capacity of over ½ million information bits.

A major innovation in the Nortronics system is the employment of a "confidence index" (discussed in detail in M/R, June 29). The index is scaled from 99 to 0 and provides a means against which test readings can be compared. This furnishes an accurate indication of how good a go reading really is. Either analog or digital signals may be measured against this standard.

When a time base is added, a rate of change is generated. From this rate, a predicted time-to-failure (due to component drift) is established. This time can be compared with a fixed time interval to determine a "drift index." Predicted times-to-failure greater than or equal to the fixed time interval result in a maximum rating of 99; those less than the fixed time figure are expressed as ratios with values from 0 to 99. (The fixed time interval is based on the predicted mean time to failure.)

• **Principal units and features**—(Refer to the simplified block diagram in Fig. 4.)

• Stimuli generator—All forcing functions are generated within the stimuli generator. These may be electronic, pneumatic, optical, mechanical, or thermal. Provisions are made for flexibility in time, amplitude, and phase. Control of function amplitudes and sequence is accomplished by the processor that specifies which signals should be fed to the switching matrix and then into the system.

• Switching matrix—Solid-state devices are used in the switching matrix for switching electronic signals. The matrix is capable of making 10,000 measurements/sec. This can be programmed to read 100 signals on 100 wires in 1 sec., or 10 signals on 1000 wires in 1 sec., or any combination thereof. It also contains basic switching blocks for switching mechanical or pneumatic signals and presents an electrical impedance of one megohm (or greater) to the system under test.

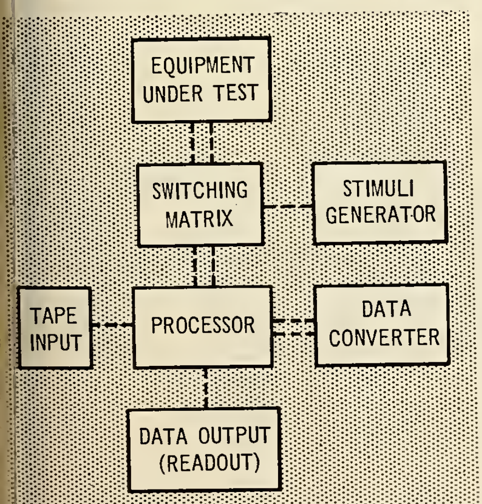
The processor controls the operation by determining which signals shall be switched to the proper wire at the proper time. Outputs from the system under test are sent through the switching matrix. If the outputs are digital signals, they go directly to the processor. If the outputs are analog signals, they are fed to the data converter.

• Data converter—The data converter performs an analog-to-digital conversion with an accuracy of 0.01% and a conversion speed of 25 microsec. The converter contains signal transducers for converting pneumatic or mechanical signals to electrical digital signals. It also has impedance matching devices and contains elements for making necessary scaling changes.

• Processor—The processor is an internally programmed digital computer, with a magnetic drum as its principal memory unit. The processor also contains an arithmetic unit, display controllers, displays, program unit, output controller, core buffer, and magnetic tape unit. The magnetic drum memory has a storage capacity of 500,000 bits of information. The core buffer, having a capacity of 1000 bits, is used for instruction storage to allow for minimum program execution time. It is also used as a buffer between the processor and the printer, between the main drum memory and the magnetic tape unit, and between the arithmetic unit and the selection matrices, which send data to, and collect data from, the system under test.

• Tape input—A high-speed tape reader, with a capability of 400 characters per second, provides the input to the processor. Initially, the tape is used to store information on the magnetic drum with respect to test sequence and test limits. Once the information has been stored on the magnetic drum, the operator energizes the test equipment and the test procedure is programmed automatically. Should any changes be made in the system under test, a new tape is inserted, the previous information erased, and new information reflecting the system changes is placed on the magnetic drum.

• Data output—The data output is under complete control of the processor. A number of different outputs from each unit may be used. The types of output depend upon the operating usage of the test equipment. They may be visual, oral, punched tape, punched



SIMPLIFIED block diagram of Nortronics' NORSCAN for broad capabilities. (Fig. 3)

PROTOTYPE CONSOLE of NORSCAN. Magnetic drum memory device in system has one-half million information bits capability. (Fig. 4)

card, printed copy, or any combination of these. Information from the magnetic tape memory may be printed in clear text for purposes of reliability reports, record keeping, and logistic determination. Reprovisioning data is also available as an output by programming the processor to provide punched cards or punched tape whenever a malfunction occurs in the system under test. This information can then be further processed or used directly to order replacement parts.

• Magnetic tape file—To store information permanently for future reference, such as malfunction prediction through the confidence index system, all data is recorded in a magnetic tape file. The unit might be comprised of an Ampex Model 800 recorder and a series of read-write amplifiers. If, for example, 30 amplifiers were employed, 15 channels would be available. A ½-inch-wide magnetic tape can store 200 bits/inch/channel. A 2500-foot tape could accommodate 7.5 x 10^6 bits with ease. Since the magnetic tape unit also records the results of the analyzer's self-test, a complete record is obtained on the unit and is available for analysis.

Fibreglass Tower Used with UCLA Antennas

Los Angeles—A fibreglass tower with interchangeable antennas has gone into operation at UCLA. The 18-foot structure, utilizing fibreglass to prevent metallic distortion of radiation patterns, rests on a pillbox base and both tower and antenna can be rotated independently on vertical and horizontal axes.

The tower was built by **Blaine Electronetics** and can be operated either by controls inside the base or by laboratory controls two floors below. A transmitting antenna 60 feet away illuminates the tower antenna.

The antenna is being used for various projects in advanced teaching of electrical engineering, radar, communications and other fields. One program under way involves research into transmission of electromagnetic signals between a missile re-entering the atmosphere and the ground. This transmission is difficult because of the ionized layer surrounding a re-entry vehicle.

Leach Opens Laboratory for Solid State Research

Los Angeles—A new laboratory designed for flexible research into solid-state devices has been opened by the **Leach Corporation.** Located at the firm's relay division, the lab will "develop solid-state packaging with no preconceived ideas," and will endeavor to meet the rapidly changing logic of space control and communications.

According to company officials, the lab will augment other work being done at previously-established electromechanical and chemical labs, as well as the new Leach Production Reliabilty Center. The lab has been well equipped with general and specific solid-state development instrumentation to permit fast study and checkout.

The lab has already developed a new programming timer which combines subminiature crystal can relays with solid-state devices in a common circuit for use in sequence progr[...]ming.

The solid-state package deve[...]ment philosophy at Leach is based [...] the belief that "even in the most r[...]lutionary electronic fields, no new [...]vice has ever succeeded in comple[...] supplanting the old." Therefore, Le[...] engineers are looking to the con[...] of combining components based on [...] peculiar characteristics of each [...] This design logic, they predict, wil[...] the outgrowth of research in sc[...] state packaging.

Recruiting Heavy at Military Electronics Me[...]

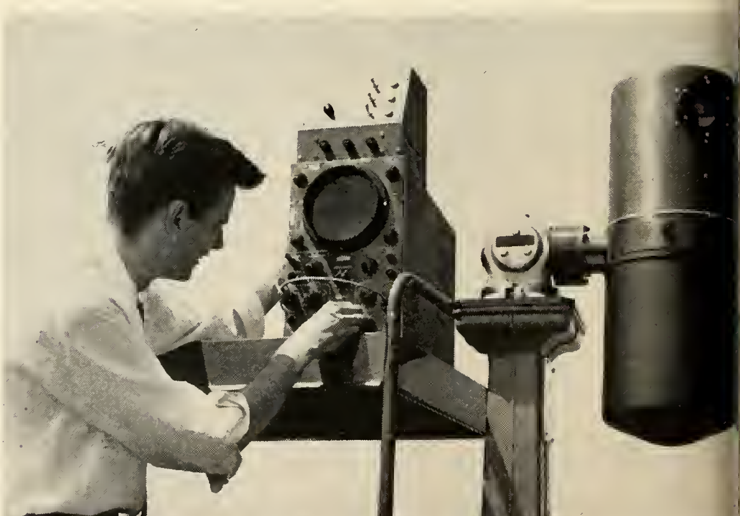
Washington—A "highly successful" third annual National Convention on Military Electronics here last week pointed up the importance of missiles in the military electronics industry. Almost all the technical sessions were devoted, at least in part, to missiles applications of electronics systems and components.

The convention, sponsored by the IRE Professional Group on Military Electronics, was attended by nearly 400 engineers—almost twice last year's figure. Some 80 exhibitors showed their latest developments in the field. Although nothing outstandingly new was to be seen at the exhibits, several items such as a pocket-sized computer and the free world's largest radar set attracted considerable attention.

The exhibit that drew the largest crowds was **Martin's** moon-satellite [...]ball machine. Walter Mitty-type as[...] designers could crank guidance [...] thrust data into the machine [...] launch a steel-ball satellite which co[...] orbit or land on the moon if t[...] calculations were correct.

Engineer recruiting was especi[...] heavy. At least 25 major compa[...] had representatives at the meeting [...] the competition for qualified peo[...] was the fiercest since before the stret[...] out. One recruiter estimated that th[...] were about 10 jobs available for ev[...] eight men interested—a demand ab[...] double that of last year.

Two **General Electric** engineer[...] R. S. Grisetti and E. B. Mullen—[...]ceived the annual M. Barry Carl[...] Award for their paper on basel[...] guidance systems.



FIRST OPERATIONAL configuration of Avion's CODES Commutating Detecti[...] System was exhibited at the 1959 Military Electronics Show in Washington. The mu[...] channel, highly sensitive, infrared receiver (first described by M/R, April 20, 19[...] employs single-channel electronics by commutating the stored outputs of 30 detec[...] cells and uses a single amplifier. It was developed for Air Force Cambridge Resea[...] Center to study satellite-detection feasibility using IR techniques.

Missiles and Rockets Editorial Index

Readers are invited to save the ollowing six-month index covering M/R issues of Jan. 5, 1959 through June 29, 1959. This index is a reference guide to major news and technical articles published in M/R during the first half of the year.

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PM INVESTMENT TO REACH $250 MILLION IN 196 Extra $75 million probably will be funded n t two years for base construction, by Robert Mo, 4/13/59, p. 36.

A HARD LOOK AT SPACE LOGISTICS; AF-sponsored conference told it may be 5-10 years before man can be kept alive in space; planners banking on better component reliability, by William O. Mil, M/R Associate Editor, 4/6/59, p. 17.

ATIS BASES TO BE HARDENED; Titan and Atlas will both be continued, Pentagon tells Congress, but Bomarc sites are cut sharply, by James Baar, M/R Associate Editor, 3/30/59, p. 15.

WORLD RAPIDLY ADDING MORE MISSILE RANGES; United States is negotiating in hopes of cooperation in man-in-space plans. Existing ranges vary from relatively small facilities to those extending thousands of miles. Small nations are participating at a fast-growing rate, by William D. Miller, M/R Associate Editor, 3/9/59, p. 15.

Production Facilities

PI FORGE FORMS STEEL ONE INCH THICK, by M/R Staff, 3/23/59, p. 31.

IE ROBOT IS BIG STEP IN NUMERICAL CONTROL; Automatically programmed tool developed at IT translates jargon and guides cutting, by ar J. Haggerty, Jr., M/R Contributing Editor, /9, p. 33.

H IRBM PRODUCTION; by Fred S. Hunter, M/ Associate Editor, 2/16/59, p. 15.

UIER IRBM PRODUCTION; by Alfred J. Zaehringer, M/R Associate Editor, 2/16/59, p. 18.

Research Facilities

IC BIG A MISSILE SUPPORT FILE? AF list il start with some 2500 data sheets but opinions if on how much longer it will get, by William Howard, M/R Associate Editor, 6/22/59, p. 13.

F CATALOGUING SUPPORT ITEMS; Massive ol e due July 1 should save millions in waste-l development of redundant equipment and io standardize handling and checking-out e by William E. Howard, M/R Associate di, 6/15/59, p. 21.

Safety

TEAM SEEKS SAFER MISSILE FLIGHTS; GMB ro is handicapped by sparse data but hopes develop a central report procedure, by Richard rOsten, M/R Associate Editor, 4/27/59, p. 28.

T WILL BE NEEDED IN MSE—WHEN MAN RS THE MISSILE, by Hal Gettings, M/R ssociate Editor, 4/20/59, p. 20.

Target Facilities

O COMPANIES PRODUCING VERSATILE NES; Bendix, Republic and Marquardt joined r in designing ground-launched Hilo, pro-d a bomber-like radar image. Bell worked t Bendix in developing Penny, air-launched to rm at high altitude and supersonic speeds, Frank G. McGuire, M/R Associate Editor, 59, p. 21.

Test and Checkout

ATLAS PARTS TEST STAND PRODUCED BY ROCKETDYNE; by M/R Staff, 6/8/59, p. 32.

A MAMMOTH GANTRY FOR SATURN; Structure will cost $9.5 million with test tower, opening new dimension in missile support equipment, by M/R Staff, 6/8/59, p. 33.

VIBRATION TESTING OF NEW MISSILES SAVES MONEY AND TIME; Trend is toward more accurate reproduction of effects of dynamic forces, using such equipment as Ling's spectral density analyzer system, by Cameron G. Pierce, 4/27/59, p. 17.

VANGUARD TESTING: BACKBONE OF PRESENT BALLISTIC MISSILE ART; Checkout 'primer' developed by Martin gives pattern for industry to follow, by William E. Howard, M/R Associate Editor, 4/6/59, p. 20.

TITAN'S TESTING TIME MAY BE ONE HALF ATLAS'; SAC personnel to join Martin's streamlined test division in September; static firings may be eliminated at Cape, by Donald E. Perry, M/R Managing Editor, 3/16/59, p. 22.

COOK LABS DO MASS COMPONENTS TESTING; Inland testing engineers screen up to 100,000 parts simultaneously without damaging those that are acceptable, by M/R Staff, 2/23/59, p. 24.

BOMARC ENGINES ARE TESTED AT MARQUARDT LAB; Huge facility stores fifty tons of air for supersonic testing at altitudes near 200,000 feet, by Raymond M. Nolan, M/R Associate Editor, 1/12/59, p. 15.

Test Ranges

A CRISIS IN RANGE INSTRUMENTATION; AFMTC commander says more funds and effort must be expended to cure the rapidly widening time bottleneck, by Maj. Gen. Donald N. Yates, 6/29/59, p. 20.

Tracking

NEW AMPLIFIERS EXTEND MISSILE TRACKING RANGE; by M/R staff, 3/23/59, p. 41.

3000-MILE RADAR MAY BE ON TRACKING SHIP; by Peer Fossen, M/R Associate Editor, 2/2/59, p. 32.

Transportation

GOODYEAR'S APPROACH FOR ATLAS MSE; by M/R Staff, 4/20/59, p. 23.

NYC TESTS MISSILE TRANSPORT; by Frank G. McGuire, M/R Associate Editor, 2/2/59, p. 19.

PROPULSION

Controls

THROTTLEABLE ENGINE PROLONGS AIRCRAFT LIFE; Rocketdyne's AR series with up to 6000-lb thrust is ready for use although Navy has cancelled program, by Frank G. McGuire, M/R Associate Editor, 4/27/59, p. 23.

COMPLICATION FOR SOLIDS: THRUST-DIRECTION CONTROL; Ballistic missiles will require thrust vector control, thrust termination, thrust modulation, by Norman L. Baker, 2/9/59, p. 23.

Cryogenics

PROPULSION ENGINEERING; New plant turns out 'purest hydrogen ever made', by M/R staff, 6/8/59, p. 45.

FLUORINE ENGINES MAY ARRIVE WITHIN FIVE YEARS; Dramatic increase in rocket capability will come when compatible materials are developed. Fuel supply considered more than adequate, by Paul Means, M/R Associate Editor, 5/11/59, p. 42.

VACUUM JACKETING CUTS FUEL LOSSES; CEC reports its jacketed lines reduce boil-off by half, compared to those insulated with other materials, M/R staff correspondent, 4/6/59, p. 22.

Hybrids

PROPULSION ENGINEERING; Advantages of hybrid nuclear-chemical rocket engines, M/R staff, 5/18/59, p. 52.

Liquid

PROPULSION ENGINEERING; Ammonium nitrate as oxidizer, M/R Staff, 4/27/59, p. 49.

BRITISH ASTRONAUTICS: British firm starts manufacture of hightest hydrogen peroxide, by G. V. E. Thompson and K. W. Gatland, M/R Contributing Editors, 4/6/59, p. 19.

PROPULSION ENGINEERING; Boron fuels, M/R Staff, 3/16/59, p. 40.

ARMOUR ENTERS EMPIRICAL ROCKET APPLICATIONS, M/R staff, 3/2/59, p. 18.

FUELS VAPORIZATION STUDY CONTRACT AWARDED BY NSF, M/R staff, 2/23/59, p. 56.

PROPULSION ENGINEERING; Pre-packaged liquid propellant announced by Navy, by Alfred J. Zaerhringer, M/R Associate Editor, 2/9/59, p. 106.

1-1.5 MEG ENGINE MAY BE OPERATIONAL IN SIX YEARS, M/R staff, 2/2/59, p. 20.

Nuclear

PROPULSION ENGINEERING; Vary thrust for optimum nuclear rocket performance, M/R Staff, 6/1/59, p. 45.

AEC IS RECOVERING VALUABLE CERIUM 144, M/R staff, 4/13/59, p. 38.

PROPULSION ENGINEERING; Aerojet's head questions nuclear rocket's practicality, M/R staff, 4/6/59, p. 47.

THE NEGLECTED ATOMIC PROPULSION PROGRAM (editorial), 3/2/59, p. 7.

GE SCIENTISTS DESCRIBE NUCLEAR POWER PACKAGE, M/R staff, 1/5/59, p. 30.

Outlook

INDUSTRY TELLS CONGRESS: DO MORE BASIC RESEARCH NOW, by William E. Howard, M/R Associate Editor, 3/30/59, p. 20.

CHEMICAL INDUSTRY EXPANDS FOR ASTRONAUTICS, by Alfred J. Zaehringer, M/R Contributing Editor, 2/2/59, p. 28.

Plasma

PLASMA ENGINE DELIVERS NEARLY 2 LBS; M/R staff, 6/8/59, p. 34.

Solids

PROPULSION ENGINEERING; Basic studies on plastics will give propulsion engineers more solid propellant data, M/R Staff, 6/22/59, p. 45.

COMPLICATION FOR SOLIDS: THRUST-DIRECTION CONTROL; Ballistic missiles will require thrust vector control, thrust termination, thrust modulation, by Norman L. Baker, M/R Associate Editor, 2/9/59, p. 23.

SPACE MEDICINE

Animal Experiments

PIONEERING MONKEYS AND MICE; Two monkeys come back strong from Jupiter flight, though one dies later; Discoverer III tests will be U.S.'s most elaborate effort, by James Baar, 6/8/59, p. 28.

SPECIAL PROBLEMS OF THE MONKEY-IN-SPACE, by Dr. Earl T. Carter, Ohio State University, 5/11/59, p. 30.

Human Engineering

ADAPTING MAN TO HIS LIFE IN SPACE, by James Baar, M/R Associate Editor, 6/29/59, p. 22.

SPACE FEEDING: BIG $$ MARKET; Air Force contracting with industries on four lines of space food with bulk of work being handled through Quartermaster Food and Container Institute, by James Baar, M/R Associate Editor, 6/15/59, p. 28.

SPACE MEDICINE PROBLEMS PROBED BY AMA, by Frank G. McGuire, M/R Associate Editor, 5/11/59, p. 22.

CONVAIR INVESTIGATES ENVIRONMENTAL TOLERANCES, M/R staff, 2/9/59, p. 63.

missile business . . .

By WILLIAM E. HOWARD

Multi-million dollar savings . . .

are envisioned through proposed electronic data processing of DOD's worldwide logistics operation. High speed equipment would be utilized to keep up-to-the-minute records of the thousands of parts and design changes in missile/aircraft and other weapon systems. AIA reports the plan will be submitted to DOD next month. It was devised by a Military/Industry Logistics Data Development Unit (MILDDU) after a 10-month study determined that a single data exchange system could be designed using a standardized punch card record length as the base for development.

Meantime, just such a "push-button" . . .

delivery system has been developed at Warner Robins Air Materiel Area, Robins AFB, Ga., to support *Mace* installations. **Goodyear Aircraft,** which recently received a $302,000 *Mace* warehousing order from Warner Robins and has the complete support contract for the **Martin**-built missile as well as its guidance system, says the new electronic logistic system is called MAST (missile automatic supply technique). Designed to eliminate slow-moving paperwork, MAST absorbs data on component usage over a global network in seconds. The data is code-punched at supply depots and transmitted to Warner Robins.

Inventories are instantly computed . . .

at headquarters and orders issued to warehouse points or manufacturers to ship required parts and supplies. The concept amounts to a supply sergeant's dream come true. No forms. Just punch a button and wait for the stuff to arrive on the next plane.

Goodyear says the MAST system has been thoroughly tested and presently is being put into operation to control *Mace* logistics primarily at launching and supply depots of the Tactical Air Command in Europe. Squadrons of the 800-mile range *Mace* are now replacing the shorter range *Matador.*

An automatic production and inventory . . .

control system is helping keep kinks out of operations at the **Rocketdyne Division of North American Aviation.** The company says the newly-installed Mechanized Production Control (MPC) system gives management a daily report on all rocket engine manufacturing activities. Moreover, it "immediately calls out corrective action for all behind-schedule parts or components."

Rocketdyne Factory Manager Ross Clark . . .

says with MPC company business is administered at considerably less cost and with greater accuracy. Here's the way it works: employing automatic tabulating machines, MPC established schedules on all production activities, starting with engineering drawings. Then, automatically, engineers are notified when to release the drawings, the purchase department is notified when to buy parts or material, and production departments are informed when they will receive the parts and given a completion date. All activities leading to engine fabrication are pre-scheduled and all components and parts are detailed on a master list.

"Move cards" keep track of progress on parts and components as they move through production departments. Information from these cards is fed into electronic accounting machines, which then compile reports listing the production status of all parts.

Benefits of the system, says Clark . . .

include reduction of production lead time, reduction of work that is behind schedule and the maintaining of accurate up-to-the-minute inventories. He says MPC is, indeed, one of the company's "most important new programs."

ppointment of **Samuel W. Stewart** as director of engineering and research at the Gabriel Electronics Division was announced. Stewart was formerly head of the Microwave Engineering Department at the Sperry Gyroscope Co., where he was in charge of research-through-production of microwave components, antennas and antenna systems.

STEWART

verett B. Boise, former supervisor of applications engineering, production types, has been elevated to manager of applications engineering, receiving tubes, for CBS-Hytron. Boise is a graduate of Rensselaer Polytechnic Institute and has served as an engineer with the RCA patent department license division, and as chief commercial engineer for National Union Radio Corp.

Tasker Instruments Corp. recently named **David J. Green,** vice president for Advanced Systems Development to direct exploratory programs into advanced R&D concepts and systems design. Green comes to Tasker from the System Development Corp., formerly a division of the Rand Corp., where he was head of Corporate Advance Planning and served as a member of the management committee.

Dr. David M. Heinz has been named senior scientist at Hoffman Electronics Corp.'s new Science Center in Santa Barbara, Calif. He will concentrate on semiconductor materials and in the field of general chemistry. Dr. Heinz was formerly a physicist in the materials and processes unit of General Electric's Instrument Department, and a research associate in the GE Research Department's General Physics Research Laboratory.

Dr. Robert E. Samuelson has been appointed to the newly created post of assistant general manager for reseach and development at Motorola's Western Military Electronics Center in Phoenix. With Motorola since 1950, Dr. Samuelson has been successively senior project leader, chief engineer and engineering manager of the Military Electronics Center in Phoenix.

SAMUELSON

Dynatronics, Inc., Orlando, Fla., has promoted former vice president and chief engineer **George F. Anderson** to vice president and general manager. The firm is engaged in R&D and production of space communication, data handling and specialized test equipment.

Epsco, Inc.'s new subsidiary, Monitor Systems Inc., will be headed by **Harry H. Rosen.** Rosen is former manager of Data Processing and Computation in G.E.'s Missile and Space Vehicle Department. MSI expects eventually to employ several hundred engineering, production, and management personnel from the Philadelphia area.

William R. White, acting general manager, takes over as president of U.S. Semiconductor Products, a division of Topp Industries, Inc. **Dr. Friedrich Schwarz,** who has headed the company since its beginning two years ago, has been elected chairman of the board of directors. In addition to his new assignment, Schwarz will be active in the research and development programs of other Topp divisions—U.S. Science and Micro-Path.

Other officers in the company will include **Robert Rutherford,** vice president and director of engineering, and **Gayle Hodges,** secretary-treasurer. Reorganization of the U.S. Semcor management team came one week after finalization of its acquisition by Topp.

PHILLIPS

Alvin B. Phillips has been appointed chief engineer of Motorola's Mesa transistor product line. Phillips is a former marketing product planner with General Electric's Semiconductor Products Department.

Carl E. Calohan was appointed advertising and sales promotion manager of Giannini Controls Corp., succeeding **Richard L. Lawrence,** who resigned to accept a similar position with Hughes Semiconductor Products.

Glen P. Bieging has been named manager of marketing for General Electric Co.'s Missile and Space Vehicle Department. He was manager of market research and product planning for the G.E. Heavy Military Electronic Department in Syracuse.

Allan F. Donovan, vice president and director of Advanced Systems Planning at Space Technology Laboratories, Inc., has been named a delegate to a panel of technical experts which will advise the U.S. Committee on Nuclear Testing. He will counsel the Committee on the possibilities of using space vehicles to carry out undetected nuclear tests in outer space. Donovan joins the eight other members of the panel headed by **Dr. Wolfgang K. H. Panofsky,** of Stanford University, in Geneva to begin discussions with similar groups of British and Russian experts.

Hal V. Miller was named liaison engineer at Packard Bell Electronics Corp.'s Technical Products Div.

New manager of the Space Technology Laboratories Field Office at Warren AFB, Cheyenne, Wyo., is **W. H. Edwards.** He has been with STL since September, 1955, and played a prominent part in the firm's *Atlas* ICBM work.

Panels Reportedly Solve Radar Van Heat Problems

FULLERTON, CALIF.—Ground systems engineers at **Hughes Aircraft Company** report that they have devised a low-velocity air diffusion panel to solve the ticklish heat problem in close quarters of new mobile radar vans designed to detect enemy missiles.

In designing and producing "3-D" radar mobile control vans, Hughes was faced with the problem of cooling both the myriad electronic equipment and the seven operators in the compact vehicles, it was reported by Wayne Stauch, Hughes mechanical engineer.

In addition to the fact that the van ceiling is only three inches above the head of the average operator, the problem was compounded by the limitation of diffusion space to a narrow central "corridor," Stauch said.

Finding that standard high velocity air diffusion was unsatisfactory from both a draft and noise standpoint, project engineers found a solution after testing the comparatively new concept of low-velocity diffusion.

The air diffusers used consist of panels with a perforated distribution plate which, by means of a pressure displacement valve, slows down the speed of the cool air and diffuses it evenly throughout the air conditioned area. The air is brought to the panels from the cooling source through the plenum above the van ceiling.

Stauch points out that depending upon the size of the van, up to three pairs of valves are used. The air flow can be regulated by a valve adjustment.

The special ventilation product used to solve the problem, Stauch reports, was the Multi-Vent panel, produced by the **Pyle-National Company,** Chicago, developers of the low velocity diffusion method.

Originally designed by Pyle-National to solve similar problems in railroad passenger cars, the technique has in recent years been used for air conditioning office buildings, computer rooms, and general commercial and institutional applications.

The product is also beginning to receive attention, he said, for mobile homes, office trailers, submarines, ocean going passenger vessels, and other uses where space limitation is a problem.

Solids Seen as Good Source for AP

SAN DIEGO—Solid propellants can be a versatile efficient source of power for many space flight purposes besides rocket propulsion.

Two Washington, D.C., scientists told the recent American Rocket Society meeting here that gas turbines fueled by solid propellants can drive electrical generators, mechanical and exhaust systems and perform several other functions.

Melvin Cohen, of the Hicks Corp., and Lt. Com. Edward J. Sheeh[y] the Navy Ordnance Bureau, said power can be used in a missil[e] electronic and guidance systems, dynamic and flight control sys[tems] and separation and termination de[vices].

Missile designers have many so[urces] of power available. Four of the common are batteries, bottled pressed gas, liquid-propellant gas erators and solid-propellant gas g[ener]ators. Cohen and Sheehy outlined advantages and disadvantages:

Batteries—Use limited by exce[ssive] weight and size as against power put.

Bottled gas—Heavy inert ponents necessitated by high gas sures; excessive space requirement cause of low density.

Liquid-propellant generators— ter than batteries or bottled gas many purposes but more com bulkier and less reliable than solid pellant generators.

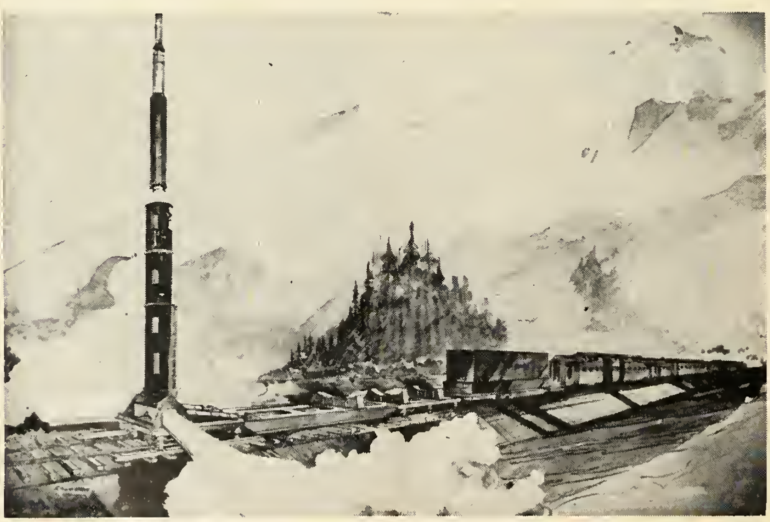
The solid-propellant generator one major limitation. It is inher a "one-shot" operation. It is not tical to turn a solid propellant off on again, although some work is done in smothering the fire before charge is completely burned up.

• **In an emergency**—Cohen the solid-propellant turbine prot never would compete with solar teries for such long-term low- power uses as light, heat and needs aboard a manned space But he said such a turbine woul valuable for emergency use while ing repairs on regular power sou He compared this to the auxi power supply in a hospital basen for use in case the city supply i terrupted.

In the laboratory, experim units have supplied gas-turbine p for periods of time on the order o to 20 minutes, Cohen reported. noted that this is nearly the maxi duration of an ICBM flight. The b ing is prolonged on essentially same principle as in a cigarette- packing the propellant in a long, row cylinder. It may be curled, ever, for convenience.

Several missiles already use s fuel gas turbines, Cohen declared, their use is growing rapidly. One missile has a turbine of this type can run an electrical generating tem from 60 to 90 seconds, more enough time to last the one-mi flight. A second turbine runs hydr equipment for about the same pe of time. Cohen declined to identify missile beyond saying it is in the class (*Talos, Terrier* and *Tartar*). added that such devices are also in in one British missile and in a h speed Navy torpedo.

Launching from Railroad



SOLID-FUEL missile being fired directly out of protective capsule on a launcher car, preliminary designs for which have been made jointly by Bethlehem Steel Co. and Paul Hardeman, Inc. Flame at the bottom is deflected by outstretched shields in this artist's conception. Hydraulic jacks, carried under car, push steel beams down over ties to stabilize the car. **(See M/R, June 1, page 19).**

—contract awards—

MISCELLANEOUS

[?]nell Aeronautical Laboratory, Inc., for [t]he creation and preliminary design an[al]yses of general support missile systems. [A]ward by The Allison Div. of General [M]otors Corp. GM and CAL will collaborate [o]n the project (amount not disclosed).

ARMY

[M]onca Manufacturing Corp., Middletown, [O]hio, has received a "very substantial" [a]mount for the production of base shel[te]rs for the *Jupiter* missile program [(a]mount not disclosed).

$[?],000,000—Raytheon Co., Andover, Mass., [fo]r continued production of the *Hawk* [ai]r defense missile. Sixty-one million for [m]issiles, eighty-four million for ground [eq]uipment and sixteen million for en[gi]neering services.

$[?]754,785—Chrysler Corp., for work on the [R]edstone 200-mile range missile.

$[?]833,870—Sperry Rand Corp., for research [an]d development work on the *Sergeant* [m]issile.

$[?]320,690—Sperry Rand Corp., for ground [an]d test equipment for the *Sergeant* [sy]stem.

$[?]32,408—Blaw-Knox Company, Pittsburgh, [P]a., for construction of *Atlas* ICBM [la]unching stands and operations build[in]gs at Fairchild AFB, near Spokane, [W]ash.

$[?]97,788—California Institute of Tech[n]ology, Pasadena, for research and devel[o]pment work to be performed at the Jet [P]ropulsion Laboratory.

$[?],000—Bowen-McLaughlin - Y a r k, Inc., [Y]ork, Pa., for vehicle engineering services [fo]r the T88 series, medium recovery ve[h]icle, including three pilot models.

$[?],020—Western Electric Co., Inc., N.Y., [fo]r *Nike* spare parts and components (ten [co]ntracts).

$[?],213—Western Electric Co., Inc., N.Y., [fo]r *Nike* spare parts and components [(t]welve contracts).

$[?],169—Rheem Manufacturing Co., Dow[n]ey, Calif., for missile warhead design [an]d development.

$[?],297—Douglas Aircraft Co., Inc., Santa [M]onica, Calif., for *Nike* repair parts and [la]unching area items.

$[?],632—Consolidated Electrodynamics Corp., [P]asadena, for recording oscillographs.

$[?]5,000—North American Aviation, Inc., [R]ocketdyne Div., Canoga Park, Calif., for [ro]cket engines.

$[?]3,712—Ordnance Specialties, Inc., El [M]onte, Calif., for a powder actuated [r]eefing line cutter.

$[?]000—Thompson Ramo Wooldridge, Inc., [L]os Angeles, for telemetering system de[v]elopment.

$[?]166—Tele-Dynamics Inc., Philadelphia, [fo]r services consisting of the manufacture [o]f telemetry transmitting systems, com[p]onents, assemblies and sub-assemblies, [a]nd the modification and testing thereof.

$[?]167—Kin-Tel, Div. of COHU Electronics, [S]an Diego, for amplifiers.

$[?]372—Hallamore Electronics Co., Ana[h]eim, Calif., for cameras and accessories.

$[?]838—Helge Olsen Inc., East Orange, N.J., [fo]r pyrotechnic area, facilities and utili[ti]es, additional altitude test chamber at [P]icatinny Arsen, Dover, N.J.

$[?]935—RIAS, Div. of Martin Co., Balti[m]ore, for research and development on [th]e effects of surface films on the me[c]hanical properties of metals.

$[?]065—Resdel Engineering Corp., Pasadena, [C]alif., for receivers and oscillators.

NAVY

$[?]00,000—Autonetics Div. of North Ameri[c]an Aviation, Inc., for electronic arma[m]ent control systems for the Republic of [W]est Germany (subcontract from Lock[h]eed Aircraft Corp.).

$2,000,000—Convair Div. of General Dynamics Corp., San Diego, for design and manufacture of a radar for navigation-bombing, system (subcontract from Autonetics Div. of North American Aviation, Inc.).

$1,500,000—Melpar, Inc., for production of target detecting devices for the *Talos* surface-to-air missile.

$1,241,057—Federal Pacific Electric Co., Newark, N.J., for missile and *Asroc* fire control switchboards.

$980,000—Summers Gyroscope Co., Santa Monica, Calif., for high performance gyros to be used in the *Terrier* and *Tartar* missiles (subcontract from Convair Div. of General Dynamics).

$760,000—Westinghouse Electric Corp., Baltimore, for production of electric propulsion motors to be used in the antisubmarine torpedo, the Mark 37.

$182,500—Telemeter Magnetics, Inc., Los Angeles, for research and development of magnetic core memory.

$166,347—General Electric Co., Syracuse, N.Y., for research on defense against ballistic missiles.

$143,007—Aeronutronic Systems, Inc., Glendale, Calif., for research on defense against ballistic missiles.

$128,079—Convair Div. of General Dynamics Corp., San Diego, for research on ballistic missile defense.

$121,061—Allied Research Associates, Inc., Boston, for research on defense against ballistic missiles.

$117,783—Hnghes Aircraft Co., Culver City, Calif., for research on defense against ballistic missiles.

$96,225—University of Chicago, for research on defense against ballistic missiles.

$25,041—Winzen Research, Inc., Minneapolis, for research on defense against ballistic missiles.

$25,000—Armour Research Foundation of Illinois Institute of Technology, Chicago, for research on high powered transducers.

AIR FORCE

$722,413—General Petroleum Corp., Los Angeles, for 6,453,000 gallons of rocket fuel.

$623,201—Litton Industries, Electron Tube Div., San Carlos, Calif., for miscellaneous electron tubes.

$500,000—United Electrodynamics, Pasadena, Calif., for an FM/AM telemetry system used in research and development flight tests of the *Minuteman* missile (subcontract from Boeing Aircraft Corp.).

$395,404—Tidewater Oil Co., Los Angeles, for 2,524,000 gallons of rocket fuel.

$315.557—Bell Oil and Gas Co., Tulsa, for 1,757,000 gallons of rocket fuel.

$175,393—Photo-Sonic, Inc., Burbank, Calif., for 18 35-mm high-speed motion picture cameras.

$131,313—Tung-Sol Electric Inc., Newark, N.J., for miscellaneous electron tubes.

$136,710—Eitel-McCullough, Inc., San Bruno, Calif., for miscellaneous electron tubes.

$70,304—Allen B. Dumont Labs, Inc., Clifton, N.J., for miscellaneous electron tubes.

$48,000—Waste King Corp., Los Angeles, for research and development of a prototype quantity of pilot static tubes capable of withstanding exposure to temperatures up to 1400°C for 15 minutes to be used on aircraft and missiles flying at speeds up to Mach 5.

$44,929—Olin Mathieson Chemical Corp., Chemicals Div., Baltimore, for 7125 lbs. of monomethyl hydrazine for testing and evaluation in support of weapons system 138a.

$35.543—Curtiss Wright Corp., Electronics Div., Calstadt, N.J., for drone control and radar tracting systems simulator used in conjunction with a modified M-4 tracting radar.

$27,486—Ampex Corp., Newton, Mass., for recorder, reproducer, magnetic tape, seven channel.

$27,441—Kenick Manufacturing Co., L.I., N.Y., for rocket assembly used on F84 and F84F1 aircraft.

NASA

$500,000—The Siegler Corp., Hallamore Electronics Co. Div., for airborne computers and associated test equipment for the *Vega* outer space rocket (subcontract from Jet Propulsion Laboratory).

The civilian space agency awarded the following contracts during the month of May, in addition to those which appeared last week.

$110,000—National Science Foundation, for support of the Space Science Board of the National Academy of Sciences.

$60,000—University of Florida, for study of general instability of cylindrical shells, aimed at aiding both rocket and space vehicle designers.

$60,000—University of Wisconsin, for design studies of an ultraviolet telescope system to go into a future orbiting space observatory. The telescope would examine the radiation emitted by stars.

$50,000—Army Ordnance, for part of 20 *Nike-Asp* sounding rockets to be fired from Fort Churchill, Canada, and Wallops Space Flight Station in ionospheric sampling experiments.

—reviews—

CTR-371 COMPUTERS, 1937-58, Available from OTS, U.S. Department of Commerce, Washington 25, D.C.

A catalog of technical reports, listing all reports in the field of computers, has been published by the Office of Technical Services, U.S. Department of Commerce.

It identifies reports on digital, analog, photographic, mathematical, navigational computers and others. Many of the reports resulted from research conducted for the Army, Navy, Air Force, Atomic Energy Commission, and other agencies of the U.S. Government. Others are German documents captured during World War II.

METAL-CERAMIC LAMINATES, R. K. Francis, R. Brown, E. P. McNamara and J. R. Tinklepaugh, Alfred University for WADC. 78 pp, available from OST, U.S. Department of Commerce, Washington 25, D.C.

Using brazing and hot-pressing techniques, metal-ceramic laminates can be fabricated when the thermal expansion of the ceramic is equal to or slightly less than that of the metal. Fosterite-stainless steel 430, molybdenum-alumina, and Kovar-alumina liminates were fabricated by brazing techniques; laminates of molybdenum and a 40% alumina-60% mullite ceramic were hot pressed.

Thermal expansion and thermal conductivity studies demonstrated that mixtures of mullite and alumina can be used to provide a varying range of thermal expansion. Measured conductivities of the stainless steel laminates were much higher than calculated results. A comparative apparatus for measuring thermal conductivity was constructed and found accurate to plus or minus two per cent in the temperature range 100 to 1000°C.

propulsion engineering

You must be a defense contractor . . .

to use the new rubber and asbestos insulation that **Astrodyne** has developed for solid propellant motors. The company developed the insulation primarily for Navy use. It greatly extends the motor life and, in effect, adds to burning time. It's cheaper and lighter than reinforced plastics now in wide use. Typical test result: Insulation held exterior of motor case to 200°F for 3.5 min., under propellant flame of 5500°F.

Tantalum producers are skeptical . . .

about the drastic price cut made by **Union Carbide Metals,** according to the magazine *Chemical Week*. Carbide cut the tantalum price from $60/lb. down to $35/lb. early this month. There was a lot of talk about a new future for the metal—wider experimentation and development would now be possible. However, *Chemical Week* says Carbide's competitors are commenting that "Carbide has been selling close to the $35/lb. level for some time." Carbide replies, according to the magazine, that the higher price always was considered a "list price" subject to negotiation on large orders, frequently whittled down to near $35, where small orders have gone at near the $60 price.

Nuclear propulsion is a step closer . . .

to reality for aircraft, manned satellites and space ships, thanks to **Goodyear's** castable nuclear shielding material announced at mid-month. The synthetic rubber-powdered boron material shields crew members from neutrons. It features a new rubber molecule high in hydrogen content, as well as mixed-in boron. The hydrogen slows down the neutrons, the boron captures them.

Until now, polyethylene slabs have been used for lightweight shielding. However, the slabs are difficult to work with since they are too rigid to conform to many shapes. The Goodyear product is fully castable—pour it into any shape, it fills the entire volume and sets at about room temperature. Goodyear scientists believe the shield is the lightest and most effective neutron shielding material yet developed.

In spite of its high hydrogen content, the material can withstand temperatures from −60°F to 200°F. It absorbs radiation without damage. Goodyear says it's "reasonably priced."

Note: The material is not the full answer to missile and aircraft nuclear shielding problems. Lead still must be used to shield against gamma radiation. The Goodyear material, however, replaces the concrete and water neutron shields used in earth-bound installations.

Forced draft air heater . . .

for testing missile components at **Wyle Laboratories,** Norco, Calif., delivers 20 million BTU/hr. at 1500°F. The unit, built by **Hirt Combustion Engineers,** can deliver extremely high flows of gaseous oxygen or nitrogen, 35 lbs/sec at 200 psi. Purpose: Test missile components at actual operating temperatures and flows. This is one of the largest units of its type ever built, according to the builders, who say there is no practical limit to the size of future units.

High temperature reactions . . .

are studied by a new technique developed at **Bell Telepbone Laboratories.** In describing the general technique in *Chemical & Engineering News*, Bell Telephone's Lloyd Nelson says it "may be helpful in attacking such problems as . . . prolonging the life of a missile nose cone, or developing protective clothing against nuclear blasts." Here's a capsule description: Fine particles or filaments of absorbing materials are suspended in a transparent medium and exposed to a high-speed, high-intensity flash of light. The particles hit a very high temperature and then cool again almost instantaneously. Chief advantage: The speed of the reaction does not allow time for side reactions—researchers can follow the main reaction without interference.

soviet affairs . . .

By DR. ALBERT PARRY

An alloy of iridium and aluminum . . .

as a tremendous boon to rocketry is discussed in the Moscow *Yunyi Tekhnik*. For a long time, despite all the experiments which were attempted, such an alloy could not be achieved, the Soviet magazine says. The reason for continued failure was plain: Aluminum melts at 660°C, while the melting point of iridium 2400°C.

But a new method . . .

accomplishing the needed alloy was at last found. The Russian journal calls the discovery "the meteorite-metallurgical technique." This consists of "shooting" at melted aluminum a charge of extraordinarily tiny particles of iridium emerging at a tremendous speed from a special electrical instrument.

"Not being in a molten state," the description in *Yunyi Tekhnik* continues, "iridium nonetheless fuses with the molten aluminum into an alloy. This alloy possesses the light weight of aluminum and the high mechanical and heat-resisting solidity of iridium, thanks to which it becomes an ideal material for the making of most important parts of airplanes and rockets." But to what extent this method and the resulting alloy are now being used in the Soviet Union, the Russian item does not say.

On broader implications . . .

of this subject, "Heat-Resisting Alloys" is the title of a special lengthy article in *Sovetskaya Aviatsia* by Professor N. Skliarov. He discusses the arrangements now being made by the Soviet government to expand and improve Russia's production of heat-resisting alloys in the Seven-Year Plan just begun (1959-65). Rather dismissing aluminum, magnesium, and other low heat-resisters, Professor Skliarov suggests that Soviet experimenters are now paying close attention to such "more infusible metals" as chrome, niobium, tantalum—and "the highest-melting metal—wolfram."

Yet Professor Skliarov also speaks of "extraordinary difficulties" hampering "the utilization of these metals." The *Sovetskaya Aviatsia* writer, who holds the degree of doctor of the technical sciences, says that these metals can be cast only in a vacuum, "in special arc furnaces from which air is barred." He reveals that the Seven-Year Plan is emphasizing the introduction and improvement of the arc-furnace method of casting various metals needed in aviation and rocketry.

Powder metallurgy is another field . . .

looming large in the Seven-Year Plan, according to Doctor Skliarov. "High heat-resisting materials," he writes, "can be obtained not alone as cast metal alloys but also by pressing and baking ready-made parts from mixtures of powdered metals with highly infusible compounds which melt at 3000°C and at yet higher temperatures."

The value of powder metallurgy, he continues, is in the fact that methods of this metallurgy help in the manufacture of such synthetic materials as "combinations of metals with their infusible oxides." He gives this example: The oxide of aluminum melts at 2500°C, and this oxide permits experimenters to create a material twice as heat-resisting as can be had from ordinary aluminum alloys.

Powdered or pulverulent metals . . .

can aid in the making of porous materials. The latter, as Doctor Skliarov points out, "combine solidity with their heat-resistance thanks to their cooling by a liquid flowing through the pores." The result is that experimenters obtain "most divergent combinations of materials with good heat-insulating qualities, a high thermal capacity, and the ability to absorb a great quantity of heat coming from outside."

That is why the Seven-Year Plan devotes so much attention to this part of Soviet technology and industry. Playing a significant role in today's technology, the heat-resisting materials "will have a yet greater importance in the technology of the future," the Soviet scientist concludes.

—when and where

JULY

Annual Basic Statistical Quality Institute, University of Connecticut, Storrs, July 12-24.

Technical Commission for Aeronautics and Los Angeles Section of the Institute of Radio Engineers, Third Biennial Joint Meeting, Ambassador Hotel, Los Angeles, July 16-17.

American Rocket Society, Propellants and Combustion Committee, "Propellants, Thermodynamics and Handling Conference," Ohio Union, Ohio State University, Columbus, July 20-21.

Annual Institute on Missile Technology, Chief of Research and Development, U.S. Army, University of Connecticut, Storrs, July 26-Aug. 7.

Denver Research Institute of the University of Denver, 6th Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 30-31.

AUGUST

Institution of Investigation of Biological Sciences, Sponsor: Air Force Office of Scientific Research, Aeromedical Div., World Health Organization, Montevideo, Uruguay, Aug. 2-7.

Association of the U.S. Army, Annual Meeting, Sheraton-Park Hotel, Washington, D.C., Aug. 3-5.

American Astronautical Society, Second Annual Western Regional Meeting, Ambassador Hotel, Los Angeles, Aug. 4-5.

Institute of Radio Engineers' Professional Group on Ultrasonics Engineering, First National Ultrasonics Symposium, Stanford University, Stanford, Calif., Aug. 17.

Institute of Radio Engineers, Western Electronic Show & Convention, Cow Palace, San Francisco, Aug. 18-21.

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

Institute of the Aeronautical Sciences' National Specialists Meeting, A Symposium on Anti-Submarine Warfare, (classified), San Diego, Calif., Aug. 24-26.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

SEPTEMBER

Air Force Office of Scientific Research and General Electric Company's Missile and Space Vehicle Department, Conference on Physical Chemistry in Aerodynamics and Space Flight, University of Pennsylvania, Philadelphia, Sept. 1-2.

University of California, 1959 Cryogenic Engineering Conference, Berkeley, Calif., Sept. 2-4.

Air Force Association and Panorama: Send Reservations to AFA Housing Bureau, P. O. Box 1511, Miami Beach, Sept. 3-6.

Standards Engineering Society, Boston Section, Eighth Annual Meeting, Hotel Somerset, Boston, Sept. 21-22.

Instrument Society of America, Conference and Exhibit, Chicago, Sept. 21-25.

Industrial Nuclear Technology Conference, Sponsored by Armour Research Foundation of Illinois Institute of Technology and Nucleonics Magazine and Atomic Energy Commission, Morrison Hotel, Chicago, Sept. 22-24.

American Rocket Society, Solid Propellants Conference, Princeton University, Princeton, N.J., Sept. 24-25.

Institute of Radio Engineers, 1959 National Symposium on Telemetering, Civil Auditorium, San Francisco, Sept. 28-30.

OCTOBER

Society of Automotive Engineers, National Aeronautics Meeting, Aircraft Manufacturers Forum and Aircraft, Engineering Display, The Ambassador Hotel, Los Angeles, Oct. 5-10.

Electronics Industries Association Conference, University of Pennsylvania, University Park, Oct. 6-7.

Stanford Research Institute, First High Temperature Symposium, Asilomar Conference Grounds, Monterey Peninsula, Calif., Oct. 6-9.

National Electronics Conference, Sponsored by American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, Northwestern University and University of Illinois, Hotel Sherman, Chicago, Oct. 12-14.

Armour Research Foundation, 15th Annual National Conference, Hotel Sherman, Chicago, Oct. 26-30.

Institute of Radio Engineers, Professional Group on Electron Devices, Shoreham Hotel, Washington, D.C., Oct. 29-30.

NOVEMBER

41st National Metal Exposition and Congress, International Amphitheatre, Chicago, Ill., Nov. 2-6.

Mid-America Electronics Conference, 11th Annual Meeting, Kansas City Municipal Auditorium and Hotel Muehlebach, Kansas City, Nov. 3-5.

Fifth International Automation Exposition and Congress, New York City, Nov. 16-20.

The Institute of Radio Engineers, 1959 Northeast Electronics Research and Engineering Meeting, Boston Commonwealth Armory, Boston, Nov. 17-19.

1960

JANUARY

Institute of the Aeronautical Sciences, 28th Annual Meeting, Hotel Astor, New York, Jan. 25-28.

APRIL

American Society for Metals, 2nd Southwestern Metal Exposition and Congress, State Fair Park, Automobile Building, Dallas, Apr. 25-29.

SEPTEMBER

International Council of the Aeronautical Sciences, Second Congress, Zurich, Switzerland, Sept. 12-16.

Advertisers' Index

CLASSIFIED

Memo from the Assistant Publisher

This is the first in a series of memos to you, the reader, keeping you informed about what we're doing and planning here at Missiles and Rockets.

Just as a starter, let's take a look at M/R's title, "The Magazine of World Astronautics." There are variations . . . such as "Technical/News Weekly of the Missile/Space Industry" . . . more comprehensive, but somewhat awkward. We believe our present definition, concise and to the point, is adequate.

Then consider the market. There are many industries combining to make up this Missile/Space field we talk about. Which are these industries, and who is the man . . . the engineer . . . whose efforts produce new developments in this area?

In short . . . for whom, and for what reason, is Missiles and Rockets being edited and published?

Astronautics Engineering (or missile engineering, space technology . . . call it what you will) has been defined as the applied science whereby simultaneous extensions of the state of the art in aeronautical, electronics, chemical, metallurgical and astrophysical engineering combine to produce new developments in the field of missiles and space vehicles. Each of these industries plays an integral part in the fulfillment of man's greatest venture to date: the perfection of the art of missilery and the subsequent conquest of space.

The astronautics or missile engineer may be basically an aeronautical engineer; he may be an electronics or chemical engineer, a physicist or metallurgist (if he's young enough, he may even bear the *title* of missile engineer). But to his basic knowledge in one or more of the above sciences he's had to add capabilities in magnetohydrodynamics, space communications, digital computer logic design, celestial mechanics, reentry simulation . . . there are scores of others.

To serve this man, the astronautics engineer, his proper diet of news and technical editorial coverage of all of these sciences *as they apply to missile/space projects* . . . coverage of Astronautics Engineering . . . is the editorial purpose of Missiles and Rockets and M/R's "reason for being."

Working toward more complete fulfillment of this editorial mission, M/R has made a number of changes and improvements in its editorial product over the past several months, not the least of which has been a decided increase in the amount and caliber of technical coverage. This week there are several more changes:

Missile Electronics, a familiar M/R department since the section was first instituted in October, 1957, now becomes Astrionics, a column heading we've used from time to time for several years. As the science of Astronautics Engineering broadens, so does M/R, and the term Missile Electronics is no longer broad enough in scope to cover electronics in both missiles and space systems. Hence a new title: Astrionics.

M/R's weekly Contract Awards feature, which you tell us is an invaluable information guide, has been expanded and relocated, enabling M/R editors to include the latest available award informati each week.

In keeping with our definition of Astronauti Engineering, we invite your attention to the editor masthead on page four, revamped this week. Na the primary fields of Astronautics Engineering: stru tures, electronics, propulsion, materials, astrophysic support equipment, and you'll find an M/R edit (sometimes two) covering each.

To get more late news into M/R each wee the editorial by Executive Editor Clarke Newlc will be moved back to this page beginning ne week; you'll find it here from then on.

So far this year, M/R has published 955 pag of editorial material devoted to the Missile/Spa market . . . more than any other magazine of a type. Beginning on page 37 of this issue, you'll fi an editorial index for the period January throu June 1959.

In addition to thorough weekly news coverage Astronautics happenings in Washington and arou the world, we've inaugurated a program to give reade a minimum of four "round-up" or "state-of-the-ar articles each week, letting you know where we've bee "where we're at," and where we're going in technic areas vital to Astronautics progresses.

Take, for example, the "Fuzing and Arming" sto on page 30. Here Astrionics Editor Hal Gettings e plores a technology of extremely high reliability paran eters, and identifies industrial and government leade in the field.

Beginning this week on page 13 is the first in three-part series by Associate Editor William E. Howa on the Missile Industry in New England . . . an ar which garners over $1 billion each year in missile co tracts and employs more than 150,000 people. Ne week Bill will get more specific and survey the Bostc area; on July 27th: a Connecticut close-up. Surveys other U.S. missile manufacturing areas will follow.

What's the outlook for aluminum? Cryogenics? A sociate Editors Paul Means and Frank McGuire te these stories on pages 18 and 21 . . . stories compile after hundreds of miles of travel on both East and We Coasts, and hundreds of man hours of editorial r search. More of this type of editorial treatment w follow next week when M/R editors discuss printe circuitry, monopropellants and the vehicle requiremen for Missile Support.

On July 20 you'll see M/R's Third Annual Enginee ing Progress Issue, featuring the famous Guided Missi Encyclopedia, expanded this year to include the late available information on British, French, Swiss ar Italian missiles in addition to those of the United Stat and Russia. Watch for this issue: It will be M/R's bi gest weekly effort to date.

Keep us posted on how we're doing: keep yo criticisms and suggestions coming. M/R is being edite for you . . . the Reader.

E. D. Muhlfeld
Assistant Publisher

PRECISION GYROS

A Proven Kearfott Capability. The increasing use of Kearfott gyros and gyro platforms in today's missile programs, underscores the company's leadership in gyro design and production. Such missile projects as the Atlas, Bomarc, Polaris, Snark, Subroc and Talos rely on Kearfott gyros or gyro platforms, as do the majority of manned aircraft now in service.

FLOATED RATE INTEGRATING GYROS. High accuracy miniature gyros specifically designed for missile use. The performance characteristics of these gyros are superior to any comparably-sized units available today. Hermetically sealed within a thermal jacket and ruggedly designed for adaptability to production methods. These gyros operate efficiently at unlimited altitudes. More precise performance characteristics can be provided in the same dimensions.

TYPICAL CHARACTERISTICS

Mass Unbalance:
Along Input Axis: 1.0°/hr maximum untrimmed
Standard Deviation (short term):
Azimuth Position: 0.05°/hr
Vertical Position: 0.03°/hr
Drift Rate Due to
Anisoelasticity: Steady
Acceleration: .015°/hr./g^2 maximum
Vibratory Acceleration: .008°/hr./g^2 maximum

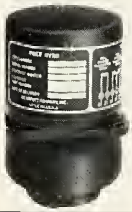
Damping:
Ratio of input angle to output angle is 0.2
Characteristic Time. .0035 seconds or less.
Weight: 0.7 lbs.
Warm-up Time: 10 minutes from—60°F
Life: 1000 hours minimum

VERTICAL GYROS. Provide accurate vertical reference in the form of two 400 cps synchro signals proportional to the sine of gimbals' displacement about pitch and roll axes. Gravity-sensitive vertical reference device provides electrical signals directly to torque motors which maintain gyro spin axis perpendicular to earth's surface. Hermetically sealed, they are unaffected by sand, dust, sun, rain, salt spray, humidity or fungus conditions as specified in MIL-E-5272A.

TYPICAL CHARACTERISTICS

Repeatability to Established Vertical: To within a cone of half angle equal to 15 minutes of arc (± 8 minutes typical).
Free Drift Rate in 5 minutes Time: 2.5° maximum at room temperature. 3.75° at −54°C and + 71°C.
Erection Rate: 2.5°/Min.
Initial Erection: The gyro will erect to within ± 1° of established vertical in 60 seconds time after application of power at room temperature.
Vibration and Shock: The gyro will meet above characteristics after vibration of 0.060" total excursion cycling between 10 CPS and 55 CPS for 4.5 hours. Shock test in accordance with MIL-E-5272A Procedure 2.
Operating Life: 1000 hours minimum.

FREE GYROS. Provide extremely accurate reference in the form of electrical output signals proportional to displacements about outer axes. With 360° of freedom about outer axes (inner axis freedom depends on the unit involved), these gyros may be mounted to give output signals of either pitch, roll or yaw. Shock and vibration resistant, they are equipped with quick-starting motors for applications in high performance missiles and aircraft.



TYPICAL CHARACTERISTICS

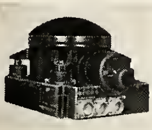
Free Drift Rate: Within 0.5° in one minute time.
Shock: The gyro operates satisfactorily without damage after 60g shock of .015 seconds duration.
Hermetically Sealed: These instruments are hermetically sealed and are not affected by sand, dust, sunshine, rain, humidity or fungus conditions.
Operating Temperature Range: Gyros operate in ambient temperatures below −20°C to + 100°C. A maximum of 3 minutes of operation at 400°F will not damage these gyros nor impair their accuracy.
Weight: 5.5 lbs. approximately.

SPRING RESTRAINED RATE GYROS. Almost universally applicable in missile and aircraft designs demanding precise angular rate measurements in environments of extreme shock and vibration. Fluid filling provides added immunity to shock and vibration, reduces bearing friction in AC types and potentiometer wiper friction in DC types. Kearfott design advances permit 30 second warm-up, overcome fluid viscosity variations resulting from ambient temperature change. These gyros are single-degree-of-freedom, viscous damped, spring restrained, with gimbals supported by precision bearings. Compensatory damping mechanisms eliminate need for accessory heaters.

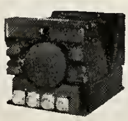
TYPICAL CHARACTERISTICS

Maximum Rate (°/sec.): 45-1000
Natural Undamped Frequency (cps) (± 10%). 16
Damping Ratio (of critical) over Temperature Range: .35 to .80
Operating Temperature Range (°F): −65 to +185
Vibration: 12 g's @ 20-2,000 cps
Shock (Motor Running): 60 g's for 6.5 milliseconds
Warmup Time (Sec.): 30
Weight (lbs.) (max): 1.5
Gyro Time Constant (Sec.): .012

Engineers: Kearfott offers challenging opportunities in advanced component and system development



Roll Stabilized Directional Gyro



3 Gyro—4 Gimbal Gyro Reference

25 Pound Inertial Platform

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