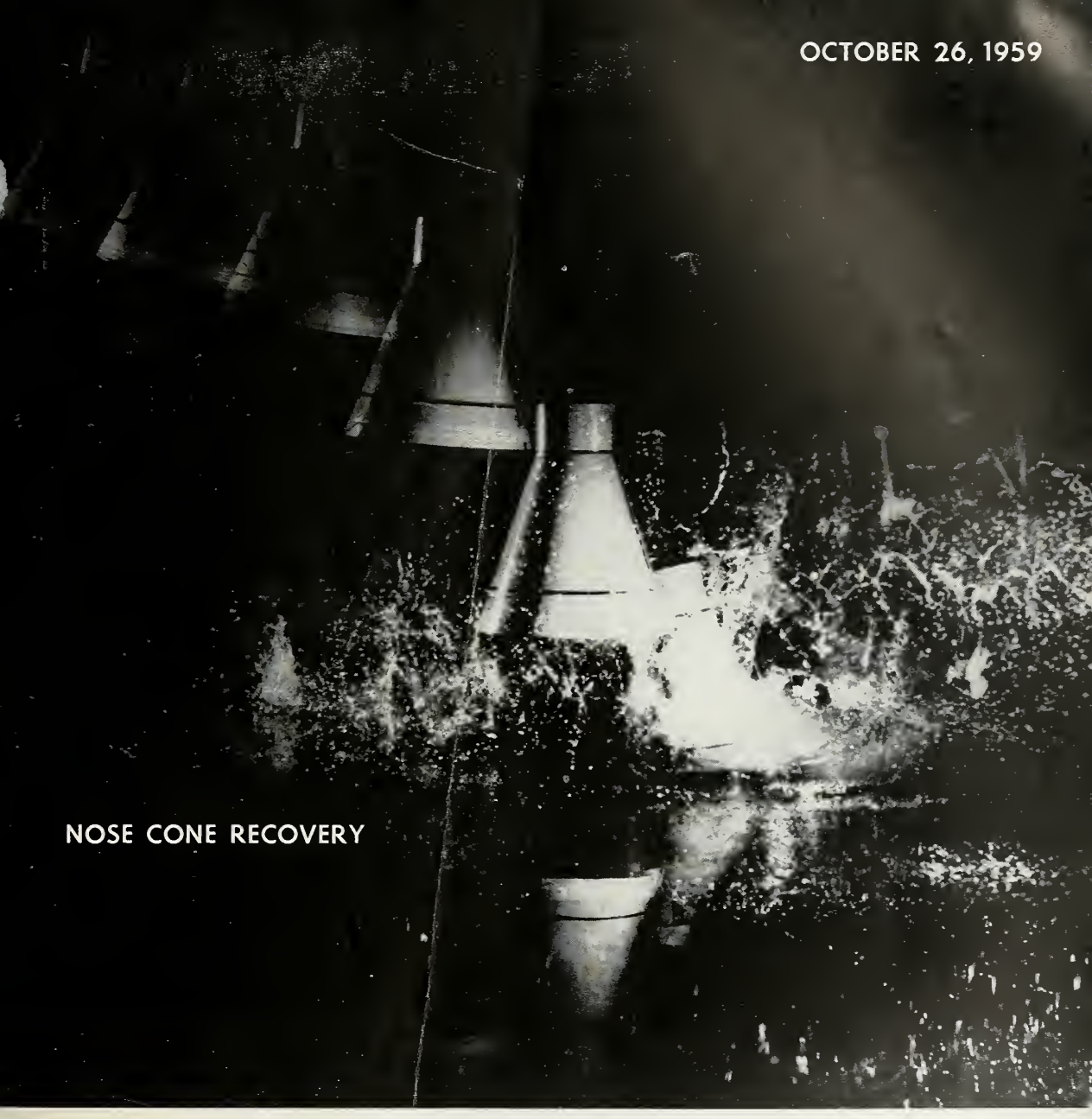
OCTOBER 26, 1959



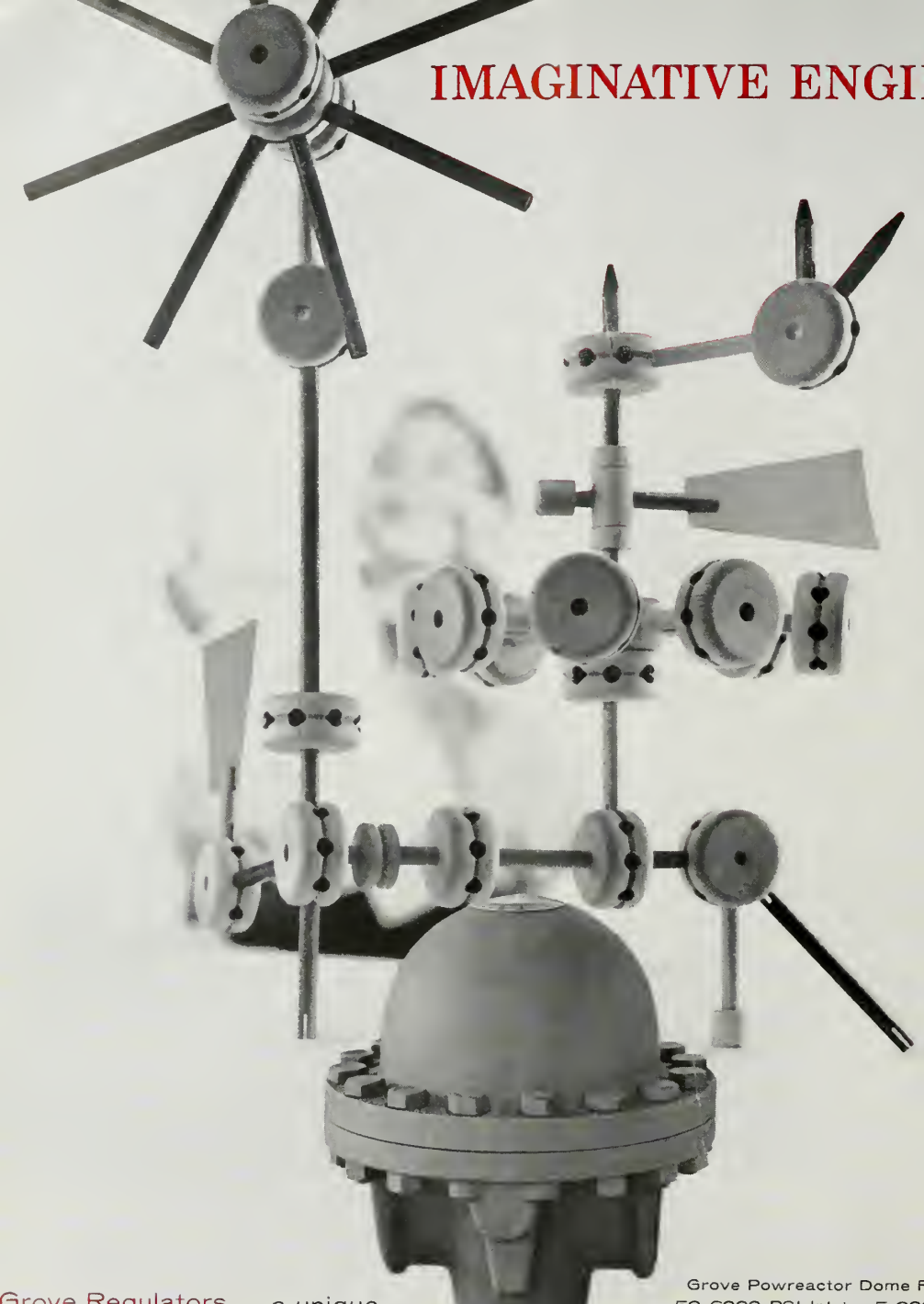
NOSE CONE RECOVERY

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

IMAGINATIVE ENGINEERING



Grove Powreactor Dome Regulator Model GH-408
50-6000 PSI Inlet...5-3000 PSI Reduced Pressu
Grove offers a wide variety of regulators f
various pressure and flow conditio

Grove Regulators . . . a unique engineering achievement which revolutionized the control of high pressure fluids. That's why for over 20 years—from th first missile experiments in the Navy Experimental Station at Annapolis, to the launchi pads of Canaveral and Vandenberg, Grove has been setting the standards for the contr of high pressure fluids. Grove Regulators—often imitated but never equalled in design ar performance. Unmatched simplicity, accuracy, safety.

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ces in other principal cities

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NEED A TAPE WORKHORSE?

"SCOTCH" BRAND Sandwich Tapes

wear longer, cut head maintenance even in digital work

1
22
336
9578
34916
872271
6355009
74400932
330562217
7703220522
888061111956
437773220071
5662225436662
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630904107 82
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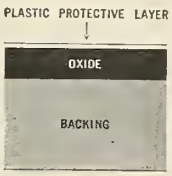
2

Tote that tape—change that reel—clean that head! If your project atmosphere sometimes seems that way, "SCOTCH" BRAND Sandwich Tape comes to the rescue. How about the possibility of getting over 50,000 passes out of a computer tape? And if that sounds attractive, consider the value in a tape that has no rub-off, won't give you any head buiid-up, drastically reduces maintenance and replacement on costly head assemblies.

One user found that the simple change to "SCOTCH" BRAND Sandwich dramatically reduced head replacements. And—where heads previously had to be cleaned after every run, "SCOTCH" BRAND Sandwich Tape cut cleaning to once a week.

The secret's in the Sandwich—the high potency oxide magnetic coating is sandwiched between the tough polyester base and a thin protective plastic layer. The coating never contacts the head—you get smooth, low-friction tape movement, plus an end to rub-off, head build-up, and a reduction in erosion of the critical slit in the recording head. Though the 50 micro-inch protective layer causes some slight reduction in high frequency response, the plain facts are that Sandwich Tape packs up to 600 pulses per inch in digital work—has broad usage in AM, FM, or PDM applications.



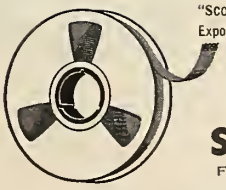
In "SCOTCH" BRAND Sandwich Tape you have a tape workhorse, pulling a big load over long distances. One user reported fewer drop-outs with each successive pass. As his recording heads were cleaned, the contaminates proved to be in the system, not the tape. Speaking of drop-outs, beware the villainous cigarette—often a culprit. One careless gesture and an ash can cause 40 to 60 drop-outs.

Whatever your application — data reduction, acquisition or control programming — count on 3M technology to create tape of higher uniformity and reliability for error-free performance.

"SCOTCH" BRAND High Output Tape No. 128 gives you top output at low frequencies, even under extremes of ambient temperatures. "SCOTCH" BRAND High Resolution Tape No. 159 lets you pack more bits per inch, offers extra playing time. Finally, for top performance at low cost per foot, "SCOTCH" BRAND Instrumentation Tapes Nos. 108 and 109 remain the standard for the industry.

Where there's no margin for error, there's no tape like "SCOTCH" BRAND. For more details, write Magnetic Products Div., Dept. MBW-109, 3M Co., St. Paul 6, Minn., or mail reader inquiry card.

"SCOTCH" is a registered trademark of 3M Company, St. Paul 6, Minnesota.
Export: 99 Park Avenue, New York, N.Y. In Canada: London, Ontario.



SCOTCH BRAND MAGNETIC TAPE
FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
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Missiles and Rockets Volume 5 Number 44

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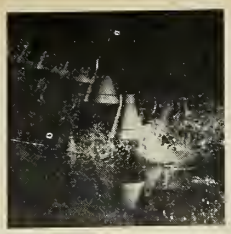
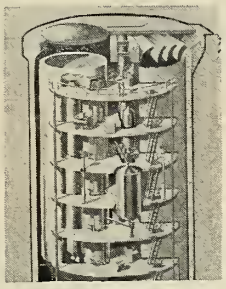
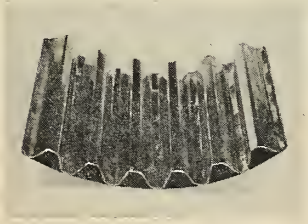


COVER: Scale model of space capsule is dropped in a water tank by scientists at NASA's Langley Research Center to simulate landing in ocean after flight.



UNDERGROUND launching facility for liquid-fueled ICBM is shown in artist's drawing. It calls for venting gases off at surface. An article on problems of ICBM launch bases begins on p. 21.

SIX-INCH diameter scanning head is a recent development in infrared airborne intercept equipment. A survey of the complex but promising IR market starts on p. 25.



MOLYBDENUM welds that can be flattened and recurved have been produced by Finn Aeronautical Division, providing unheard-of ductility for structural applications. See story on p. 40.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

31,000 copies of this issue printed

OCTOBER 26 HEADLINES

ASTRONAUTICS ENGINEERING

U.S. Reg. Pdg.

MISSILE SUPPORT

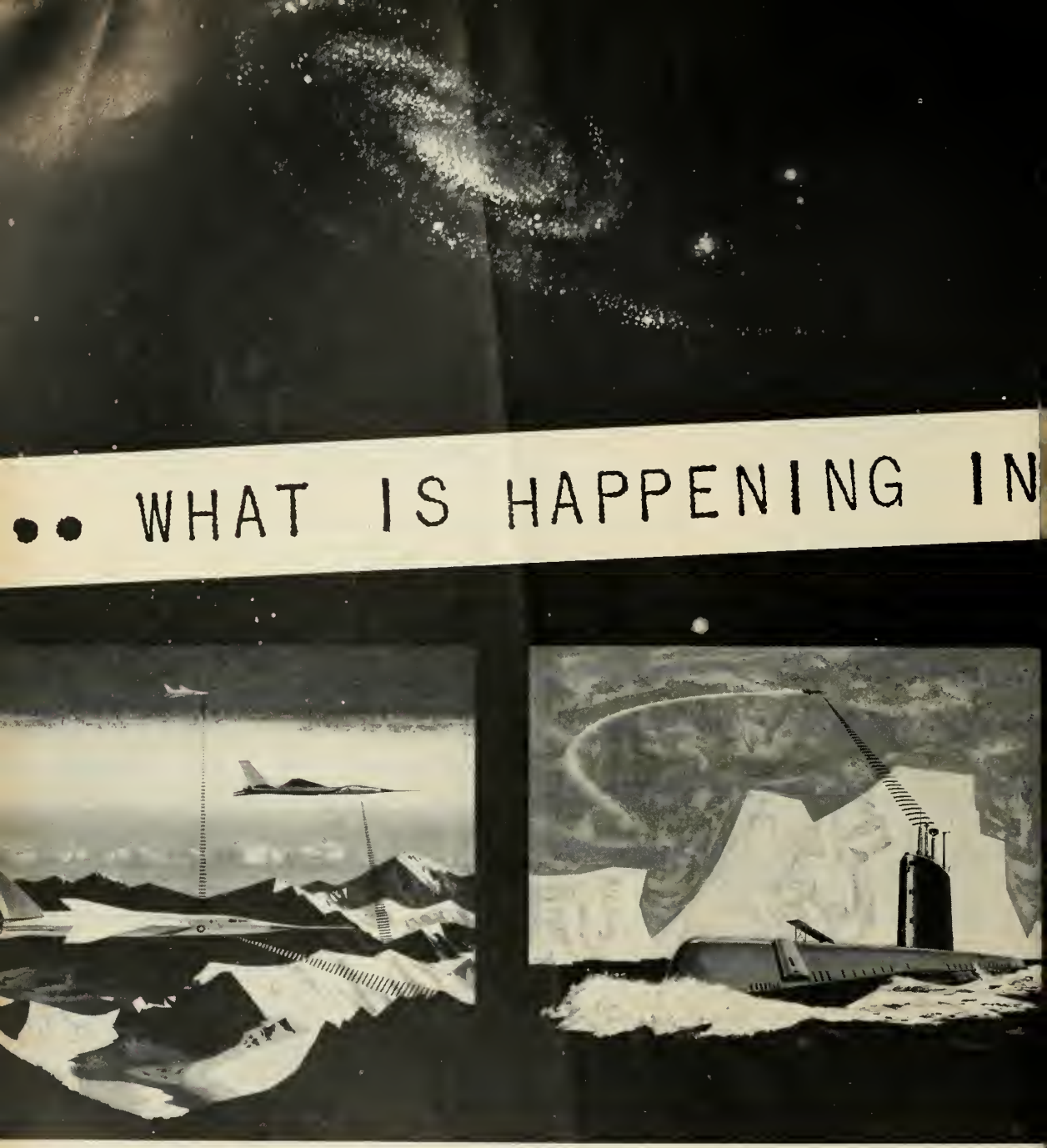
U.S. Reg. Pdg.

ASTRIONICS

THE MISSILE WEEK

U.S. Reg. Pdg.

DEPARTMENTS



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- An oirborne search, bamb nov and terrain avoidance rodor weighing less thon 235 pounds.
- A sferics system thot trocks severe weather disturbances over o 2000 mile radius.
- A twelve-pound rodor tronsponder far tracking research vehicles 200 miles above the eorth.
- High-pawer air seorch radors are being reduced fram 6000 pounds ta less than half.
- Missile contral systems hove been shrunk 70% in volume, 60% in weight, ond designed for mechonized ossembly.
- A missile launching sila wos completely instrumented in two months.
- Anti-jomming techniques ore being perfected for odvonced rodors.
- Simulotors ta train submarine-based missile crews in guidonce techniques ore being produced in quantity.

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..represents three major capabilities; antenna development, electromagnetic detection systems, and passive detection of long-range missiles and submersibles.

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- Broadband High Frequency, High Power Worldwide Communications Antenna
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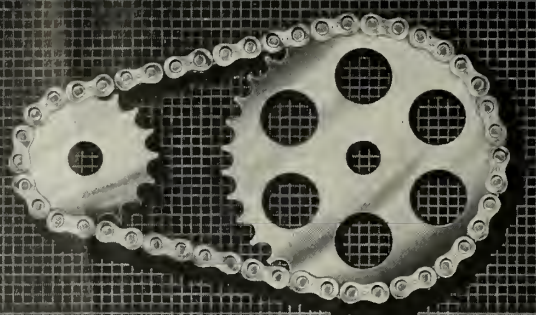

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NEW DIAMOND *Micropitch*

for miniature and sub-miniature devices . . .

Precision-built of non-magnetic Stainless Steel

SPECIFICATIONS

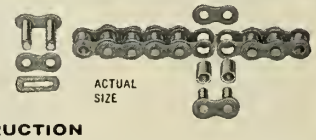
Pitch	.1475"
Overall Width	.210"
Weight per Foot (Approx.)	½ oz.
Chain length	+.051" to −.000/ft.
Operating Temp.	−65°F. to +400°F.
Tensile Strength	180 lbs. Average
Material	18-8 SS non-magnetic grade

Available also in ¼" Pitch, ASA No. 25 in stainless steel or standard steel.

SPROCKETS—Made to your specifications in regular or stainless steel, bronze, aluminum, nylon or other materials.

DIAMOND *Micropitch* is the first extremely fine pitch bushing chain (.1475") made especially for small-space applications such as cameras, computers, recorders, data processers and many other devices using miniaturized movements. It is ideal for power transmission, synchronization or conveying . . . and conforms to the same high standards of quality that have characterized all DIAMOND chains for more than 69 years.

You are invited to utilize DIAMOND'S *wealth of roller chain experience. Write for engineering recommendations for your project. Please supply complete details.*



CONSTRUCTION FEATURES—Large joint bearing areas • High order press fits • Precise chain length control • Corrosion resistant, non-magnetic stainless steel.

ADAPTABILITY

Permits wide variety of shaft centers. • Multiple shaft drives can be accurately timed • Sprockets may engage both sides of chain • Connecting links easily assembled or disassembled without removing sprockets.

ACTUAL SIZE

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On special order, DIAMOND *Micropitch* chain can be supplied for small conveyors in elongated pitch construction and with special attachments.

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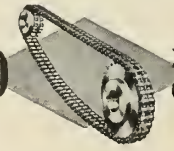


DIAMOND ROLLER CHAINS

when and where

OCTOBER

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

AFOSR/Mechanics Division, Aeronautical Sciences Directorate, WADC, ONR (host) AEC, ERDL, BuWeap, BuShips, NASA, Maritime Adm. First International Symposium on Gas Lubricated Bearings, (An open Meeting) Washington, D.C., Oct. 26-28.

Society of Photographic Scientists and Engineers, National Conference, Edgewater Beach Hotel, Chicago, Oct. 26-30.

Aircraft Electrical Society, Show and Convention, Pan-Pacific Auditorium, Los Angeles, Oct. 28-30.

Symposium on Space Age Chemistry, Cincinnati Section of American Chemical Society, Engineering Society Headquarters, Cincinnati, Oct. 29.

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

NOVEMBER

Institute of Aeronautical Sciences, Annual National Midwestern Meeting. Wichita, Kan., Nov. 2-4.

The Combustion Institute, Western States Section, Fall Meeting: Equilibria and Performance of High Temperature Systems, Los Angeles, Nov. 2-5.

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

Society for Nondestructive Testing, 19th Annual Convention, Hotel Hamilton, Chicago, Nov. 2-6.

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

Institute of Radio Engineers, Fourth IRE Instrumentation Conference, Biltmore Hotel, Atlanta, Nov. 9-11.

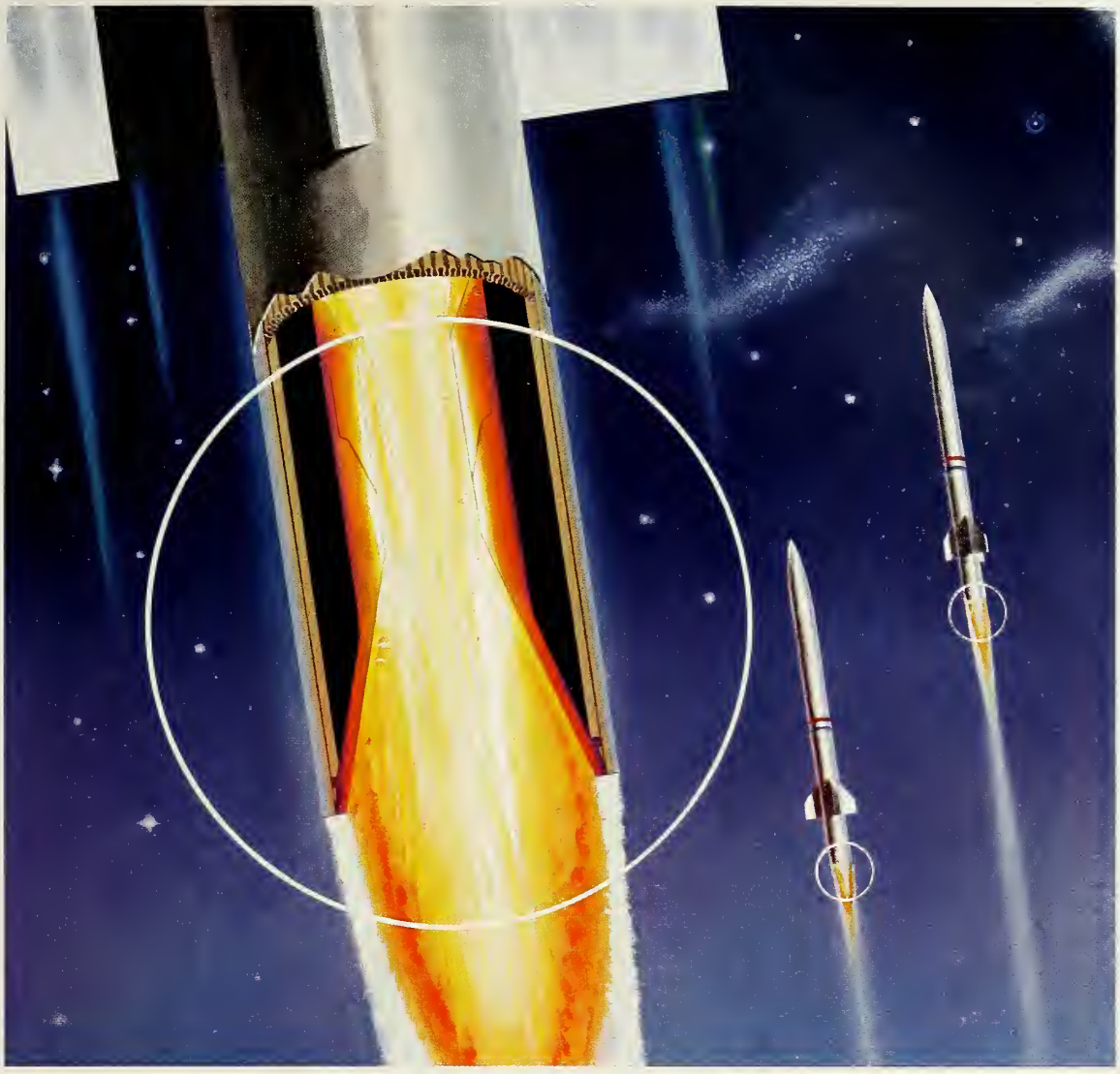
Operations Research Society of America, 16th National Meeting, Huntington-Sheraton Hotel, Pasadena, Calif., Nov. 11-13.

University of Michigan, Fifth Annual Conference on Magnetism and Magnetic Materials, Sheraton-Cadillac Hotel, Detroit, Nov. 16-19.

American Rocket Society, 14th Annual Meeting, Sheraton-Park Hotel, Washington, D.C., Nov. 16-20.

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

Instruments Division, Philips Electronics, Fifth Norelco Electron Microscope School, Hotel Victoria, New York City, Nov. 16-20.



REFRACTORY MATERIAL FORGINGS FOR 5000° F TEMPERATURES

Cameron forgings have solved many a design problem, but this is one of which we are particularly proud. Nozzle throats in solid propellant missiles must control the fantastic temperatures which make high performance possible. All the push passes through this part and temperatures range over 5000° F almost instantly, but the throat insert must maintain its shape for peak burnout conditions. Just to complicate matters, the exotic alloys specified for these important parts are extremely brittle and expensive. In forming and machining the costly metal every ounce is important — with conventional processes fragility makes matters worse.

When Cameron's unique forging methods were applied to this unfortunate situation, some interesting things happened. Our years of experience in forging high stress, high temperature components helped change the picture completely.

Less material was required because our specially designed presses could forge to a near-final shape. Moreover, the ductility of these tricky alloys was increased, making them easier to handle and machine. As a result, we are now turning out quite a variety of our advanced forgings for nozzle throats to help give missiles the proper push.

Cameron forgings have opened many possibilities in advanced design today. Extreme service components for airframes, jet engines, guided missiles, nuclear power plants, and a wide range of other end uses are being forged by the Cameron split-die and down-acting presses.

If your design problem involves high stresses, high temperatures, or large, intricately shaped ferrous parts, maybe we can help. Just call, write, or come by . . .

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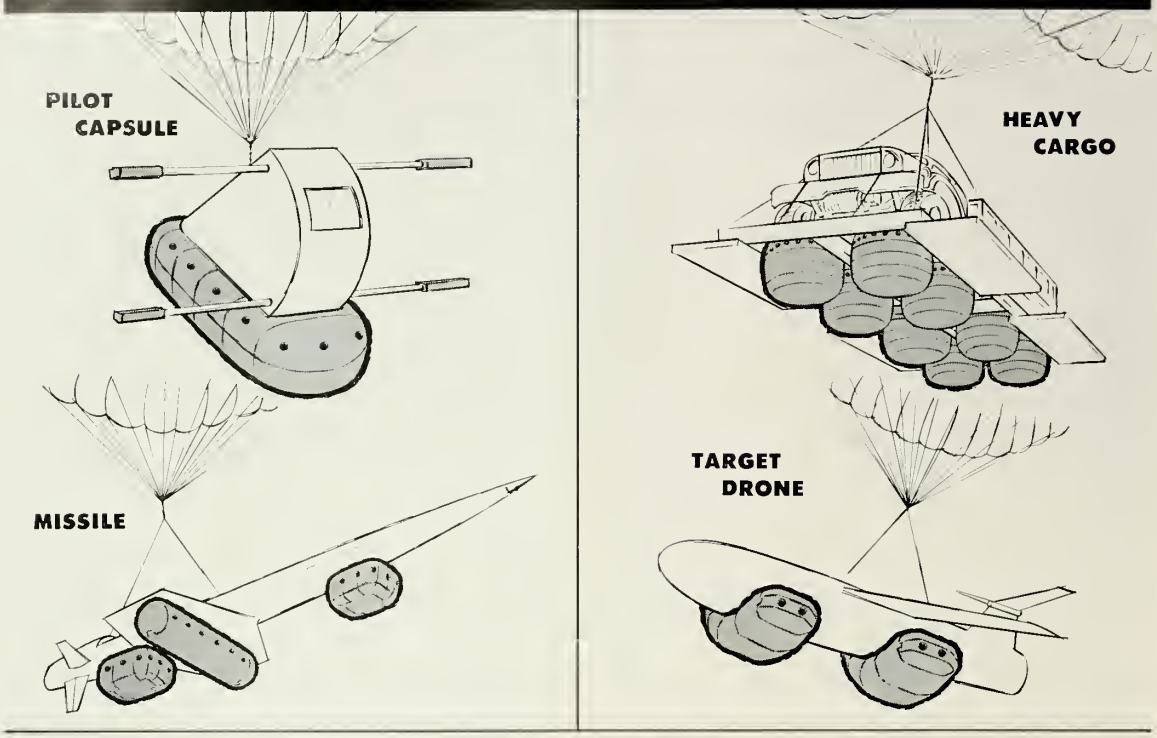
P. O. Box 1212, Houston 1, Texas

REFRACTORY MATERIALS: Molybdenum • Tungsten • Tantalum • Moly Tungsten • Tantalum Tungsten and others.

PNEUMATIC RECOVERY SYSTEMS / another product of Air Cruisers research



Solve New Missile and Capsule Recovery Problems

Air Cruisers has nearly a decade of experience in the development, testing and production of pneumatic recovery systems. Beginning with aerial cargo recovery, the company expanded its activities to include deceleration systems for various missile and target drone applications.

Other Air Cruisers system designs include recovery of missile nose cones and component parts, and pilot capsule recovery which enables the crew to land safely in the sealed capsule.

Air Cruisers' recovery systems consist of inflatable deceleration and/or flotation bags specially designed to meet all requirements:

- Provide maximum protection from landing damage
- Insure uniform deceleration
- Limit maximum "G" loadings
- Insure complete protection at normal drift and oscillation attitudes
- Provide dependable and adequate buoyancy for water recovery

With these rugged impact bags, you may have your choice of inflation methods, including the proved jet pump method to save added weight and space. Air Cruisers starts with your problem statement and can furnish the complete system. Write for full information concerning pneumatic recovery systems.

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Aeroquip Quick-Disconnect Couplings and Hose Lines of Teflon Speed 'Hound Dog' Handling

Hound Dog, the Air Force's new air-to-surface nuclear-armed missile, lengthens and strengthens the retaliatory arm of the Strategic Air Command. Designed and manufactured by North American's Missile Division, the GAM—77 Hound Dog is equipped with Aeroquip Hose Lines of Teflon and Quick Disconnect Couplings. Used on its internal hydraulic system and on ground service checkout equipment, these Aeroquip products speed handling and checkout of system components.

As the leading designer and producer of fluid line products for aircraft/missile systems, Aeroquip can offer complete engineering and manufacturing facilities to meet your fluid system problems. Mail the coupon below for specific product information, or outline your problem to our sales engineering department.

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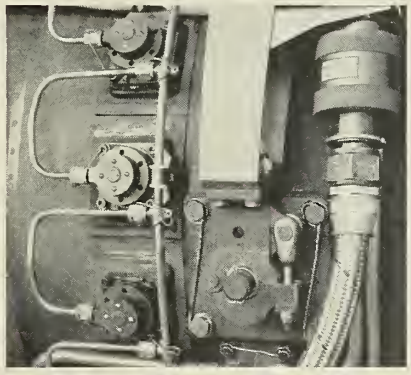
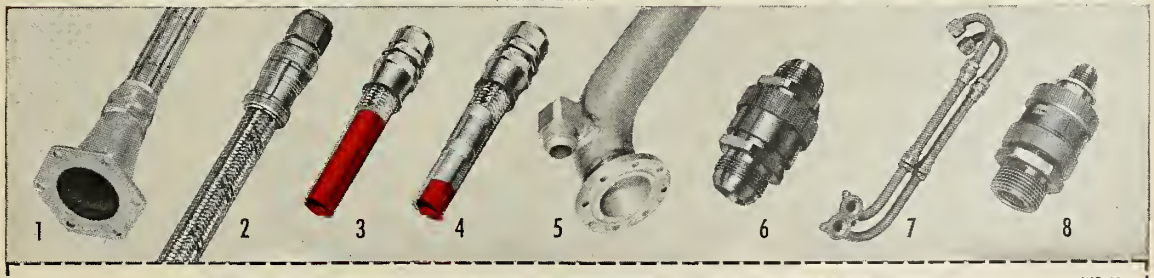


Aeroquip Hose of Teflon with patented* "***super gem***" Reusable Fittings and 3200 Quick Disconnect Coupling shown here on the Hound Dog Missile, are also used on the external check-out system.



AEROQUIP CORPORATION, JACKSON, MICHIGAN—PLEASE SEND LITERATURE AS INDICATED: MR-10

1 Large diameter hose lines of Teflon for corrosive fluids. ☐
2 6000 psi. pneumatic hose of Teflon for charging systems. ☐
3 1500 psi. hose lines of Teflon for fuel, hydraulic and pneumatic systems. ☐
4 3000 psi. hose lines of Teflon for hydraulic and pneumatic systems. ☐
5 Large diameter formed tubing. ☐
6 Fuel and oil quick-disconnect couplings in accordance with MIL-C-7413A. ☐
7 Precision tube and hose assemblies. ☐
8 3000 psi. quick-disconnect couplings for pneumatic and hydraulic systems. ☐
68-page Catalog #104 covering Hose Lines of Teflon. ☐

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TITLE_____
COMPANY_____
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"***super gem***" is an Aeroquip trademark. *U.S. Patent Nos. 2,833,567 and 2,731,279. Teflon is DuPont's tradename for its tetrafluoroethylene resin

Industry Countdown

MANUFACTURING

Nike-Zeus may go underground . . .

in hard bases if the Eisenhower Administration decides to go ahead with production of the **Western Electric** anti-missile missile. (See p. 18) The AICBM would require a 15-foot diameter silo. Originally, it was planned to emplace *Zeus* on the surface, like conventional *Nike* sites. Hardening would add billions more to the missile's pricetag—already estimated at $9 billion to $14 billion, depending on the number of batteries.

• • •

Motor case problems . . .

reportedly are still plaguing the *Nike-Zeus* project. The Army is still trying to develop a case that is lighter and cheaper than the present prototype which is hand-tooled and costs around $25,000. **Grand Central Rocket** and **Olin Mathieson** are said to be offering Huntsville some new approaches.

• • •

Japan gets 14 *Sidewinders* . . .

from the U.S. this week—the first combat missiles to be deployed with the Japanese Defense Agency. This first shipment was delayed because of demand by other U.S. allies. Japan is hoping to obtain delivery of 90 more of the **GE-Philco** air-to-air missiles during FY 1960.

• • •

The Italian cruiser Garibaldi . . .

will be armed with U.S. *Terrier* anti-aircraft missiles. **Vitro Laboratories** is the systems engineering contractor.

• • •

How to beat Russia . . .

to putting a man on the moon? Here's a half-serious suggestion making the rounds of one rocket fuel company: pick three prime contractors with the most feasible approaches. Give each a drawing account of $100 million and complete freedom—no progress reports required. The first one to return with a bucket of moon dust wins $1 billion. After all, Lindbergh flew the Atlantic for a $25,000 prize.

PROPULSION

Second attempt . . .

to test the **Martin** *Titan* second-stage engine will be made next month at Cape Canaveral. Release clamps on the test stand malfunctioned Aug. 4, causing the big ICBM to blow up in the first try at second-stage separation and ignition. Despite the setback, Martin says the program is still on schedule.

• • •

Industry trend to plastic . . .

motor cases is gaining momentum. More and more designers are claiming reinforced plastic cases offer the best promise for short flight-time, high-performance missiles. **Aerojet-General,** with a $14 million plastics sales volume, believes that in five years 20% of its business will be in plastics—provided the potential of the material is developed properly.

ASTRIONICS

"Bonded" transistors . . .

are now being handled as carefully as 100-proof bourbon. Under a new "Meg-A-Life" program, **Motorola's Semiconductor Products Division** produces transistors to stiff MIL-standard specs and tests, all the while keeping them in bonded areas to assure use only in military equipment and to prevent intermixing of unchecked units.

• • •

$7.3 million Army . . .

contract has been awarded **Hughes Aircraft** to increase the company's "Missile Monitor" system capability for *Nike* and *Hawk* missiles.

WE HEAR THAT—

North American's B-70 . . .

is picking up some congressional support as a possible ALBM or boost-glide rocket launcher . . . **Rocketdyne's** 400,000-pound-thrust E-1 engine has been fired at least 25 times under regenerative cooling and a like number without cooling. Reportedly the engine works as well with storables (probably nitrogen tetroxide) as with conventional fuels . . . An education fund is underway in Minneapolis for the children of the pioneer balloonist M. Lee Lewis, killed last July . . . Engineering schools report a decrease for the second year in a row of undergraduate enrollments . . . **Ford Motor Co.** and **Coca Cola** are said to be among several big companies considering "orbital advertising"—using privately-owned satellites to beam taped commercials to earth.

Washington Countdown

IN THE PENTAGON

Twenty percent more range . . .
than previously announced is being built into the **Boeing** *Bomarc B*. The air-breathing surface-to-air missile is expected to have a range of more than 500 miles instead of 400. The range of the already-operational *Bomarc A* is less than half as much.

• • •

Extra cash for *Polarises* . . .
may come out of the Air Force's budget hide. The Navy is arguing that it should get a larger slice of the frozen defense budget at the Air Force's expense because the **Lockheed** *Polaris* system will soon be ready to take over some of the strategic targets that the Air Force has had to worry about.

• • •

The full *Saturn* timetable . . .
has almost been lost from sight in the current hullabaloo over the big program. Talk of operational dates such as 1962 or 1963 involves only the clustered 1.5-million-pound-thrust *Saturn* booster—not the three-stage *Saturn* vehicle that would be capable of lofting more than 15 tons into orbit.

• • •

Another year or two more . . .
is needed to develop the huge three-stage bird after the booster is operational. Even with a speed-up, that means a three-stage *Saturn* would not be operational before 1963 or 1964. Under the present program, it isn't expected to be ready to go to work before 1964 or 1965.

• • •

The new *Atlantis* . . .
is the Navy's latest program aimed at developing an underwater DEW Line for defense against missile-launching Soviet submarines. The goal is to spread an electronic screen hundreds of miles off U.S. coasts. Red subs could not pass through it without being detected.

• • •

Spacemen better beware . . .
of radiation caused by solar flares. Some scientists say it is a greater threat to space travel than the Van Allen radiation belts. New data shows that the sporadic solar flares increase radiation 10,000 to 100,000 times above normal.

The Douglas ALBM's future . . .
is being determined in the office of Pentagon R&E Boss Herbert York. The question: Should the almost-expired six month design study program be extended or should a big development program be started?

ON CAPITOL HILL

A new budget format . . .
is being pressed on the Pentagon by Congress, according to some reports. It would force the services to list their expenditures by function—particularly under the headings "limited war" and "total war."

• • •

A blueprint for battle . . .
is clearly seen in calling for such listings. By next June the advocates of more money for tactical missiles and other limited war forces are expected to be at the throats of the advocates of more money for ICBM's, *Polarises* and bombers.

AT NASA

Equatorial launch sites . . .
probably are headed for the scrap-basket. They are being done in by **Jet Propulsion Lab's** *Vega* and the "parking orbit" concept that it will make possible. By parking in orbit, the advanced rocket will be able to launch satellites and space probes into any orbit desired, thereby eliminating the need for specially-placed geographical sites.

• • •

Early obsolescence . . .
is expected to overtake the use of capsules in the exploration of space. The chances are good that the Project *Mercury* capsule will be rapidly replaced by winged space vehicles after the first manned space flights.

AROUND TOWN

Some of the reports . . .
being heard around the nation's capital:

. . . U.S. scientists are betting on a quantum jump soon in technology—possibly involving the secrets of gravity.

. . . One reason Russia is beating U.S. space efforts is that the Reds are concentrating on some 50 major space projects, the United States 150.

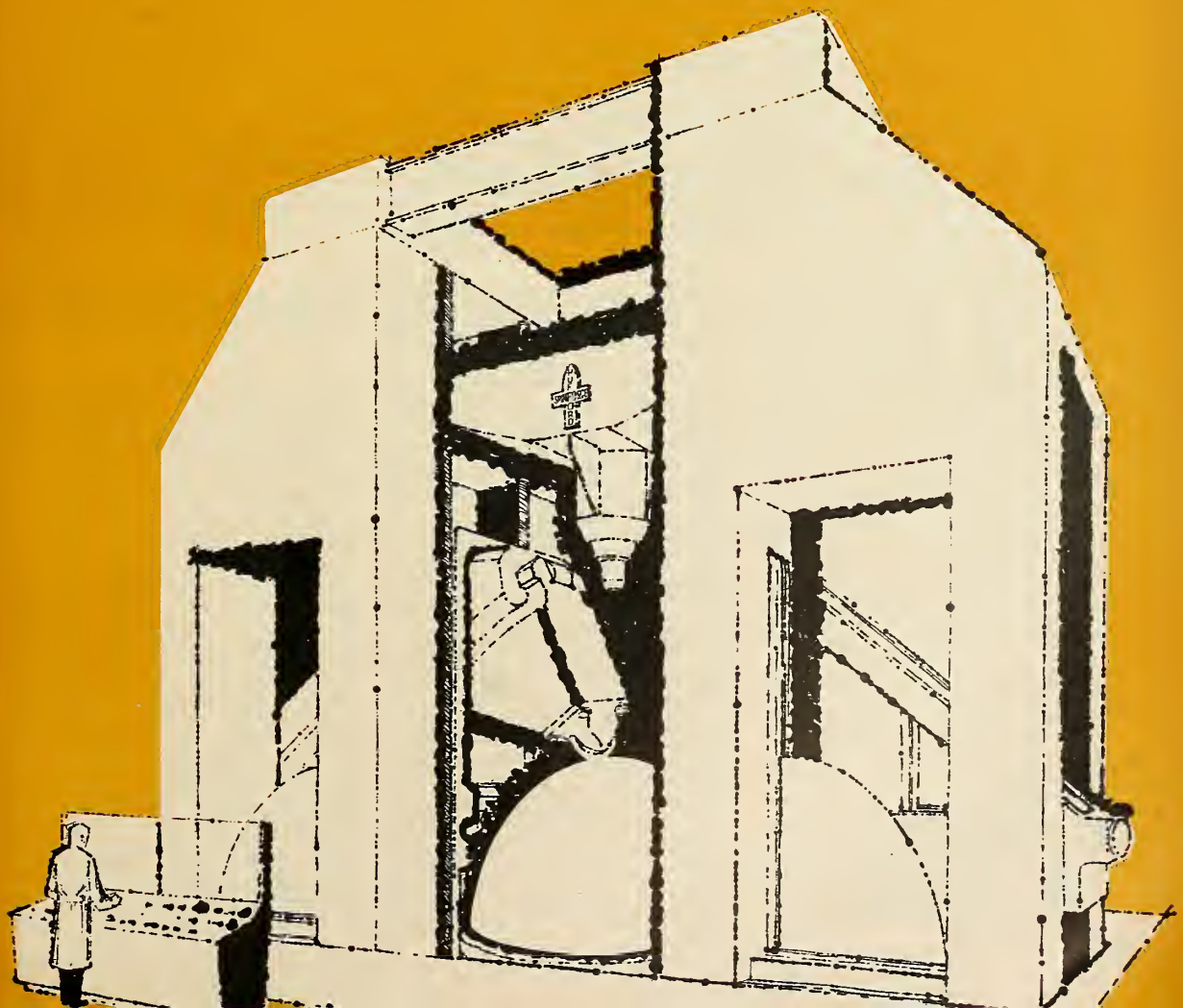
More About the Missile Week on Page 46

HUFFORD

A DIVISION OF THE **SIEGLER** CORPORATION

The Missiles and Space Division of Lockheed Aircraft Corporation has joined other leading missile manufacturers in selecting the Hufford Spin Forge. Largest machine tool of its type, the new giant will be capable of producing components as large as 8 feet in diameter and 20 feet in length...in conical, tubular, or parabolic shapes. Fully automated and immensely powerful (to 175,000 pounds vertical and horizontal roller force), it will form precision parts, of variable thickness to 1 inch, from toughest metals...in minutes. Only Hufford applies this new and important manufacturing process in such a dramatic range of products and with completely automated quantity precision. Only Hufford offers industry a complete Spin Forge development and production division. Let us assist you in the application of spin forging to speed your space age production. Write The Hufford Corporation, 1700 E. Grand Avenue, El Segundo, California.

WORLD'S LARGEST SPIN FORGE TO SPEED LOCKHEED SPACE AGE PRODUCTION



Expected by January . . .

Painful *Nike-Zeus* Choice Draws

by James Baar

WASHINGTON—The fateful decision on whether the United States will produce the *Nike-Zeus* anti-missile missile has come down to the basic question: How many bucks will we spend for the bangs?

The multibillion-dollar decision is of such paramount importance that it could:

- Rend the Eisenhower Administration in its final year and wreck its chances of coming up with a new balanced budget and a possible tax cut.
- Become a major factor in the 1960 presidential election campaign.
- Tip the life-or-death power balance in the Cold War.

Finally, because of the immense cost of *Zeus,* the decision will have a powerful effect on the nation's economy. More than 80 companies in 17 states from New York to California are taking part in the program.

Dr. Herbert York, Pentagon R&E Chief, is expected to complete drawing up his recommendations on the big **Western Electric** missile and pass them along to the Secretary of Defense and Joint Chiefs of Staff. The Defense Department is expected to make its decision by December.

• **Top-level headache** — Informed sources say that if the decision is to go ahead with production, the money to do it will have to come through an increase in the Administration-imposed $40-billion-dollar limit on the defense budget. Therefore, the final decision will have to be made by the White House.

On the other hand, any decision to kill *Zeus* or even to postpone production has such strategic and political ramifications that the final word is almost certain to come from the White House anyway.

Despite contrary reports, the final decision is expected before the first weeks in January, when the new budget will be sent to Congress. Any short-term further delay would force the Administration to announce its decision in the middle of a presidential election year—a politically risky business at best.

In essence, the Administration is faced with deciding whether to start a *Zeus* production program that is expected to cost anywhere from about $7 billion up, depending on how much protection the nation wants to buy.

The cost in FY 1961 alone will be about $1.5 to $2 billion. The cost then jumps to about $2 to $3 billion a year.

• **Time awasting**—Moreover, this decision must be made now if *Zeus* is to become operational on its present schedule—about early 1963. The schedule already is slipping week by week.

The reason for the current slippage is that the Defense Department and the Army are holding up spending $137 million voted by Congress for long leadtime items in order not to waste it if the decision goes against *Zeus.* A good share of this money is for the machines needed to produce electronic components for the *Zeus* system.

If *Zeus* is killed, the Army would spend the $137 million on its much-starved development and procurement programs for tactical missiles and other modern tactical weapons.

The fight over *Zeus*—the nation's only foreseeable anti-missile missile until the late 1960's at best—is far more involved with dollars, strategy and politics than with technology. To understand this, two points must be kept in mind:

- *Zeus* is primarily designed to defend SAC missile and bomber bases. It would give assurance that at least some of the nation's retaliatory forces not airborne in advance would live through an ICBM attack. Most experts concede that *Zeus* would be able to do this—at least until the Russians make their ICBM's more complex.
- *Zeus* is almost certain not to be used to defend large metropolitan areas, although some advocates of the program have proposed this, too. *Zeus'* value as a city defender is highly questionable; unlike a hardened ICBM base, a city is about as vulnerable to a near-miss by a nuclear warhead as it is to a direct hit.

Therefore, *Zeus* emerges as a costly protector of SAC retaliatory forces. The question is whether the United States can afford such a defense—or would the money be better invested in buying more ICBM's and bombers?

One rejoinder is that building more SAC bases still does not guarantee that any would survive. Another is that if the money isn't spent on *Zeus* there is a good chance on the basis of past performance that it won't be spent on anything else either.

• **More money a must**—This brings us to the money freeze, which is mak-

Reds Predict Two-couple Moon

WASHINGTON—Two eminent Russian scientists have predicted (according to a Soviet paper translated in Germany) that the USSR will send two men and two women around the moon for half a year next March or April. They admit there is little chance the four voyagers would return alive.

Published in the West for the first time on Oct. 1 by the Dusseldorf *Der Mittag,* the paper by Soviet scientists Evgeny K. Federov and Anatoly A. Blagonravov outlines a Russian space program which is both dynamic and ruthless.

The paper predicts that a Soviet satellite carrying two men will orbit the earth for 14 days by the end of this year.

Four weeks later, it says, two men with a TV camera will make a round trip flight to the moon, circling it twice.

In March or April next year, the two men and two women are predicted to make their sensational but almost certainly fatal trip. The Russians have some hope of picking the four up by a "Lunik Robot" rocket next September or October.

The timing of this shot coincides with the trip to the Soviet Union by President Eisenhower.

The scientists frankly state that lives will be lost in completion of these missions. "The base rockets," according to the paper, "will have no provisions for return to earth. A speaker for the Academy of Sciences pointed out that mankind must be ready to offer sacrifices for the privilege of exploring space, the moon and the planets."

"The first people who will be launched into space are fully aware of slight survival and return possibilities," the paper cautions.

Professor Federov is a geophysicist with the Soviet Academy of Sciences. A winner of two Lenin prizes, he was director of the Institute of Applied

Nearer

ing the Pentagon's dilemma all the more difficult.

The Army—low man in the defense budget—has no so-called "fat" whatever for diversion to a *Zeus* production program.

The Navy isn't in a much better position; nor is the Air Force.

Therefore, military men see an increase in the defense budget as the only way to buy *Zeus*. And such a move could mean that the Administration would have to throw away any possibility for a vote-getting tax cut and balanced budget. This does not make *Zeus* more attractive. However, the Administration also must face the politically unpalatable possibility that if it kills *Zeus* the program could become a juicy campaign issue.

In the end, the decision probably will have to be made mostly on the basis of national Cold War strategy.

Zeus would buy the United States more safety in the dangerous years around 1963—the years of the Missile Gap. The question that must be answered is whether anything else would buy the time as well—and cheaper. Or whether the United States is willing to run the deadly gauntlet without either *Zeus* or a substitute.

Orbit in Spring

Geophysics of the Academy in 1955, and an executive of the Soviet IGY program for rockets and satellites in 1957. Professor Blagonravov is also a much-decorated scientist with the Academy of Sciences, and well-known to the West.

According to Federov and Blagonravov, the Russians have 200 well-trained crew members to carry out manned space projects.

Future Russian space achievements envisaged by the paper include:

- Rockets to Mars and Venus during 1961;
- Rockets to Mercury and Jupiter shortly thereafter;
- Manned ships carrying from two to six men to Mars and Venus;
- Large space "cruisers" carrying more than 100 people that will be assembled outside the earth's stratosphere from space stations, and which will be able to travel around the solar system. (No time schedule.)

Ion Rocket Can Shift Orbits

NASA experts suggest low-I_{sp} devices for switch from 300-mile to 24-hour level

BOSTON—Raising an earth satellite to a 14-hour orbit is likely to be one of the first tasks of an ion rocket.

J. Howard Childs and William R. Mickelson of the Lewis Research Center of the National Aeronautics and Space Administration at Cleveland have calculated that specific impulse values below 4000 seconds are ideal for such an application in terms of the time needed for raising the satellite.

They chose as an example the mission of raising a 6000-lb. satellite from a 300-mile circular orbit to the 24-hour orbit of 19,300 miles, 1° off circular. The analysis was presented at the Avco-Air Force symposium on Advanced Propulsion Concepts here earlier this month.

The best specific impulse for this application, they said, is determined by its effect on the rocket's efficiency and propellant consumption.

Grid electrode configurations were analyzed because of their simplicity, high efficiency and ease of replacement. High current densities are possible with moderate accelerating voltages. Thus high-voltage generators are not necessary.

In the case of such a satellite raising, the weight of the electric rocket necessary to adjust the orbit is quite small in comparison with the chemical rocket plus propellant that would otherwise be required.

The NASA experts said that the desired I_{sp} in this instance is below the range where the ion rocket attains its highest efficiency, but that such rockets still remained competitive.

• **Grid electrode erosion**—The assumption is first made that the satellite requires a 30-kilowatt power generating plant as part of the payload.

Ion impingement on the grid causes considerable erosion in a very short time. Unless this can be reduced to less than 1% of the ion flow, some scheme of replacing grid wires will be necessary.

The analysis showed that even with 1% of the ions impinging on the accelerating grid, this type of ion rocket still appears promising. The mass of wire material eroded is not large compared with the propellant consumed during the mission. If contamination of the ion source by sputtered grid material should prove damaging, tungsten wires could conceivably be used to eliminate the problem.

In some vacuum tubes, the ion impingement is approximately proportional to the grid area blockage. If it comes impractical to continuously replenish the grid wire coating as it is eroded, or if tungsten is used, then this amount of ion impingement could not be tolerated.

But, say Childs and Mickelson, the limited data available from vacuum tube experience provide a reasonable expectation that impingement of less than 1% can be attained through ion focusing.

Considerations of grid wire replenishment and energy losses associated with secondary electron omission point to a limiting voltage of about 2380 volts.

With this accelerating voltage and 1% ion impingement, the efficiency is about 67% at 2000 seconds I_{sp} and 82% at 3000 seconds I_{sp}.

These efficiencies give a raising time of 61 days at 2000 I_{sp} and 78 days at 3000 I_{sp} for the 6000-pound satellite.

It is not clear, the scientists said, that any other type of ion rocket configuration could yield efficiencies comparable to those of the grid electrode at low specific impulse.

If more sophisticated electrodes are employed, they will probably require a greater spacing and a larger accelerating voltage. This would result in excessive energy losses and sputtering erosion unless ion impingement of essentially zero could be obtained.

Childs and Mickelson said it appeared desirable to continue the development of grid-electrode ion rockets for propulsion of earth satellites in view of the favorable results of their analysis.

Hamburg, Genoa Weigh 640-Mile Rocket Mail

CUXHAVEN, GERMANY—The West German, Italian and French postal ministries are considering a proposal for establishing the world's first rocket mail service, between Hamburg, Germany and Genoa, Italy.

The Italian post ministry strongly supports the proposal. Delivery of mail

over this 640-mile distance would take about 30 minutes.

Capt. G. Partel of the **Missile Systems Consulting Co.**, Rome, described the project at the international meeting of the German Rocket Society here last month. He said that if mail missiles could be scheduled hourly between the two cities, postage for a rocket letter would not be much more than that for a regular airmail letter.

The proposed mail missile is 13 feet long and weighs about 200 pounds. It can deliver a cargo of 750 to 1000 letters and postcards, weighing about 12 lbs. The missile is started with the aid of a booster rocket and continues its flight at an altitude of 8500 feet at a speed of Mach 2. Sustaining propulsion is on the ramjet principle.

Prior to landing, the missile is slowed by several braking rockets. Partel maintains his missile has guidance sufficiently accurate to land in a specified area not larger than its own length. At the destination point, the missile is turned around, refueled, provided with new cargo and a booster rocket and sent on another flight.

Italian postal authorities regard the new project as the first step toward the realization of a worldwide rocket-mail system, Partel declared. He said plans are being worked out to establish a central rocket postoffice in Europe for international rocket mail service.

The German society already is using rockets to deliver mail from the mainland to small islands in the North Sea. The first 10 were successful earlier this year and the society has begun mass production of mail-carrying rockets.

Space Materials Meeting Scheduled in Cincinnati

CINCINNATI—"Materials—Key to Space Flight" will be the theme of a national meeting here next April 27 and 28.

The Cincinnati, Dayton and Columbus chapters of the American Sociey for Metals will sponsor the program presenting a broad review of unclassified information on the unique demands made on materials by space flight systems.

The meeting also will include discussion of progress made to date in satisfying these demands and outlining of the unsolved problems that require intensive future efforts.

Speakers will be top technical experts from government and industrial organizations working in space flight technology. The program has been planned to cover the critical materials problems involved in launching, space flight and atmospheric re-entry.

Aerojet Pushing Hybrid Liquid-Solid Engines

SACRAMENTO—The **Aerojet-General Corp.** reports it has turned up some promising data in its studies of hybrid solid-liquid propellant rocket engine potentialities.

Aerojet said last week it has studied more than 200 possible fuel and oxidizer combinations and has found that some of them have very desirable specific impulse and impulse density values.

Aerojet hybrid engines are prepackaged combinations of liquid oxidizer and solid fuel, as in the diagram. To obtain maximum benefit from the system, the two should be hypergolic—that is, ignite spontaneously on contact.

The flow of oxidizer is controlled by a valve. This makes it possible to turn the engine on and off at will, just as with an all-liquid system. However, the use of solid fuel makes it possible to reduce the size considerably. A hybrid engine might have about half of the density advantage of a solid system. The size of a hybrid engine might be about halfway between that of solid and liquid for any given amount of thrust. However, Aerojet has not yet made detailed compactness studies.

Choice of fuels and oxidizers is limited, of course, by the availability of hypergolic combinations. Aerojet spokesmen declined to say what substances have been tested. Nor were any figures on impulse and density released.

(The Naval Ordnance Test Station at China Lake, Calif., reports it has attained a specific impulse between 255 and 265 seconds with a common nonaluminized double-base solid propellant and an ordinary halogenated oxidizer. It says calculations based on combinations designed especially for use in hybrid systems indicate impulses up to 365 seconds.

(Douglas D. Ordahl of NOTS did not limit his investigation to hypergolic combinations. Instead, he included a pyrotechnic igniter in his design.

(He said the only difficulty in using a hybrid system is the necessity to pressurize the oxidizer tank above the pressure of the combustion chamber.)

Cryogenics as oxidizers were not ruled out, even though the additional refrigerating gear adds more weight to a system. An Aerojet engineer said several members of the polyurethane family are hypergolic with liquid oxidizers.

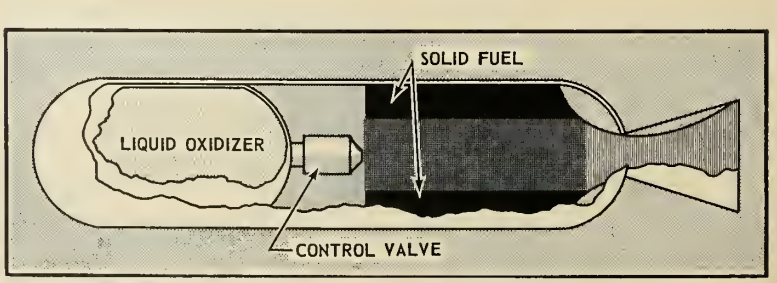
Some small-scale engines have been fired in the Aerojet program. More feasibility studies are in progress, particularly in the examination of various oxidizer-fuel combinations.

"Extensive performance analyses and optimization studies indicate that for many applications hybrid motors could be designed having distinct performance advantages compared with either solid or liquid engines," the company said.

"These analyses assume propellant availability above certain specific impulse and density values . . . It was found that some . . . systems possess exceeding desirable specific impulse and density impulse values.

"These facts have renewed our interest in the hybrid motor; we feel extensive studies are warranted to determine the practicability of the calculated system and to reduce some of the design concepts to practice. It is expected that within a year substantial additional data will be available to support the potential of such a powerplant."

Aerojet, a subsidiary of the **General Tire & Rubber Co.**, said it was conducting the studies entirely with company funds.



HYBRID ENGINE: Control valve sprays liquid oxidizer across solid fuel.

Launching: Where ICBM's Are Weak

'Mix' of hard, mobile and dispersed sites needed to escape enemy missiles; new design for 'hard' Titan base

by Warren R. Stumpe*

GREENWICH, CONN. — Launching techniques for ICBM's are a military operational-analysis problem. Today the trend appears to be from soft to hard to harder to hardest to mobility and dispersion.

No one launching technique necessarily is better than another. Rather, just as any good team mixes its plays, we need a good mixture of all the launching techniques to confuse the enemy. The problem becomes, therefore, not so much one of absolute cost, as cost per retaliatory missile launched after an initial enemy attack.

The launching problem for retaliatory ICBM's is quite simple to state, but quite difficult to achieve. The weapon must be relatively immune to an initial salvo of enemy missiles carrying nuclear warheads and still be capable of retaliatory firings within a specified minimum time.

For this discussion a "soft" launching site is defined as one basically not designed to withstand the blast, ground shock, heat or radiation effects of a nuclear or thermonuclear explosion. A "hard" launching site is designed to withstand these effects for a specific warhead megaton yield and within a specified overpressure. Now, let's look at today's ICBM's and see how well they meet our launching criteria.

• **Hard *Atlas* base concept**—Present *Atlas* bases are above ground. The 75-foot high, 10-foot diameter missile, weighing 243,000 pounds is stored horizontally in an unfueled condition. For launching it is raised to the vertical position by an overhead erector, fueled and fired.

Good design of the sliding roof, erector, and fueling system achieves the required minimal response time.

** A graduate of West Point and Cornell, Mr. Stumpe is manager of American Machine & Foundry's mechanical laboratory.*

RAIL SYSTEM for *Minuteman* is shown in model conceived by AMF and ACF. Some 20 firms are bidding for the system.

While not meeting requirements of a hard site, the unusually large quantities of reinforcing steel used in concrete construction do provide some blast resistance.

Since megaton warhead yields are becoming larger, the enemy can be a considerable distance off-target and yet damage the installation. In order to overcome this deficiency, a new underground launcher design, similar in concept to the *Titan* launching system described below, is now on the drawing boards at **American Machine & Foundry Co.** and at the **Bechtel Corp.** under the direction of **Convair-Astronautics.**

Like the *Atlas, Titan* is liquid-fueled. The *Titan* is 90 feet long, 10 feet in diameter and weighs 222,000 pounds fully fueled. It will be stored, serviced, and launched from completely contained underground installations.

This is the first missile installation that can be justifiably designated as hard, since it is designed to operate in a high overpressure range against a high megaton warhead yield.

In the silo, the *Titan* missile is placed by stages onto the launcher platform, which operates as an elevator. When the first stage is loaded above ground, the launcher platform is lowered so the second stage can be installed at ground level; and lastly, the nose cone is similarly installed. The fully assembled missile, when lowered with the concrete doors closed, is in the *hard* condition.

Needless to say, data describing the effects of nuclear or thermonuclear explosions, in regard to blast and ground shock are not abundant. AMF, as the launcher system contractor on the *Titan* program, was contracted by the Air Force to define the effects of the nuclear explosion. This resulted in an Architectural Engineering Handbook available to both the A&E contractor for his installation design and to AMF for the launcher design.

In the hard condition, the missile is isolated by means of a crib structure which is shock-mounted through a mechanical spring system. Within this crib structure, the missile is raised and lowered on the launcher platform. When the command to launch is received, the crib is locked to the silo walls, the missile is fueled, the doors are opened, and the missile raised to the firing-position.

It is obvious that the *Titan* approaches our initial criteria of installation protection and minimum retaliatory time. It should also be noted that in addition to the missile itself, all the ancillary parts of the weapon system must also have the same hardness capacity.

A missile complex involves three missile silos, 155 feet deep and 40 feet in diameter; three propellant silos 37½ feet in diameter; three equipment silos 50 feet deep and 40 feet in diameter; two antenna silos 65 feet deep and 27 feet in diameter in addition to a control center. All of these underground

installations are interconnected by tunnels 6 to 10 feet.

Of course, since they are self contained, they must be fully air-conditioned and provide the necessary living quarters.

It is obvious that the actual costs of hard installations are substantial, but the actual cost of retaliation, based upon war gaming, may be lowered. Just as *Atlas* has now adapted the *Titan*-type hard system, *Titan* is now being studied for an in-silo-type launching complex similar to that of the *Minuteman* by which the missile is launched from below ground. (See illustration.)

• **Silo launch testing**—The *Minuteman* ICBM weapon departs radically from *Atlas* and *Titan* in concept and operation. *Minuteman* was conceived as a relatively inexpensive weapon system. Since it is a solid propellant weapon, it has some definite operational advantages over the liquid fueled *Atlas* and *Titan*. Its warhead capacity, however, is smaller than either *Atlas* or *Titan* and therefore the need for these ICBM systems for selected targets will remain.

The *Minuteman* operational concept is quite simple. Many missiles will be stored in underground silos similar to *Titan*. However, because of the solid propellant, and other system improvements, *Minuteman* can be stored underground for long periods with minimum service requirements. On the command to launch, doors will be opened and the missile launched directly from the underground position.

The advantages of this system are obvious from an operational point of view. The missile remains in the hard condition for the maximum amount of time prior to launch. In addition, the improved reliability achieved by eliminating those mechanisms required to bring the missile to the surface is definitely worthwhile.

Titan launching from a below-ground position, would be improved in reliability enough to warrant the change, even if no economic benefits were accrued.

The engineering problems of a below-ground launch are substantial. Today, test programs are going on at Edwards Air Force Base to determine the effects of such a launch. The acoustical problem of reducing the contained noise level to a value at which the missile itself is not damaged by the resonances is a substantial one, as is the handling of the exhaust gases of combustion.

• **The future?**—With weapons such as *Atlas, Titan,* and *Minuteman,* the United States has the capability of massive retaliation with minimum reaction time. The problem is simply how to protect these weapons from a surprise attack since we are committed never to launch the first blow. We've talked about hardness, but that is still a relative term depending upon the megaton yield and the overpressure. The question really is "How *hard* is *hard?*"

As megaton yields become larger for similar size warheads, is our present hard criteria becoming obsolete? Can the enemy damage our retaliatory capability by using larger megaton warheads within present accuracies or even with less accuracy? This answer is probably yes. When we talk about the affect of a multi-megaton bomb, we are talking about craters several miles in diameter and ½ mile deep.

The problem of putting in a hard installation against this type of attack is enormous. It can be done through such methods as installations within mountains, or underwater launching sites, but several of these types of installations could easily use up a good portion of the yearly defense budget. In addition, there is already arising criticism in some quarters against fixed bases as a "Maginot Line" philosophy. The answer—if fixed bases will not suffice, we must consider mobility and dispersal.

• **Mobility**—The problems associated with the mobility of inter-continental missile sizes are considerable. Essential characteristics of inter-continental missiles for mobility requirements are that the missile contain a power plant or thrust package which will permit minimum reaction time for the weapons system. Also, the trend for more efficient power packages is producing missile configurations and characteristics which are more adaptable to mobile launching than the present liquid fueled missile. Pre-packaged fueled missiles may, however, satisfy the operational requirements for mobility.

As the circular probable error of future enemy weapon systems decreases, launcher system mobility and dispersal may become an essential requirement for the survival of our deterrent missile forces.

• **Types of mobility**—There are three types of mobility, namely, air, sea and land. In air and sea, we are already developing a capability with the air launched ballistic missile being developed by **Douglas** and the *Polaris* submarine launched ballistic missile by **Lockheed.** Land mobility is an area relatively untouched to date for ICBM size missiles. Recent articles have indicated that *Minuteman* is being considered for a mobile system to supplement the fixed installation. There are three basic types of land mobility—railway, on our vast railroad network, vehicular, on improved roads or cross country, and inland waterways, on our navigable rivers and lakes. While the latter may be thought to be closer to sea mobility, since it is within the continental United States, it is included as land mobility.

• Railway—American Machine & Foundry Company, in conjunction with **American Car & Foundry Company,** has recently completed a thorough study of the railroad mobility problem for an inter-continental missile size. There are ¼ million miles of main-line railroad within the United States. It is AMF and ACF's belief that rail-borne launching systems provide exceptional capabilities for mobility and dispersion in relation to overall system cost.

It is expected that costs for railroad missile support systems may be considerably less than for competing hard based systems. The operational philosophy would be quite simple. Many missile car complexes would be kept in almost continual motion. Numerous launch areas could be surveyed along railroad right-of-ways. When the launch command is received, the missile car would proceed to the closest launch area and fire the missile.

The problem is, of course, that a ballistic missile must be accurately launched if it is to hit a target, hence the need for surveyed predetermined launch areas. The simplest way would be to launch the missile directly from the car, although separate launch pads are also a possibility. Of course, there must be a number of ancillary cars in the missile car complex to provide the required services and accommodations.

• Vehicle—Vehicular mobility is also a definite capacity. Whereas railroad mobility can be achieved utilizing standard railroad equipment, vehicular mobility poses a somewhat different problem. The vehicles needed for a complete system would be numerous and somewhat large for an ICBM size.

This would make over-the-road travel undesirable as it would require special escorting, load surveying and routing. It would, therefore, seem to be more desirable to use cross country travel utilizing the 400 million acres of land still in the public domain. There are many areas of this country in that category with sparse populations and little or no natural obstacles to impede a convoy of this type. This system might operate by continual rotation between several fixed soft launching

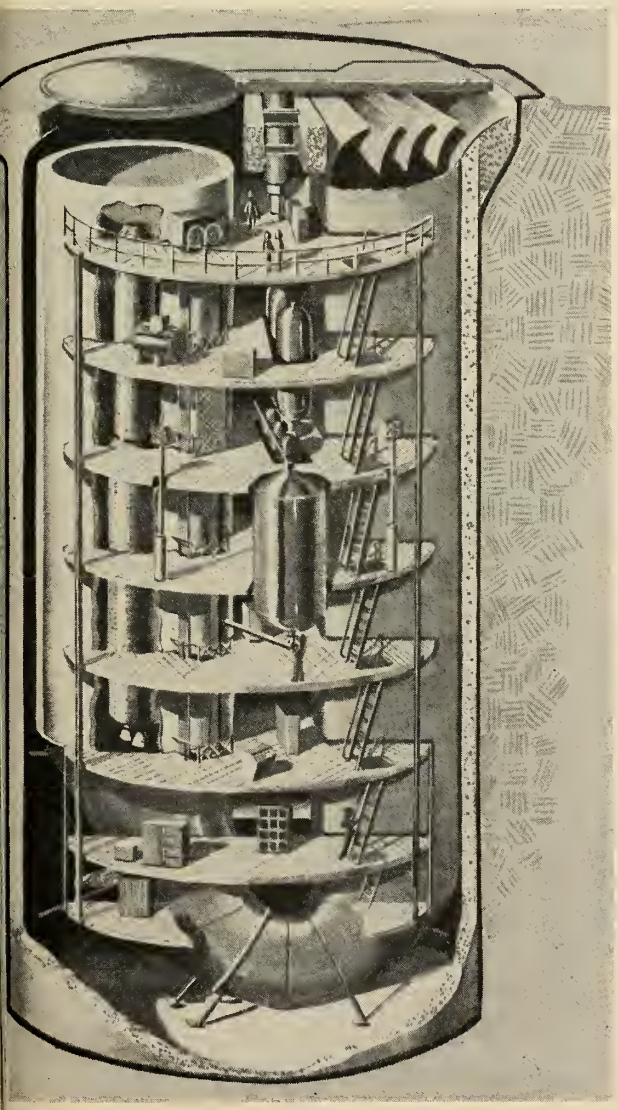
sites. It would be difficult, if not impossible, to predict where the missile was at any particular time.

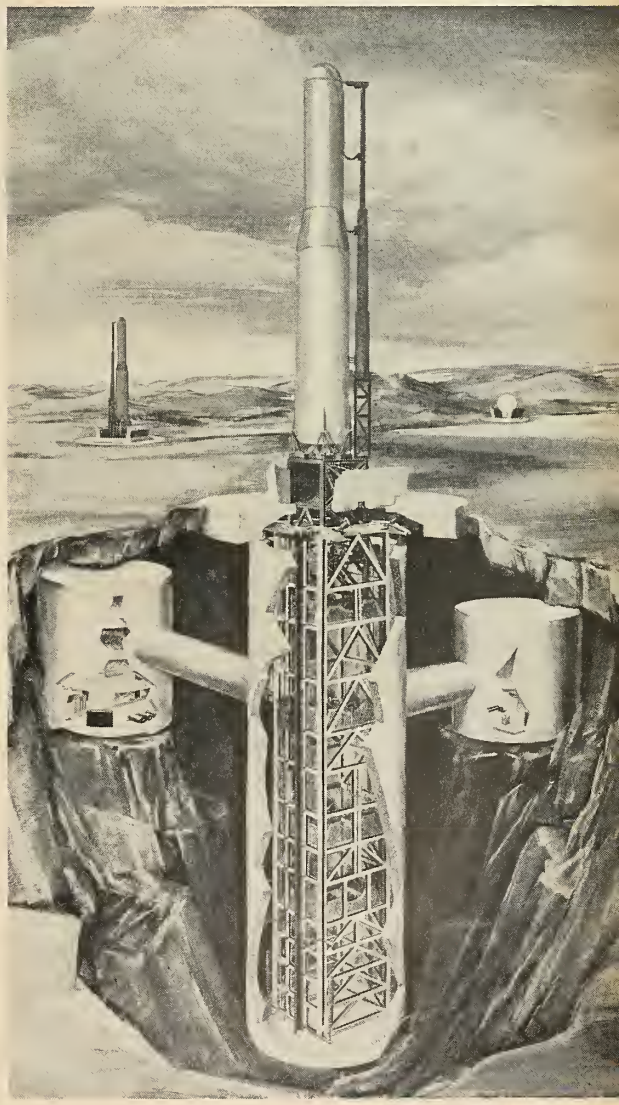
• Waterway—The thousands of miles of navigable waterways offer still another type of mobility. Here the missile system could be contained in a single barge or Great Lakes steamer. It, too, could be kept in continual motion so that prediction of its location would become difficult. Its prime disadvantage is the slow speeds attainable so that if it is spotted and reported, it might be still within blast zone of an enemy missile launched.

• Integrated Mobility — Mobility with dispersion may offer an answer to the ultimate hardness problem. We call it "Integrated Mobility" in AMF; that is, a good balance of all types of land mobility—rail, vehicular and waterway. Its concept is based on the premise that specific areas of the country can support more than one type of mobility dispersal technique.

Much land suitable for vehicular overland mobility also comes in contact with the railroad systems and navigable waterways. In these areas, a higher mobility potential can be achieved if all the techniques are integrated. It may even be feasible to transfer missiles between systems—overland to railroad to overland, as an example. The "piggy-back" type of operation is a proven system and it combines the long-haul efficiency of the railroad with the short-haul flexibility of the road vehicle.

The ultimate in mobility (if, indeed, there is an ultimate) will be the ultization of all mobility approaches. Launchings will be possible from railway cars, overland vehicles, inland waterway vessels, ships at sea, submarines, and conventional aircraft. Nuclear powered aircraft, that can stay aloft indefinitely and space platforms will add a new dimension to the mobility area, and perhaps will then achieve the ultimate in mobility.





UNDERGROUND LAUNCHING concept for liquid-fueled missiles is shown in artist's drawing at left. It would allow for firing the missile from the silo, with gases vented off at surface. *Titan* launching site of type now being built at Lowry AFB is shown in drawing at right. Bird is stored underground but must be raised to surface for firing.

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East Hartford, Connecticut

Billion-dollar Market Seen for IR Industry

Future expansion rate depends on research breakthroughs and product development

by Charles D. LaFond

WASHINGTON—The infrared industry is growing like an adolescent pup. Just now learning its own strength, it is rapidly becoming a major contestant at the electronics-market feedbowls, successfully snatching large chunks from several dishes heretofore dominated by its more mature cousins.

It is a most unusual field. Leaders in the industry are not even roughly consistent in describing the market picture. But they agree to one premise: The infrared market—and this includes both research and development plus hardware—has only barely been tapped. Its strength is apparently based on the compatibility between commercial and military IR developments which result in broad applications with every breakthrough.

• **Market today**—Estimates of the total market for fiscal 1960, including associated R&D and hardware, range from $300-500 million. Total defense market appears to be in the range of from $115-125 million. A very large portion of this total represents DOD research dollars.

The defense expenditures in the IR field may be considerably higher. Stringent security classifications applied to these government R&D and hardware contracts make it very difficult to obtain complete figures. Estimates are further confused because of the inclusion of such things as electronic amplifiers and data handling equipment, produced by the same manufacturers. Other totals often are buried in other military R&D budgets.

Also, while many IR-device designs are firm, the future is clouded because of the uncertainty associated with many missile and aircraft programs.

• **Review**—Infrared radiation is electromagnetic radiation. In the electromagnetic spectrum, it ranges in wavelength from 0.7 to 1000 microns. Thus it falls between the areas of visible light and the radar wavelengths.

All objects emit IR radiation which varies with the temperature above absolute zero. The emissions are broadband and, as temperature increases, peak radiation occurs at decreasing wavelengths. The molecular thermal characteristics of the object determines its emissivity. This emissivity factor determines maximum IR radiation at any given temperature for each object.

The IR radiation can be collected and focused optically or it can be transmitted through certain opaque materials, such as germanium and silicone. Using a suitable photoelectronic detector the energy can then be electronically utilized, depending on the particular application.

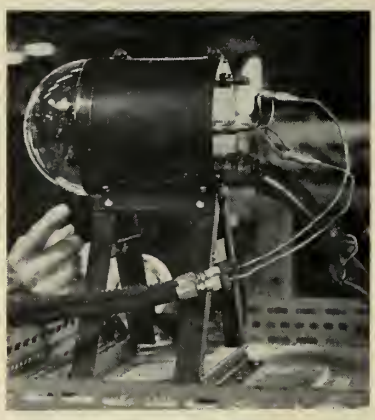
The physics of infrared technology have been known for years, yet it was not until World War II that any real progress was made in the exploitation of IR radiation. This was due largely to the lack of suitable detectors originally, but later it was simply a failure to recognize the vast potential.

By the time this country began to invest in limited IR research, others had given their programs a high priority. As early as 1944, the German Air Force was in final development stages for the use of IR homing devices in guided missiles. When the war ended, these missiles were awaiting field tests. They also had developed successful applications of infrared to airborne and ground search and tracking systems, proximity fuses, and temperature mapping.

• **IR leaders**—As might be expected, most of the electronics systems leaders have a strong investment in the infrared field. Many have come in late, but

A few of the developments . . .

THERMICON thermal imaging tube being developed by Westinghouse for track-while-scan, multiple target handling.



PORTION OF an IR airborne intercept system, this six-inch diameter scanning head weighs only 10 pounds.

the possibilities are so great that almost any interested company can find an area through which it can enter the field and progress.

The Avionics Division of **Aerojet-General Corporation** is one of the oldest and largest firms in the IR industry. According to R. W. Powell, new division manager, his organization has completed more different military IR hardware programs than any other company. Currently, the division is carrying a minimum of $10 million of this part of the market. Powell pointed out, however, that this figure may be low. Sixty percent of the available funds (military hardware) is allocated for the production of just a few systems and Aerojet is a major contributor to each, he said.

The division has employed IR techniques in military equipment such as: missile seekers for terminal guidance; surface and surface-to-air fire control devices for target detection and tracking; aircraft defense equipment; attitude references and satellite horizon scanners; search gear for warning, acquisition, or collision avoidance; radiometers, and spectrometers for target radiation profiles or for field data-recording. It also produces IR accessories and test and checkout devices.

Philco Corporation is currently producing IR detection systems, new types of highly sensitive detector cells, and cryostats for cell cooling. The company has under development a family of mosaic detectors—linear arrays and rectangular configurations.

And, of course, the company has been a major contributor to the field with its infrared-homing *Sidewinder* air-to-air missile.

A recent Philco development is an all-electronic IR scanning system called "Filterscan." It uses a detector external to the scanner. The scanner, according to a company spokesman, contributes no measurable noise and is wavelength independent, thus noise limitations and spectral response of the system depend primarily on the detectors. Scan rate, using a fast-response detector, is comparable to standard TV.

The Air Arm Division of **Westinghouse Electric Corporation** for four years has been chiefly concerned with developmental work on IR systems for space and aircraft vehicles. Its areas of principal interest are reconnaissance, guidance, stabilization, and armament control.

A number of complete IR search, tracking, warning and navigation systems have resulted from the efforts of the Santa Barbara Research Center, **Hughes Aircraft Co.** Out of this R&D work, design and production, a whole line of accessory devices and IR components have evolved: detectors, low-noise transistor preamps, and extensive photodetector test equipment.

In addition, SBRC has done extensive research into IR detector cooling, producing miniature cryostats, liquid transfer coolers, and miniature closed-loop coolers. It also has achieved significant results in increasing search and tracking range with shielding techniques (M/R Sept. 28).

The Research Center has nearly completed work on new far-infrared photo-detectors. It is believed that these will have greatly increased sensitivity and will employ improved coolers.

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Some near-breakthroughs . . .

IN DEVELOPING associated IR devices for missiles, Eastman Kodak researchers use this insulated, 30-ft. diameter hemisphere to isolate infrared radiation sources and eliminate unwanted ones.

LARGE APERTURE, long-wavelength "irdome" developed by Ramo-Wooldridge for Sperry Gyroscope employs faceted configuration to simplify companion optical system design.

Another principal in the IR field is the Avion Division of **ACF Industries, Inc.** It is primarily interested in search and tracking systems, missile guidance and control, and passive IR velocity-over-height systems. Avion, earlier this year, achieved a great deal of success with its development of a commutating IR search system called CODES. Having very high sensitivity and relatively long range, it employs AC commutation with a multi-element system and a single amplifier (M/R, April 20).

Now under development in the company's research center are high-intensity pulsed-light communications and detection systems, mosaic tubes, IR thermal imaging vidicons and a star-occlusion system.

One of the country's largest IR systems groups is Crosley Division of **Avco Corporation.** The division is now working in the areas of reconnaissance and surveillance, ICBM detection, fire control, mapping, aircraft early warning, tracking, ranging, navigation, countermeasures and industrial applications. It is pressing for more developments in passive ranging devices.

HRB-Singer, Inc. has achieved success while confining its work to detection systems—all types. The company recently received a contract for 17 surveillance systems—cost, $2.3 million.

The Missile Systems Division of **Lockheed Aircraft Corporation** limits its efforts to research and development services. These include analysis of IR techniques for satellite and space applications; feasibility studies and preliminary design for detection, tracking and radiometric equipment; lab services for IR materials study.

Linde Company, a division of **Union Carbide Corporation,** is making significant advances in IR detector cell cooling. While they have produced a whole family of devices for cooling down to liquid nitrogen temperature (–320°F), preliminary designs have been completed for systems operating at liquid hydrogen (–423°F) and liquid helium (–452°F) temperatures. All are liquid refill systems.

Kearfoot Company, Inc., already producing a multitude of precision components and systems for missiles and aircraft, is now gaining a foothold in the IR field. Until recently, the company was primarily interested in detection systems in this field. But it has just been awarded an Air Force contract to develop a "solid-state multi-headed celestial comparater."

Specifically intended for space navigation, the device is to be completely solid state, with no moving parts.

A pioneer in the field of infrared photography, the **Eastman-Kodak Company** currently is working on the de-

velopment of better physical and optical properties for IR filters, detectors and window materials in the 8-13 micron region. It recently introduced a new family of IR transmitting materials called IRTRAN Optics. The lenses, operating in the 1-to-8-micron region, retain high transmittance at 800°C and above. (Normally when subjected to this kind of heat, the lens itself would tend to emit IR radiation and thus "cloud" the target radiation.)

GB Electronics Corporation has achieved a near-breakthrough by combining microwave techniques with a semiconductor cell. The result is a "noiseless" amplification and improved sensitivity. Called an ultra-sensitive microwave IR detection system, USMID, it employs a parametric amplifier and harmonic generator. Because of its potentially small weight and size and low power requirements, applications for the device will be broad.

Another leading supplier of IR components and systems is the **Barnes Engineering Company.** A pioneer in the field, its activities are strong both in the military and industrial market. For missile and space applications, Barnes makes horizon sensors for space vehicle stabilization, radiometers, trackers, and surveillance systems. For industry it produces all types of IR monitoring, analysis and control devices.

Others important in the field are: **Baird Associates, Bausch and Lomb Optical Co., Minneapolis-Honeywell, General Electric, RCA, Perkin-Elmer, Servo-Corporation of America, Texas Instruments,** and **Ramo-Wooldridge.**

• **Future market**—A summary of problem areas in the IR field necessarily corresponds to those items currently under development. For one thing is certain, the future breadth of the IR market, as with many other young fields, is tied directly to its research breakthroughs.

It is significant that a great many of the companies surveyed indicated that this market, with just a few major developments, can and will increase by 3 or 4 orders of magnitude within the next five years.

Market estimates indicate that by FY 1965 total IR military expenditures may reach $240 million or more. Estimates for the combined defense-industrial market go as high as $1 billion. It is interesting to note the close relationship between individual company research efforts and market estimates. Those companies investing large amounts of time and money in the field are naturally extremely optimistic about the future.

It is believed that a marked increase in IR R&D money will occur within the next five years, but expansion will still be the spawn of research results.

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Thus a corresponding increase is also foreseen in the use of IR devices and systems in the military.

• **Future developments**—Important developments now in progress are for the most part an indication of the problem areas in infrared technology. The problems are extensive but they fall in definite categories. For brevity, these are summarized items or techniques currently under development:

• Detectors—new cells and transducers having improved sensitivity and wider spectral response, (some using MASER techniques); better, uncooled cells and longer-wavelength detectors (8-13 microns); increased metallurgy research; improved characteristic reproducibility to provide cell uniformity and more stable sensitivity under adverse environments.

• Cooling—more efficient coolers; techniques or different gases to permit closer approach to absolute zero (to be practical, this must be achieved without excessive handling problems and high cost); better miniaturized cryostats.

• Optics—improved optical transmission materials with good physical strength; improved fabrication techniques.

• Circuitry—new electronic processing circuitry; better background discrimination techniques; low noise sampling devices; techniques for ranging and modulating the IR source.

• Design—improved reliability; miniaturized IR receivers (power supplies and electronics account for nearly 80% of total volume and weight of many systems); better scanning systems, filters, and image converters; coordination is needed between IR-system designers and detector manufacturers.

• Costs—more inexpensive materials in almost all areas are needed, but primarily for optics and detectors; cheaper cooling systems are needed.

Antenna Test Range Is Over Half-mile Long

SHERBURNE, N.Y.—A new antenna test range, over a half-mile in length, was opened here last week by **Technical Appliance Corp.** The facility will be used for development and checkout of antennas up to 60 feet in diameter. Pattern analysis as well as structural testing of towers and reflectors can be conducted at the site.

TACO produces a wide range of antennas, wave guides and feed systems for missile and aircraft telemetry, space tracking, and communications. It developed the complete DOPLOC system used in the Army "space fence" for satellite detection.

NEC Hears Reports on New *Explorers*

by an M/R Correspondent

CHICAGO—The 1959 National Electronics Conference held here at the Hotel Sherman was deemed a success both by those attending and by the exhibitors. Only the recruiting teams seemed disappointed—they vastly outnumbered applicants.

According to NEC officials, 188 companies were represented in 288 booths throughout the five exhibition areas. The total of 8700 engineers, scientists, educators, military representatives, and student guests attending the three-day meeting fell somewhat below pre-conference estimates. But it appeared to most observers that the various technical sessions and panels drew bigger-than-usual audiences.

Exhibitors also indicated that the average registrant investigating booths was in a position within his own organization to decide whether to purchase and use the items shown. They, together with the large number of educators from nearby universities, set the tone of the conference.

• **Principal speakers**—Dr. John C. Green, director of the Office of Technical Services-Commerce Department, discussed the universal problems of digesting and effectively disseminating technical information. He revealed the importance with which the problem is viewed by the Russians and how they are striving to reduce to 3 months their present 7-month time for processing abstracts of world information.

He suggested that "information scientists or researchers" be utilized having a salary and corporate level equal to that of technical scientists and researchers. With the full backing of the government and industry, he said, we too could learn to pool, use, and keep pace with technical findings effectively.

On succeeding days, other principal speakers were J. Lewis Powell, and Dr. F. A. Kraemer, both of the Department of Defense. Powell discussed the transition of "Cave Men-Space Men." Kraemer reviewed "U.S. Capabilities in the Battle for Men's Minds."

• *Explorer VI* **results**—Of particular interest was a presentation revealing many of the important results obtained from *Explorer VI*. A full-size model of the "paddlewheel" satellite was shown by the three **Space Technology Laboratories'** men responsible for its sophisticated instrumentation, Drs. Bagely, Booton, and Chalmers.

One important finding, said Dr. Booton, was the isolation of the most hazardous region in the Van Allen belts. This, he said, is a belt 5 kilometers in depth at an altitude of approximately 2000 km, having an unusually high proton concentration.

Besides the vast amount of data being received, the satellite has provided other significant returns, said Dr. Bagely: it demonstrates the worth of the highly sophisticated power system utilizing vast banks of solar cells, and it also shows our ability to interrogate and command the satellite via radio, plus the ability to change information rates.

The National Electronics Conference is sponsored by the American Institute of Electrical Engineers, Institute of Radio Engineers, Illinois Institute of Technology, University of Illinois and Northwestern University. Participants include the Electronic Industries Association, Society of Motion Picture and Television Engineers, and Michigan State, Michigan, Purdue, Wisconsin, Notre Dame and Wayne State Universities.

Also discussed was the capability of the telemetering transmitter employed. The current device has a 5-7 million-mile range. But, said the STL experts, with the addition of a small 150-watt transmitter unit and using the Jodrell Bank paraboloidal-reflector antenna, range could be extended beyond 50 million miles for space communication.

• *Explorer VII* **details**—A paper of high current interest was presented by Prof. R. Parent and Drs. W. B. Swift and Verner Suomi, University of Wisconsin, describing the instrumentation for the heat-balance measurement program for *Explorer VII*. This low-cost (roughly $150,000) effort could well have far-reaching results for future weather control.

Through a better knowledge of the total heat input from the sun, reflected energy, and earth heat radiation, the authors hope to achieve a fundamental meteorological understanding. To control weather, two facts must be clearly understood, said Dr. Swift: atmospheric motion or circulation and the reasons for rapid large-scale weather changes.

• **Abstracts**—Many significant papers covering subjects associated with the missile and space field were presented. A bound volume of the *Proceeding of the NEC*, Volume 15, will be published early in 1960. Copies may be obtained at a cost of $10 by writing the National Electronics Conference, 228 North LaSalle, Chicago 1, Ill.

Missile Support Test Chamber Being Built

TORRANCE, CALIF.—A new environmental testing chamber for wheeled missile support equipment is being constructed by **Horkey-Moore Associates.**

The unit will be programmed and data will be recorded automatically on tape. The operating temperatures range from −100°F to 200°F and the humidity conditions can be varied from 40% to 100% over a temperature range of 40°F to 200°F.

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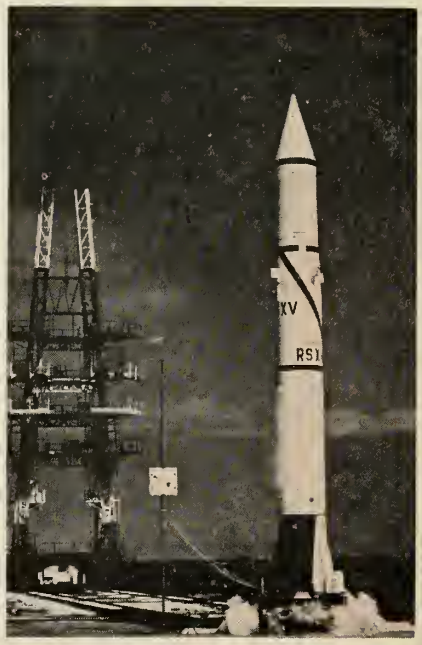
Ducts, pods, heat-shields, electronic components and other high-temperature parts for missiles or aircraft can be fabricated easily of lightweight silicone laminates. These laminates have good strength, good heat resistance, and are unaffected by moisture, weathering, ozone and corrosion, thermal shock or fungus attack. Dow Corning silicone resins, coupled with glass cloth or other inorganic fillers, give better strength-to-weight ratios "at temperature" than many light metals. And they're simple to form.

In the North American Aviation Super Sabre F-100, for example, designers needed a rigid material for the drag-chute case. As this chute case fits right up against the engine at the rudder base, the rigid outer wall of it must: 1) reflect heat away from the chute; 2) resist jet engine ambients; 3) retain structural strength without necessity of replacement.

Development engineers tried numerous "high-temperature" plastics without success. Too much heat. Then they hit on silicone-glass laminate, gold-metallized for heat reflectance. Not only did this prove entirely suitable, it also turned out to be more easily formed. The finished part can endure continuous service at 750 F and intermittent exposure to 1200 F. Vibration resistance is excellent.

Silicones for the Army Redstone

In the Redstone, Chrysler Missile Division engineers employ silicone laminates several ways. As in the case of the F-100, large heat shields behind the Redstone's engine compartment are fabricated of the laminates because of their light weight, heat resistance, thermal impedance. Also, due to excellent electric strength and creep resistance, silicone laminates are utilized for terminal boards in black boxes within the missile and in Ground Support Eqnipment control boxes.



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missile business . . .

By WILLIAM E. HOWARD

The U.S. Labor Department has surveyed the dimensions of U.S. "missile activity" and come up with these vital statistics: As of October, 1958, there were 319,300 persons producing missiles and their components. This was a 38% increase from the previous 12 months. By last April, the department estimates, total employment had jumped to 350,000.

Biggest Number of missile workers—125,600 . . .
were in aircraft plants. The remaining 61% were distributed over 14 major industry groups. Ordnance claimed 21% and the communications field 18% as of a year ago.

The proportion of aircraft employees working on missiles rose from 8% in 1957 to 17% last year. Comments the department: "It is evident that this activity has been extremely important in keeping the decline in aircraft employment within moderate proportions."

Distribution by states showed California leading . . .
with about 127,000 missile personnel, 40% of the national total. New York was second in the 1958 survey with 24,000 and Massachusetts third with 16,600. Other states: Washington—13,600; North Carolina—13,500; New Jersey—12,200; Maryland—11,900; Michigan—11,800; Pennsylvania—10,900; Minnesota—10,000; Alabama—9,300; Florida—8,800; Arizona—6,900; Missouri—6,900; Colorado—6,600 and Texas—5,800. The remaining states combined had 23,500.

It should be noted that the Labor Department survey was confined to "missile activity." The Department defines this as including "research, development or production of complete missiles (including rockets), launching devices, ground control and testing units, propulsion units, war heads, fuel, electronic components, and other parts designed for inclusion in the missile or in ground support equipment."

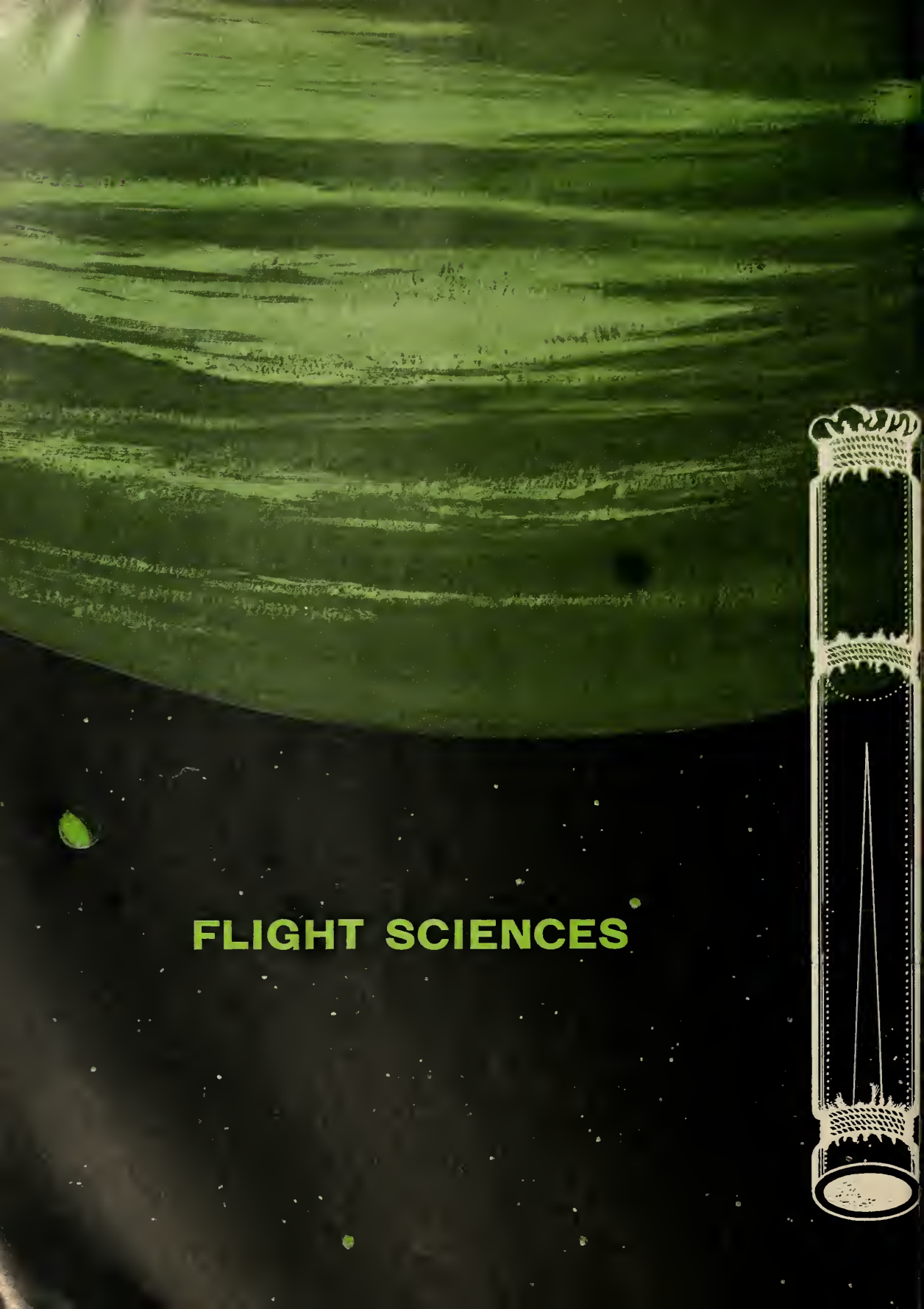
Surprisingly enough, only 433 private . . .
and government establishments were covered in the survey. Missile plants were identified through DOD lists of contractors and subcontractors. "Although it is presumed that the coverage represents the greater proportion of all establishments engaged in missile work," says the department "complete information as to the actual total number of firms engaged in missiles work was not available."

This admission on the part of the Labor Department may come as something of a minor shock to the Small Business Administration and perhaps cast some suspicion on the reliability of the survey. SBA issued more than a year ago a "Missile Sub-Contracting" book containing names, addresses and type of components manufactured by more than 2000 small firms. The SBA also lists more than 1000 R&D concerns—about 300 of them in missiles—in another directory which also was available to its fellow Federal agency.

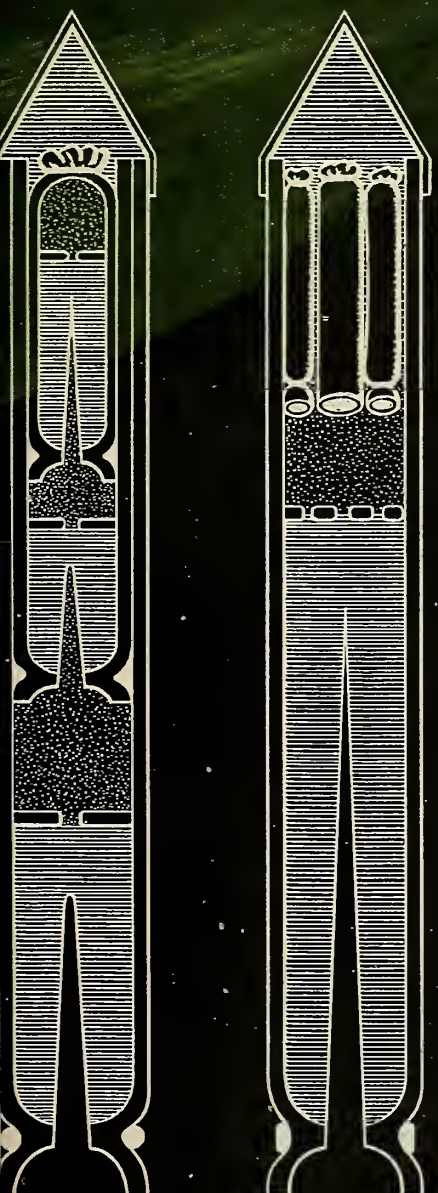
M/R recently has published several surveys which indicate a substantially higher degree of activity than found by the Labor Department.

People hard at work in the $7 billion missile field . . .
may also be interested to know that the Labor Department does not recognize their scope of endeavor as an "industry." Here's the official finding from the survey: Since there are only a relatively small number of establishments in which the principal activity is the production or assembly of *complete* missiles, this does not constitute a sufficiently large body of economic activity . . . for designation as a separate industry."

May we point out: only a relatively small number of companies assemble *complete* autos in the automotive industry.


FLIGHT SCIENCES

FLIGHT SCIENCES: Principle of the step or multi-stage rocket, considered fundamental to the art of modern missiles and space flight, was set forth as long ago as 1650 by Kazimierz Siemienowicz, lieutenant-general of ordnance to the king of Poland. His design featured a 3-stage rocket with each step having its own gunpowder fuel, fuse, and nozzle.



EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Pioneering work at Lockheed is being conducted in free molecular flow in orbital flight; high altitude atmospheric properties; trajectory studies and missile flight dynamics; celestial mechanics with emphasis on orbital tracking predictions and de-orbiting.

Lockheed's capabilities in gas dynamics and thermodynamics are unsurpassed in private industry. Basic work is being performed in boundary layer flow and heat transfer; cooling and insulation; thermodynamic flight test; instrumentation; rocket motor controls and nozzle structures; reentry and materials; thin film thermometry; and measurements of dissociation and re-combination reactions.

Fundamental studies include hypersonic aerodynamics; environmental effects on satellite surfaces; magnetohydrodynamics; ultra-violet and infrared radiation from high temperature air flows; structure of hypersonic shock waves; new measurement methods; analysis of boundary layers near melting surfaces and study of lag or non-equilibrium in high speed flow through shock waves.

Equipment includes an electrically-driven wind tunnel—fastest in industry—which produces airflows to Mach 20-plus and stagnant temperatures approaching 16,000°F, with an instantaneous power output of 20 million kilowatts. A spark-heated, magnetically driven research shock tube produces velocities of over Mach 250 and temperatures of 500,000°F, and a specially designed, electric gun has accelerated projectiles to speeds approaching 20,000 ft/sec.

Major emphasis in structures concerns the design of reentry bodies, thrust termination and underwater launching devices. The Navy Polaris FBM required the solution of complex structural problems necessitated by the unique launching environment—water.

Other significant work has been accomplished in diversified aspects of aerodynamic and hydrodynamic load distribution, aeroelastic effects, studies of special dynamic problems arising from aerodynamic disturbances, cavitation, launching conditions and thermal problems relating to analysis of a complex structure taken through a complete time-temperature environment.

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Finn Finds Feasible Method of Welding Molybdenum for Structures

by John F. Judge

WASHINGTON—The production of molybdenum welds with the strength and room-temperature ductility required for structural applications is now possible through the efforts of the **Finn Aeronautical Division,** Hawthorne, N.J.

The successful spot and fusion welding techniques are the result of several years' research, during which the company also delved into another major molybdenum problem—oxidation at high temperatures. After a thorough investigation of all coatings now available, various coatings have been found which will prevent oxidation of structural members at temperatures above 2000° F.

Finn cannot now reveal the actual method by which it produces satisfactory molybdenum welds, but Vice President Charles W. Brunstetter describes the process this way:

"It might best be considered as a development of new procedures and processes of welding, rather than a new welding method. It can be performed by ordinary welding equipment, and with only the ordinary precautions taken with any high-temperature metal."

The hundreds of weldments already made on an experimental basis have been proved again and again, Brunstetter says, and while further work remains to be done, they have certainly created a wave of interest and subdued excitement throughout the industry.

• **Flattening & recurving**—Among the most impressive of these sample weldments are curved sandwich structures, which are ductile enough at room temperature to be repeatedly flattened out and returned to their curved position.

Such ductility was so unheard of in molybdenum welds that when a U.S. government expert saw it being done during a West Coast exhibit he refused to believe at first that it actually was a molybdenum sandwich . . . and then had to be convinced that a low melting point braze had not been used. Such reactions are typical among the molybdenum experts throughout the country, Dr. J. Z. Briggs of **Climax**

Molybdenum Company said.

"At the very least, it shows that molybdenum welding is possible—that welds with the needed structural strength can be made."

• **Government cautious**—Government molybdenum experts, as might be expected, are somewhat cautious in their appraisal of the Finn results, pending the actual production and use of molybdenum welds in structural applications.

But even so, there is no lack of enthusiasm for the possibilities revealed by the process.

E. W. Matthauser of the Structures Research Division, National Aeronautics and Space Administration, points out one such aspect.

"The ability to use molybdenum structures," he said, "would raise the maximum operating temperatures from the present 1800-2000°F level to the 2500-3000°F level. Such an increase should improve vehicle performance and would permit a wider selection of trajectories for re-entry vehicles."

• **Large pieces**—N. E. Promisel, Chief Materials Scientist of the Navy's Bureau of Aeronautics, said that his organization was keeping a close and interested watch on this new method though he has not had an opportunity to evaluate them in the laboratory, the welded sandwiches he has seen appear very impressive.

"If it can be done on a reproducible basis, with ductility and uniformity in large pieces," he said, "it would indeed be a very important development, in view of the real need for a practical, reliable method of welding molybdenum and its alloys in a variety of gages and large sizes."

This matter of production, of course, is of direct concern to the prime contractors on missile programs. Like the government research men, they are vitally interested in any feasible method of producing welded molybdenum structures.

• **Uniform quality**—In the Finn organization itself, officials are fully aware that more development work remains to be done before large molybdenum welded structures become commonplace, and much of this work is now in progress.

But even now, they feel, the welds already made, and the test results on them, prove that they have found the key to producing perfectly satisfactory weldments for structural uses. The rest is a matter of expanding and perfecting the work already done.

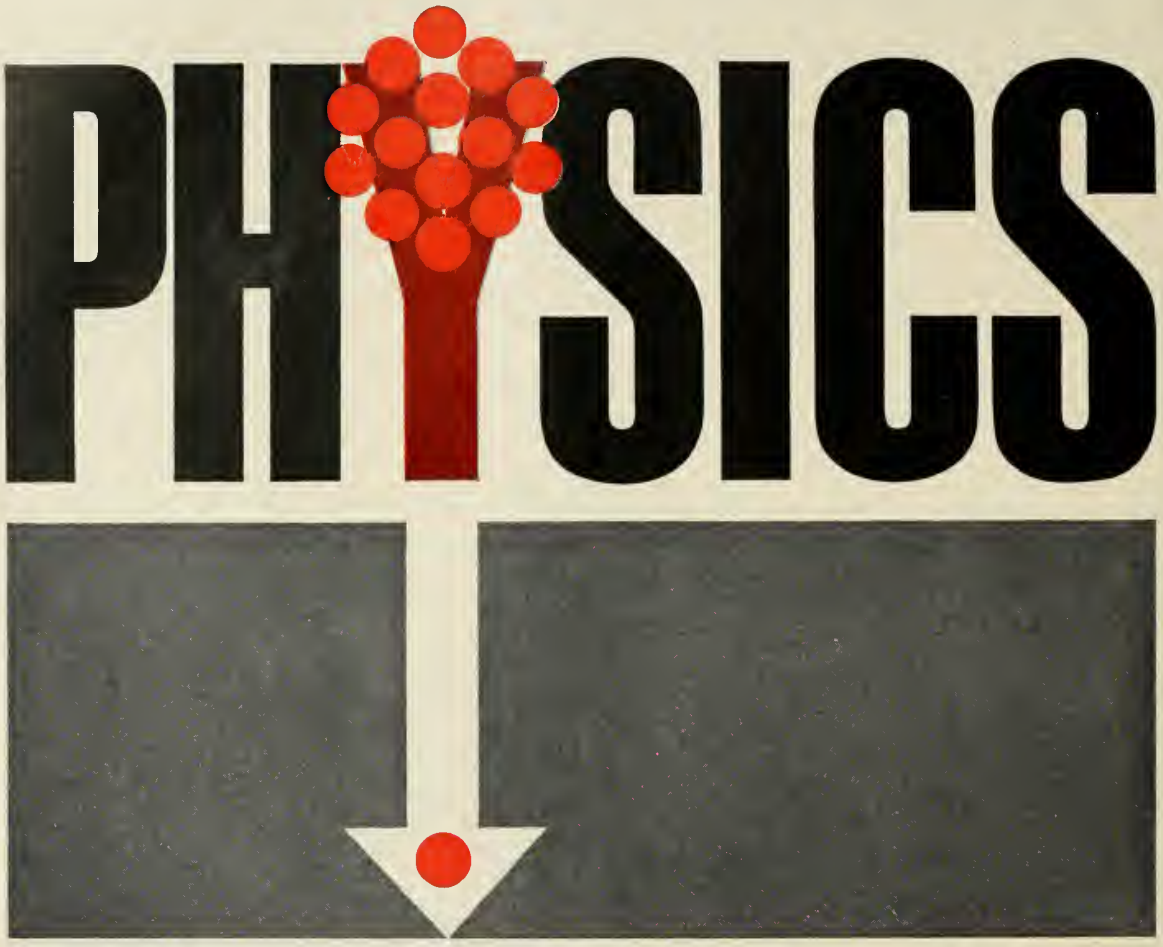
Also of significance, is the interrelationship between welding molybdenum and the other two great molybdenum problems—oxidation at high temperatures and the difficulty of producing sheet after sheet of molybdenum with the same quality in each sheet, or even of maintaining the same quality in all portions of the same sheet.

The ability to successfully weld molybdenum lessens in some respects the importance of both these other problems. For instance, there are some applications where oxidation is not a problem, or at least one of secondary importance. In cases like this it would now be possible to use a welded structure, even if the oxidation problem were never solved.

Successful welding can go a long way toward overcoming the problem of uniform sheet quality, as it is much easier to maintain such uniformity in small sheets than it is in large ones. Since the uniform small sheets can be welded into large ones, it is not difficult to see how satisfactory welding can contribute to uniform sheet quality.

Also, there is a general feeling among industry metallurgists that work such as Finn has done on molybdenum will be a significant help in learning how to work with the other refractory metals, since in many areas the same types of problems exist.

Explore new areas at IBM in



At IBM, scientists, mathematicians and engineers are currently engaged in many unique assignments in advanced physics. For example:

1. Photoelasticity is being studied to determine strain propagation as a function of time in solids. This work is designed to clarify laws governing impulse strain waves, as well as to determine dynamic stresses that exist in impact and other phenomena.
2. Fundamentals of the magnetic properties of materials are under study. The immediate interests are spin-wave investigations, particularly those relating to the switching times of remagnetization and spin-wave propagation in polycrystalline materials.
3. Optical techniques, with organic and inorganic thin films, are being used to examine the properties of absorption phenomena in surfaces and substrates.

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new products

Solid Transducer Detects Near Infrared Light

A solid state radiation tracking transducer that detects position of visible to near infrared light sources is now being marketed by **Electro-Optical Systems, Inc.**

This single element, linear functioning semi-conductor device will detect the angular position from which a light or heat source is radiating and is applicable to tracking, instrumentation, automation control and computed technique. Highly sensitive, the RTT possesses microsecond response characteristics. Its wide angle scope, minute size and self-generating power capabilities add to its extensive application.

In tracking, the RTT's wide angle feature eliminates the need for mechanical positioning. By combining RTT detection capabilities with light source and reflecting surface, the device provides ideal instrumentation for a broad spectrum of transducer applications. It is also highly efficient as a CRT direct readout recorder. RTT is adaptable as a high-speed multiple vector summing device for computer techniques and enables fast accurate measurement and inspection of parts and processes for automation control.

Electro-Optical System
170 N. Daisy Ave.
Pasadena, Calif.

C-Band Microwave Filter Developed by Airtron Inc.

A compact microwave filter which passes only specific frequencies above the pass band is announced by **Airton, Inc.**, a division of **Litton Industries.**

Initial designs constructed are for C-Band operation, but reports say they can be developed for any waveguide size or frequency range from 3000 to 36,000 MVPS and for larger or smaller pass and stop bands. The unit consists of a straight section of waveguide with four E-plane cutoff stub arms located along one broad wall of the waveguide. Higher rejection in the stop band is obtained by using more stub sections.

Stub sections are properly proportioned to yield a certain value of cutoff frequency; stub lengths are chosen so as to be resonant within the rejection band and are stagger-tuned so the rejection band is of the desired width. Microwave energy at frequencies below the stub cutoff frequencies is transmitted through the guide with minimum loss, since each stub appears as a small reactive element in series with the waveguide.

Megawatt C.W.
Airtron, Inc.
Litton Industries
Morris Plains, N.J.


A TALENT FOR AIRBORNE ELECTRONICS
STROMBERG-CARLSON
A DIVISION OF GENERAL DYNAMICS
1400 N. GOODMAN STREET • ROCHESTER 3, NEW YORK

propulsion engineering . . .

BY JAY HOLMES

A new approach to solid propellants . . .
is suggested by Dr. Milton Farber of **Rocket Power Inc.** Instead of using the fuel as a binder—that is, to provide the strength and elasticity needed in the grain—Farber proposes using the oxidizer as a binder. In a paper at the recent **Avco-Air Force** symposium on advanced propulsion concepts, he suggested that fluorine-containing polymers can serve as excellent oxidizer-binders.

Many high-energy fuels . . .
ruled out because they lack binder properties, could be used if an oxidizer could do this job. An important advance might result if the necessary physical properties could be provided by the oxidizer, which already accounts for 70 to 80% of the weight of a composite solid-propellant grain. The advance conceivably might provide the 10-to-20 seconds of additional specific impulse wanted by the Advanced Research Projects Agency of the Defense Department.

Very low molecular-weight product gases . . .
are another approach to this continuing problem. Specific impulse varies inversely as the square root of the mean molecular weight of the product gases. That is, the impulse increases as we reduce the average weight of the molecules of product gases.

This is the reason . . .
underlying the popularity of hydrogen, the lightest element, in both solid and liquid propellant systems. When hydrogen burns in oxygen, the resultant H_2O has a molecular weight of 18. The only practical way to lower the average is not to burn all of the hydrogen. This is done in liquid-fuel systems using liquid hydrogen.

Flame temperature need not be high . . .
if product gases have low enough molecular weight, G. F. Huff of **Callery Chemical Co.** told the symposium. He suggested also that propellant systems need not be considered merely as combinations of oxidizer and fuel. He proposed considering the systems as suppliers of certain amounts of energy and specified combustion products.

This is the approach that solved . . .
the aluminum puzzle several years ago. It was believed on the basis of thermodynamic calculations that adding aluminum powder to a solid propellant grain ought to improve the impulse considerably. Aluminum is a high reactive metal.

There was only one trouble . . .
It didn't work in practice. Adding 9 or 10% aluminum, as called for by the calculations, didn't help at all. No appreciable rise in impulse was noted. Keith Rumbel of **Atlantic Research** re-examined the problem on the basis of combustion products. Obviously, there could be no error of such magnitude in the amount of energy assumed to be in the system. This provided the key. The products had been assumed to be aluminum oxide, carbon dioxide and water vapor.

The actual combustion products . . .
are carbon monoxide, hydrogen and aluminum oxide. The heat added by using 9 or 10% aluminum is used up in dissociating CO_2 and H_2O. When he made his thermodynamic calculation on the basis of these products, Rumbel came up with a requirement for about 20% aluminum by weight. When he tried adding that much aluminum, he obtained the predicted improvement.

The moral of the story . . .
is one that applies in research as well as in ordinary life: Don't take anything for granted.

• **Washington**—The White House was expected to make a "political" appointment in selecting a successor to Defense Department Controller Wilfred J. MacNeil, who is resigning to become president of Grace Lines.

• **Dallas**—There is speculation **Chance Vought's** *Regulus*, dropped by the Navy earlier this year, may be used as an interim target missile for *Nike-Zeus* in tests at Kwajalein. The air-breathing *Regulus* can carry about 1000 pounds of electronic gear as a target and possibly may be modified to radar-simulate various types of re-entry bodies.

• **Washington**—Congress was urged to straighten out a conflict between U.S. Patent laws and "second source" procurement requirements of the Defense Department. George J. Pandapas, president of **Electro Tec Corp.**, Hackensack, N.J., said patented inventions with a "legal . . . protected monopoly" frequently are "shunned" by DOD agencies which insist upon at least two sources of supply.

• **Tyndall AFB, Fla.**—Gen. Benjamin W. Chidlaw (USAF Ret.), vice president of **Thompson Ramo Wooldridge, Inc.**, predicted that within 10 years it will be possible to watch through TV on earth the action of space ships and "our personnel operating a defense program for outer space."

• **Cambridge, Mass.**—Fred L. Whipple, Director of the Smithsonian Astro-physical Observatory, said that "telepuppets"—remote-controlled robots with TV eyes —probably will build the first space platforms for launching moon and interplanetary expeditions. In a report to the Office of Naval Research, he said he doubts that it would be safe or efficient to have the work done by human beings wearing space suits.

• **Los Angeles**—A miniature carbon dioxide sensing device to check the air supply for the first Project *Mercury* pilot will be developed by **Beckman Instruments, Inc.** The company will build 13 of the sensors under a $48,000 order from **McDonnell Aircraft Corp.**, makers of the *Mercury* capsule.

• **Washington**—The Navy is pushing an equatorial launching of space vehicles from ships, rather than a costly Pacific island site. Several major contractors are teaming up with A&E outfits to submit proposals. NASA is due to issue a report shortly on the feasibility of an equatorial land site.

• **Washington**—Negotiations to establish IBRM bases in Greece have come to a standstill and are not expected to be resumed. However, an agreement to place a single IRBM squadron in Turkey was due for announcement soon, government officials said.

• **Fort Belvoir, Va.**—An Army Nuclear Weapon Coordination Group has been set up here to monitor the Army weapons program from design stages through operational capability. The group also will work in the field of nuclear weapon ssafety.

Advances Reported in Working 'Exotic' Metals

Exotic metals for spacecraft took several strides forward last week.

Standard Pressed Steel Co. opened a $100,000 pilot plant operation for fabricating bolts and other threaded parts of beryllium. Standard is using bar stock of 125,000 psi tensile strength, equal to 500,000 psi steel on a strength-to-weight basis.

The **Bendix Aviation Co.** obtained a patents license covering alloys of zirconium, the rare earths, thorium and magnesium from **Magnesium Elektron Ltd.** of Manchester, England. The Bendix Foundries at Teterboro, N.J., will make use of the Elektron casting process.

Stauffer-Temescal Co., an affiliate of **Stauffer Chemical Co.**, announced development of a series of tantalum-tungsten alloys with melting points ranging from 5430 to 6150°F, which retain tensile strength of about 15,000 psi at 4500°F. Stauffer and **Aerojet-General** jointly worked on their application to critical components of solid-fueled rockets. The alloys are produced by Stauffer's electron-beam melting techniques.

Westinghouse reported perfection of a process that makes it possible to construct large objects of tungsten, molybdenum and other strong high-temperature metals. The process compresses metal powders into bars, after which they are baked in an oven.

The **Pyromet Co.** of South San Francisco, Calif., said it has developed a high-vacuum furnace for brazing and heat-treating titanium, beryllium, zirconium, molybdenum, tungsten, tantalum and niobium. The furnace can hold a 10^{-6} mm vacuum at room temperature and 10^{-4} mm in the 1800-2000°F range.

Mergers & Expansions

Federal Manufacturing and Engineering Corp., Garden City, N.Y., moved into missile tracking and photographic instrumentation with the acquisition of **Cameraflex Corp.** and **Television Specialty Co. Inc.** . . . **Consolidated Electronics Industries Corp.** took over **Philips Industries Inc.** and **Central Public Utility Corp.** to form a new electrical, electronics, pharmaceutical, chemical and utility concern at Wilmington, Del. The merged firm declared an immediate 25-cent dividend. . . . **Documentation Inc.** of Washington, D.C., was merged into the **Benson-Lehner Corp.** of Santa Monica, Calif. Benson-Lehner said Documentation's data-retrieval techniques will prove valuable. . . . **Chance Vought Aircraft** made a similar move with the acquisition of **National Data Processing Corp.**, also of Dallas. . . . To obtain major metal fabrication facilities so it can bid on "many important projects," **Telecomputing Corp.** of Los Angeles bought **Monrovia Aviation Corp.** which had been a subsidiary of **Carrier Corp.** . . .

To be closer to missile-makers, **Johnston & Funk Metallurgical Corp.** moved its headquarters and plant from Wooster, Ohio, to Huntsville, Ala. . . . **Electronautics Corp.**, a new enterprise, was formed in Maynard, Mass., to manufacture reinforced plastics for the electronic and astronautic industries.

ABMA Switch Leaves Space Plans Uncertain

By William E. Howard

WASHINGTON—The future of the nation's space program remained in doubt last week following transfer of the Army Ballistic Missile Agency to NASA and with it responsibility for large space booster development.

In ordering the switch to civilian control, President Eisenhower left open these questions:

- Whether there will be an increase in funding for NASA and, if so, how much.
- Whether the 1.5 million-pound-thrust *Saturn* vehicle being developed by ABMA would be dropped in favor of some other large engine—possibly the 400,000-pound **Rocketdyne** E-1—or continued.
- Whether the move will signal the start of a "crash" program to try and overtake Russia in the conquest of space.

There was also some speculation immediately after announcement of the shift last Wednesday whether Dr. Wernher von Braun, civilian chief at ABMA, would stay with his team. Von Braun said earlier in the week that should ABMA be denied a "challenging" job under civilian control, he would resign.

Transfer of ABMA takes the Army completely out of the space field. All military space projects were placed under the jurisdiction of the Air Force last month. DOD has said it has no immediate requirement for a booster as big as *Saturn*. Presumably, if such a requirement does come up in the future, the booster will have to be procured through NASA.

The President said the shift to NASA was intended to "strengthen the national space effort and provide for America's changing requirements in this field."

Von Braun's Development Operations Division, which includes 4300 persons at Huntsville, will be integrated into NASA immediately—although under the Space Act Congress has the right to object anytime within the first 60 days of the session starting in Jan.

- **Reservations**—Several high NASA officials are known to be lukewarm both about having the ABMA group handed them, because of the lack of funds, and about *Saturn*, which is considered by many to be much too costly for its space needs. Consideration reportedly is being given by DOD to clustering a pair of E-1 engines into an 800,000-pound-thrust booster. This approach is said to be cheaper than the *Saturn* cluster for which $100 million already has been programmed and which is expected ultimately to cost $300 million or more.
- **Thrust years away**—NASA already is developing the 1.5-million-pound-thrust Rocketdyne F-1 (formerly known as *Nova*). About $20 million is being spent in FY 1960 on the F-1, and it is expected to take about six years to perfect the single-chamber booster. Later, it is planned to cluster four or Six F-1's into one booster of upwards of 6 million pounds thrust. However, this will take an additional two or three years.

Until these multi-meg boosters are ready, the U.S. will be competing against Russia with boosters only as big as the 360,000-pound *Atlas*, and be prevented from attempting any manned exploration of space outside of the *Mercury* orbital capsule. Many space experts have been urging a speedup in big booster development to compete with the 800,000-pound-thrust Russian rockets.

The decision to transfer ABMA came after a 70-minute White House conference of the President and his top military and space officials—and including acting Budget Director Elmer Staats. Army Secretary Brucker did not attend. But sitting in were Defense Secretary McElroy; Gen. Nathan M. Twining, chairman of the Joint Chiefs of Staff; NASA Chief Dr. T. Keith Glennan and his deputy, Hugh Dryden; Deputy Defense Secretary Thomas S. Gates; Dr. Herbert York, DOD's director of research and engineering; and Mr. Eisenhower's science adviser, Dr. George Kistiakowsky.

Bringing the issue to a sudden boil was Maj. Gen. John B. Medaris' decision to quit as chief of the Army Ordnance Missile Command. Medaris made the announcement Monday night. The next morning, at a breakfast meeting in Washington, Von Braun lashed out at the leisurely and indecisive pace of the entire space program. He implied that this was the reason Medaris was resigning. Medaris later denied his resignation was an act of protest. He said he was "tired" and had actually handed in the letter 60 days previously, long before the Air Force was given the dominant role in military space activities.

Von Braun declared that the nation was "wasting time and energy in ponderous reappraisals and re-examinations" of space programs. A big booster program must be pursued boldly, he said, "if we don't mean to abandon the heavens to the Reds."

MISCELLANEOUS

Robertshaw-Fulton Controls Co., Aeronautical & Instrument Division, Richmond, Va., has received two contracts for special change-of-state components ovens for use in a missile tracking system being designed by Space Technology Laboratories, Inc. Amounts not disclosed.

$838,163—The Martin Co., Nuclear Div., for development of a simplified and highly advanced nuclear reactor system.

$400,000—Radiation, Inc., for a highly advanced PCM flight test data acquisition and data processing system. (Subcontract from Norair Division, Northrop Corp.).

$200,000—Hallamore Electronics Div., The Siegler Corp., for (1) design and manufacture of special checkout equipment for LMSD space vehicles, (2) design fabrication and installation of modifications to a tracking antenna in Hawaii; (3) for special shipboard power supplies for atomic submarines. Three contracts.

NAVY

Tasker Instruments Corp., Los Angeles, for development and production of special launcher test sets for the *Sidewinder* missile. Amount not disclosed.

ARMY

$7,300,000—Hughes Aircraft Co., Culver City, Calif., for increasing the capabilities of the company's missile monitor system used in connection with the *Nike* and *Hawk* missile batteries.

$1,608,000—Telecomputing Corp., Los Angeles, for production of gyro systems for the *Nike-Hercules* ground-to-air missile. (Subcontract from Western Electric Co.)

$1,000,000—Summers Gyroscope Co., Santa Monica, Calif., for a quantity of "free" gyros destined for use in the *Lacrosse* missile. (Subcontract from The Martin Co.-Orlando.)

$500,000—Temco Aircraft, Dallas, Tex., for building aluminum shipping and storage containers for *Sergeant* missiles.

$200,000—Dunn Engineering Associates, Inc., Cambridge, Mass., for design and construction of specialized electronic test equipment for production testing of radome and radar antenna components of the *Hawk* missile. (Subcontract from Raytheon Co., Missile Systems Division.) Two contracts.

$199,779—J. R. Cantrall Corp., El Monte, Calif., for radar tower at Norad Control Center.

$22,956—Potter Instrument Co., Plainview, N.Y., for digital magnetic tape recorder reproducer.

AIR FORCE

Food Machinery and Chemical Corp., San Jose, Calif., for building support equipment for *Bomarc*. (Subcontract from Boeing Airplane Co.) Amount not disclosed.

$30,271,000—Boeing Airplane Co., Seattle, for spare parts and support equipment.

$7,776,637—Hughes Aircraft Co., Culver City, Calif., for repairs and modification of fire control and weapons control systems components.

$505,000—Varian Associates, Palo Alto, Calif., for electron tubes.

$432,186—Prodelin, Inc., Kearny, N.J., for radio frequency transmission line acceptable fittings and hardware, pressurizing system for use with *Bomarc* GATR sites.

$400,000—Consolidated Avionics Corp., Westbury, N.Y., for a large scale data processing system involving advanced computer techniques. Classified contract.

$200,000—System Development Corp., Santa Monica, Calif., for additional facilities for the SAGE programming and training program.

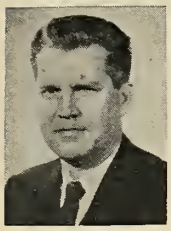
$200,000—Stellardyne Laboratories, Inc., El Cajon, Calif., for extensive testing and evaluation work on missile components.

$100,000—Jonathan Manufacturing Co., Fullerton, Calif., for delivery of an undisclosed quantity of ultra-thin ball-bearing slide mechanisms for *Bomarc B* ground installations. (Subcontract from Aero-Space Div., Boeing Airplane Co.)

$81,924—James Pastoriza Associates, Boston, for development and construction of a satellite orbit simulator and display prototype.

$70,000—The Perkin-Elmer Corp., Norwalk, Conn., for optical systems to be incorporated into satellite tracking cameras.

people



ZAMBROW

Dr. John L. Zambrow has been appointed director of engineering for Sylvania-Corning Nuclear Corp. He has been with Sylcor for the past ten years, most recently as manager of the Metallurgy Dept., and was previously associated with Culter-Hammer Manufacturing Co., Battelle Memorial Institute and Ohio State University Research Foundation.

Aikman Armstrong has been appointed chief application engineer for nuclear products, marketing division of The Marquardt Corp.'s Power Systems Group.

With 25 years in the field of engineering, business administration and law, Armstrong formerly served as executive assistant in contracts and proposals at North American Aviation, and as assistant general manager of Turbocraft Co. He also was chief staff and administrative engineer in the nuclear projects department at Aerojet and was associated with the Atomic Energy Commission as chief of the process engineering section.

JATRAS

Stephen J. Jatras has been named director of engineering for Lockheed's Electronics and Avionics Division.

Jatras joined the the company in 1956 as a staff scientist in the Missiles and Space Division, serving as business administrator for the research branch and manager of the flight controls and guidance division before becoming assistant to the director of research.

Prior to joining Lockheed, he was vice president and chief engineer of Midwestern Instruments, Inc.

Consolidated Electrodynamics Corp. has named **Herbert I. Chambers** as associate director of the DataTape division. He will direct the activities of the Engineering Dept., Special Projects Dept., and Magnetic Head Section. **Fred F. Grant,** formerly a senior supervisory engineer, was named manager of the Engineering Dept., and **Edgar E. Hotchkin,** a senior development engineer, named manager of the Magnetic Head Section.

Dr. John J. Myers has joined the research staff of Hoffman Electronics Corp.'s Science Center as a senior scientist.

Dr. Myers, former research assistant

professor at the coordinated Science Laboratory of the University of Illinois, will be responsible for studies in industrial electronics, including data processing.

Dr. K. N. **Satyendra** has been elected director of research, Electronic Systems and Equipment Dept., at Nortronics division of Northrop Corp. He will direct studies and research in applied sciences and technologies directly relating to space electronics.

SATYENDRA

Dr. Satyendra formerly associated with the Advanced Systems Planning Group of Westinghouse Defense Products, directing long-range research and development programs in space technology. He joined Westinghouse in 1954 as a member of the Air Arm division and was principal investigator in many weapon system studies.

General Electric's Rocket Engine Section has announced establishment of a new organization responsible for the manufacture of solid rocket cases, naming **R. H. Wettach**, manager.

Wettach joined GE in 1950 as a test engineer and subsequently held assignments in the assembly and manufacturing operations of the company's Production Engine Dept.

Bernard M. Goldsmith has been appointed president of Nytronics Inc. He was formerly president of Essex Electronics. Nytronics Inc. is a recent consolidation of three companies now operating as divisions of the parent company—Essex Electronics, Essex Electronics of Canada and Sutton Electronics.

William B. Bergen, president of The Martin Co., has been named a director of The Black & Decker Manufacturing Co., replacing the late **Stanley B. Trott.** Bergen, who began his career at Martin in 1937 as vibrations engineer, has been president of that firm since last April and was responsible for initiating development of the Air Force TM-61 *Matador* missile and the Navy's *Viking* research rocket.

BERGEN

G. W. McGinley has been named sales manager of Stromberg-Carlson division of General Dynamics Corp., responsible for all sales activities for the firm's line of high-speed electronic printers, data display and recording devices. charactron-shaped beam tubes and other electronic equipment.

Prior to joining the company, McGinley was supervisor of system sales for Union Switch and Signal division of Westinghouse Airbrake Co.

The following appointments have also been announced:

Cooper Alloy Corp. has made two changes within its marketing division: **Stuart F. Cooper** from sales manager, Foundry Products Division to sales manager, Vantom Pump and Equipment Corp. division; **Harold W. Rimalover** from sales engineer to sales manager, Foundry Products division.

Maj. Gen. Donald N. Yates has been designated DOD representative for Project *Mercury* support operations. **Capt. James G. Franklin,** Navy, will assist Gen. Yates in the recovery operation.

The Range Systems division of Chance Vought has announced the following appointments: **S. O. Perry,** division manager; **C. H. Coleman,** manager of engineering branch; **J. F. O'Marah,** manager of business branch, **W. S. Micchelli,** manager of operations branch.

James Guardia, formerly design engineer with Jacuzzi Pump Co., has joined the design group at Tinsley Laboratories, Inc.

Mercast Manufacturing Corp. has announced appointment of **John Weaver,** former chief project engineer for B. H. Hadley Co., as director of customer relations, succeeding Michael Gladstone.

Tudor A. G. Randell has joined the staff of Dr. Peter A. Castruccio, Technical Director of Aeronca Manufacturing Corp.'s Aerospace Division, as chief electrical engineer.

Avtron Manufacturing, Inc., has appointed **Arthur F. Pelster,** formerly a vice-president of Leland Electric, vice-president-sales, and **Ruben Kazarian,** prior assistant chief engineer at Ohio Crankshaft, chief engineer.

E. M. Armstrong, formerly with Coleman Engineering Corp., has been chosen director of customer relations for the Electric Machinery & Equipment division, American Electronics, Inc.

Republic Aviation Corp., has announced two special administrative appointments: **Richard G. Bowman,** who has served the company in a number of executive engineering posts since 1935, has been made technical assistant to the president, and **Carver T. Bussey,** special assistant to the president.

Russell J. Jameson, formerly with Foote Brothers Gear & Machine Corp., has joined Dalmo Victor Co. as manager of the methods and industrial engineering department.

—reviews—

OPTIMUM FREQUENCIES FOR OUTER SPACE COMMUNICATION, Army Radio Frequency Engineering Office, Washington, D.C. Order PB 151629 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 33pp. $1.

This report has been compiled as a preliminary investigation to provide Army frequency officers, engineers and project officers with a general appreciation of the propagation and frequency aspects of space communication as known to date, and to provide a point-of-departure for further study and discussion of this subject.

A further detailed study directed solely to radio propagation aspects is under preparations.

THE CORROSIVITIES OF PLASTICS AND RUBBERS, H. A. Perry Jr. and others. Order PB 151750 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 41pp. $1.25.

Studies confirmed that some plastics and rubbers can corrode metals in humid surroundings. The cause appeared to be the release of electrolytes which are dissolved in water films and droplets on metals surfaces in concentrations heavy enough to bring galvanic corrosion.

In a few materials, volatile electrolytes such as ammonia and hydrogen are released. The most corrosive plastics and rubbers apparently are phenolic molding compounds, foams, and casting resins. Those containing cellulosic fillers appear worse than mineral filled phenolics.

Also corrosive are chloroprene rubbers, suffer-vulcanized GRS rubbers, poly esters, vinyls and halocarbons (under thermal degradation), and the two-step phenolics.

Three techniques for testing corrosivity are described. The best, which permits identification of water-soluble ionic constitutents which contribute to galvanic corrosion, is recommended for use with thermosetting or thermoplastic organic resins, inorganic or organic plastic fillers, laminates, adhesives, and natural and synthetic rubbers.

TENSILE PROPERTIES FOR THREE THERMOPLASTICS OVER SIX DECADES OF RATE, R. E. Ely, Redstone Arsenal, U.S. Army Ordnance Corps. Order PB 151573 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 75p, $2.

Tensile properties for ethyl cellulose, and polymethyl methacrylate are reported for testing machine crosshead velocities of 0.02 to over 5000 in/min.

Polyethylene data are given for a slightly smaller range of velocities. Fracture times varied from a few milliseconds to hundreds of minutes.

A pneumatically operated, high speed machine and a standard tester were used. Temperature ranged from –76 to 158°F, with a few tests as low as –320°F.

The range of tensile strengths in one case was over 1000%. Brittle points were found to high rates and low temperatures. Included are some data for ultimate strains and elastic moduli.

ADVERTISER'S INDEX

EMPLOYMENT SECTION

CLASSIFIED

A Captive Small Business?

There are probably more misconceptions about Small Business and the role it plays in the defense industry than there are concerning almost any other field of American business.

Unfortunately a great deal of this misconception is in the minds of the Congressmen who will come up at the next session with a number of proposals, some or any of which may be enacted into laws covering the Small Business field.

The great danger is that any laws passed under these misconceptions may not, in the long run, aid Small Business. They are, however, very likely to make Small Business, or that portion dealing in government contracts, actual captives of the government.

Let's take a look at some of the erroneous notions which have been carefully fostered:

1. Competent Small Business prefers advertised bids.

2. The negotiated bid is a pretty shady operation and usually results in favoritism.

3. Government buyers use negotiation to exclude the little guy; it's a device to favor the big primes.

4. Advertised bidding means that everyone is being treated fairly and automatically means also the lowest cost to the government. (Also that non-defense industrial buying is usually done by advertising.)

5. By ignoring learning curves, tooling problems—that the Defense Department is to blame for not getting all design data from the R&D phase of a weapon system so competitive bids may be let for subsequent production.

6. That government money pays for the design of all components of weapon systems, hence these designs belong to the public.

7. That the Department of Defense favors the big primes by design, that the weapon system is a result of this, and that big contractors will automatically try to retain component making in order to keep all the money in the house.

Actually, none of the above points is true, or true to any important degree, but who can make this fact known to Congress?

Big Business can't do it. As someone has said, Big Business is automatically considered to be self-serving—and a little too rich to be honest.

This leaves Small Business, itself. And Small Business is really the one to do it, because small manufacturers stand to gain or lose the most if new laws tend to make them captives instead of free competitors.

The average Small Businessman is a pretty rugged individualist. He had to be to start and to survive. Also, he is a busy man and the more successful he is, the busier. Normally, he has neither the time nor the inclination to go to the Small Business Administration or to his Congressman.

If you ask him individually, he doesn't want or expect to be favored in price over anyone. He doesn't like the principle of renegotiation any better than the big prime. He isn't very keen on going to the SBA for help. He *doesn't* favor the advertised bid over the negotiated bid. And, above all, he doesn't want a direct government contract. He usually hasn't the capital to handle it and, more important, he wants to protect the proprietary rights to the components he develops himself. He would much rather be a subcontractor.

But he is the man who is going to have to tell this to Congress—or to the Congressional staffs which usually draft the proposals—if he doesn't want to face the alternatives. These include SBA participation in prime contract negotiations; SBA influence in subcontract source selection; giving government agencies greater power in "make or buy" decisions or placing an SBA representative in prime plants for that purpose.

We can't quite believe that the responsible Small Businessmen want this degree of socialism, control, government supervision or what have you thrust upon them by act of Congress. We can't believe they want to be captured and reduced to the lowest or even mean level of competency. But they are the ones who are going to have to communicate this to Congress. It's election year and "Aid to Small Business" is a nice nebulous phrase that sounds good in a stump speech.

CLARKE NEWLON

He put a new twist in an old trick

His problem was to take a 3"x6"x 3-foot piece of wave guide tubing made of .08-inch thick aluminum and to twist one end 90° to the other *without buckling or stretching any part of it...so that a cross section taken anywhere along its length remained a perfect rectangle.*

The standard solution for a problem like this: Support the tube internally with a solder-like substance that's melted in, cooled, melted out after twisting. It won't work here because the mass of the substance is too great.

Here's how this AMF production engineer found the answer. First, he visualized the concept that, in any symmetrical twist, *the center axis never moves.* Then he applied this concept by stringing a metal rod through the center of 288 rectangular shims, inserted them in the tube, cushioned them with the same solder-like substance. Jaws clamp on either end. One of them rotates *slowly* (twisting time: over 2 minutes) giving the metal time to flow. The result: Perfect twists, every time.

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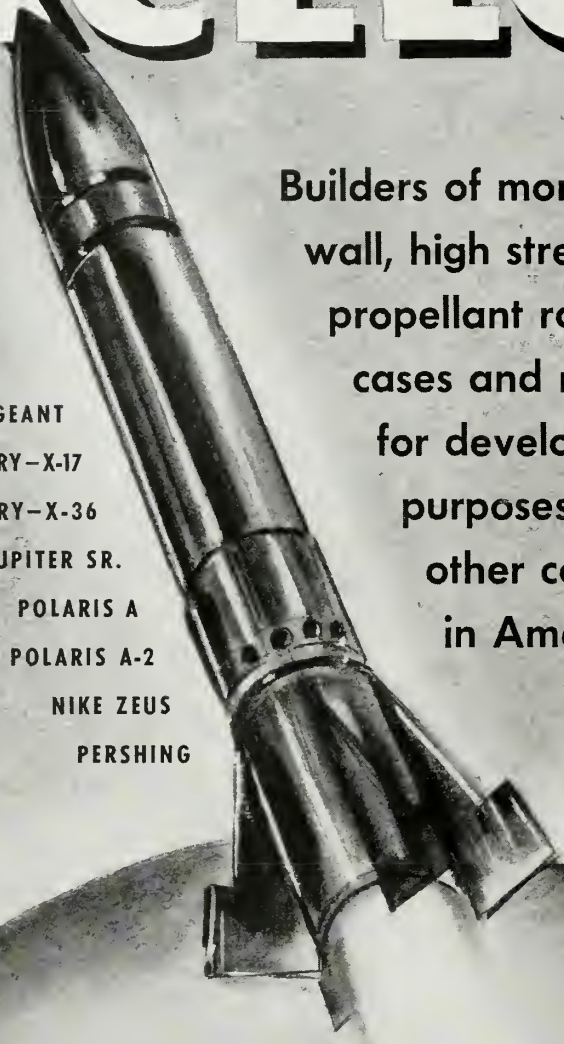

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