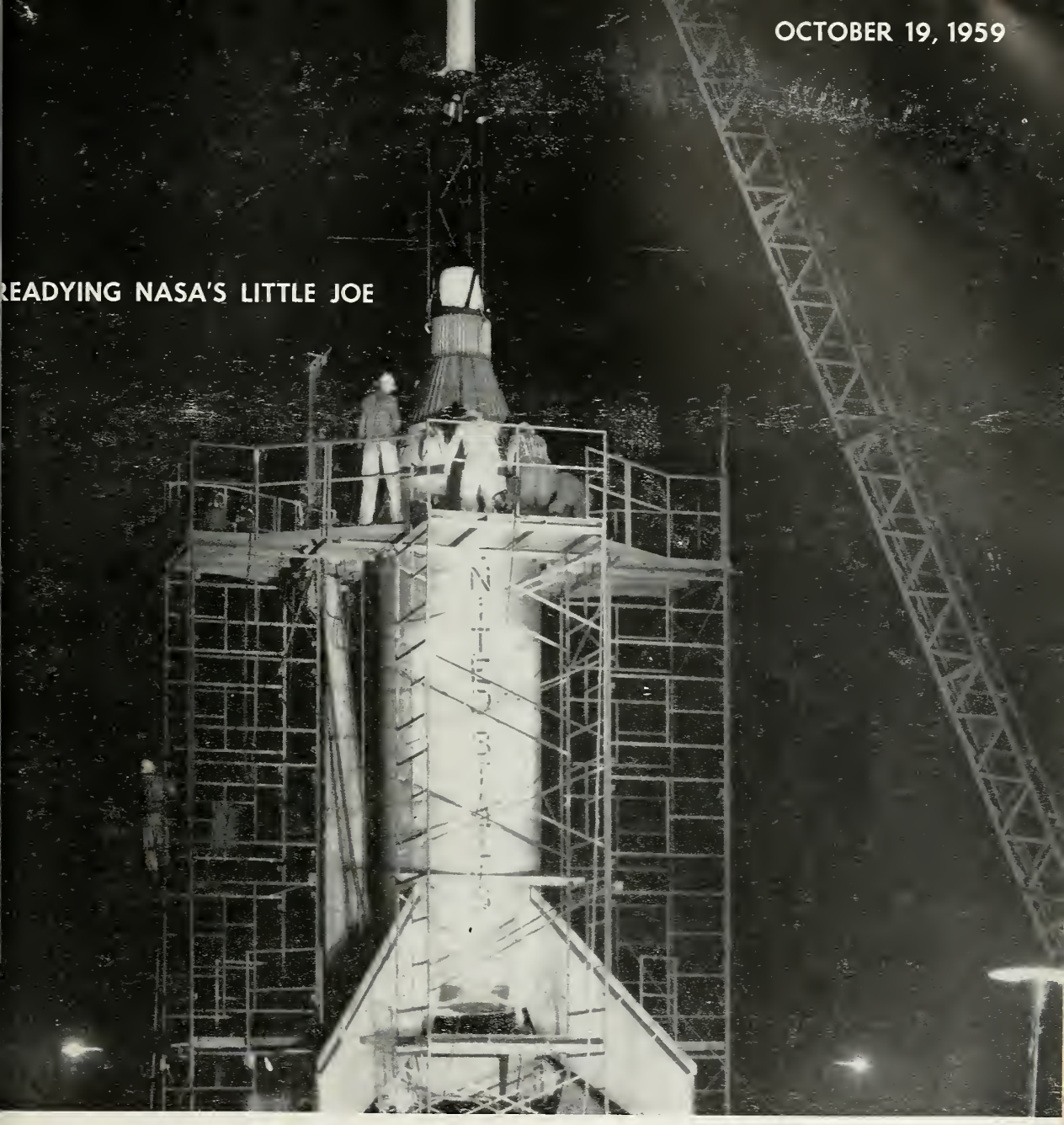
OCTOBER 19, 1959



READYING NASA'S LITTLE JOE

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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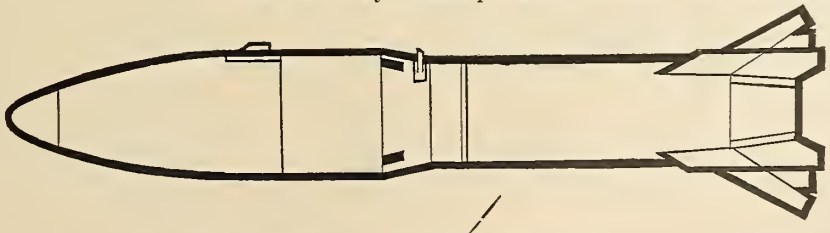
Air Force interceptor fires a "live" *Genie* atomic missile

The missile:

. . . the Douglas-built *Genie*. This nuclear missile has actually been fired in flight. Retractable fins allow the missile to nest close to the plane's fuselage. Or it can be carried in the bomb bay. Interceptors can be armed with two *Genies*.



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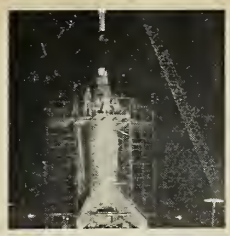
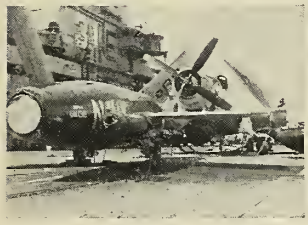
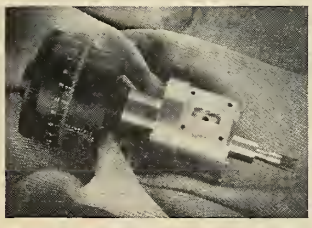


COVER: NASA's *Little Joe* was successfully launched for the first time at Wallops Island, Va., recently. A report on the annual inspection at the Langley Research Center starts on p. 11.

ACHIEVER guidance system undergoes simulated flight tests at AC Spark Plug's Milwaukee labs. The company is a major factor in surging Great Lakes Area missile/space activity. See p. 17.



IRRADIATION of *Regulus I* by radar mounted on plane on Navy carrier. A report on Navy's Project *HERO*, studying the hazards of R-F radiation, begins on p. 21.



WAVEMETER with precision of about 3 parts in a million was developed by National Bureau of Standards for its broad study of dielectrics aimed at obtaining better measurements and materials. Turn to p. 37.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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OCTOBER 19 HEADLINES

ASTRIONICS

ASTRONAUTICS ENGINEERING

U.S. Reg. Pdg.

MISSILE SUPPORT

U.S. Reg. Pdg.

NEW MISSILE PRODUCTS

THE MISSILE WEEK

U.S. Reg. Pdg.

DEPARTMENTS

Lockheed's endless-loop tape recorders

DEVELOPED FOR SPACE COMMUNICATIONS, the recording capabilities of Lockheed's new endless-loop tape recorders are creating interest wherever the need exists for stored data in a critical environment. The original design is now operational in delayed and continuous recording and playback of stored data. Its endless-loop mechanism records and plays back in the same direction of tape travel . . . without rewind. Variations of this lightweight, small size, low power consumption unit are available in a wide range of tape speeds and multiplicity of tracks. For more information on advanced recording techniques to meet your recording needs, write Marketing Branch, Lockheed Electronics and Avionics Division, 6201 East Randolph Street, Los Angeles 22, California.

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Washington Countdown

IN THE PENTAGON

An anti-satellite missile . . .

R&D program is expected to result from the successful Air Force launching of an airborne missile at the *Explorer VI* paddlewheel satellite. The last of a series of **Martin** *Bold Orion* test vehicles roared through the satellite's orbit scoring a deliberate near-miss (within 20 miles). The big question: Will the Air Force seek development of a separate anti-satellite missile or try to give the **Douglas** *ALBM* a dual role?

• • •

The next *Transit* . . .

satellite is still scheduled to be launched in late winter (M/R Oct. 12). Top officials say reports of plans for earlier launchings are erroneous.

• • •

New space radiation studies . . .

2000 miles above the earth will be conducted by the Air Force during the next three months. **Aerolab Development** *Journeymen* will carry 115-pound payloads through the Van Allen radiation belts. The last of three Aerolab *Javelins* also will be fired 1000 miles above the earth with the same size payload.

• • •

A second-stage snag . . .

that caused a *Polaris* test vehicle to fall short of a planned 900-mile flight Oct. 12 apparently was a random failure resulting in loss of pressure. The test-vehicle was the second of the new 900-mile series. The first went the full range.

• • •

Discoverer trouble . . .

is believed to have been solved. ARPA scientists have corrected what they think has caused repeated failures in recovering *Discoverer* satellite capsules from orbit.

ALONG EMBASSY ROW

The Turkish IRBM base . . .

being planned by the United States and Turkey is expected to be armed with **Douglas** *Thors*. The Turks are expected to be given one 15-bird squadron. The 1500-mile range *Thors* would be capable of hitting most of European Russia and Western Siberia.

• • •

The first French IRBM . . .

will have a solid and packaged-liquid propellant so that it can be installed in hardened sites. The French are expected to shoot for a 2000-mile range.

A Philippine missile base . . .

apparently is being sought by the United States. It probably would be used for deploying **Martin** *Matadors* or *Maces*—both capable of striking the Red Chinese mainland from the Philippines with big nuclear warheads.

AT NASA

Wings may sprout . . .

on the Project *Mercury* capsule. Engineers are seriously considering using them in order to ease re-entry. The wings probably would be foldable.

• • •

Wanted: More data . . .

on aerodynamic heating of the *X-15* rocket plane in full-scale free flight. So far scientists have been unable to get all they want to know about it in the laboratory. They expect to have to go to the real thing to get the answers. Some 650 thermocouples have been placed throughout the rocket plane to record temperatures.

AROUND TOWN

The Martian-made satellites . . .

that some Russians believe may be orbiting the Red Planet are not getting the ha-ha from a number of U.S. scientists. Even scientific speculations labeled "made in USSR" get respect these days.

• • •

Worried U.S. space lawyers . . .

continue to try to get the Administration to worry about future Soviet space claims. The legal experts warn that time is running out for reaching agreements on such problems as who owns the moon and when is a reconnaissance satellite not a Peeping Tom.

• • •

Some of the reports . . .

being passed as "the latest" in the nation's capital:

. . . The government is showing an increasing interest in the shipping of cargo by air-breathing missiles.

. . . The Russians are considering launching a spacecraft with two men and two women on a "one-way" trip around the moon.

. . . The pressure is on to kill the development of the solid 700-mile-range *Pershing*.

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Industry Countdown

MANUFACTURING

Market for a variety . . .

of short-range, air-launched missiles may be created by successful firing of **Nord's** wire-guided anti-tank *SS-10* and *SS-11* from U.S. Army helicopters and fixed-wing aircraft (See p. 26). Army has 6000 recon air vehicles, many of them capable of providing close-in troop support with missiles.

• • •

French *Masurca* and *Malafon* . . .

missiles will be used to equip the country's first 5000-ton "pocket" missile cruiser. *Masurca* is surface-to-air and *Malafon* is an ASW surface-to-underwater missile. The French Navy decided to go ahead with *Masurca,* although similar U.S. missiles have better performance, because existing ships would have to undergo major modification to accommodate U.S. guidance systems. The Navy also doubts whether U.S. missiles can be manufactured successfully under license by French industry.

• • •

Japan now has four . . .

missile development teams. The latest, formed last month, brings together six Mitsui Group companies into the Missile and Technique Research and Development Group. The members—**Tokyo Shibaura Electric, Fuji Heavy Industries, Japan Steel Works, Dai Nippon Celluloid, Tokyo Instrument** and **Mitsui & Co.**—will use **Raytheon** *Hawk* for research.

• • •

Latest addition to ASW . . .

field is **Avien Inc.,** Woodside, N.Y., which is forming a new Department of Undersea Technology. Heading up the undersea instrumentation and propulsion effort is former **Fairchild Engine & Airplane Co.** USW expert Woodford M. Rand.

PROPULSION

Fuel injector . . .

of **Rocketdyne's** 1.5-million-pound-thrust single-chamber F-1 engine has been tested above one-million pounds thrust. Kerosene and LOX were pumped into the combustion chamber at the rate of three tons per second. Combustion generated temperatures in excess of 5500°F.

Standing idle . . .

Rocketdyne's 400,000-pound-thrust single-chamber E-1 engine. The Air Force says it hasn't any immediate requirement for it and, apparently, NASA hasn't the money to put a vehicle around it—even though the engine might be a major asset to the nation's faltering space program.

ASTRIONICS

Sequel . . .

for its ALBM guidance, **Douglas** last week picked the **Nortronics Division** of **Northrop Corp.** M/R reported July 6 (p. 11) ALBM specs would demand "complete digital system for stellar acquisition, interpretation and readout measured in seconds rather than minutes. Manufacturer who produces quickly, therefore, has a lucrative opportunity." At that time, for security reasons, M/R withheld the fact that Nortronics had such a system already in being.

• • •

'Second-source' . . .

procurement policy of DOD is taking the motive out of company-paid efforts to produce better missile components. Military officials have held up acceptance of improved devices—in one case a miniature servo motor—until a competitor is found who can make the same item. Thus, the originator loses the advantage bought by his R&D investment.

• • •

Getting tiny motors . . .

to operate at high temperatures is mostly a problem of improved lubrication. However, demand for this type of heat-resistant oil would be so small, it wouldn't pay the R&D cost—a mounting problem in miniaturization.

WE HEAR THAT—

Bell Aircraft officials . . .

are labelling the rumor (M/R Oct. 5, p. 13) that Dr. Walter Dornberger may leave Buffalo for a Washington job as "extraordinarily remote from the truth." Dornberger will stay at Bell . . . Year-old **Missiles & Space Division** of **United Aircraft** has landed Navy contract for *Talos* booster fins and an AF award for studying ballistic missile defense equipment . . . **Texas Instruments** is denying in court charges brought by **Sperry Rand Corp.** that TI infringed on Woodyard Patent No. 2,530,110 for germanium diodes.

More About the Missile Week on Page 45

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NASA Stresses Winged Re-entry R&D

Week-long event is highlighted by attention given to winged vehicle research and by new trends in structures, shielding and propulsion

M/R Staff Report

LANGLEY FIELD, VA.—Space scientists of the National Aeronautics and Space Administration last week gave the missile industry an insight into the structure, materials, design, propulsion and communications systems of future space vehicles.

Keynote of the 1959 NASA inspection at the Langley Research Center was that astronautics research must now be extended to solve the problems of returning winged vehicles from the space environment.

Major portions of the week-long inspection attended by more than 2000 representatives from government and industry were devoted to research reports on winged vehicle re-entry feasibility. Project *Mercury* scientists intimated that this nation's first manned satellite capsule may sprout wings before it goes aloft.

Lectures that were of particular interest to the missile and space industry included:

• **Manned re-entry vehicles**—Glider configurations will replace capsules as manned re-entry vehicles as soon as they can be stabilized as payloads on top of rocket boosters, and as soon as materials are available to protect their leading edges from the severe heat of re-entry.

Langley Research Center scientists pointed out that the lifting capability of a glider configuration would greatly reduce the g force stress on the astronaut during re-entry.

Another advantage of the glider vehicle, according to Langley scientists, is the wider corridor within which it can re-enter the earth's atmosphere. A capsule returning from space must be in a corridor only seven miles wide. If too high, the capsule will re-escape into space, and if too low, will experience severe deceleration.

A glider configuration, however, would have a corridor 60 miles wide.

• **Re-entry physics**—NASA's effort in re-entry physics is principally in two areas: The first concerns the effects of ionization on electromagnetic radiation and the second is concerned with research on advanced materials and systems suitable for thermal protection under conditions of extreme heat.

ENGINEER checks valves on cutaway, full-size model of NASA's 6000-pound thrust *Vega* rocket vehicle.

A "plasma sheath" is formed from the ionized gas by a re-entry vehicle. This "sheath" acts as though a metallic shell is covering the vehicle and problems arise when the vehicle's transmitter attempts to contact the ground. Telemetry signals can be completely cut off by severe ionization.

The ionized shell also gives a radar appearance that is much larger than the vehicle. Though the larger blip can be an aid to radar detection, it hampers interpretation of the radar signal.

• **Structures**—In the field of structures research, NASA showed it was not at a loss to come up with proposed new vehicles or the laboratory conditions needed to simulate their environment.

The space agency demonstrated for the first time a re-entry condition simulator made up of two devices which apply high heat and heavy loads to glider-type configurations. The radiator is a quartz-lamp heater in the shape of a re-entry glider wing. Aerodynamic loads are simulated by hydraulic jacks acting on the structure. Gold plated reflectors direct heat from the quartz lamps toward the test model, and 400 transducers, strain gauges and thermocouples measure reaction of the structures to the heat—up to 2500°F and loads.

NASA said that the time a vehicle would spend at temperatures greater than 2000°F is expected to be of the order of five minutes in a total re-entry heating period of approximately 20 minutes. After 20 minutes the glider is expected to slow to a speed at which aerodynamic heating is not a significant problem.

• **New shields**—NASA also gave details about two new types of heat shields which should have superior qualities over the heat sink and ablation types presently in use.

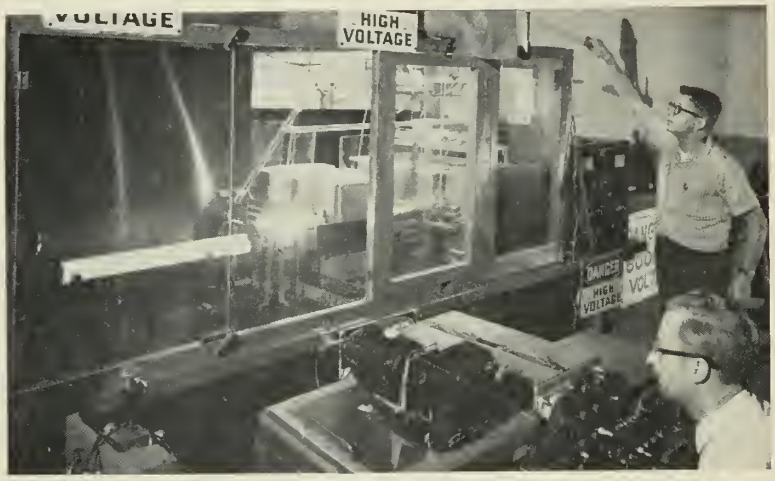
An insulated design uses an insulating material which is held in place by a thin metallic outer skin which is corrugated to provide a means for absorbing thermal expansion and to provide sufficient stiffness to prevent flutter. The design can be fabricated from refractory metals such as molybdenum, niobium or tungsten.

This type of heat shield would reduce the lower surface load carrying structure's temperatures of a glider re-entry vehicle to 1200°F when heat shield surface temperatures are 2500°F.

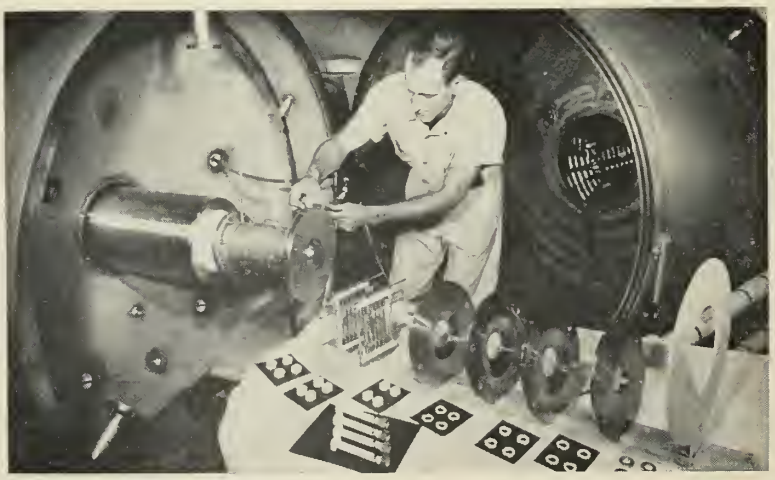
An even better shield, according to NASA, is an insulated structure with added heat absorbing capacity gained by the storing of water in the channels formed by the stiffeners in the structure. Structure temperatures could be held down by this shield to the temperature of boiling water (200°F).

Temperatures in excess of 3000°F in the nose and leading edges of re-

AT LANGLEY Research Center's 11-inch hypersonic wind tunnel, models used include basic flow and heat transfer wing, wing-body combination and re-entry vehicles.



SEQUENCE CAMERA (foreground) is used at Center to observe test of plasma accelerator studying some of the basic physical phenomena of ionized gases.



ION ENGINE research model is assembled in the High Vacuum Test Facility at NASA's Lewis Research Center, Cleveland. The engine operates with cesium propellant.

entry gliders will be coped with by ceramics and refractory materials. Two methods of constructing leading edges were given: a radiative approach and an ablative approach.

The radiative method uses materials in short segments with expansion joints because of the high thermal gradients involved. They are attached to the glider structure so that expansion is not restrained by the supports. Most of the heat is radiated into space, and only a small fraction passes through the insulation and is conducted to the glider structure.

The second method absorbs heat by melting and vaporizing leading edge materials. Graphite, NASA said, is a promising material for leading edge constructions although it has an undesirable large amount of surface erosion due to surface oxidation, which could be corrected by protective coatings such as pyrolytic graphite.

• **Propulsion**—NASA's Lewis Research Center unveiled two types of electric propulsion systems which hold great promise of supplying the continuing jet velocities needed for deep space interplanetary missions.

Both systems create low-thrust but high-jet velocities by the ionization of atomic elements by removing one electron from the atomic mass, giving them a positive charge.

Lewis scientists unveiled a small scale ion engine capable of producing an ion or plasma velocity of 60,000 feet per second. Though it is not powerful enough to have any present space application, Lewis technicians are confident that electrical propulsion systems using the ionization process will be capable in the near future of producing jet velocity values of 216,000 mph.

Lewis scientists feel that the element with the greatest possibilities for electric propulsion is cesium because the electrical energy needed for its ionization is low.

The two methods demonstrated creating ion propulsion using cesium were an electrical conductivity engine and an ion engine.

The electrical conductivity engine induced electrical current to pass through the plasma or ionized gas in the presence of a magnetic field. The resulting force—similar to that used to turn an ordinary electric motor, propels the space vehicle. The current heats the propellant, vaporizing and ionizing it, and at the same time, produces a magnetic field by running through the back electrode. The ionized gas, or plasma, is then accelerated by the combined effect of the magnetic field and the electric current, and moves out of the chamber.

The ion engine injects cesium into

a boiler, where temperature controls the vapor pressure and the flow rate. When the cesium vapor impinges on the hot tungsten grids, it becomes ionized and is accelerated out of the rear of the chamber by electrodes. As the stream of ions leaves the engine it is joined by a matching stream of electrons shot out the rear by an electron gun so that the beam has no net charge.

Lewis scientists operated a small ion engine within a bell jar, but pointed out that larger ion engines at the research center had obtained ion beams up to 12_0 ma at 10KV, a thrust of about 1/16 pound.

• **Magnetoplasma dynamics**—Supplementing the Lewis Laboratory's work on electrical propulsion units is the Langley Research Center's basic research into the concept of magnetoplasmadynamics.

This unwieldly term defines a new branch of physics which devotes itself to the study of electrically conducting high-temperature gas or plasma.

Besides MPD's applications in space engine development, there is reason to believe that the principle may be used to generate radio waves in space and to produce commercial electric energy.

Another effect of MPD, noted above, is the ionized shell that surrounds an incoming ICBM nose cone or a space vehicle during re-entry.

As a source for microwave communications, Langley scientists predict that microwave velocities of the order of millions of miles per hour should be possible.

Other practical applications of MPD include plasma accelerators for hypersonic wind tunnels, and powerful commercial electric generators.

• **Hypervelocity impacts**—The Ames Research Center's scientists gave some details of laboratory studies to develop lightweight structures which will be capable of resisting catastrophic damage by impact of space debris.

To simulate a phase of interplanetary environment where an object is bombarded by atoms and actual erosion occurs, Ames Laboratory scientists have developed a "particle accelerator."

This beam of high-speed atoms and molecules has been directed at various materials suitable for spacecraft. Bombardment of a copper surface simulates erosion which would take place in one year for a 300-mile orbit or hundreds of years for interplanetary space travel.

• *Vega*—The **Jet Propulsion Laboratory** demonstration revealed publicly for the first time what the ingredients of the 6000-lb.-thrust encapsulated liquid 6K third stage *Vega* engine were, and how the JPL-developed *Vega* inertial guidance system works.

The storable third stage *Vega* engine, now under development by JPL, uses nitrogen tetroxide as the oxidizer and hydrazine as the fuel to produce its 6000 pounds of thrust. This is the first practical application of this oxidizer and fuel in a propellant system.

Because of its encapsulation technique, JPL claims that the 6K engine can be loaded weeks ahead of time, will lie dormant and not even be a part of the final launch countdown.

The *Vega* guidance system, contained in JPL's third stage, is inertial and provides commands to the booster and the second stage. It has the capability to compensate for unsuitable firing locations by not firing the third stage until it is in the proper location to complete a given mission.

This is done by putting the second stage of the three-stage vehicle into a "parking orbit." Then the third stage fires the payload out of the satellite orbit when it is in the proper position to complete a lunar or other exacting and difficult deep space missions.

"In other words," according to the JPL spokesman, "we place the second stage over that part of the earth where we would have like to have had the launching pad, and we have fired from that point."

• **Space R&D**—Spokesmen for the newest space research organization in the NASA family—the Goddard Space Flight Center—told the NASA Inspection audience what its future role in the civilian space program would be.

Made up of a combination of older existing organizations such as the Naval Research Laboratories' *Vanguard* team, the Army's Signal Research and Development Laboratories, and NASA's Project *Mercury* team, the new organization will devote itself to R&D on future manned satellites, on space science and satellite applications, and on the tracking and data systems needed for future space research.

The Goddard Center's work in manned space flight includes the Project *Mercury* program, designed to orbit the first man into space.

House Group Agrees With Shutdown of Boron Plants

WASHINGTON—The House Space Committee agreed with the Defense Department's decision to shut down the Model City, N.Y., and Muskogee, Okla., production facilities for high-energy boron fuels.

The technological advances in missiles, the subsequent shift in weapons systems and the increased aerodynamic performances of aircraft were some of the factors involved in the decision.

Members of the Committee were dissatisfied with the Defense Department's management techniques employed in making the final decision regarding the high-energy fuel program. The Committee felt the decision could have been made sooner.

A considerable increase in the total cost and the heavy impact on the industries and communities involved were a direct result of the delay by DOD in recognizing the changing requirements of the "ZIP" fuel program.

The Committee called for a firm national program in boron fuels to preserve the scientific teams formed over the past ten years.

The House Group recognized that the boron production facilities were in support of a highly speculative research and development program and do not desire to make any statement which would affect any national research and development effort.

String-type Igniter Adds Speed, Uniformity

WILMINGTON, DEL.—A new string-type igniter, "Pyrocore" has been developed by **DuPont** to answer the need for faster and more uniform ignition.

Essentially a small-diameter, continuous metal tubing containing a detonating-ignition core, the device may be initiated at either or both ends by electrical or other means.

The string-type igniter, insensitive to ordinary shock, can ignite wet, dirty, or otherwise inhibited rocket grains because of its ability to scour the prepellant with the minimum residue produced.

Tests show that certain types of "Pyrocore" can be detonated in small, eight-point rocket grains with less brisance than a standard squib plus metal/oxidant igniter.

Once the end primer is applied, the sections not intended for ignition purposes may be encased or potted in practically any substance.

Thiokol Chemical Opens Solid Propellant Plant

MARSHALL, TEX.—New solid propellant facilities, operated by **Thiokol Chemical,** will meet present motor requirements and are capable of producing the *Pershing* and *Nike-Zeus* propulsion systems.

Dr. Harold W. Ritchey, Technical Director of Thiokol, said that rocket motors currently in production here could land an object on the moon if used in the proper combination.

Lt. General John Hinrichs, Army Chief of Ordnance also states that the Longhorn Works could be used by the three services interested in solids.

Thiokol's *Minuteman* first stage was successfully fired recently at Edwards Air Force Base, California, in a silo test shot.

While Soviets probe moon . . .

Fund Shortage Delays *Saturn* Program

ABMA Chief Medaris reports money bind caused delay of first static test from December, 1959, until next spring; President weighs agency's status

by Jay Holmes

WASHINGTON—The test program for the *Saturn* booster, America's best hope for catching Russia in the race for space, has been delayed by a fund shortage, Maj. Gen. John B. Medaris declared last week.

Medaris, commander of the Army Ballistic Missile Agency at Huntsville, Ala., said the money situation has delayed the first static test of the booster from December, 1959, to some time in the spring of 1960. First flight tests are planned for 1962 or 1963.

Saturn is a cluster of eight liquid-fueled **Rocketdyne** engines of the type used in the *Jupiter* and *Thor* missiles. The cluster is to develop 1½ million pounds of thrust, compared with the 500,000 to 800,000 pounds in the boosters that lifted the Soviet *Luniks*.

ABMA is developing *Saturn* under contract to the Advanced Projects Research Agency of the Department of Defense, with a current budget of $70 million. An ABMA spokesman said the original request to the Defense Department was for about $135 million.

ARPA officials agree it would be possible to speed the *Saturn* program. But they question whether it would be desirable. The cold facts are that *Saturn* last month just barely survived a proposal that it be killed. Any idea that Defense Department money might be allocated to speed the development seems to be completely out of the question.

Why is this so? The answer is simple. The armed forces are in the business of national defense. There are many military tasks that a big booster rocket can perform. But none of these is needed before the 1963-5 time period. And so, ARPA spokesmen point out, it doesn't make sense to spend extra military money on a crash program to develop a booster rocket sooner.

• **NASA's job**—Furthermore, the armed forces have no official mission in space. Exploration of the region beyond about 600 miles up is the task of the National Aeronautics and Space Administration, a civilian scientific agency.

"*Saturn* is a part of the national booster program," the ARPA spokesman said. "Our requirements are military. NASA's are scientific. But the decisions are made on the political level." He continued:

"If there is any scientific or political need to develop this booster faster, it hasn't been communicated to us. We have received no such request from NASA or the State Department or any other government agency."

On the purely political level, of course, the *Saturn* program has been the subject of several suggestions and requests. A scientist on the staff of Sen. Stuart Symington, Missouri Democrat, proposed last week that an additional $100 million be transferred to the *Saturn* program. The scientist, Dr. Edward Welsh, said the money could be used to speed testing.

What is NASA's position on *Saturn*? Officials of the space agency say it is a Defense Department project and that any comment by them would be improper.

• **Delicate situation**—A factor underlying the NASA reticence is the doubtful status of ABMA. The Defense Department announced last month that the Army is getting out of the space business. Dr. Herbert York, defense director of research and engineering, said he expected ABMA would eventually be transferred to the Air Force. More recent reports indicate that the idea of a transfer to NASA may be gaining ground.

In such a delicate situation, neither NASA nor Air Force spokesmen are making any statements that might tip the balance.

The decision, of course, is up to President Eisenhower. But it cannot take effect without at least tacit approval by Congress. The Space Act of 1958 provides that any transfer of an agency involved in the space program may not take effect until the passage of 60 days during which Congress is in session. The act gives Congress power to veto such a transfer by a joint resolution.

To assist him in making his decision, the President has the advice of the National Aeronautics and Space Council, composed of the secretaries of defense and state, the NASA administrator, the Atomic Energy Commission chairman, the director of the National Science Foundation, the president of the National Academy of Sciences and two non-government members. John T. Rettaliata, president of the Illinois Institute of Technology, is one of the latter. The other non-government post is vacant.

The law specifies that the President is chairman of the council. However, President Eisenhower's scientific adviser, Dr. George B. Kistiakowsky, has been sitting in for the President at some council sessions.

• **Decision time**—There were reports last week that the question of ABMA's status has reached the White House and that a decision is expected soon. However, since Congress is not in session, any decision could not take effect until March at the earliest.

Obviously, the funding and the schedule of the *Saturn* program depend on this White House decision. This in turn depends to some extent on the concept of America's activities in space.

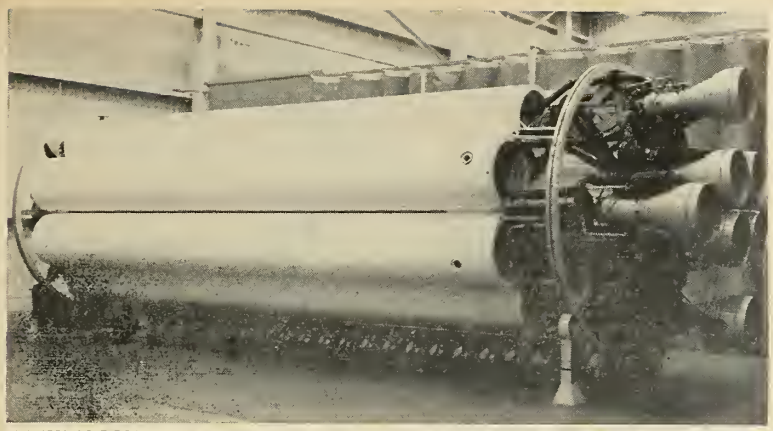
Washington Name-Dropping

WASHINGTON—*The National Aeronautics and Space Administration has quietly dropped the name* Nova *for its 1½-million-pound liquid engine under development by* **Rocketdyne.**

There now is no official code name for the project. Rocketdyne calls the engine simply "F-1."

"We just didn't like the implications of the word nova," a NASA spokesman commented.

A nova in astronomy is a star that explodes.



SATURN **MODEL: A quarter-scale version of the clustered engine with 1½ million pounds thrust being developed at Huntsville.**

The question of whether we should engage at all in a race with the Soviets is far from settled.

The scientists who are advising the President decline quite properly to say what advice they are giving. However, it is logical to assume that they are influenced by the current trend of opinion within the scientific community.

Many influential American scientists doubt we should spend the money necessary to race with the Soviets into space. They feel that the government money available for scientific research could be better spent in other areas. The National Academy of Sciences recently recommended a large increase in oceanographic research. Others think we could support more medical research. Dr. Dael Wolfle, executive officer of the American Association for the Advancement of Science, explained the situation as follows:

• **Costly experiments**—"I think there are people in the scientific community who feel that the money it takes for a major shoot into space would be better spent for a systematic program of sea-bottom coring or to solve fairly specific medical problems. The Van Allen radiation belts and the results of the *Argus* experiments are interesting but tremendously costly. We may get more scientific results from other, less expensive, programs.

"Of course," Dr. Wolfle added, "we must realize that, to a large extent, space science is riding along on military developments. So it is not fair to charge all of this cost off to science."

He agreed that some of the cost can be charged to national prestige. But he added: "There is never as much prestige involved in catching up as in doing something else."

A possible "something else" is the Project *Mercury* man-in-space program. Dr. Homer J. Stewart, NASA director of program planning and evaluation, told an interviewer last week that *Mercury* still has first priority on the space agency's list of jobs to be done.

Stewart said *Mercury's* priority was the reason underlying the NASA decision not to have a backup *Atlas* booster available in case something went wrong with the booster assigned to the *Atlas-Able* moon shoot. That was scheduled for early this month, about the same time the Russians fired *Lunik III*.

Some military men have criticized the NASA decision, saying that a reserve vehicle should have been on hand for an experiment that carried so much national prestige. The shot, an attempted moon orbit, was postponed after the assigned *Atlas* exploded during a static test late in September.

• **No spares scheduled**—On this criticism, Stewart commented: "We don't have so many *Atlases*. Every one available has a significant use. They are not scheduled as spares."

Security considerations forbid disclosure of either the total number of *Atlases* available or the number assigned to NASA. Every one that comes off the production line has an assigned use long before delivery. Stewart said: "We have to decide now on our *Atlas* needs two or three years hence."

The *Atlas*, with a total of 360,000 pounds of thrust, will play a large part in our space program until *Saturn* is ready. In addition to its use as a *Mercury* booster. *Atlas* will be used as a booster for the *Vega* series of vehicles. *Vega*, due to be flight-tested next year, will provide propulsion for our heaviest and longest space probes until *Saturn* becomes available.

A more long-range program is the 1½-million-pound booster being developed for NASA by Rocketdyne. NASA is spending about $20 million in the current fiscal year for this single-chamber liquid rocket under a development program of four to six years. Another two or three years will be required to cluster that engine to produce a booster with six million pounds or more of thrust.

Herbert H. Rosen, NASA deputy director of public information, said this program could be accelerated somewhat by spending a little extra money. This would speed the program over the long run by providing insurance in the form of concurrent testing, additional machine-shop work and more computer time. Any attempt to push it more rapidly would run into such barriers as unavailability of engineering manpower, he added.

• **Erroneous estimates**—But the question of money runs headlong into another problem. Rosen said NASA officials made several errors on the low side last year in estimating their budget needs. He said the errors, plus the budget cuts made by Congress, have caused a slowdown in several NASA programs. "We could use more money," Rosen concluded.

To draw even and then ahead of the Soviets in propulsion, it is necessary to program a whole series of steps in rocket development. *Saturn*, whenever it is ready, is to be capable of putting 33,500 pounds into a 300-mile orbit or of delivering 2,700 pounds to a soft landing on the moon. Present ARPA plans to do this call for a *Titan* intercontinental missile booster as the second stage and a *Centaur* high-energy liquid-fuel engine as the third stage. The two **Aerojet** *Titan* engines use conventional liquid fuels to develop 360,000 pounds thrust. *Centaur*, under development for NASA by **Pratt & Whitney**, will be a liquid hydrogen-liquid oxygen engine with twin chambers each having 15,000 pounds of thrust.

Since the cluster of the 1½-million-pound single-chamber engines probably will not be available until 1968 or 1970, both ARPA and NASA officials are studying ideas for interim improvement of the *Saturn* system.

One of these ideas is a high-energy second stage. A. O. Tischler, chief of the NASA liquid fuel rocket engine program, says the Pratt & Whitney experience has demonstrated the possibility of scaling up to the size necessary for it to replace *Saturn* in the second stage.

• **Bigger payloads**—The advantage of a high-energy second stage, of course, is the increased payload. NASA calculations indicate that, in general, payload is increased by 50% whenever a conventional liquid-fuel stage is replaced by a high-energy hydrogen-burning stage.

Tischler said he believes development ought to begin now on a liquid hydrogen second stage. But again, funds are a major hurdle. He said all

the major liquid-fuel rocket makers know the NASA requirements. "If we can find funds next spring, I think we may go ahead," Tischler added.

Tischler would make no estimate of the cost. "We shall approach this by competitive negotiation," he said.

Although Tischler said bids from all rocket companies would be considered if money becomes available, two would seem to be in a better position than the others. Pratt & Whitney has the benefit of its experience on the *Centaur* engine. Aerojet has made feasibility studies of such a stage under an Air Force contract.

An engineer on the staff of one rocket company made a "guesstimate" that developing high-energy second stage might cost from $50 to $100 million, depending on its size. Of course, only a small part of this would be spent in the first year.

Tischler said that if the development program takes three years, the engine can be ready for mockups in about two years.

• **Solid boosters?**—All of the foregoing concerns liquid-fueled engines. This does not mean that solid-fuel rocketmakers have given up the idea of building big boosters. Dr. Harold Ritchey, chief scientist for **Thiokol,** has put forth a proposal for a solid booster with 10 million pounds thrust. He said it would take about three years to develop.

Somewhat more conservative, D. F. Sprenger of Aerojet suggests that a solid motor could be developed with one million pounds of thrust. Both proposals were made at the **Avco**-Air Force Symposium on Advanced Propulsion Concepts in Boston earlier this month.

What are the Russians doing while we develop bigger boosters? As usual, they say very little. Published reports of Soviet propulsion research indicate they are investigating nuclear ramjets, ion acceleration and upper atmosphere recombination, as well as conventional nuclear rockets. They also report work on such exotic schemes as propulsion by radioactive isotopes, beta batteries and beamed microwave power.

Just as in this country, Soviet security rules seem to be relaxed a little for the more exotic systems of propulsion. We can only assume that they are working at top speed to improve their conventional, highly secret chemical systems.

NASA Orbits *Explorer VII*

WASHINGTON—The National Aeronautics and Space Administration was successful on its second attempt last week to launch a 91.5 pound payload which will study radiation and charged particles in the ionosphere.

An earlier attempt to put the top-like satellite into orbit ended in failure on July 16 when the *Juno II* booster was destroyed in flight by the range safety officer.

The vehicle, named *Explorer VII,* was sent into a 50-degree inclination, low-eliptical orbit so that it passes through the inner Van Allen belt. Its perigee is 346 miles and its apogee is 664 miles. The Army's *Juno II* rocket was the booster.

Explorer VII's payload is one of the most comprehensive and sophisticated to be sent into space by the United States thus far. (see M/R, April 27, page 20).

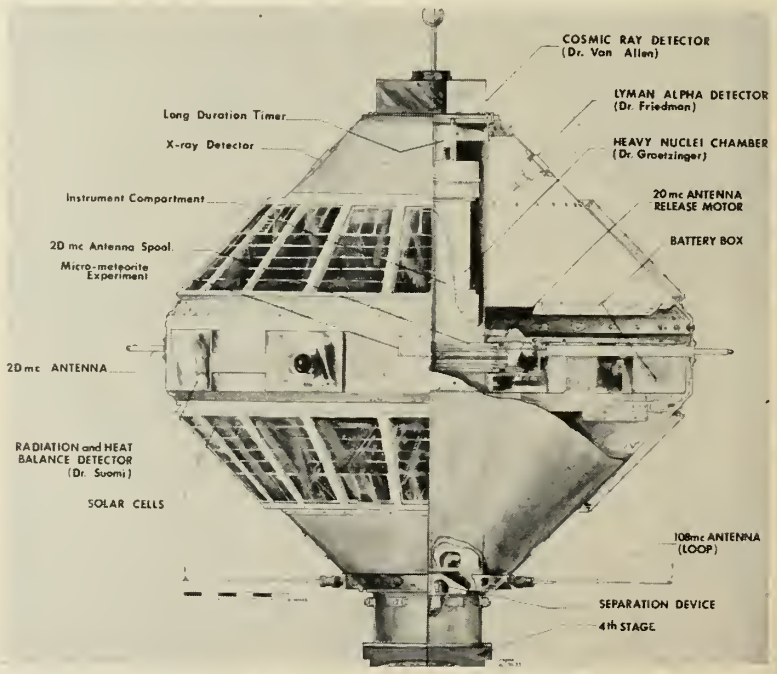
The top-like design aided fabrication of solar cells into the payload, and also helps obtain maximum gyro-stabilization with little or no precession. Release of the 20mc antenna spool retarded the vehicle's spin.

Instruments conducting major experiments include a cosmic ray detector, a lyman alpha ray detector, an X-ray detector, a heavy nuclei chamber, a radiation and heat balance experiment, and a micro-meteorite density detector.

The power is supplied by solar cells, charging nickel cadmium batteries. One of the experiments is to measure the performance of the solar cells which are not protected by micrometeorite shields.

A clock will shut the payload's transmitter off after one year. The transmitter could conceivably be turned on again when and if NASA scientists require more information (See M/R, June 1, 1959).

The satellite has no recorder, and ground stations record information only when the satellite passes over.



PARTIAL CUTAWAY drawing of the radiation satellite launched by a *Juno II* vehicle from the Atlantic Missile Range last week. Designed by the Goddard Space Flight Center, the payload will attempt to learn more about the Van Allen belts.

Second in a Series . . .

Explosive Growth in Great Lakes Area

M/R survey shows the multibillion-dollar missile business still expanding

by William E. Howard

MILWAUKEE—In the early Cold War days of 1948, 50 engineers and technicians on company orders pulled stakes from **AC Spark Plug's** home plant in Flint, Mich., and set up shop here in a government-owned factory. Their mission was to build SAC bomber navigation and sighting systems utilizing gyros.

By 1955, the new division was manufacturing a stellar inertial bombing system (SIBS) based on principles developed by MIT's guidance wizard, Dr. Charles S. Draper. SIBS proved to be the forerunner of an all-inertial guidance system, AChiever, which the company began to develop a year later for the Air Force *Thor* IRBM. It was also the start of a vast expansion in plant and personnel.

Today, AC's Electronic Division holds contracts totalling more than $300 million. Along its assembly lines move the highly precise guidance units for not only *Thor,* but the Air Force *Titan* ICBM and the Tactical Air Command's 650-mile *Mace*. The division has more than 7000 employees and farms out work to 4000 subcontractors and suppliers employing thousands more.

The division this week is in the process of adding close to a quarter million square feet of floor space to its modern plant which already covers 500,000 square feet in suburban Oak Creek. All of this activity, in just eleven years, has made AC the largest missile contractor in Wisconsin and the main producer of defense products in the huge **General Motors** industrial empire.

The remarkable expansion of AC is but one illustration of the enormous impact of missile/space demands upon industry in dozens of communities in states bordering the Great Lakes. An M/R survey shows, in addition to Wisconsin, an explosive growth of missile electronics in Minnesota; prime systems and sub-assemblies in Michigan, Ohio and Indiana; and missile support in Illinois.

• **Ten missile primes**—Eight prime missile system contracts are distributed throughout five of the six states in the region. (Wisconsin is the exception.) These include the Navy's *Asroc, Eagle, Subroc,* and *Weapon A,* which is also called *Able;* the Air Force's *Jupiter* and *Wagtail;* and the Army's *Redstone* and *Davy Crockett*.

If the region is stretched a mite to embrace St. Louis, across the Illinois border, then the total will be 10, counting the Army's *Little John* made by **Emerson Electric,** and the Air Force *Quail* by **McDonnell Aircraft Corp.**

Contracts for these 10 birds total well over $1 billion. Additional millions are being spent by the military and civilian agencies on components and subsystems for dozens of other programs. Moreover, the Great Lakes area is deeply involved in government-funded advanced research and development of metals and materials for missiles and space vehicles.

For most of the states, the outlook is for a continued steady growth of the missile industry. One possible exception is Michigan, which has suffered defense procurement reverses (M/R Oct. 12, p. 18) and is now hoping for new contracts to offset the washout of *Redstone* and *Jupiter,* both primed by **Chrysler Corp.** The state's remaining prime is **Bendix Aviation,** Ann Arbor, for the Navy's *Eagle* air-to-air missile.

• **Astrionic rivals**—Wisconsin, famed for its beer, Braves and dairy products, and Minnesota—better known for its mineral deposits and the wild beauty of its hundreds of lakes—today are running neck and neck for regional leadership in the field of astrionics. The race boils down pretty much to the two giants, AC Spark Plug and the **Minneapolis-Honeywell Regulator Co.,** Minneapolis. But there are scores of other companies in the field.

AC's missile guidance contracts and other work give the electronic division annual sales estimated at $100 million a year. M-H's military electronics volume is estimated at around $90 million—about 25% of the company's gross yearly income.

M-H is prime for the surface-to-underwater *Asroc,* an anti-submarine weapon and also the AF's *Wagtail,* a low-level air-to-ground missile now in R&D. The company also produces gyros for *Sergeant* and fuzes for *Sidewinder.* In the space field it makes the guidance for NASA's *Scout* and last week the Aeronautical Division delivered a seven-ton space cabin simulator to the AF School of Aviation

Medicine, Brooks AFB, Tex., for the training of astronauts.

Minnesota may hold the edge in total volume. The State Department of Business Development says there are more than 100 firms engaged in electronic and electrical work, generating aggregate sales of $500 million annually. They include an **International Business Machines** plant at Hopkins, with a $30-million volume; **Remington Rand's** Univac division at St. Paul, doing an estimated $90 million; **General Mills** Mechanical Division, Minneapolis, with 2000 employees and sales exceeding $25 million; and **Minnesota Mining and Mfg. Co.'s** Electrical Products Division—$65 million.

Apart from large companies, in the Minneapolis-St. Paul area there are 47 small firms employing 3600 persons and grossing $50.5 million annually in sales. Many of these were started within the past five years. The latest one—**General Magnetics**—was founded this year.

Minneapolis also boasts an investment company—**Midwest Technical Development Corp.**—which specializes in the financing of scientifically-oriented companies.

• **Wisconsin development**—Contributing to the growth in electronics in Wisconsin are the **John Oster Mfg. Co.**, Racine, which produces components for several missiles; **George W. Borg Corp.**, Janesville, indicating devices; **Milwaukee Transformer Co.; Milwaukee Electronics Co.; Gibbs Mfg. and Research Co.**, Janesville; **Heale Mfg. Co., Waukesha;** and the **Trionics Corp.**, Madison.

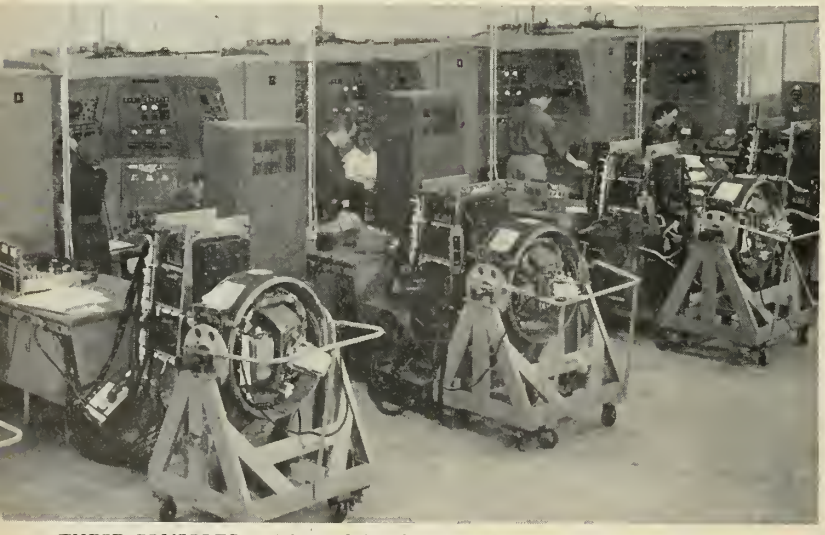
General Electric Co.'s X-Ray Division, Milwaukee, is a maker of airborne cameras, which may have missile/space applications.

ANTENNA farm for microwave relay system used by Harvard University was built by Raytheon at Havana, Ill., southwest of Peoria.

The state also has moved swiftly ahead in metallurgy and metal fabrication. Two outstanding examples are the **Ladish Co.**, Cudahy, a major missile component supplier and leader in drop forging, and the **A. O. Smith Co.** of Milwaukee. Ladish produces drop forged forward domes, nozzles and seamless rolled ring body cylinders. A. O. Smith has developed a roll and weld fabricating process for rocket chambers.

In addition to several manufacturers of specialized machinery used by the missile industry, there are such companies as **FWD Auto** and **Oshkosh Truck** supplying missile support vehicles. **Marathon Electric Mfg. Corp.**, Wausau, makes generators for *Nike* sites.

The AF Milwaukee Air Procurement District, biggest military buyer in the area, reports that as of June it had $395 million outstanding in contracts—mostly for missiles. Out of every $100 it spends in Wisconsin and Minnesota, the District says $77 goes for electronic end-items.



THESE CONSOLES at AC Spark Plug's Milwaukee plant put a complicated AChiever guidance system through simulated flight tests before delivery to missile bases.

• **Illinois has** *Davy Crockett*—Illinois, which has suffered a sharp cutback in defense production since the Korean War, so far has been able to come up with only one prime missile contract. This is the Army's bazooka-like *Davy Crockett*—an in-house R&D project of the Rock Island arsenal.

However, many companies are big subcontractors on other projects and others are making important contributions in the way of materials and support items. Most of the activity is concentrated in the northern part of the state.

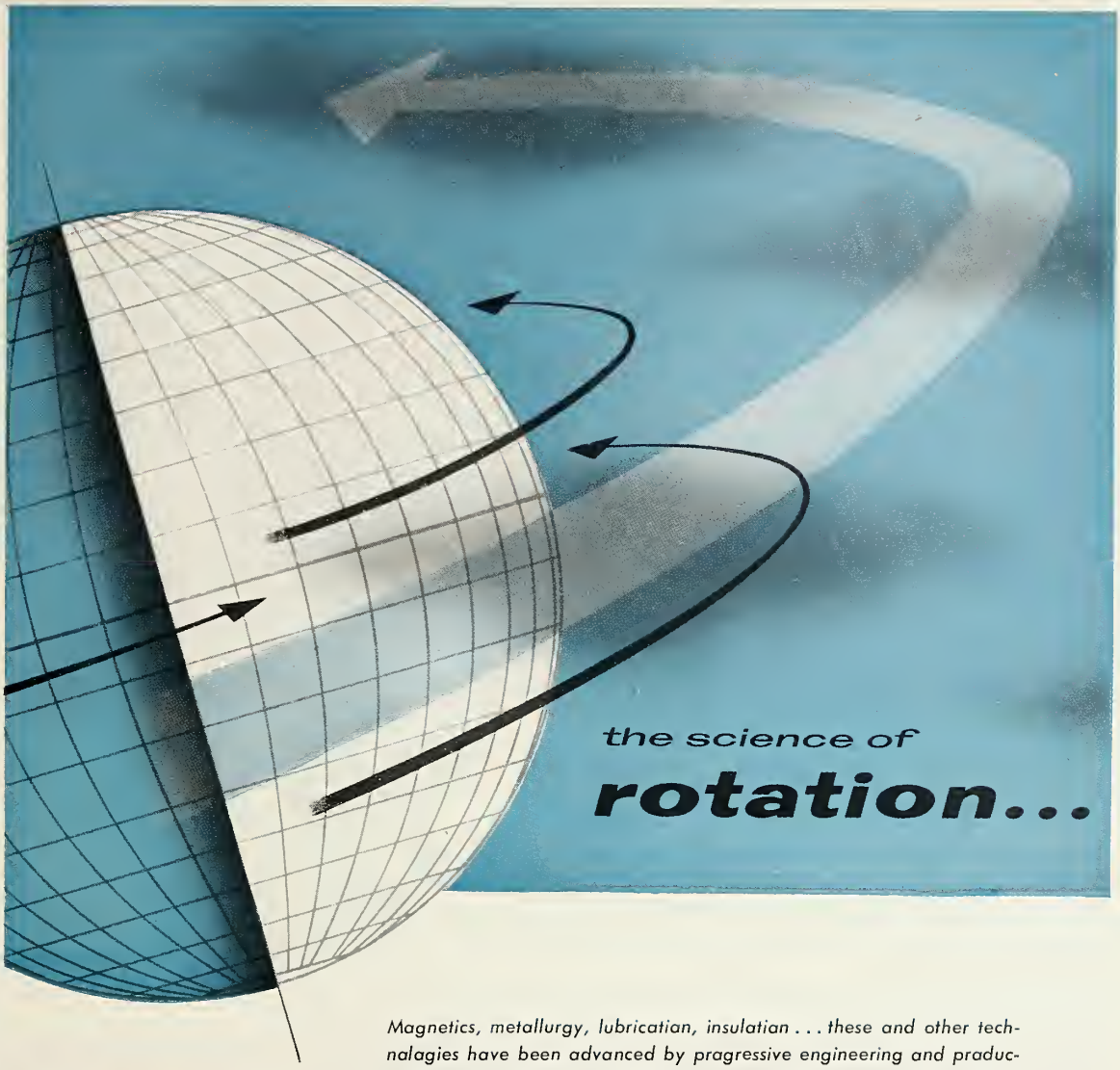
Around Chicago, **Stewart Warner Corp.** is making heat exchangers for the AF *Hound Dog* air-launched missile; **General Sintering Corp.** is fuzing the AF air-to-air *Falcon*; **Continental Can** and **Joy Mfg. Co.** are making, respectively, target radar mounts and compressors for *Nike*; and the **Elgin National Watch Co.** is fuzing *Sidewinder*. At La Salle, **General Time Corp.'s** Westclox Division is providing the safety and arming device for *Sidewinder* and is also fuzing the Navy's *Zuni*. And in Rockford, **Sundstrand Aviation** is making hydraulic meters for *Hound Dog*.

Electronics manufacturing has quickened around the Windy City, too. One of the major missile suppliers is **Cook Electric Co.**, which currently is providing instrument calibration standards facilities and services for R&D contractors at Vandenberg AFB, Calif.

Physical evidence that the Space Age has caught up with the land of Lincoln can be found at Havana—southwest of Peoria—where a huge antenna farm has been built. This is a microwave relay system being used by the Harvard College Observatory to study meteor particles and their effect on radio transmission.

• **Flipper for** *Falcon*—Two Navy missile systems are lending impetus to Indiana's industry. The Mishawaka Division of Bendix Aviation Corp. is prime for assembly and test of the surface-to-air *Talos* and also makes the weapons' propulsion subassemblies. At

(Continued on page 44)



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ATLAS ICBM

MERCURY

VEGA

CENTAUR

CONVAIR

A DIVISION OF GENERAL DYNAMICS CORPORATION

BULLPUP missiles, mounted on FJ-4B, are irradiated by APS-20E radar on search aircraft in the rear.

HERO Explores R-F Radiation Hazards

Unpublicized Navy project seeks to identify electromagnetic dangers to missiles and control them; one goal is to cut radio receptivity

by Hal Gettings

DAHLGREN, VA.—A relatively modest program being conducted by the Naval Weapons Laboratory (formerly the Naval Proving Ground) may have much more important implications for the missile business than its limited budget indicates. Designated *HERO* (for Hazards of Electromagnetic Radiation to Ordnance), it is aimed at determining just what potential dangers exist and what can be done about them.

Ordnance people have become increasingly aware that the trend toward more and higher-powered electronics equipment in the vicinity of explosive ordnance constitutes a hazard of unknown extent. No organized research was started, however, until less than two years ago. It is to the Navy's credit that the problem came under scrutiny before a possible catastrophic explosion did take place.

Practically nothing has been published on the project. Until about six months ago, even the definition of *HERO* was classified. Today, although most of the findings and results of the work must still be kept under security wraps, the problem can be examined in some detail. And the Navy feels that awareness of the work in progress may smoke out ideas from other engineers living close to the situation.

Fiscal 1959 and 1960 budgets for the Navy project amount to approximately $1 million per year. About one-third of this is spent in-house by the Weapons Laboratory. The balance is spread among several other agencies and research institutes shown in the organization chart.

This is a problem that concerns the entire Department of Defense. Although work is mostly concentrated in the Navy's RadHaz (Radiation Hazards) program, other branches of the armed forces are also supporting efforts in this area. Bureau of Aeronautics is spending approximately $100,000 per year on similar work. The Army has no programmed research but maintains a facility at Edgewood Arsenal to check on any reported damages to personnel or equipment. Air Force work is confined mostly to radiation hazards as affecting personnel.

• **The problem**—Before any problem can be solved it must be defined; the first function of the *HERO* investigation is to explore the magnitude of the problem and its relation to handling, storing, and delivering missiles. This leads to the second function: learning what to do about it.

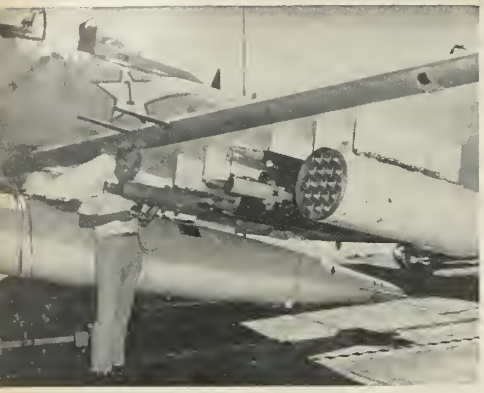
The surprises which can be produced by electromagnetic energy are indicated by some fairly familiar phenomena. More than one photographer has had flashbulbs suddenly pop in a radar-equipped airplane or near ground-based radar. Stories are legion of the old lady's bridgework that unexpectedly acted like a crystal radio and tuned in the eleven o'clock news. There have even been reports of a kitchen range making like a hi-fi set.

Radio-frequency energy—at microvolt levels—literally surrounds us. All we need to do is tune it in on a receiver and we can hear sound or see a picture carried by this energy. In the vicinity of missile bases, aircraft carriers and other ships, and defense installations in general, a high concentration of radars, communication transmitters, and similar electromagnetic generators raises the amount of this energy to a potentially dangerous level.

In the missile business, the problem is compounded by two facts: modern weapons require high-powered radar; they also require electroexplosive devices in the propellant, fuzing and arming systems.

Potential hazards exist almost everywhere. Warheads and propellant systems may be exposed to high r-f energy levels in storage, use, and transportation. Missile-carrying planes fly through radio ranges and radar beams. Their own radar and radio equipment

interim safety instructions are early result . . .



SELECTION OF aircraft rockets are mounted under the wing of an AD-6 for exposure to high-level r-f energy.

ENERGY FROM aircraft search radar (in rear) is beamed at *Regulus I* missile with booster during the RadIlaz program directed and funded by the Navy's Bureau of Ships.

is, of course, always a present threat. Control, guidance, and tracking equipment all direct energy directly at the missile. Communications equipment is always in the vicinity.

• **Techniques**—The problem is extremely complex because of the infinite number of variables involved. Work at present, therefore, is concerned largely with setting guidelines for further investigation.

HERO's approach is to look at each weapon as a receiver which is or may be tuned to a particular frequency of electromagnetic radiation. Every circuit element is considered as a potential tuned circuit capable of absorbing r-f energy at certain frequencies.

The Navy will not reveal exact details of techniques used in this work. In general, however, field energy intensities must be measured in the vicinity of ordnance and the intensity related to "susceptibility."

Some tests involve beaming r-f signals from a variety of sources directly at the missile. In most cases, dummy warheads and propellant loads are installed. In others, the complete weapon is tested. These go/no-go tests show which propellant igniter or warhead fuze can be fired by the radiation. Failure to fire, however, indicates only that the particular item *may* be safe.

Other tests use instrumentation installed in the circuitry to measure levels received and determine susceptibility. These methods are complicated by the fact that missiles must be tested in their usual environments—in the launcher, storage area, or transportation package. Tests must therefore be conducted aboard ship or wherever else the missile may possibly be used or handled. Further, in some instances the addition of instrumentation can change circuit characteristics and cause a completely false result.

• **Facilities**—Since most of the *HERO* project work is concerned with aircraft air-to-air and ship surface-to-air missiles, much of the actual testing is done aboard carriers and missile ships. In addition, simulated ship installations are being set up on shore. One such facility has been constructed at NOTS, China Lake, Calif. Another is being built at Dahlgren. This will include a 15-foot turntable in a simulated carrier deck for orientation of weapons with respect to transmitting equipment.

A selection of high-powered radio transmitters—some mounted in mobile vans—covers most of the frequency spectrum. Except for more or less conventional measuring instruments, the balance of project equipment consists of A4DB missile-carrying fighter aircraft. Other equipment is being added as requirements develop.

• **Results**—About 10 major test programs have been conducted by *HERO* to date. Here, again, data on results are kept under tight security. But several important basic facts have been brought to light:

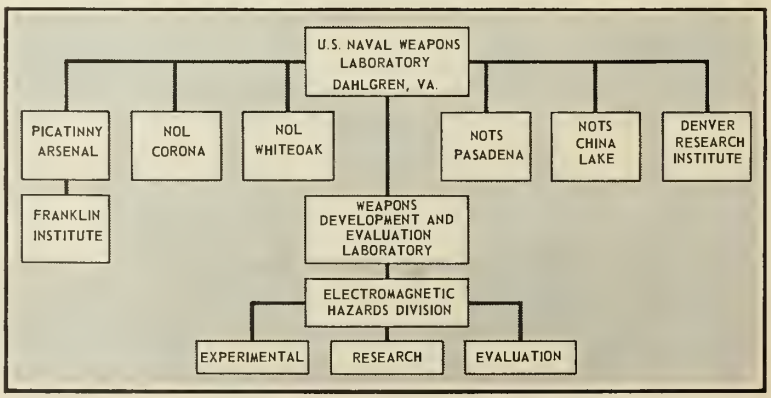
• A hazard definitely exists where electroexplosive ordnance is subject to electromagnetic radiation. The magnitude of this hazard is not known. It can be determined only with further work and better instrumentation.

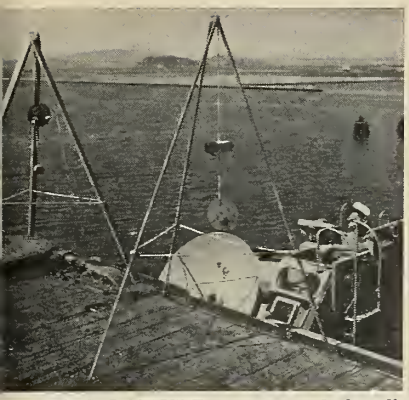
• Certain ordnance is susceptible under certain conditions.

• The hazard can be reduced or eliminated in several ways.

As a result of their findings, *HERO* engineers have provided the fleet with interim safety instructions on handling, storage, and operation of ordnance in proximity to r-f sources. They have researched several ideas on "r-f proofing" ordnance. Some of these have proved successful over specific frequency ranges but none over the entire spectrum.

Organization of Project HERO





TESTS INCLUDE exposure of demolition firing device and parachute control to transmitted power.

Recommendations and instructions based on team findings show three possible approaches for those concerned with the threat:

1) How to live with an existing and unchangeable situation;

2) How to modify to alleviate the problem;

3) How to design around the problem.

Future work is aimed at making a major advance in reducing the radio receptivity of the missile—from tens to hundreds of db down. Thus they will be safe under almost any level of electromagnetic intensity. To date, the Navy has had no known fatal accidents from electromagnetic radiation sources—the mission of *HERO* is to keep that record clean.

It is fairly certain that facts learned from this investigation would be useful in developing the often-mentioned "death ray"—the concentration of electromagnetic energy to knock out enemy weapons and personnel. But project engineers deny that they are interested in this aspect; neither, apparently, do they foresee the techniques used in countermeasures work.

Project *HERO* is a Bureau of Ordnance-funded program, but closely allied with the broader RadHaz program funded and directed by Bureau of Ships. BuShips, under the direction of J. J. Fisher, has responsibility for coordinating the various projects concerning r-f hazards to personnel, fuels, and ordnance. BuOrd chain of command for *HERO* includes C. A. Johnstone, chief engineer; C. B. Brown, assistant for electronics; C. M. Cormack, special assistant for radiation hazards; J. W. Payne, head of Electromagnetic Hazards Division; and LCdr. C. F. Fadeley, assistant.

Meteor Bursts Used in Radio

BOULDER, COLO.—Intermittent meteor-burst communications can be used competitively with other long-distance radio systems according to a recent report by the National Bureau of Standards.

A three-year test program has been conducted by NBS Boulder Laboratories to determine the feasibility of a long-distance VHF communication system employing signal reflections from ionized meteor trails.

Sponsored by the Air Force Cambridge Research Center, the program has resulted in a two-way radio teleprinter system having a transmitting speed of up to 4800 words minute. This is 80 times that of regular teleprinter speeds. In addition, the meteor-burst mode appears to be relatively free of the ionospheric disturbances which often degrade HF communication systems.

Preliminary tests were performed over a 390-mile path from Sterling, Va., to Walpole, Mass. An 800-mile path between Kilbourne, Ill., and Erie, Colo., was used for most of the test program.

Because of the nature of meteor trails, a new approach to message handling and control was necessary to successfully use the phenomenon. Most of the millions of small meteors entering the earth's atmosphere are vaporized by the intense heat developed by atmospheric friction in the lower ionosphere. This creates a trail of electrons and, thus, ionized atoms extending approximately 15 miles behind the remains of the meteor.

This ionized trail reflects radio waves and causes short-time signal enhancement.

Since the trail is short-lived, a system making use of its reflective characteristic must operate intermittently at very high speed, and must be operated automatically. Message storage is mandatory while awaiting a usable meteor trail.

By its nature, this type of system is almost totally safe from jamming.

The system employs two 5-element Yagi antennas. It was operated at a frequency of 49 mc/s with a 2-kw power output. Antenna design is based on meteoric ionization at an elevation of 110 kilometers.

The system is not without defects, and these will require more study before they can be minimized. Two coexistent meteor trails occur frequently enough to be a serious error source. Electrical storms and precipitation static also can be a serious problem. Manmade radio interference causes degradation but NBS feels this can be minimized through improved equipment design.

NBS Certifies Needed Critical Measurements

The National Bureau of Standards, in a development necessary in the production of critical components for space vehicles and systems, has certified the accuracy of its length measurements made on two commercial gage blocks to better than one part in 5,000,000.

The measurements announced by the U.S. Department of Commerce were made on a 16" and an 18" gage block. Each block was converted into a line standard by wringing a graduated gage block to each end. They were then compared with the working standards of the U.S. bars with carefully engraved lines marking the standard distances.

The blocks were then measured in terms of wavelengths of light. The results obtained by the two methods agreed to the nearest millionth of an inch or better for both gage blocks. This not only "proves" the accuracy which can be obtained in gage-block measurements, but also serves to verify the accuracy of the wavelength of various light waves as expressed in terms of the international meter bar. The NBS measurements also agreed to two microinches with independent measurements made by the National Physical Laboratory (England) on the same blocks.

Solar Flares May Cause Much Radio Disturbance

PONTIAC, MICH.—Solar flares may cause more interference with radio transmissions than do sun spots, long blamed for such difficulties.

This is one of the tentative conclusions reached as a result of new research into the daily activity of the sun, conducted by University of Michigan astronomers here under a grant by the National Science Foundation.

The study is part of a long-term worldwide effort to relate solar phenomena to various earthly effects such as radio disturbance. The information collected is sent daily to the Bureau of Standards, which predicts interference patterns and affected frequencies up to a week in advance.

Solid Fuels are simple—

at RAS-IAS meeting . . .

Canadians Say Transmitter Withstands Half-million G's

by an M/R correspondent

NEW YORK—Development of miniaturized instrument packages which have withstood g-forces far in excess of a full impact on the moon was reported by the Canadian Armament Research and Development Establishment at the 7th Anglo-American Conference here Oct. 5-7.

According to the report of Dr. G. V. Bull, superintendent of the CARDE Aero/Physics Wing, at the Royal Aeronautical Society-Institute of the Aeronautical Sciences Conference:

"A transmitter was found to be in good working order after taking half a million g's upon slamming into a two-inch aluminum pipe."

The transmitter consisted of nine electronic components assembled and potted into epoxy resins. The basic unit was then potted into araldite reinforced with fiberglass cloth and machined to desired shape. The complete circuit fit a cylinder 0.5-inch in diameter and 1.5 inches long, which was placed in a projectile 1 inch in diameter and 3.75 inches long and launched with a velocity of 6000 ft./sec. from a 3.125 smooth-bore gas gun.

The transmitter batteries were broken off on impact, but when batteries were added in the laboratory, the transmitter was still operating. It was powered by 5-RM 400 R Mallory-cells, which delivered 33 milliwatts and were capable of operation for 16 hours.

"Such packages could easily withstand hard impact on the moon," said Dr. Bull, who estimated that a payload might be subjected to 100,000 g's in crashing on the moon.

• **Solar flares and satellites**—E. C. Cornford, head of the guided weapons department, Royal Aircraft Establishment, Farnborough, disclosed that a team of three British scientists has compiled new data confirming a relationship between solar activity and satellite orbit decay.

Cornford, working with D. G. King-Hele and R. H. Marson, all of the RAE, studied kinetheodolite data on 15 satellite orbits, collected in RAE sightings and from other European observers. Results from the United States also were studied. The material was presented in a paper entitled "Recent studies of Satellite Orbits."

Plots of sightings, particularly of *Sputnik II* and *Vanguard I*, showed a 28-day oscillation in the rate of orbit-time change. The 28-day period between peak values in orbit-time change correlated closely with solar flare activity. Cornford described correlation between the flares and *Vanguard I's* plot as "nearly perfect." This was also supported by data from *Vanguard II* sightings, now under study. The British scientists also found close correlation between minimum orbit period change and minimum solar activity.

The authors concluded that solar activity strongly influences the air density in the upper atmosphere.

Cornford also presented his teams calculated values for air density, ranging from 4.1×10^{-11} lbs/ft^2 at an altitude of 100 nautical miles, to 4.0×10^{-13} at an altitude of 220 n.m.

New values for various J_n orbit perturbation factors were presented. Using these new values, they determined that the difference in the earth's equatorial and polar diameters is 500 feet less than that computed before satellite sightings were available.

• **Ablation for nozzles?**—Dr. Lester Lees, professor of Aeronautics, Guggenheim Aeronautical Laboratory, California Institute of Technology, in discussing "Ablation in Hypersonic Flows," disclosed that ablation is under study for special uses in rocket nozzles. He declined to elaborate.

Dr. Lees said he did not think it would be long before ablation applications would be disclosed in "certain internal combustion applications in rocketry."

He compared ablative shields in re-entry problems to meteors entering the earth's atmosphere. The enormous kinetic energy of the meteor, at a relative entry speed of 44 miles per second, with millions of BTU's per pound, causes it to burn. Man, through use of ablative shields, seeks to bring this process under control. At present, man's efforts are with re-entry velocities of only about 40,000 feet per second, and heat of about 30,000 BTU per pound. He described numerous theoretical investigations which have contributed to understanding of the fluid mechanics of ablation.

French *SS-10, SS-11* Stake Out Possible Big Role with Army Air

Growing Army airpower may use both birds on fast helicopters and fixed-wing aircraft; new R&D SS-12 may also join the arsenal

WIRE-GUIDED *SS-10* (far left) flashes from Bell H-13. Explosive bolts remove launcher and wires after firing.

by James Baar

WASHINGTON—The **Nord** *SS-10* and *SS-11* are coming into their own as principal weapons of the Army's growing airpower.

The two solid-propelled missiles—originally purchased as light surface-to-surface anti-tank weapons—have been found particularly effective when launched from Army reconnaissance helicopters and fixed-wing aircraft.

The Army no longer sees the conventional warhead-packing French missiles as primarily anti-tank threats, but rather as weapons proven effective against a wide variety of targets.

It has found that helicopters loaded with *SS-10's* and light fixed-wing planes loaded with *SS-11's* will be capable of providing powerful close air support to infantry and armored columns.

Moreover, this firepower may be augmented by the new, secret Nord *SS-12* which is rapidly approaching the operational stage.

The solid-propelled *SS-12* is about twice the size of the *SS-11*, has greater range and may eventually be able to carry a sub-kiloton nuclear warhead. Unlike the *SS-10* and *SS-11*, the *SS-12* is not wire-guided.

The successful marriage of the *SS-10* and *SS-11* to U.S. Army aircraft is expected to lead to new increases in the Army's already-large purchases of them.

The Army purchases of either the *SS-10* or *SS-11* also is expected to be increased greatly with the completion of evaluation studies of the *SS-11* next month or in December. The Army will decide at that time whether to switch to the *SS-11* for use on tanks, jeeps and trucks.

The decision will be reflected in the FY 1961 budget. No money for the *SS-10* or *SS-11* was included in the FY 1960 budget because the Army wanted to wait until the evaluation of the more powerful *SS-11* was completed.

The Army in the last year signed contracts for some $12 million for the two missiles, and deliveries are still in progress. No official figures have been released on how many of the missiles have been purchased. However, a good estimate is more than 10,000 *SS-10*'s for deployment to troops in the continental United States and overseas.

To date Nord has sold a total of about 28,000 *SS-10's* and *SS-11's* to 11 countries including France and the United States. Other buyers are West Germany, Italy, Sweden, Denmark, Norway, Israel, Canada, Great Britain, and Switzerland. The missiles have virtually become standard NATO equipment except in Great Britain.

Both missile's popularity is based on a number of attractive features that include:

- Weight and size—The *SS-10* weighs only 33 pounds; the *SS-11* only 63. Both are stubby and compact. These features make them extremely mobile.
- Cost—Both missiles are relatively cheap. The *SS-10* costs about $750. The *SS-11* costs about $1150.
- Accuracy—Both are highly accurate. They are guided by two thin wires that are played out of the mis-

sile as it flies. The 1600-yard-range *SS-10* can hit a six-by-two foot target.

U.S. purchases of *SS-10's* already have been delivered to the 7th Army in West Germany, the 8th Army in South Korea and STRAC divisions in the United States. Meantime, both the *SS-10* and *SS-11* are undergoing evaluation—particularly for their use on Army aircraft.

So far, the *SS-10* appears more suited for use on helicopters; the *SS-11* on fixed-wing planes because of its 3800-mile range and greater speed.

Loaded with *SS-10's*, the helicopter becomes a formidable weapon or war.

It can hover in woods or behind hills, rise long enough to fire its missiles and disappear again. It can fly at tree-top level. It can move rapidly with advancing infantry, knocking out enemy emplacements and tanks. It can move with tank columns, providing continuous close air support.

The **Bell** H-13 Sioux helicopter can carry four *SS-10's*. The helicopter carries two men—a pilot and one man to fire the missiles. It operates at about 65 miles an hour and has a 200-mile range.

The new Bell HU-1A can carry four to six *SS-10's* plus an extra supply in its five-passenger cabin. It has a speed of more than 100 miles an hour and a 230-mile range.

Arming helicopters with missiles is a departure from the Army's previous use of aircraft since the creation of the Air Force as a separate service. But it has had its precedents.

The Army for the most part has been using its some 6000 helicopters and fixed-wing planes for such activities as observation, short-hop troop movement, reconnaissance, communications and casualty evacuation.

However, Army helicopters in the past have been armed with 4.5-inch high velocity rockets, 50-calibre machine guns and 20-millimeter cannon. A **Sikorsky** H-34 Choctaw helicopter has been armed with all three, giving it as much firepower as one volley from a World War II artillery battalion.

The French were the first to deploy the *SS-10* on aircraft. French helicopters have fired them with considerable success in the Algerian insurrection. Army tests have been based on the French experience.

The possibility of any rapid buildup of Army missile helicopter squadrons depends on two factors: The tight budget problem and the division of missions between the Army and Air Force Tactical Air Command.

The Air Force, which must spend its dollars first on strategic airpower rather than tactical aircraft, may be willing to look the other way rather than fight an Army buildup of close support air forces.

But money may prove to be the big stumbling block.

The Army FY 1960 budget has only $5.8 million for 100 H-13's and $25.2 million for 90 HU-1's. The FY 1961 budget probably won't provide for any increase in buildup if as much.

Mobile Fire Control Unit in Service at Test Track

HOLLOMAN AFB, N. M.—A "traveling blockhouse" is being operated here on a 35,000-foot captive missile test track.

The 1.5-ton mobile fire control unit—designed and constructed by Captain Burden Brentnall, fire control officer, and Earl McDonald, chief maintenance foreman—will eliminate the heavy equipment hauling of concrete pillboxes previously necessary at the track.

Fabricated of armor plate with plexiglass blastproof windows, the unit contains its own generating and air conditioning systems, two-way radio, multi-cable for track wiring and a base-connected telephone.

The unit will save an estimated $35,000 annually in equipment costs, the Air Force said.

Canadians May Free-fire *CHARM* in Early Summer

TORONTO—The Canadian Rocket Society has hopes of running full-scale free firing tests of Project *CHARM*, its low-budget, high-altitude research rocket, by sometime early next summer.

A working model of the "Canadian High-Altitude Research Missile" system, on display at the I.R.E. Canadian convention recently, included encoder, 240 mcs. radio link, decoder, automatic data reducer, high-speed recorder and a just-finished 12-foot launcher.

The Society says it has been conducting a series of static tests for the past year and hopes during the next winter to produce the final grain configuration for the first stage. It also reports the development of a modified GALCIT fuel and "promising results" with radial burning designs.

A method of forming the grain was developed which divides it into six separate "cassettes," each completely enclosed in its own inhibitor except for the internal star section burning surface. The cassettes are locked in place in the motor casing. Stress problems associated with a large single grain were said to be largely overcome.

Linde Offers 'Super' Insulation

Here's a report on a new advance in the search for better cryogenic insulating materials, together with a guide to practical comparison of systems

by John F. Judge

WASHINGTON—**The Linde Company** has developed a laminated "super insulation" which makes liquid hydrogen as easy to handle as LOX.

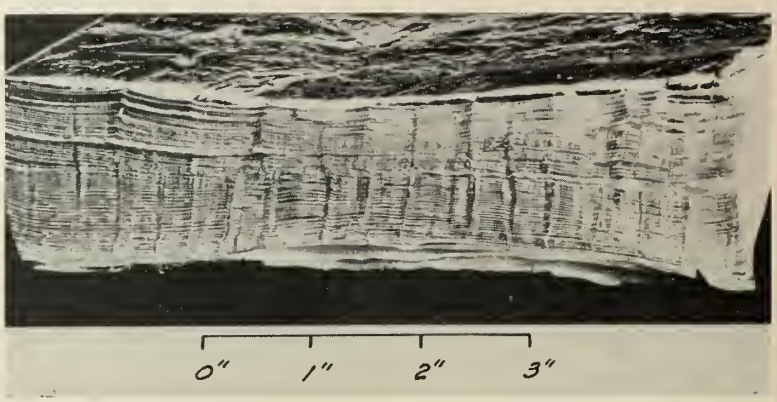
The material consists of 40 to 80 layers per inch of sub-micron glass-fiber paper and aluminum foil under absolute pressure, in insulating space, of 1.0 microns of mercury or less.

When incorporated into the popular 26,000-gallon storage tank, the new insulation, designated SI-4, makes it possible to store liquid hydrogen for a year with less than 10% content loss.

The development is the latest advance in the search for better cryogenic insulation to meet the changing demands of the missile/space industry.

SI-4 has a thermal conductivity of 0.025 x 10^{-3} BTU/hr-ft-F° (commonly known as the k factor) between 80°F and –297°F with a density of 4.7 lbs/ft³.

Another laminate, SI-12, is lighter (2.5 lb/ft³). But its k factor is 0.11 x 10^{-3} BTU/hr-ft-F° between 80°F and –297°F.



SAMPLE OF Linde's SI-4 laminated "super insulation," which greatly eases handling of liquid hydrogen. The company is working on a similar type to cost half as much.

Linde believes the upper operable limit of these insulations is at least 1000°F. This ceiling, largely determined by the materials of construction, could be extended if stainless steel were substituted for the aluminum and quartz fibers were used in place of the glass.

The practical problems in the application of the insulations have been resolved. These included maintaining a permanent vacuum, applying the insulation to geometrically irregular contours, and accommodating supports and piping through the insulation. The systems remain vacuum tight without re-evacuation indefinitely under the conditions of shock and vibration encountered in the handling and transporting of the vessels.

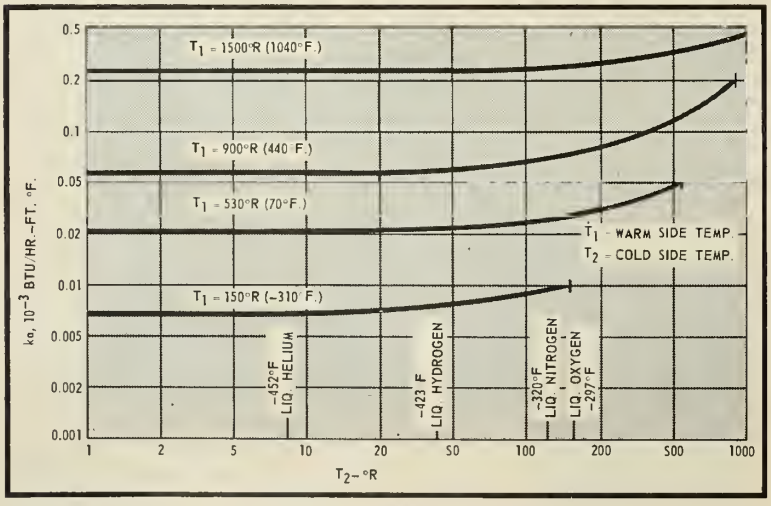
Linde has filed patent applications covering this type of insulation.

Work is progressing on a laminate roughly equivalent to SI-4 but with the cost cut in half.

A lighter insulation (4 lb/ft³) with a lower thermal conductivity than SI-4 is currently in the laboratory stage of development.

• **High temperatures**—At the other end of the insulation picture **Johns-Manville** approaches the problem in a diversified manner.

Min-K, a molded, low-conductivity material, and Min-Klad interlock, an integrated structural material which combines reinforced plastic with



PERFORMANCE OF SI-4 at various boundary temperatures.

This large concave spiral bevel gear is so distortion free after heat treatment that it meets the highest aircraft gearing standards without subsequent tooth grinding.

Precision is our only product!

In the rapidly changing field of aeronautical technology, the word "precision" becomes more and more common in use. At Indiana Gear, however, precision has always been more than a word. It is a way of thinking . . . a method of working always beyond the fringe of the state of the art.

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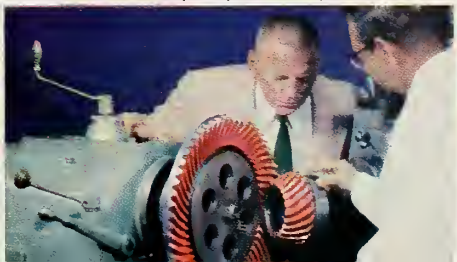

clarifying the comparisons . . .

Min-K are two of the company's developments applicable to missile insulation.

Both of these are being considered for cryogenic applications where vacuum systems are unnecessary. For vacuum areas, the standard glass paper used as a spacer between foil radiation elements employs extremely fine diameter micro fibers produced by the Johns-Manville Fiber Glass Division.

• **Companies involved**—Many firms, besides Linde and Johns-Manville, are engaged in supplying the insulation demands of the missile/space industry. While it is impossible to list them all, here are a few of the more familiar: **Taylor Fibre,** in high-temperature laminated plastics; **H. I. Thompson Fibre-Glass,** producers of Refrasil and Astrolite; **Continental-Diamond Fibre,** makers of molded and flexible insulations; **Hooker Chemical,** producers of the Durez line of heat-resistant phenolic resins, and **General Electric** and **B. F. Goodrich** in the field of reinforced plastics for re-entry applications.

• **Insulation comparisons**—Scientists at both Linde and Johns-Manville expressed concern over the confusion existing in attempts to compare various recent insulation advances.

Normally, the effectiveness of any specific insulation material or system is judged by the rate of heat flow through it during a steady application.

Dr. S. Speil of the Johns-Manville Research Center explained that there are three distinct definitions of heat flow in normal use—conductivity, conductance and transmittance. He listed them as:

• Conductivity, per se, refers only to a homogenous material or system and is a measure of heat flow through a unit size system based on unit difference in temperature between two surfaces.

• Conductance is a measure of the heat flow through any system irrespective of homogeneity or dimensions per unit area—based on the unit difference in surface temperature.

• Transmittance is the overall measure of the heat flow through a unit area of any system based on unit difference in temperature between the two air (not surface) temperatures. It is markedly affected by many ambient and surface considerations.

• **Meters and feet**—The familiar k factor, usually expressed as BTU/hr-ft-F°, applies to the definition of heat flow in terms of conductivity.

Some of the confusion arises from the many mathematical substitutions and conversions available in the k factor equation. For example, another method of expressing the thermal conductivity is in microwatts/cm-C°. But this, says Linde's Dr. E. L. McCandless, is only the normal confusion inherent in a scientific society which refuses to stabilize its system of measurements.

The insulation issue, however, is clouded by the choice of temperature difference. This difference is an essential part of each of the three basic definitions. It does not require much imagination to see the effect on the k factor of an intelligent choice in temperature gradients. Its presence is mandatory if any comparison between insulations is to be attempted.

• **Comparison dangers**—Either surface temperature, says Dr. Speil, or drop in temperature across an insulation is an extremely poor and often contradictory measure of the effectiveness of a thermal insulator. It must always be accompanied by a complete enumeration of the test conditions and is very difficult to correlate with other data obtained under different test conditions.

Furthermore, he says, extrapolation of conductivity data beyond the actual measured range when any change in density or temperature is involved is definitely hazardous, and, in most cases, wrong—unless sufficient data are available to express the conductivity in a mathematical relationship. Even in this instance, the extrapolation cannot be extended beyond the point where the density and the thermal radiation change markedly.

In general, a valid comparison of insulation systems involves more than the k factor. In fact, as Linde points out, if the relative merits of cryogenic containers are involved, convection and radiation are also important.

Perhaps, suggests Dr. McCandless, the best measurement in this area would be the relation of heat leak to contents.

ARPA To Back College Work

NEW YORK—Basic research programs in materials will be initiated by the Advanced Research Projects Agency at three to five selected American universities.

Roy W. Johnson, Director of ARPA, said that 25 universities were asked to submit proposals for participation in the project. The new materials program is a result of a recommendation by the President's Federal Council for Science and Technology.

The New York section of the American Chemical Society heard Dr. Johnson explain that there will be a minimum of governmental restriction involved. The research is to continue over a period of years and will incidentally result in the creation of 150 to 200 new Ph.D.'s annually.

ARPA also expects to invest some $32 million in solid propellant research to increase the useful energy of solids by 10 to 20% or more. Johnson said that during 1959, $15 million funded 54 contracts in six broad areas of solid propellant research.

Four of these contracts involved integrated programs totalling $6 million. As a result of an evaluation of the year's work, these four will probably be funded at a slightly higher level while the others will remain about the same.

In addition, Dr. Johnson said, ARPA is negotiating with representatives of the chemical industry for research on the deflagration-to-detonation phenomena, part of a new area of non-destructive testing in solids.

Heat-resistant Ceramic May Be Used in IR Lamps

SCHENECTADY, N.Y.—A new translucent ceramic, developed by scientists at the **General Electric Research Laboratory,** is said to withstand much higher temperatures—up to 3600°F—than most ceramics now in use. The polycrystalline ceramic, made from powdered aluminum oxide, has a high degree of strength and is relatively easy to fabricate.

Called "Lucalox," the material reportedly has the composition of a ceramic, structure of a metal, and light-transmitting ability near that of glass.

Lucalox is closely related to sapphire and ruby gem stones. It could be used as a gem-bearing material in precision equipment, or an electrical insulator. Its most immediate potential appears to be in high-intensity incandescent and discharge lamps, now limited by the temperature sensitivity of their transparent envelopes. Infrared lamps, especially, used for heat-resistance testing of missile nose cones and space vehicle equipment, would be a possible application. The "glass' usually used is fused quartz which is limited to temperatures below about 1800°F.

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NASA About To Try Orbit Near Venus

Thor-Able launching next month would be trackable beyond 50 million miles; success would restore much lost U.S. prestige

by C. Paul Means

WASHINGTON—An attempt will be made in November to launch a solar satellite capable of being tracked at distances greater than 50 million miles.

The National Aeronautics and Space Administration will make the solar orbit attempt with a *Thor-Able* vehicle that was originally scheduled to launch a payload towards Venus last June.

If successful, the *Thor-Able* payload will be the first to send back information from any great distance of solar space. Coupled with a successful launching of the *Atlas-Able* moon orbit shot, scheduled for the favorable astronautical times in either early or late November, the solar satellite would enable the United States to recoup some of its lost prestige in the race to space with the Soviet Union.

The payload is scheduled to be launched into an orbit inside of the earth's and very close to the orbit of Venus. How close the man-made planetoid will come to Venus has not been disclosed.

If accurate information is obtained about the satellite's orbit, it will be possible to receive information from it any time it comes within 50 million miles of the earth, giving scientists a solar observation platform which will continue to furnish information for years to come.

• **Other duties**—Principal objectives of *Thor-Able IV*, aside from any information it may be designed to pick up about Venus, will be the study of interplanetary gas and solid particles, and the study of solar-terrestrial relationships.

Studies by Van Allen in the earlier earth satellites indicated that the sun emits quantities of plasma gas into the solar system, some of which is captured by the earth's magnetic field to form belts of charged particles.

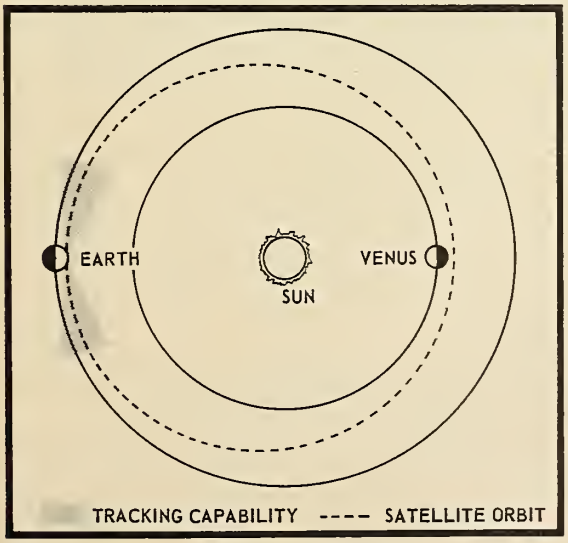
These streams or fields of gas will be studied by a magnetometer possessing a sensitivity of at least 10^{-5} Gauss.

The satellite will also study the magnetic fields of the plasma globs floating through interplanetary space from the sun and try to determine what the mechanism is for the propagation and transportation of the plasma streams from the sun to the earth and into the rest of the solar system.

The satellite's instrumentation will also observe meteorites and dust particles in solar space outside the earth's gravitational field. And it will collect data on the sun's ultraviolet and X-ray regions, which when correlated with the plasma and meteorite information, should give a clearer picture of terrestrial relationships.

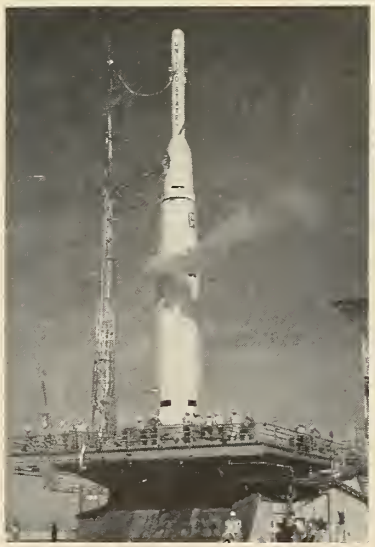
• **Special equipment**—The *Thor-Able IV* payload is similar to the "paddlewheel" payload developed by **Space Technology Laboratories** for *Explorer VI*, with two of the most important features being the solar cells and the transmission equipment.

The solar energy converters, manufactured by the **Hoffman Electronics Corp.**, are tiny wafers of specially treated silicon, which when exposed to



← ***SOLAR ORBIT*** **of proposed satellite would, if successful, provide an observation platform for many years to come.**

→ **FORERUNNER of the planned vehicle was *Thor-Able III*, shown on launch pad prior to boosting *Explorer VI* into orbit Aug. 7.**



light, convert approximately 10% of the energy of the light into electrical energy. *Explorer VI* used 8000 of these cells, 1000 on each side of the four paddles.

These cells will allow *Thor-Able IV* to transmit signals in its orbit around the sun indefinitely.

Helping to transmit the information received by the satellite's instruments is a compact telemetric digital unit called "Telebit," developed by STL. This instrument, designed to transmit information over interplanetary distances upward of 50 million miles, collects, stores, and tallies data while the transmitter is off, and sends the totalled information by radio signal to earth when the transmitter resumes operation.

Initial design and development of the sun satellite experiment began in late 1958 when NASA and the Air Force's Ballistic Missile Division assigned major tasks of the project to STL.

Thor-Able IV was to have been part of a three-stage project to investigate Venus last June, when the earth's sister planet was at its closest proximity to earth. The two other vehicles were *Explorer VI* (*Thor-Able III*) and the *Atlas-Able* vehicle which will now attempt to orbit the moon. The project was called off when *Thor-Able III's* payload could not be readied in time.

Shorter Method Developed for I_{sp} Hand Calculation

DOVER, N.J.—A rapid method of approximating machine calculations of I_{sp} has been developed by John D. Clark of the Naval Air Rocket Test Station.

The "NQD" method (NARTS Quick and Dirty) permits the consideration of novel propellants without the expense of machines and the drudgery of complete hand calculation.

Clark said the NQD method was faster and more accurate than the old Reinhardt System. All the new system involves is four sheets of thermodynamic data, a nomograph for solving one equation and a knowledge of arithmetic.

NQD is suitable for screening, Clark added, but inadequate for design purposes since it yields no information as to the actual state of affairs in the combustion chamber.

Based on a thermal equilibrium hypothesis, NQD utilizes the exhaust conditions as a direct route to I_{sp}. Clark considered special cases such as condensates and insulated particles, but he is skeptical of the validity of the former.

propulsion engineering

By JAY HOLMES

The Navy's new 'miracle' liquid monopropellants . . . have a specific impulse ranging from 249 to 255 pounds of thrust for each pound per second of fuel consumed. This is a quantum jump of at least 20 and perhaps 60 seconds over nitromethane, the best existing monopropellant. It pulls monopropellants even with—and perhaps ahead of—the best storable liquid fuel-plus-oxidizer bipropellant systems. For it isn't necessary to match the specific impulse of a bipropellant to be competitive. The weight saving in one set of pumps, hose, tank, etc., accounts for many seconds of I_{sp}.

Security still shrouds the exact composition. . . of the new monopropellant family. Monopropellants are compounds whose molecules have fuel on one end and oxidizer on the other. You can think of them as chemical hermaphrodites. All the Navy will say is that the new compounds consist of carbon, hydrogen, oxygen and nitrogen. Since the same can be said of the chemistry of the human body, not much information is being given away.

Stability is a major advantage . . . The monopropellants can be heated to 320° F for 48 hours without explosion or appreciable decomposition. They are liquid at ambient temperatures (boiling point about the same as water) and freeze from +23° to below –100° F. They appear to be wholly indifferent to ordinary shock. A high-order nearby explosion is necessary for detonation. The compounds can be stored a long time without deteriorating. Corrosion is so low that they can be easily prepackaged.

About 80 compounds were studied . . . before a half-dozen members of the chemical family were found promising during five years of research at the Naval Rocket Test Station, Lake Denmark, Dover, N.J. Two of the best are named *Tallulah* and *Cavea*. Dr. John D. Clark, chief chemist, says their density—ranging from 1.3 to 1.5 gm/cc—gives them a tremendous density impulse advantage. Density impulse, the product of specific impulse and density, is considered a better criterion than just I_{sp} in judging high-performance fuels for certain applications, particularly small rockets. A high density makes it possible to save weight by putting the propellant in a small container.

Monopropellants can't compete with solid propellants . . . in density impulse. But, being liquid, they can be turned off. Navy tests have shown that 93 or 94% of the theoretical impulse can be attained easily in a tube whose integrated length (volume divided by area of cross-section) is as little as 50 inches. Bipropellant systems require much greater length for high efficiency. Clark said specific impulse was figured on a shifting equilibrium basis at the now-standard 1000/14.7 psia.

No one has bought *Tallulah* or Cavea yet . . . for use in a piece of hardware. Clark contends they would be ideal for *Nike-Zeus* and *Polaris*. As in almost all cases with new high-performance fuels, first uses would be in upper stages. But he insists a booster could be built too. He even proposes trying *Tallulah-Cavea* in *Minuteman*.

What about cost? . . . Raw materials are commercially available in ample quantity, the Navy says, and the cost in mass production is expected to be no more than $5 or $6 a pound. At least four major chemical companies are capable of doing this job. Clark reports that every company in the rocket business and half of the chemical industry are "breathing down my neck." He says the production method is so simple that "any chemical processing plant above the level of a garage hobby shop can use it."

How To Pick Liquid Tank Materials

An Army expert outlines how compatibility and strength characteristics vary as the chief factors determining a choice of container composition

WASHINGTON—Compatibility and strength characteristics are the major factors in choosing liquid propellant tank materials.

Dr. Wilbur A. Riehl of Army Ordnance Missile Command reported this conclusion in a paper delivered at the Armed Forces Chemical Association meeting. Outlining requirements for all containers, he said cost replaces strength as a major consideration in shipping; the shipping container may be made as heavy as necessary so long as cost is favorable.

In a missile tank, the relative importance of compatibility and strength characteristics depend on the missile's mission. Defining compatibility as the ability of a material to resist chemical reaction with the propellant, Riehl noted that the quality can often be sacrificed for strength when the propellant is loaded a short time before launch. There is not enough time for a slow reaction to occur.

However, for storable propellant tanks, compatibility has just as great importance as for shipping containers. For example, high-purity aluminum containers are used for shipping concentrated H_2O_2, Riehl remarked. But the peroxide container in the *Redstone* is made of high-strength stainless steel, a material not suitable for long-term storage. The overriding consideration here is the greater strength-to-weight ratio of the steel chosen, while the compatibility is sufficient for the short time involved.

Evaluating strength characteristics involves such factors as compressive strength, tensile properties, Young's modulus, ductility and fabrication, Riehl pointed out. These are measured against density, so that the lightest material meeting strength requirements is used.

Strength-to-weight requirements are set in turn by design functions. For instance, the question arises whether the tanks are part of the structure—and thus must bear their share of the load.

A further question is expected lifetime. If a missile is to be storable, and may be subject to rough handling, a greater safety factor is necessary than for space flight, where it may be possible to shave a few pounds by careful handling.

In general, Riehl declared, aluminum alloys and austenitic type stainless steels are compatible with missile propellants, although other materials may be better in special cases. For contact with the halogens, such as liquid F_2 and ClF_3, monel or nickel is preferred. Aluminum or stainless steel may be used for LOX, N_2H_4 and fuming nitric acid.

Prior to use, laboratory tests must be made to establish compatibility with particular alloys. For example, molybdenum in stainless steels appears to react slowly with hydrazine or H_2O_2. Tests would be necessary to determine the exact reaction speed.

Some materials, such as nitrogen tetroxide and unsymmetrical dimethylhydrazine, can be shipped in mild steel containers. Nevertheless, aluminum or stainless steel containers are used. The reason is that both propellants are extremely hygroscopic and increases in water content could result in severe corrosion of mild steel.

The accompanying table shows container material that may be chosen for 10 common liquid propellant ingredients.

Composition of Typical Propellant Containers

PROPELLANT	MATERIALS FOR LONG TIME STORAGE	MATERIALS FOR MISSILE USE
LIQUID O_2	ALUMINUM, STAINLESS STEEL	ALUMINUM, STAINLESS STEEL
LIQUID F_2	MONEL, NICKEL	MONEL, NICKEL, STAINLESS STEEL
LIQUID H_2	MONEL, STAINLESS STEEL	ALUMINUM, STAINLESS STEEL
N_2H_4	ALUMINUM, STAINLESS STEEL	ALUMINUM, STAINLESS STEEL
UDMH	MILD STEEL	ALUMINUM, STAINLESS STEEL
		MONEL, NICKEL STAINLESS STEEL
CLF_3	MONEL, NICKEL	ALUMINUM, STAINLESS STEEL
H_2O_2	1100 ALUMINUM	ALUMINUM, STAINLESS STEEL
FNA	ALUMINUM, STAINLESS STEEL	ALUMINUM, STAINLESS STEEL
N_2O_4	MILD STEEL	ALUMINUM, STAINLESS STEEL
KEROSENE BASE FUELS	MILD STEEL	ALUMINUM, STAINLESS STEEL

GM Developing Model Satellite Powerplant

INDIANAPOLIS—A model of an earth satellite powerplant—which uses solar, nuclear, or chemical energy as fuel and can operate unattended for two years or more—is being developed here by **Allison Division** of **General Motors.** A laboratory model already has been operated successfully on solar radiant energy, producing enough power through an a-c generator to operate a small radio.

The Stirling-cycle engine—the principle of which dates back to 1816—operates at a constant speed of approximately 3600 rpm and drives two 12,000 rpm alternators.

The engine operates from external heat produced by solar energy, gases or organic materials. Where solar power is used, a special plastic Fresnel lens 20 feet in diameter concentrates the sun's rays and focuses the energy on a "window" in the engine's heat trap.

This heat is transferred inside the engine head to an operating fluid such as air, helium, or hydrogen. Changes in pressure from expansion and compression within the engine furnish power for the work piston. Solar energy is stored in heat-retaining lithium hydride to supply energy while the satellite orbits on the dark side of the earth.

soviet affairs . . .

By DR. ALBERT PARRY

What Soviet scientist . . .

has been in charge of calculating *Lunik* trajectories? The answer: V. A. Yegorov, who, although in charge of a group of prominent specialists assigned to this task, is not even a doctor of sciences yet. Yegorov's rank is merely that of the candidate of physical and mathematical sciences, which is less than our doctorate but more than our master of sciences. Yegorov's *Lunik* work is praised in a brief paragraph in a recent issue of *Sovetskaya Aviatsia,* amidst a long article on Soviet lunar rocketry by K. Portsevsky, an astronomer.

From earlier data on the subject . . .

we know that Yegorov is attached to the Steklov Mathematical Institute of Moscow, and that another outstanding expert working with him on *Lunik* trajectories is M. V. Cheldysh of the Soviet Academy of Sciences. They and their staff began their electronic-machine computations way back in 1952. By 1956, they had prepared more than 600 possible trajectories of a rocket flight to the moon, including hits, near-hits, circumflights, and afflights—the latter being approach trajectories, neither touching nor circling the moon, but permitting a view of its far side and a subsequent return to earth. Since 1956, many more trajectories have been added.

Writes Astronomer Portsevsky: . . .

"From among these numerous trajectories, our greatest interest is attracted by those which burn our *Lunik's* fuel the shortest time possible, and which cover the longest part of the route with the aid, not of the rocket's motors (these to be turned off early in the flight), but of the gravity force of celestial bodies." The Soviet astronomer practically dismisses as being of minor importance the influence of the sun on the *Lunik's* movement. But he writes of the necessity to calculate the gravity pulls of both the moon and the earth to a very exact point, indeed. He compares the precision of the Soviet guidance system of each *Lunik* to "the exactitude of a sniper aiming at—and hitting—the eye of a fly one hundred kilimeters away."

Basic discoveries . . .

shedding light on the problems of the origin of the earth and the moon have been made in the course of *Lunik* flights. This was recently announced at a Moscow gathering by Professor Leonid Sedov who, according to *Izvestia,* says that "these discoveries are now being checked, to be made public in the near future when they will become the possession of all the world's scientists."

Changes in the moon's place-names . . .

are soon to be proposed by the Soviet government. This can be deduced from a compaint voiced in *Komsomolskaya Pravda* that too many lunar place-names are meaningless to modern man. The complainer, V. Shishakov, a member of the staff of the Moscow Planetarium, asks indignantly: "Who were those men after whom the moon's mountains and craters are named?" He points out that the long-dead, long-unknown personalities of the seventeenth century, honored by that era's German and Spanish astronomers and mathematicians in devising lunar place-names, do not deserve such laurels in our times. Worse (from the atheistic Soviet view), some of the largest lunar craters are named after monks and other clergymen! Shishakov cites Sacrobosco, Schickhar, and Clavius as lunar names that are too "churchy" in their origin, and therefore simply do not belong on our modern moon. He blames Francesco Grimaldi, a Jesuit of bygone times, for establishing this trend. The Soviet astronomer says that the names of such well-deserving scientists of yore as Copernicus and Kepler "were given to comparatively small craters" of the moon. "Astrological superstitions" were responsible for such names as Mare Crisium. "But," Shishakov consoles his Russian readers, "selenography will soon doubtless be enriched with new names. The pencil of astronauts will put them on the lunar map."

NBS Conducts Broad Study To Aid Understanding of Dielectrics

DOD is sponsoring some of the research seeking materials which will be unaffected by temperature; knowledge gaps must be filled first

WASHINGTON—Because of the increasing demands of the missile and aircraft fields for better dielectric materials, the National Bureau of Standards has been conducting a program of fundamental research.

Partly sponsored by the Department of Defense, the work is aimed toward a greater understanding of dielectric phenomena to improve measurement accuracy and produce materials for severe environmental operation. In particular, dielectrics must be developed having electrical properties relatively free from temperature influence.

Supported by an active theroetical program, the investigations have resulted in development of new laboratory hardware and handling and measuring techniques.

Both the NBS laboratories in Boulder, Colo., and in Washington, D.C., have responsibilities in the current studies.

Primary objectives are to explain observed dielectric phenomena and to develop theories which can be used to predict the behavior of certain materials. In most of the work, a solid state approach is employed to probe the molecular behavior responsible for dielectric phenomena.

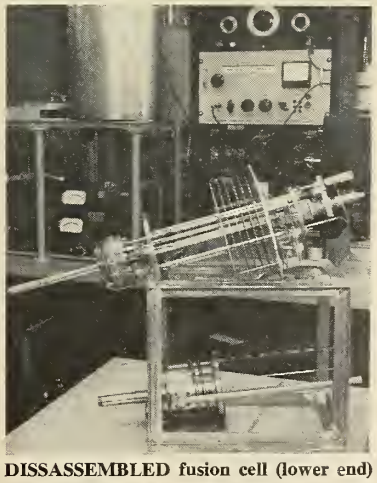
• **Basic studies**—Dielectric phenomena often are associated with a property known as "electric polarization." This is due in part to a displacement of bound charges in molecules when a voltage is applied. Little or no dielectric loss is associated with this contribution.

It also can take the form of interfacial polarization, that is, polarization arising from movement of electric charges on the interface between two discrete phases. Still other electric polarization arises from the presence of orientable permanent electric dipoles in molecules. Loss caused by "frictional" restraint on the motions of the ions or dipoles is associated with these last two types of polarization.

NBS is interested primarily in dipole polarization because it provides a basis for studying both intermolecular and intramolecular motions in such important materials as high polymers and for establishing the relationships which exist between the electrical characteristics and certain chemical and physical characteristics.

• **Special equipment**—A wide variety of special bridges, circuits, holders, transmission lines, resonant cavities, and cells have been put into use to accommodate the frequency and temperature ranges involved in the measurements. Dielectric constants and dis-

DIMENSIONS OF a dielectric sample under consideration are being measured as a reference standard. To insure top accuracy, NBS uses traveling microscope.



DISSASSEMBLED fusion cell (lower end) and controls form principal unit of special holder designed by the Bureau. Outermost housing is at upper left.

SINGLE CRYSTALS of inorganic nonmetallic materials are "grown" at the Bureau. Powdered material drops through flame, melts and forms crystal at base.

sipation factors are measured over a frequency range of from 10^{-1} to 10^{-10} cps at temperatures from −100° to +500°C.

Facilities for millimeter-wave work are available at the Boulder Laboratory and studies have been made at the low-frequency end of the dielectric spectrum involving frequencies having extra long periods (over 24 hours).

Although frequency determines the applicable dielectric measuring technique, temperature dictates the structure of dielectric cells. Several systems have been developed by NBS, including dielectric cells with micrometer-electrode holders for use at temperatures up to 500°C and down to −196°C. Two electrodes, one movable and one stationary, are employed to contact the specimen, and a precision micrometer is used to determine the position of the movable electrode.

A "fusion cell" has been designed to study materials that pass from liquid to solid form in the temperature range of interest. Although similar to other holders, the material in liquid phase can be held in the space between and around the electrodes. Pressure is applied to the movable electrode as the sample is solidifying, thus preventing voids from forming as the material contracts.

Current work seeks to determine the effects of solidification on the electrical properties of a variety of interesting materials. (For example, one substance, 2,2-dinitropropane, has a nearly spherical molecule that undergoes rotation in the solid state.)

To study materials involving a transition from gaseous-to-liquid-dielectric behavior, resonant cavities for compressed gases have been developed. Studies have shown that liquid-like behavior can occur at pressures of less than an atmosphere for the strong dipolar gases (ND_3). Further work is being initiated which will determine dielectric losses of very low-loss gases (such as sulfur hexafluoride, which very closely approximates a spherical molecule).

In the study of crystalline nonmetallic inorganic solids, although measuring circuits similar to those mentioned are employed, somewhat different theoretical and empirical problems have been presented. With polymeric materials it is desirable to consider the polarization in terms of molecular structure, but here crystal structure is of utmost importance.

Contributions to the dielectric constant arise from electron displacement, local displacements of the nuclei forming the lattice, and migrations of these nuclei to other sites. These contributions will be affected not only by the crystal structure and orientation but also by crystalline defects such as impurities, vacancies, and domain boundaries.

One major difference in experimental technique arises from the high dielectric constant of the titanate materials presently being studied. Instead of employing the micrometer holders used in the other studies, electrodes must be directly bonded to the surface of the specimen. The electrodes are made to cover the entire surface to minimize edge effects.

Because ceramic materials are especially sensitive to temperature and humidity fluctuations, studies must be carried out in a controlled environment. A constant-temperature holder has been developed for use with a Schering bridge. It consists of an inner chamber in which 19 specimens can be maintained simultaneously at 35.1°C by circulating water from a constant-temperature bath.

Between the inner chamber and an insulating outer chamber, a flow of dry nitrogen eliminates humidity effects. A second specimen holder designed for studies of the effect of temperature variation (20° to 200°C) on individual specimens also has been constructed.

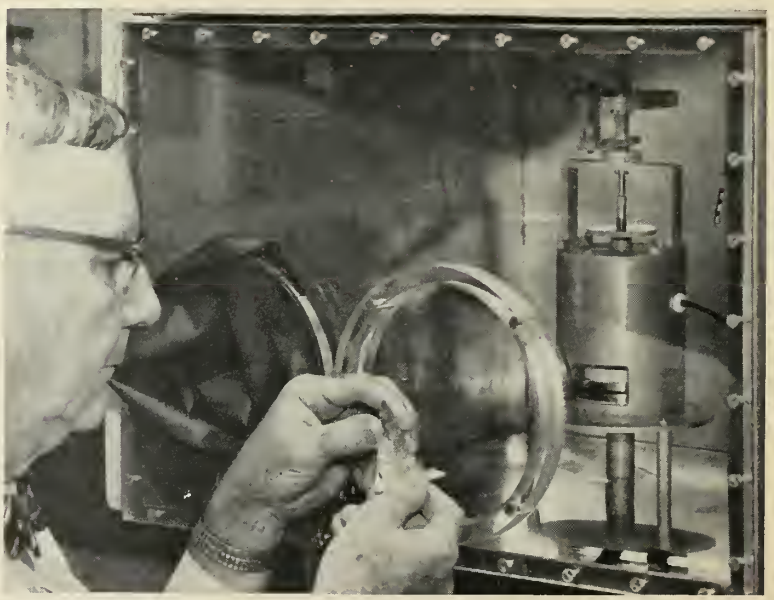
• **Areas of investigation**—An added difficulty in making accurate dielectric measurements on ceramics arises from the large effects of even small changes in specimen fabrication. To compensate for possible error, considerable attention is given to improving measurement techniques and characterizing specimens.

Two efforts are being made in this direction. First, an exploratory program on the effects of the electrodes has resulted in the adoption of indium-gallium amalgam instead of silver as the accepted electrode material. Second, some single crystals to supplement ceramic specimens are being produced with the idea that the crystals will be easier to characterize.

Through these continuous efforts to improve accuracy and reliability, it is hoped that eventually the complete relationship between the composition and electrical characteristics of ceramics can be worked out. For the present, the ferro-electricity group in the Boulder Lab will continue to concentrate on the titanates in general, and on barium titanate in particular. With its aim to provide a better understanding of the dielectric behavior of a single group of interesting materials, this program forms an integral part of the dielectric studies throughout the Bureau.

While ceramics are crystalline by definition, many polymers are neither completely crystalline nor completely amorphous. Therefore, to obtain a comprehensive picture of these materials, it is necessary to determine the degree of crystallinity as a function of such variables as temperature and previous history.

The degree of crystallinity is re-



HUMIDITY CABINET is used at the Bureau to determine the effect of atmospherics on dielectrics under consideration as reference standards.

lated in a simple manner to the density of the polymer. This density is easily measured by weighing the material in silicone oil. As the density of the oil at any temperature can be measured, a means for studying the amount and speed of crystallization in the specimen at various temperatures is thus provided.

A comprehensive set of measurements on polyethylene at temperatures from −50° to 250°C has provided such data on the relationship of specific volume to degree of crystallinity. Dielectric measurements have been made over approximately the same range of temperature, and correlated with the degree of crystallinity.

Similar dielectric measurements are now being made on nylon at temperatures from −100° to 175°C. These measurements are complicated by the appearance of a large dc conductance at the higher temperatures, and by an electret effect (resulting from the permanent polarization of a dielectric).

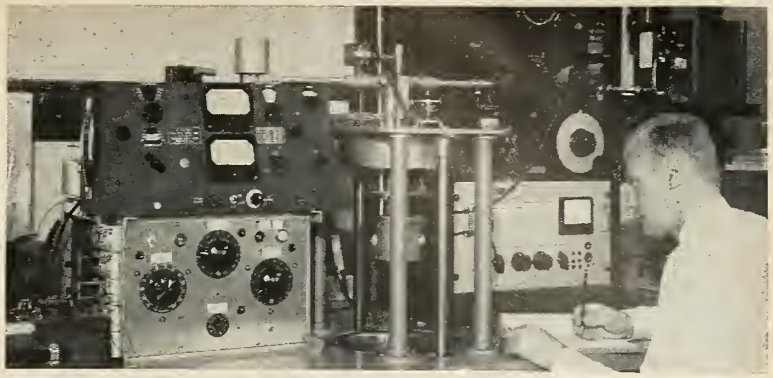
Theoretical studies, which are being conducted to explain the relationship between the electrical properties, the amount of crystallinity, and the effects of temperature, will form a prominent part of the dielectrics program on semicrystalline polymers for some time in the future.

Certain crystals such as sapphire, certain molecules such as the noble gases (helium, argon, etc.), and some other molecules have extremely low loss which can be studied conveniently at microwave frequencies. Also, measurements on very pure aluminum oxide reveal dissipation factors smaller than most materials now known. According to NBS, this demonstrates the possibility of obtaining even lower losses with very pure substances.

Because the theory of these losses is not yet well developed, NBS is conducting theoretical studies and making new and more accurate measurements. Such investigations will have practical applications especially important at higher temperatures where low-loss materials are essentially nonexistent at present. Further work in these areas is dependent upon obtaining pure materials under carefully controlled conditions.

In the interaction between electromagnetic waves, conductivity properties of materials are essentially inseparable from the dielectric properties. At radio and microwave frequencies, conductivity studies are therefore an important component of any dielectrics program.

In this connection, the Radio and Microwave Materials Section is investigating the tensor or directional conductivity of semiconductors such as single crystals of germanium at microwave frequencies under different physical conditions.



SPECIAL HOLDER (center) designed for use from the liquid-nitrogen range up to 300°C, is placed in a Dewar containing liquid nitrogen.

Some important questions in the theory of solid state will be investigated in this work. It is expected that these studies will yield a better understanding of the crystal lattice forces and processes. The results may prove of value in microwave engineering if the tensor properties for radio waves are appreciable.

Among other examples of the Bureau's research in dielectrics are refractometer studies. The refractometer determines the dielectric properties of the atmosphere, which in turn determine the propagation characteristics of the troposphere, so important to radar and other means of microwave communication. The Bureau's work constitutes the background for successful applications in this field for military and other purposes.

Propagation of electromagnetic waves or radio signals through a material is governed by the product of the material's magnetic permeability and its dielectric constant. For many substances the magnetic permeability is unity. In such cases the travel of waves in the material is dependent only on the complex dielectric constant of the ability of the material to "store" electrical energy.

Ferrites have important magnetic properties at radio and microwave frequencies and have gyrotropic or directional characteristics important in microwave applications. They also have very high dielectric constants which are currently being investigated. Studies on soils are important in locating radio transmitters and antennas and establishing and predicting radio communication links.

• **Standardizing measurements**—Accuracy in dielectric measurements is basic to all electrical applications, where dielectrics often set limits on voltage, frequency, absorption, reflection, and temperature of operation.

For this reason, the electrical properties of dielectrics must be determined before the materials are incorporated in electrical equipment such as capacitors, transmission lines, antennas, transmitters, transducers, and generators. Furthermore, as small changes in production techniques may radically alter the electrical properties of the material, additional measurements are sometimes necessary to control the quality of finished equipment.

A principal task at the Bureau is its effort to meet the ever-increasing need for accuracy and reliability by improving measuring techniques and developing reference standards. This work is carried out principally by the Dielectrics Section in the Washington laboratories and the Radio and Microwave Materials Section in the Boulder laboratories.

The Boulder laboratories are responsible for dielectric tests and standards at and above 30 kc, and the Washington laboratories are responsible for similar work at lower frequencies. In addition, results obtained by the Bureau's chemistry laboratories in research on molecular dynamics are frequently applicable to standardization procedures.

In further efforts to assure accuracy, the Bureau is cooperating with the American Society for Testing Materials in developing improved techniques for two-terminal measurements and for dielectric measurements of microwave ferrites and ceramics.

Through this comprehensive program of dielectric activities, which begins with the development of a primary standard, extends through improved measurements, and results in materials data and an understanding of fundamental behavior, the Bureau provides the basis for the technological application of dielectric materials. Efforts will continue along the lines described, with emphasis continually shifting toward basic studies as the accuracies necessary for the effective application of data are realized.

——contracts——

NAVY

Aircraft Armaments, Inc., Cockeysville, Md., for design and development of an operational trainer for the Army's *Sergeant* weapon system. Amount not disclosed.

Packard-Bell Computer Corp., for the development of a high-speed analog-to-digital conversion system. Amount not disclosed.

United Aircraft Corp., Sikorsky Aircraft Division, Stratford, Conn., for manufacture and delivery of booster fins for the *Talos* guided missile. Amount not disclosed.

$8,000,000—**Aerojet-General Corp.**, Sacramento, Calif., for development of a high-performance rocket powerplant for the *Eagle* air-to-air missile. Subcontract from **Grumman Aircraft Engineering Corp.**

$906,650—**The Singer Manufacturing Co.**, Bridgeport, Conn., for six hundred AN/ASR detecting equipment and related items.

$240,098—**Webcor, Inc.**, Chicago, three hundred sixty-eight magnetic tape recorders less control and indicator.

$200,000—**Ruscon Construction Co.**, Charleston, S.C., for construction of motor inspection building for *Polaris* missile assembly.

$124,347—**Westinghouse Electric Corp.**, Aviation Gas Turbine Division, Kansas City, Mo., for manufacture and assemble propulsion units.

$73,343—**National Research Corp.**, Cambridge, Mass., for establishing procedure for the production of high purity ultrafine powders of the metals of high melting point.

$52,050—**Bell Aircraft Corp.**, Buffalo, N.Y., for one hundred fifty KY-55/ARW decoders and one hundred fifty MT-950/ARW mounts.

$40,965—**Metlab Co.**, Philadelphia, for services and material required to heat-treat Tartar dual thrust rocket motors.

$40,480—**Ampex Corp.**, Washington, D.C., for magnetic tape recorders.

$31,752—**Valley Pressed Metal, Inc.**, Cornwells Heights, Pa., for the manufacture and assembly of complete guided missile container.

$28,475—**Kin Tel Division, Cohu Electronics, Inc.**, San Diego, Calif., for digital voltmeter.

NASA

$171,870—**Western Electric Co., Inc.**, N.Y., for assembling and operating a transmitting and receiving facility.

$300,000—**Bendix Aviation Corp.**, Baltimore, for call orders in connection with a satellite tracking program.

$72,962—**Republic Aviation Corp.**, Long Island, N.Y., for carrying out a program for accurate determination of the position and velocity of a lunar or interplanetary space probe.

MISCELLANEOUS

$270,000—**Consolidated Avionics Corp.**, subsidiary of **Consolidated Diesel Electric Corp.**, Westbury, N.Y., for special dual-output airborne transistorized power supplies. Subcontract from **Loral Electronics Corp.**

ARMY

$2,795,193—**Raytheon Mfg. Co.**, Waltham, Mass., for engineering services in connection with the *Hawk* missile.

$500,000—**I.T.T. Laboratories Div., I.T.T. Corp.**, Nutley, N.J., for ground stations modification for *Courier* communication satellite system.

$213,272—**The Martin Co.**, Orlando, Fla., for concurrent repair parts for the *Lacrosse*. (Two contracts.)

$117,610—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for research investigations leading to development of solar regenerative chemical system.

$59,048—**Emerson Electric Manufacturing Co.**, St. Louis, for research and development of booster metal parts for missile "A" rocket.

$50,297—**Consolidated Electrodynamics Corp.**, Pasadena, Calif., for a 16-channel, cathode ray, recording oscillograph.

$49,157—**Mathewson Tool Co.**, Orange, Conn., for launchers and spare parts, plus effect of producibility study contract.

$30,441—**Tung-Sol Electric, Inc.**, Newark, N.J., for electron tubes.

AIR FORCE

The Rucker Company, Oakland, Calif., for twelve additional hydraulic power systems for *Atlas* ICBM launching sites. Amount not disclosed.

United Aircraft Corp., Missiles & Space Division, E. Hartford, Conn., for feasibility study of ballistic missile defense equipment.

$38,900,000—**Raytheon Mfg. Co.**, Waltham, Mass., for production of doppler radars for bombing navigational systems. Subcontract from **Sperry Gyroscope Co.**

$1,700,000—**Reeves Instrument Corp.**, Subsidiary of **Dynamics Corp. of America**, for production of various systems including support equipment and airborne inertial devices for the *Discoverer* project.

$1,242,000—**Kearfott Co., Inc.**, subsidiary of **General Precision Equipment Corp.**, Little Falls, N.J., for a product improvement program on the true heading computer group comprised of the AJA-1 and the N1 directional gyro compass system.

$155,000—**Consolidated Avionics Corp.**, Westbury, N.Y., for delivery of a 20-channel analog-to-digital conversion system to be used as an on-line force and moment readout system for a hypersonic wind tunnel.

$110,000—**Electronic Associates, Inc.**, Long Beach, N.J., for precision AC digital voltmeters to be used with TM-76 *Mace* missile program. Subcontract from **Martin Co.**, Baltimore.

$99,800—**Kearfott Co.**, Little Falls, N.J., for a solid state multiheaded celestial comparator.

$99,200—**Giannini Controls Corp.**, Pasadena, Calif., for services and material to repair control gyros.

$88,680—**The University of Washington**, for research on "Theory of Molecular Electronic States."

$85,383—**Texas Instruments, Inc.**, Dallas, for control units used with radar equipment.

$42,000—**Massachusetts Institute of Technology**, for investigations on problems of ordinary shock waves, without the effects of magnetic fields or chemical reactions.

$40,985—**Stanford University**, Stanford, Calif., for research on "Non-Linear Control Systems."

$38,574—**University of Illinois**, for continued basic research into internal friction (the damping of elastic vibrations) in metals.

$36,016—**Cosmos Industries, Inc.**, Long Island, N.Y., for test oscillator, spare parts, engineering data and maintenance data.

$27,000—**Electro-Mechanical Research, Inc.**, Sarasota, Fla., for calibrator and transmitter.

$26,355—**Sylvania Electric Products, Inc.**, N.Y., for electron tubes.

$20,000—**University of New Hampshire**, for research involving a theoretical investigation of transport phenomena and the general mechanism of conduction in gaseous plasmas and in solids.

$14,500—**Yale University**, for basic research investigating the kinetics of reactions in gases.

$14,000—**Texas A & M Research Foundation**, for continued basic research on nuclear magnetic resonance.

$12,000—**University of Wisconsin**, for conducting basic chemical research.

$10,000—**University of Minnesota**, for research in basic chemistry.

$9,000—**University of Wisconsin**, for basic research in chemistry involving chain addition reactions to hydrocarbons.

Richard W. Powell, an authority on infrared devices, has been named manager of Aerojet-General Corp.'s Avionics Division.

Powell, who joined Aerojet in 1950, was named chief engineer, Electronics and Guidance Division in 1954, supervising research, development and pilot production of infrared systems and sub-assemblies. Prior to his recent appointment he was assistant manager of Avionics.


POWELL

Hughes Aircraft Co. has announced formation of an advanced program development operation within its Airborne Systems Group, naming: **C. Gordon Murphy,** formerly of the Washington, D.C. office, manager of the operation; **William A. Van Allen,** head of contracts for the Airborne Systems Group; **Barney E. Turner,** manager of Air Defense Systems; **Dr. Norman E. Peterson,** manager of Tactical Systems; **Dr. Rex C. Mack,** manager of Space and Ballistic Missile Systems; **Paul S. Visher,** manager of the Subsystems Dept.; **Malcolm D. Hudson,** manager of Microwave Products, and **Benjamin W. Davis,** manager of Nuclear Electronic Products.

George Morrison, propellant expert, has been named the first associate technical specialist in the technical service and development department of The Dow Chemical Co. Morrison, who joined the firm in 1945, has been assigned to developmental activities in high-energy fuels, explosives, missile propellants and metal hydrides.

Fred Wolff, formerly a staff engineer with Servo Corporation of America, has been named acting manager of the Data Systems Engineering Division of the firm.

Prior to joining Servo, Wolff was chief engineer, UAC Electronics Div., Universal Transistor Products Corp. Two transistor circuits he developed while with Universal have been patented. Earlier, he supervised research and development at Freed Transformer Co.

Telemeter Magnetics, Inc., has awarded UCLA a $9000 grant-in-aid for engineering research in the field of digital data storage and handling. The grant was awarded to **Melvin Breuer,** graduate engineering student, who will receive $3000 annually for research in the field with emphasis on input-output problems. Dr. Gerald Estrin, Professor of Engineering, will direct the project.

Peter H. Escher has been elected manager of the newly formed Electronics Systems Division of Electro-Optical Systems, Inc. He will be concerned with problem analysis and system design of guidance and control equipment for space vehicle application.

Prior to joining the firm in April, as a senior staff scientist in guidance control, he was manager of the Electro-mechanical Division of Aerophysics Development Corp.

Claire A. Stepnitz has been elected supervisor of research and development for Bowmar Instrument Corp.

Stepnitz joins Bowmar after eight years in supervisory capacities at the Federal Division (formerly Farnsworth Electronics Co.) of IT&T Corp., where he specialized in radar systems and missile test equipment. He served as system engineering manager on *Bomarc* missile test equipment and electrical equipment programs. He was also project engineer and section head on several electromechanical projects and on the development of an airborne radar antennae control system.


STEPNITZ

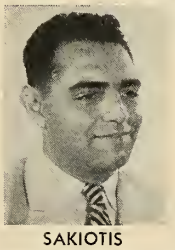
Dr. Hugh L. Cox has been appointed lead engineer on advanced classified projects by Martin Co., Denver.

Dr. Cox' new post comes to him after a three-year association with Kirk Engineering, during which time he was assigned to Martin Co. as a consultant in dynamics and structures. During this time he worked on stand vibration analysis for the *Titan* missile.


COX

Prior to his association with Kirk, which he will continue on a consulting basis, Dr. Cox was with ABMA in the capacity of structures and dynamics engineer.

Nicolas G. Sakiotis, formerly associated with the Naval Research Laboratory in Washington, D.C., has been appointed project leader in the Microwave Applications Laboratory of the Motorola Solid State Electronic Department.


SAKIOTIS

Sakiotis will conduct advanced investigations on microwave properties of solid-state materials, ferrites in particular, as applied to switching circulator techniques, ferrimagnetic limiters and phase shifters for antenna scanning.

In 1959 he received the NRL Incentive Award and the Scientific Research Society of America's Applied Science Award for professional achievement.

The following appointments have also been announced:

George H. Lockwood has been named manager of development and research for The Heald Machine Co.

John W. Rane, Jr., formerly of Bell Aircraft Corp., has been elected director of military relations for Ryan Aeronautical Co.

Dr. George K. Hess, Jr., previously on the staff of the Los Alamos Scientific Laboratory and associated with projects devoted to designing and testing atomic and hydrogen devices, has been appointed staff assistant to C. M. Edwards, associate director, technical, of the Research Laboratories Div. of Bendix Aviation Corp.

William O. Laande, former engineering representative and Boeing Aircraft instrumentation specialist, has joined Packard-Bell Electronics as liaison engineer.

Michael Leavitt, formerly with Laboratory for Electronics, has joined the staff of Burnell & Co. as supervisor of operations.

Jules M. Kleinman, previously with Hoffman Laboratories, has been elected president and director of engineering at Mini-Rad, Inc.

Wells R. Chapin has been appointed manager of marketing for Dage Television Division, Thompson Ramo Wooldridge, Inc.

IBM Corp. has announced the following promotions: **Raymond G. Fox,** business and fiscal manager; **Philip N. Whittaker,** manager of contracts, and **Fred G. Bergheim,** manager of Ballistic Missile Early Warning Systems administration.

Dr. Donald S. Arnold has been named manager of research at American Potash & Chemical Corp.'s Trona, Calif., plant.

Robert G. Parks, formerly with the Electrodata Div. of Burroughs Corp., has been named senior project engineer at Neff Instrument Corp.

The Sheffield Corp., subsidiary of Bendix Aviation Corp., has named **William I. Wilt** vice president in charge of advertising and sales promotion and **Louis Polk, Jr.** vice president-manager of gaging and automation systems.

Stephen F. Leo, formerly special assistant to the Secretary of the Air Force, has been elected to National Research Associates, Inc. board of directors.

Dr. Leonard Pode, formerly with the Norair Division of Northrop Aircraft Co., has joined General Controls Co. as chief engineer of the electronic systems division.

Resin Coating Adds Flexibility

A new line of resin coated fabrics has been announced by the **Irvington Division** of **Minnesota Mining and Manufacturing Co.**

Called "Irvington" brand coated fabric 4222, the material is coated with a modified polyester resin applied to nylon, dacron and glass cloth or other types of farbics in various weaves to provide desired burst and tear strength properties.

It has sunlight and ozone resistance, remains flexible at −80°F and will operate at 375°F without degradation, and resists mildew, wind and salt water. It also offers abrasion resistance and high adhesion to base cloth.

The new fabric has solvent resistance to aromatic, aliphatic, ketones and esters at room temperature. It is resistant to jet fuels, synthetic ester oils and hydraulic fluids as well.

Flexibility of the material is permanent since it contains no plasticizers which could bleed out with age.

The material is described as having excellent sewability and can also be cemented with adhesives having the same general properties.

"Irvington" 4222 is currently available in various colors on nylon, dacron, and glass cloth in 7 and 14 oz./sq. yd. coated weight. Characteristics of the material lend it to applications in missile covers, fuel cells, protective clothing, diaphragms, ducting, splash curtains and others.

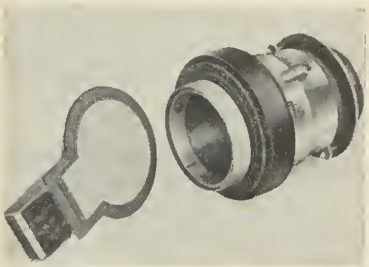
Minnesota Mining and Manufacturing Co.
Irvington Division
900 Bush Avenue
St. Paul 6, Minn.

Cooling Coupling Meets Missile Requirements

A new line of extremely lightweight remote-operated quick disconnect ventilating couplings has been announced by **On Mark Couplings, Inc.**

Available in 2½", 3½" and 5" sizes, the coupling gains its light weight from the airborne half which is made of magnesium alloy. The airborne half is contoured to the configuration of the missile. The simplicity of both the airborne and socket halves of the coupling results in a high degree of reliability.

The new On Mark coupling, designated type 5-8092-80, is disconnected remotely by means of a lanyard or by compressed air prior to launching of the missile. Positive disconnection is



accomplished by an ejector which provides the dual function of ejection and protecting the nose of the socket when it is not engaged.

Connection or disconnection is indicated remotely by approved switches installed within the socket. The coupling will operate in spite of freezing conditions and will resist the high temperatures encountered by missiles and satellites.

On Mark Couplings, Inc.
Los Angeles, Calif.

Portable Hydrocarbon Detector Is Versatile

A completely self-contained portable Hydrocarbon Detector affording rapid analysis of total organically bonded carbons in atmosphere or gases has been developed by **Perkin-Elmer Corp.**

Unique characteristics of the new instrument make it highly suitable for use as an atmospheric monitor of air pollution or lower explosive limits. The unit, which has been designated the P-E Model 213, will also serve effectively as a leak or impurity detector in lab, field and processing systems. Cost of the instrument is less than a third that of equipment normally employed in these functions.

Sensitivity of the new instrument is better than 0.1 parts per million for such organic carbon compounds as hydrocarbons, aldehydes, ketones, alcohols, and amines. It is completely free of interference from such common backgrounds as water vapor, oxygen, nitrogen, CO_2 and rare gases. The range of the Hydrocarbon Detector may be adjusted from as low as 0-to-1 ppm up to 0-to-10%.

In addition to its speed, range, sensitivity and portability, the P-E Model 213 is a rugged and highly accurate unit; identical results were produced on group of samples after the unit was transported across the country as ordinary baggage. Maintenance requirements are negligible and—of vital importance—it can be operated by nontechnical personnel with only

thirty minutes of instruction.

The heart of the new instrument is the Flame Ionization Detector, recently incorporated in Perkin-Elmer's gas chromatographic instruments. A metered flow of sample is fed into a hydrogen flame in an enclosed chamber. The flame ionizes combustibles in the sample to effect changes in current flow of a surrounding electrical field. These changes are proportional to total carbon content of the sample. Results are read out on the Detector's meter or an attached milliamp or millivolt recorder.

The P-E Model 213 is housed in sturdy suitcase-type enclosure of durable aluminum measuring 18 x 13 x 8 inches. It weighs 47 pounds fully equipped with batteries and air, hydrogen and standardizing gas clyinders. Air supply, with normal operation, will last 18 hours; hydrogen supply and batteries have average service life of 180 hours; and calibrating gases will last a year. All are of standard types, readily available from suppliers.

The Hydrocarbon Detector incorporates all necessary features to ensure reliability and safety. It may be operated with a hand or motor-driven pump for use with unpressurized samples.

Perkins-Elmer engineers foresee a tremendous scope of application for the Model 213. Combustion engineers will use it to control efficiency.

Perkin-Elmer Corp.
Norwalk, Conn.

SMPTE Hears of Space Age Challenge

by an M/R Correspondent

NEW YORK—Engineers who in the past have contributed to research, development and refinement of the television industry must return to their laboratories to produce new image-sensing devices for space exploration.

Sidney Sternberg, chief engineer of Astro-Electronic Products Division, **Radio Corporation of America,** made the observation after the first "Space Age" technical program of the Society of Motion Picture and Television Engineers held here recently.

Sternberg was program chairman for the session in which papers were presented on a wide variety of topics calculated to acquaint the SMPTE with problems of Space Age image-sensing and instrumentation.

"More sensitivity, higher resolution, much broader spectral response, more gray levels, variety of frame rates will become musts," Sternberg said. "Broadcast standards will no longer hold for space use."

A new electrostatic imaging and recording device being developed by three RCA engineers was described in a paper presented by one of the researchers, Dr. E. C. Hutter. Working with him are J. A. Inslee and T. H. Moore, also of the Company's Astro-Electronic Division.

The sensing device is being engineered for satellite use and one RCA official called it "the most advanced work in this field."

The electronic camera focuses on a special film which consists of a four-layer sandwich. The base of the film is a layer of transparent Conar 60 to 125 microns thick. Light passes through the Conar, then through a transparent conductor layer of gold, 0.01 micron thick. Next it passes through a layer of SbS_3 2.0 micron in thickness. The electrostatic image is deposited on a layer of polystyrene 0.6 micron in thickness.

The image is read off by a scanning electron beam.

In the laboratory model described by the three scientists in their paper, the electronic elements are built into a glass vacuum tube roughly similar in shape to a mushroom. The "stem" is a television pickup tube containing an electron gun. The "head" contains the roll of electrostatic film-tape mounted in an automatic assembly for winding and re-winding during exposure and readout, somewhat in the manner of standard motion picture film.

A company spokesman said advantages include extreme simplicity and durability, large picture capacity, widely variable speed of operation, and reduced sensitivity to radiation effects in space.

A continuous strip of pictures showing cloud formations completely around the earth could be contained in 180 feet of tape, which could be carried in a camera only slightly larger than the present laboratory test models.

Dr. Hutter said the new film has stored its images up to two weeks under laboratory conditions, and "theoretically could store them for months."

The film retains high image density, he said, but some image loss is realized during the electron scanning. A company spokesman told M/R this loss is no higher than the loss in other image transmission systems now in use.

• **Project** *Tiros*—Information concerning NASA's Project *Tiros* was included in several papers presented during the day, with emphasis on the scanning satellite's special equipment.

David S. Johnson, of the U. S. Weather Bureau in Washington discussed "Image Sensing as Applied to Meteorological Satellites."

He told of a cloud imaging system now under development for *Tiros* by RCA. It will view the earth through two television cameras with optic axis coincident with the spin axis of the spin-stabilized satellite. *Tiros* would be orbited at an elevation of about 400 nautical miles.

A high-speed shutter would minimize image smearing.

A 500-line raster would be used with a vidicon tube, and the signal would be stored on a tape recorder for subsequent playback when the satellite is interrogated by a ground readout station.

Each camera would take 34 pictures at approximately 30-second intervals during a selected part of each orbit.

One camera utilizes a lens with an included angle of 104 degrees, resulting in a picture approximately 800 miles square when the optic axis is normal to the earth's surface. Johnson pointed out, however, that area coverage would increase and resolution would decrease when the optic axis is not normal to the earth's surface. The second camera system would take magnified pictures about 30 miles square in the center of the area photographed by the first camera, enabling meteorologists to identify cloud types.

Johnson said that the *Tiros* electronic scan systems are limited to daylight operation. Recent laboratory results hold promise for high sensitivity, image orthicon image converter tubes for nighttime use, at least with moonlight, he said.

Magnetic tape recorders will be used in *Tiros*, Johnson said, but storage of 10^9 bits of data in one orbit, pending ground interrogation of the satellite, makes it doubtful that magnetic tapes are practical for worldwide meteorologic coverage desired. He cited the work of Hutter, Inslee and Moore on RCA's electronic camera as a possible solution for future satellites.

Dr. R. A. Hanel, of the Goddard Space Flight Center, NASA, in discussing "Infrared Imaging from Satellites," cited *Tiros* as a step toward infrared mapping at various spectral bands.

Tiros will scan the earth with medium resolution of about 30 by 30 miles in five spectral regions, Dr. Hanel said.

These are 0.2 to 5 microns, which covers about 99% of solar radiation; 7 to 40 microns, which measures the earth's "black body" temperature; 8 to 12 microns, the atmosphere window which yields surface temperature as well as day and night cloud cover; 5.6 to 7 microns, characterized by strong water vapor absorption; and .55 to .75 microns, a reference close to the spectral response of the eye. The last range will be helpful in interpretation of the other channels, and will also yield daytime cloud cover.

W. G. Stroud, also of the Goddard Center, co-authored the paper presented by Dr. Hanel.

• **Other NASA Plans**—Dr. N. G. Roman, head of the observational astronomy program at NASA, discussed long-range objectives in astronomy, and detailed the limitations of observatories on earth. NASA plans include a Gamma ray astronomy project to measure spatial frequency distribution of very high-energy photons.

She said NASA plans include:

A Gamma ray astronomy project which will measure the spatial and frequency distribution of very high energy photons.

An orbiting astronomical observatories project which will explore the region of the spectrum in which optical techniques can be employed.

An orbiting radio astronomy project which will provide observations of the longwave end of the spectrum.

GREAT LAKES AREA

(Continued from page 18)

Richmond, the Crosley Division of **Avco Mfg. Co.** is prime for *Weapon A* and turns out the stabilizer, missile container and flipper for *Falcon*.

Packard Mfg. Corp., Indianapolis, is making JATO parts for *Honest John* and in Columbus, **Cummings Engineering Co.** produces generator sets for *Nike* installations. Around Ft. Wayne, support equipment for *Nike* and *Bomarc* is being produced in quantity by the **Wayne Pump Co.** and **Farnsworth Electronics.**

The Magnavox Co., with a backlog of more than $50 million in military electronics devices, this year established an Anti-Submarine Warfare Department at Ft. Wayne. Its chief product is sonobuoys—developed over eight years of research, much of it in-house.

The Allison Division of General Motors at Indianapolis entered the rocket field several months ago and today is working on first- and second-stage motor cases for the *Minuteman* ICBM in a joint development program with **Thiokol.** And, recently, **P. R. Mallory & Co.,** at Indianapolis, formed a new electronics division oriented around missiles.

• **Boost for Ohio**—Of all the Great Lakes states, Ohio today appears to have the greatest single concentration of missile/space manufacturing. The big production centers are Akron, Cleveland and Dayton/Cincinnati.

Goodyear Aircraft, with sales running close to $100 million a year, is prime for the Navy's hot new ASW missile—*Subroc*—scheduled to be operational in about a year. The Akron company also has a multimillion-dollar contract for the *Nike-Zeus* AICBM Luneberg lens, is making radar antennas for *Hawk* and is handling logistic support for *Mace*. Another **Goodyear Tire & Rubber** subsidiary, **Goodyear Aviation Products,** also is in the missile support field—including carriers for *Atlas*.

Thompson Products Accessories, Cleveland, a division of **Thompson-Ramo-Wooldridge,** has the nose section for the Navy's *Bullpup,* the Army's *Pershing* transporter-erector, power drives for the Navy's *Terrier* and the pumps and fuel boost for *Hound Dog*.

Also at Cleveland, **Visioneering Co.** is making trailer undercarriages for *Nike-Hercules*. **Clevite Corp.** is fuzing *Bullpup* and **Willard Storage Battery** is making the batteries for *Falcon*.

Two of the Nation's leaders in the R&D of new metals are also in Ohio—**Mallory-Sharon** of Niles and **Brush Beryllium,** Cleveland. Brush is the developer of a 72-inch beryllium shield for the *Mercury* manned space capsule.

In the Dayton-Cincinnati area **Baldwin Piano** is fuzing *Sidewinder,* **Bendix Aviation** is building hydraulic equipment subassemblies for *Talos,* at Lockland **General Electric** is producing powerplants for the *Quail* decoy and **Aeronca,** Middletown, is working on a contract for *Jupiter* operational check-out shelters.

One of the Defense Department's largest R&D centers—the Wright Air Development Center of the AF Air Research and Development Command—at Dayton today is originating a continuous stream of work for companies across the country. On Sept. 1, WADC was administering 4003 active contracts totalling $100.5 million.

While no hub of private industrial development, WADC is itself a huge installation. More than 8300 persons—6700 of them scientists and engineers—are at work in 25 areas of technical research in laboratories sprawled over 1325 acres. The 200 buildings and their equipment are valued at $342 million.

In addition to contributing to the development of molecular electronics, WADC scientists recently came up with a high-acuity photographic system producing clearly defined pictures of the earth at 45,000 feet with a 1½-inch lens. The development, says WADC, suggests that a 36-inch lens 200 miles up in a satellite could achieve the same definition.

There is a 2700-man professional staff in the state's other major R&D facility—NASA's Lewis Research Center at Cleveland. The center's current budget is in excess of $27 million and there are plans to expand its facilities for studying chemical, nuclear and nuclear-electric rocket propulsion systems.

reviews

FATIGUE STRENGTHS OF AIRCRAFT MATERIALS. AXIAL-LOAD FATIGUE TESTS ON EDGE-NOTCHED SHEET SPECIMENS OF 2024-T3 AND 7075-T6 ALUMINUM ALLOYS AND OF SAE 4130 STEEL WITH NOTCH RADII OF 0.004 AND 0.070 INCH, H. J. Grover, W. S. Hyler and L. R. Jackson, Battelle Memorial Institute. Order NASA TN D-111 From National Aeronautics and Space Administration, Washington 5, D.C. 25p, $.25.

Results of axial-load fatigue tests on specimens described in the title, each having a theoretical stress-concentration of 4.0 are presented.

Tests were run at 0 and 20,000-psi nominal mean stress. The results extend those previously reported for tests on similar specimens and are compared with them.

EFFECTS OF CREEP STRESS ON PARTICULATE ALUMINUM-COPPER ALLOYS, E. E. Underwood and G. K. Manning, Battelle Memorial Institute. Order NASA TN D-109 from National Aeronautics and Space Administration, Washington 5, D.C. 62p. $1.75.

Particle dissolution, grain growth, and precipitation were studied under creep conditions in overaged alloys of aluminum with 1, 2, 3 and 4% copper.

With or without stress, particle dissolution is described by the same kinetic equation that applies to tempering and other phase transformations. The activation energy for dissolution in 3% copper alloys decreases from 70 kcal/mol without stress to 40 kcal/mol for a stress of 200 psi.

Relative activation energies for particle dissolution and grain growth coincide closely, suggesting that both are governed by the same process.

DEVELOPMENT OF NIOBIUM-BASE ALLOYS, R. T. Begley, Westinghouse Electric Corp. for WADC. Order PB 151739 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 192p. $3.

Included are results of studies on creep-rupture properties, flow and fracture characteristics, oxidation behavior, weldability, and purification techniques.

Flow and fracture experiments indicated that the ductile to brittle transition of niobium was little affected by the oxygen content in the range 0.01 to 0.1%. The impact transition range of electron-beam melted niobium was considerably below that of powder metallurgy niobium of somewhat higher oxygen concentration. An activation energy of 27,100 cal/mol was determined for strain aging in niobium.

Studies of the thermodynamics of niobium oxides and the kinetics of Nb-water vapor reaction showed that the thermodynamic functions obtained for the formation of Nb_2O_5 from Nb_2O were in agreement with the calculated values.

HIGH ENERGY RATE METAL FORMING, G. N. Rardin and others, Lockheed Aircraft Corp. for USAF. Order PB 151849 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 70 p. $1.75.

Tests performed during a three-month period to select the best method for explosive metal forming and to establish the quality of the product of the method are described.

Cupping tests confirmed that use of a shock focusing device is advantageous for increasing draw depth for air shots. Tests with a steel cupping die, with the air evacuated between die and work piece, and the explosive charge suspended above the work piece were inconclusive because the work pieces fractured before drawing to the full depth of the air.

Forming tests using plastic dies were satisfactory. Tests using a one-gallon paper container to support tap water as a transfer medium proved this size container too small.

Preliminary results using the cupping and beading dies in assembly with the bolster and tube, and a 24" column of water as the transfer medium, showed satisfactory performance with considerably less explosive weight.

• **Wood-Bridge, N.J.**—In a surprise move, **Curtiss-Wright Corp.** announced it is withdrawing from both Aerospace Industries Association and the Manufacturers Aircraft Association. C-W President Roy T. Hurley said his company is "convinced that the AIA and the MAA can no longer serve the defense program or the defense industry as is required to meet today's competition and have a healthy industry." C-W in 1958 paid $75,000 in dues to AIA, according to Hébert Committee testimony.

• **White Sands, N.M.**—The Army fired a test model of the *Nike-Zeus* AICBM for the first time here on Oct. 14 and reported that the shot was successful even though the bird fell short of its planned range, because it "yielded the desired technical data."

• **Salina, Kan.**—The first dispersed *Atlas* ICBM Squadron will be built here. Nine sites will be scattered over a 5500-square-mile area around Shilling AFB. One of them will be located not far from President Eisenhower's home town, Abilene.

• **Redlands, Calif.—Grand Central Rocket Co.** is embarking upon a multi-million-dollar expansion program coupled with a $2-million step-up in propellant R&D. Twelve new installations are planned with those required by the company's *Nike-Zeus* work getting top priority. Present employment of 600 is expected to double, perhaps triple. GCR says research will be aimed at developing and proving "a new class of high-performance propellants capable of delivering more specific impulse than has ever been obtained and to have them ready for application within the coming year."

• **Washington**—Sen. Stephen M. Young (D-Ohio) has demanded the complete unification of the armed forces and the expenditure of $2 billion to help the nation overtake Russia in the missile/space field. He said there was grave danger despite "a lot of soothing syrup" handed out by Defense Secretary Neil McElroy.

• **Washington**—The House Space Committee called for a "firm national program" to preserve U.S. know-how in boron fuel research. The committee said the nation has "a continuing requirement" for boron fuels for use in rockets and possibly ramjets (see p. 16).

• **Moscow**—Evgeny Fedorov, a top Soviet scientist, indicated Russia will continue its boycott of the U.N. Space Commission unless the Soviet Bloc is given as many votes as the West has in commission proceedings. The commission is seeking to reach international agreements on exploration of space. Fedorov also accused the U.S. of withholding space research data, specifically *Argus* results.

• **Cleveland**—NASA announced development of a prototype ion engine at its Lewis Research Center. It said plans for building larger models are underway.

• **Edwards AFB, Calif.**—A second full-scale **Boeing** *Minuteman* successfully roared from an underground silo. Nylon cables stopped the missile after it soared 500 feet.

• **Aberdeen Proving Grounds, Md.**—Army Secretary Wilber M. Brucker said the Army will seek a "large amount" of new money in FY 1960 for procurement of modern weapons—particularly missiles. He said the request would exceed the $1.7 billion the Army has for procurement of weapons in FY 1960.

• **Washington**—President Eisenhower renewed the Pentagon's right to keep secret from Congress and the public all military aid contracts. Congress has been bucking the President's refusal to disclose the contracts to congressional auditors.

Mergers & Expansions

With an eye toward developing specialized nuclear power systems, **Aerojet-General Corp.** is merging its turbo-machinery and nucleonics divisions . . . **Union Carbide Corp.** is building 25 million-pound capacity bisphenol-A plant at Marietta, Ohio. It will be ready in 1961 . . . Planned square footage of **Varian Associates** facility at Stanford Industrial Park, Calif., has been upped from 500,000 to 1 million . . . **Melpar Inc.**, Falls Church, Va., has just acquired five additional plants totalling 50,000 square feet for assembly of electronic devices . . . On the West Coast, **Electro-Pulse Inc.**, Culver City, has opened a new engineering division facility . . . and **Tamar Electronics Inc.** is in the process of building near Gardena, Calif., a 50,000-square-foot plant replete with a roof-top helioport and a swimming pool . . . At Woodside, N.Y. on Long Island, **Bulova Research and Development Laboratories** has fitted out an addition with $300,000 worth of new environmental and electronic test equipment to test missile warhead safety and arming systems.

Beryllium Extrusion Process Uses Glass

U-shaped beryllium extrusions 15 feet long and one-eighth of an inch thick have been produced by the **Norair Division** of **Northrop Corp.** The company is hoping shortly to produce 20-foot channels of the same thickness.

Norair is employing glass as a lubricant to guard against overheating when a billet is forced through dies at pressures up to 1700 tons and temperature of 2000°F.

Minuteman Rail System Bidders Now Total 20

Representatives of 20 firms have been briefed on railroad mobility requirements of the *Minuteman* ICBM by officials of **Boeing's Aero-Space Division.** Companies represented included: **ACF Industries Inc., Allis-Chalmers Mfg. Co., Baldwin-Lima Hamilton, Bethlehem Steel Co., The Budd Co., Chrysler Corp., Consolidated Western Steel (a division of U.S. Steel, Fairbanks, Morse & Co., Firestone Tire & Rubber Co., Food Machinery Corp., General American Transportation Corp., General Motors, Lockheed Aircraft, Magor Car Corp., Ortner Co., Pacific Car & Foundry, Pullman Standard Mfg. Co.,** and **Thrall Car Mfg. Co.**

west coast industry . . .

By FRANK G. McGUIRE

Even zoning laws can throw a monkey wrench into a missile program—witness **Convair's** troubles at Kearney Mesa. The company has partially succeeded in its efforts to get a zoning change approved so that it can build a 300,000-square-foot, $4-million warehouse for storage of *Atlas* materiel and prefabricated parts. The change, although approved by the city Planning Commission in San Diego, holds some restrictions that Convair would like to have eliminated. The commission required street paving, water-main construction, and setback lines. Convair maintains this last provision would prevent it from building the Air Force-required security fence as specified. Convair pushed the change through the city council with an interim emergency zoning ordinance last month. The 24-acre site was needed, Convair said, or else the delay "might result in **Douglas Aircraft Co.** succeeding in its effort to get the additional *Atlas* work" which was required by the recent increase in *Atlas* squadrons. Douglas, however, has denied that it is negotiating for the additional *Atlas* work. Presuming City Council approves the final rezoning petition, the warehouse will be built by **Lessor Industries** and **Diversified Industries, Inc.**

Perkin-Elmer Corp. has opened a West Coast office . . . in Los Angeles, and will complete its manufacturing facility here soon. The firm's sales for FY ending July 31 were a record $17.5 million, 16% over the preceding year. Heading the West Coast operation will be Leslie J. Cook, previously with **Thompson Ramo Wooldridge.**

"Made by the Bay for the USA . . ." was considered as a label for the *Polaris* missile/submarine combination recently shown together for the first time at Mare Island Naval Shipyard. The launching of the USS Theodore Roosevelt (SSB(N)) brought the missile (full-scale model) and submarine together for the public, which marvelled at the small size of *Polaris* (28 feet). Prime contractor for the missile is **Lockheed**-Sunnyvale, propellant by **Aerojet**-Sacramento, and submarine nuclear reactor by **Westinghouse,** while the Navy's Mare Island Shipyard constructed the sub; hence all the major firms involved were located in the San Francisco Bay area.

Nomination for the best play on words . . . in this Space Age goes to BMD's Astro News for its column heading of "The News Cone: Capsule Comments on Spatial Events."

Fabricel Division of Poly Industries . . . fabricated the 20-inch-square aluminum paddles for *Explorer VI* in just three weeks under a contract from **STL.** The paddles, made of ultralightweight aluminum honeycomb, form the base for mounting of 8000 solar cells used to convert sunlight to electricity for charging the satellite's nickel-cadmium batteries.

Manned targets for aircraft rockets . . . are being used by the Air Force at Holloman AFB, N.M. The **McDonnell** F-101B and the **Convair** F-106 are undergoing weapon system checks and adequate unmanned targets for them are not available. The rockets used are fired at a point ahead of the target plane, and would hit it if it continued on course. F-100's, F-102's and F-104's have been used as targets so far.

Sundstrand Turbo takes exception to the belief . . . that turbine APU's were cancelled for *Atlas* because they were deficient in performance. Actually, the company says, the missile's design was frozen early, and AF was reluctant to make any design changes involved in a switchover from battery to APU systems.

letters

To the Editor:

There are two unfortunate errors of fact in the caption for the world's first industrial atom smasher that appeared on page 17 of the Sept. 14 issue.

The first error: "This is the world's first industrial atom smasher at Shippingport, . . ." This atom smasher is located at the atomic power department in nearby Forest Hills (our old Research Lab) and not in Shippingport. These two places are about 35 miles apart.

The second error: ". . . a direct industrial outgrowth of the atom bomb." This atom smasher preceded the atom bomb by seven years, having been dedicated in 1938 . . .

H. C. McDaniel, Director
Technical Information
Westinghouse Electric Corp.
Pittsburgh, Pa.

M/R apologizes for the mislabeling. The photo, printed as an illustration for the article on "How Missile/Space Spending Enriches the Peacetime Economy," actually is the Van de Graaff accelerator constructed in the late 1930's. Westinghouse has since replaced it with more modern equipment, including the testing reactor at Waltz Mill, Pa. The shell shown in the photo has been retained for its historical interest.—Ed.

NOT AT SHIPPINGPORT

WHEN AND WHERE

OCTOBER

American Standards Association, Tenth National Conference on Standards, Sheraton-Cadillac Hotel, Detroit, Oct. 20-22.

Society for Experimental Stress Analysis, 1959 Annual Meeting, Hotel Pick-Fort Shelby, Detroit, Oct. 21-23.

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.

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

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.

Society of Aircraft Materials and Process Engineers (SAMPE) Eastern Division, Fall Meeting, Sheraton Carlton Hotel, Washington, D.C., Nov. 17.

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

ADVERTISER'S INDEX

Air Force Lays Down Space Policy

Speaking before a group of scientists in Boston recently, Brig. Gen. Homer Boushey, Director of Advanced Technology for the Air Force, established a few points of Air Force policy in the conduct of space exploration. Since the USAF was recently given a primary role in the field, they are of more than ordinary significance.

Space, he noted, is a location—and area—and not a project. As a medium it is indivisible with the atmosphere. There is no line of demarcation, nor is there one between aircraft and spacecraft. (An aircraft goes high, fast and far; a spacecraft goes higher, faster and farther).

Space should be used only when it can be used best, not because its use is more exotic. (It may be simpler, easier and cheaper, for instance, to lay more communications cables than to communicate via a satellite).

The general saw no conflict between the military and the scientist, and he could give many precedents for this feeling. Columbus was an admiral in the Spanish navy, but his voyages were not military. Admiral Byrd's work at the South Pole is a joint civilian-military effort. So was Capt. Cook's. So was the Lewis and Clark expedition. Space exploration probably will be the same and both the civilian scientist and the military man will profit.

The Air Force has definite ideas on the controversy over whether space should be investigated by men or machines and this is probably true of all the services. There is an old military maxim that nothing takes the place of personal reconnaissance. The USAF feels that man will find a useful role above the atmosphere as well as in it.

Gen. Boushey pointed out that man is a thinking animal; man is curious; man has judgment; man can contribute to reliability. For an investment of 165 pounds in weight, no machine yet devised can approach him in any of these respects. No machine can reason—nor be so fascinated by the unknown that it must go a little farther, a little higher, a little faster. No machine can have judgment when confronted by unforeseen emergencies. And no machine is as good as a man at replacing tubes or making adjustments in machinery.

Do We Like Being Second?

Emerging from an all-day meeting in Washington recently, the Science and Technology Committee of the Democratic Advisory Council proposed the establishment of a scientific laboratory or agency to work out the technical problems of maintaining world peace.

The suggested new agency, the Committee said, would act as a permanent laboratory for active study by recognized scientists of disarmament problems. These would include such areas as sending up satellites for nuclear inspection.

The Committee, which is composed of 17 scientists and engineers including two Nobel Prize winners, said that in the face of the enormous and highly dramatic challenge from the USRR, the United States has been given "intellectual tranquilizers" instead of intelligent action.

The Committee touched on the American space program only incidentally, listing it among the four items studied during the day-long meeting, but space matters tinged and weighted the report. Individual members spoke of the "enormous and dramatic challenge from Russia." They noted the "Soviet space probing successes." They said that *Sputnik I* had given President Eisenhower a tremendous opportunity to awaken the nation to deficiencies in its educational system—but that he had failed to take advantage of it.

The voice of the Committee is just one more in a mounting chorus of conviction that our position as a poor second in the space race is due to the Administration's failure to regard the race as important.

An industrial scientist recently told a group: "My company intends to devote its time and money for the next year or so to research. There is no point in putting concrete proposals forward now." A military leader said: "I'm afraid we'll see little progress in the next 18 months, though this doesn't mean we shouldn't keep trying."

Where have we lost the vigor and the enthusiasm and the drive that brought the United States to world leadership? Where has the magic gone? The boldness? We talk in platitudes of the "technical approach," a cover-up phrase for timorous hesitation. We pinch a few pennies—pennies in terms of our national wealth—and watch the Russians soar ahead.

Is this really what the country wants?

CLARKE NEWLON

Business end of the Titan—by Avco—The nose cone for the Air Force's Titan—designed to withstand the scorching heat and incredible shock of atmospheric re-entry—is a product of Avco research. Now, with the successful flight of this ICBM, the Air Force has assigned two new and important projects to Avco: an advanced design nose cone for the Titan and the nose cone for the third generation of intercontinental missiles—the mighty, solid-fueled Minuteman.

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