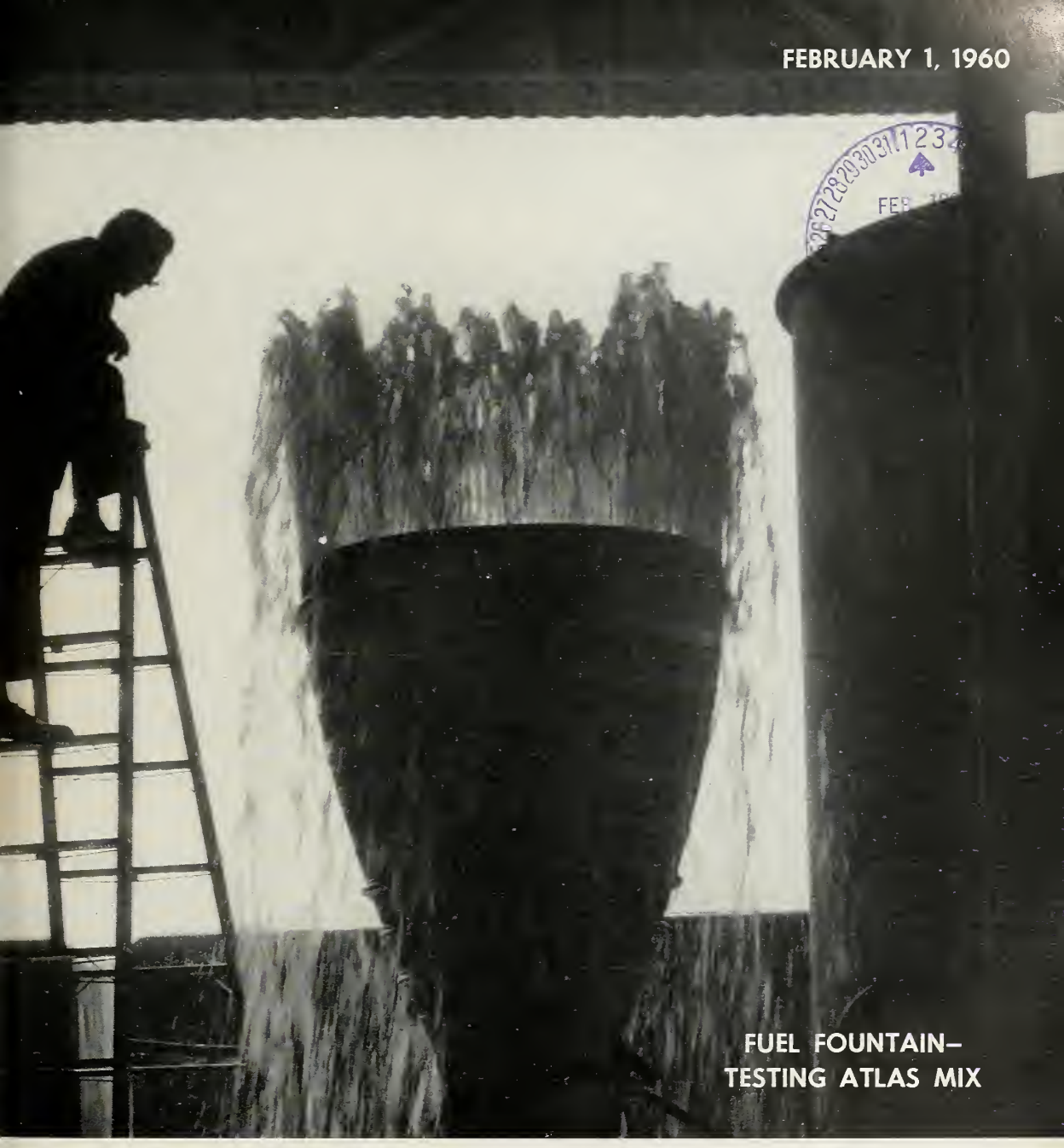
FEBRUARY 1, 1960



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missiles and rockets

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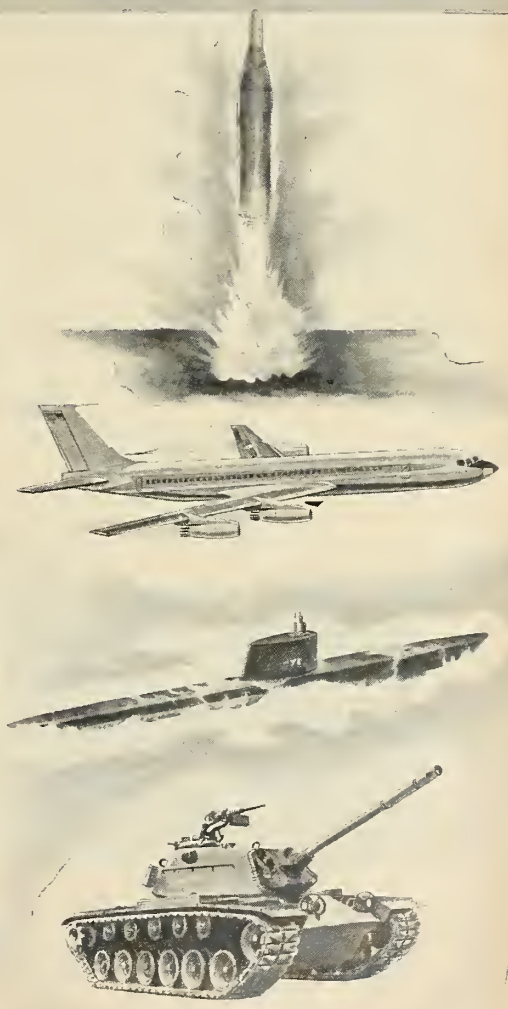

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By STANLEY M. INGERSOLL, *Capabilities Engineer*

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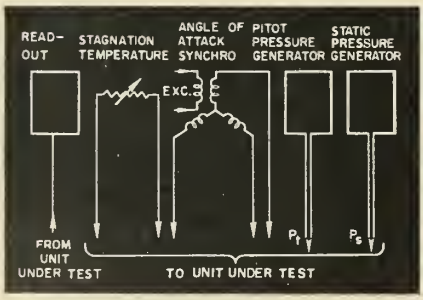
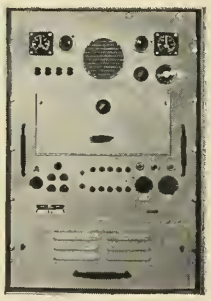
Angle of Attack, α_i	Full 360 Degrees





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COVER: Fountain from 300 water tubes at Rocketdyne test lab provides visual check on distribution of RP-1 fuel used to cool thrust chamber of *Atlas* ICBM booster engine.

RETIRED chief of Army Ordnance Missile Command, Maj. Gen. John B. Medaris blasts the Administration's space policies and calls for abolishment of NASA in exclusive interview with M/R. Turn to p. 12.

STORABLE *ATLAS* blasts off in M/R artist's conception. The Air Force is studying a Convair proposal for a completely storable *Atlas*. See story on p. 14.

PRE-TEST checkout of experimental ion engine is conducted at WADC's Propulsion Lab. Electro-Optical Systems Inc. has won contract for first ion engine for space. See p. 24.

missiles and rockets

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ASTRIONICS

NEW MISSILE PRODUCTS

THE MISSILE WEEK

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Washington Countdown

IN THE PENTAGON

Contracts on *Missile A* . . .

for development of test models are scheduled to be let soon by the Army. Some six firms will be awarded contracts for development of components that will be integrated by the Army Rocket & Guided Missile Agency.

• • •

Little doves . . .

are hampering missile test operations at Holloman AFB, N.M. They perch on the rails of the 35,000-foot captive missile test track and pack a powerful wallop when hit by a speeding missile.

• • •

Big boosters . . .

of the class of *Saturn* and *Nova* still interest the Pentagon only vaguely despite the Soviet Pacific tests. The reason: The Administration continues to insist that the military has no foreseeable mission in space beyond a few thousand miles out.

• • •

Some 400 *Hound Dogs* . . .

at the most, plus spares, are expected to comprise the stockpile now planned by the end of 1962. All 14 B-52 bomber wings will have the North American air-to-surface missiles. But not all B-52's will be armed with them.

• • •

More budget breakouts . . .

from total missile procurement figures for FY 1961:

. . . $170 million will be spent on the *Hound Dog*.

. . . $421.5 million will be spent on the Boeing *Bomarc-B*.

. . . $111.4 will be spent on the Western Electric *Nike-Hercules*.

> In the Industry and Military argot of Washington, the "mumble meeting" and the "no purpose conference" have long been well known. To them recently was added a new phrase—the "dither index." Its appearance coincided with the normally-almost-incomprehensible national budget.

ON CAPITOL HILL

Widespread howls . . .

will be heard from the halls of Congress when the still-classified GAO report on Air Force missile management is released—probably within the next month. The report:

. . . Hits at Air Force operations involving the Ballistic Missile Division and Space Technology Laboratories.

. . . Charges tax money was wasted because of Air Force refusal to disclose information to Congress.

• • •

The suppressed book . . .

written by SAC Commander Thomas Power is attracting renewed attention in the current debate over the Missile Gap. Several committees are taking a new look at just why Power's book came under the official Pentagon ban.

AT NASA

Italian Somaliland . . .

is understood to have been offered NASA as a possible spot for constructing an equatorial launching site. The pad complex would be located near Kisimaio. The launchings would take place eastward down an island-dotted 7200-mile sea range.

• • •

The first *Scout* launching . . .

now is expected about June. The *Scout* launching pad under construction at Wallops Island, Va., is about 80% completed.

• • •

The last *Little Joe* test . . .

which will have McDonnell's *Mercury* capsule on top, is scheduled for March. The last preliminary shot is scheduled for next month.

INTERNATIONAL

The Soviet *Komet D* . . .

an air-to-surface tactical missile, is reported to have reached the advanced testing stage. The nuclear-tipped turbojet missile is understood to be 33.46 feet long and 3.96 feet in diameter.

• • •

French *Nike* trainees . . .

picked to man a second French *Nike-Ajax* base are scheduled to arrive in the United States this year for basic training. Classes are expected to be at Ft. Sill, Okla.

• • •

Soviet A-subs . . .

are reported under development at shipyards in 11 cities—Molotow, Severodminsk, Ischensk-Kolpino, Leningrad, Reval, Riga, Kolomna, Gorki, Odessa, Nikolajew and Sevastopol. The first of the Russian nuclear-powered submarines is understood to be undergoing sea tests.

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Industry Countdown

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Now coming off production . . .
lines at MATRA of France is the two-stage, 395-lb. *R-511* air-to-air-missile. Equipped with either IR or electromagnetic homing guidance, the *R-511* is powered by a solid Hotchkiss-Brandt engine and will be used aboard Vautour, Super Mystere and Mirage III aircraft.

• • •

East's first *Atlas* . . .
ICBM base will be at Plattsburgh AFB, N.Y., about 250 miles north of New York City. The Air Force also will put *Atlas* squadrons at Altus AFB, Okla.; Dyess AFB, Abilene, Tex., and at Walker AFB, Roswell, N.M. Each of these four new squadrons will contain nine missile launchers, located in underground complexes of three dispersed within a 35-mile radius of the AF bases. The four ICBM bases will cost $47 million apiece. This makes 10 *Atlas* bases designated so far; a total of 13 are planned.

• • •

Hardening of *Bomarc* . . .
interceptor missile bases is out. DOD officials say putting *Bomarc B* launchers underground would only delay making them operational.

PROPULSION

Sectional technique . . .
for fabricating multi-meg solid rocket boosters at the factory and then assembling them at launch site has been developed by United Aircraft's United Research Corp. The company, which has signed patent applications, believes its approach will cut costs greatly by eliminating logistic problem of on-site loading.

• • •

After switch to storables . . .
the Martin *Titan* ICBM probably won't be used as a space booster. The Air Force says it is interested in *Titan*—as well as *Atlas*—primarily as a weapon. Both ICBM's are expected to be in service through 1970.

• • •

System for recording . . .
all shock and temperature change damage to a solid motor from factory to time of launching has been developed by Avien Inc. Details are classified, but the company claims the test device is simple, reliable and fast.

ASTRIONICS

***Minuteman* guidance . . .**
system being developed by Autonetics is undergoing tests up to 10 g aboard a Mach 2 sled at Holloman AFB. The Aerojet-General sled is propelled by a three-chamber liquid propulsion system developing 114,000 lbs. of thrust.

• • •

Rash of orders . . .
for electronic instrumentation equipment has followed the Russian launch of a missile into the Pacific. Some manufacturers reportedly are swamped with work and are wondering if the U.S. is going to instrument the Soviet range.

• • •

Major companies . . .
are closely watching the expansion plans of potential subcontractors—particularly in the electronics field. Some feel they should shy away from awarding contracts to firms which are growing too fast. Reason: management and talent may be spread too thin to guarantee a reliable product.

WE HEAR THAT

Japan plans to make . . .
Sidewinder air-to-air missiles at $500 per unit. (Price of European-made *Sidewinders* has been quoted at $3000 to $4000) . . . Republic Aviation is scotching rumors of a 2000-man layoff. Officials say big buy of F-105's in the FY 1961 budget insures employment stability for foreseeable future . . . Bids are due at the end of February on the second stage of the NASA-ABMA *Saturn* vehicle . . . The German Rocket Society is setting up a training center and manufacturing facility at Bremen with the help of $35,000 in donations from German industrial firms . . . Germany's Focke-Wulf is negotiating an agreement with Short Brothers and Harland of England for test and possible procurement of the surface-to-air *Seacat* . . . the *Sky Dart* has been selected as the primary target drone for the missile competition at Nellis AFB in July.

an M/R exclusive . . .

Medaris Retires with Blast at NASA

Would abolish civilian agency and give space/missile job to joint military command; says U.S. is 'second-rate' space power now, USSR may be dominant by 1970

by James Baar

HUNTSVILLE, ALA.—Maj. Gen. John B. Medaris, chief of the Army Ordnance Missile Command, retired this week with a lashing attack on the Administration's space policies and a call for the abolishment of NASA.

In phrases as clipped and well-groomed as his usual appearance, the general:

• Raked the civilian-military separation of U.S. space programs as "fundamentally unrealistic" and called for creation of a single missile-space agency—a joint military command.

• Charged that the Administration's unchanging "reluctant dragon" attitude toward space is leading to disaster.

• Brushed aside as "utter nonsense" the contention of President Eisenhower and other Administration officials that the Armed Forces have no business in exploring space.

• Warned anew that America must develop huge boosters as quickly as possible or find itself "out of the race" with Russia.

Medaris opened up on the Administration in an interview in the office here from which he had directed most of America's first successful space efforts. His statements appeared to be a preview of what he will say later this month when, freed from the restraints of being on active duty, he is scheduled to testify before the House and Senate Space Committees.

"The next 10 years will set the pace for a long time to come in this world," Medaris said. "One of three things has to happen in the '60's."

• One—"We can be so far outdistanced in missiles and space that we will become a second-rate power with all the consequences that will mean to the Free World and the integrity of man."

• Two—"We can achieve parity (at least) with Russia with the consequent ability to hold our position."

• Three—"The Millenium is going to arrive and the lion and lamb will lie down together in peace."

Medaris paused; then he added pointedly:

"If the second isn't achieved, the third is unlikely."

The 57-year-old general said the Russians with their "present start" can achieve domination of the moon and cislunar space by 1970 "if there is nothing around to interfere with them."

He said if that happens "the threat will be very considerable" and the United States won't be able to do much about it.

"Unfortunately we already are second-rate in space," he said. "No one will even argue that point anymore."

Medaris sat at his large desk and smoked cigarettes. Behind him stood his personal two-star flag and an Army flag resplendent with battle ribbons.

Occasionally as he talked, Medaris got up and paced around the room. He wore his decorations on a well-cut uniform. His hair and mustache were carefully cut.

• **Pull ourselves together**—"We can't do this thing correctly and with full efficiency unless we get all of it together someplace," he said. "You can't separate missiles from space and you can't separate military space from civilian space with a technology that is all part of the same thing and that is moving so rapidly on so many fronts.

"In a single organization it is not too difficult to get anything of any importance to the top. Everyone shares information. You can move ahead with your successes. And you don't have to make the same mistakes twice."

Medaris said there is only one place to put together a single agency—inside the Pentagon as a joint command.

"The services must develop the new weapons and only the services have the vast support and other facilities that are needed," he said. "The services are as interested as the scientists in advancing space exploration because they know that any new piece of information can have military value.

"The only excuse for NASA was to take projects from the competitive area. But a joint command would do the same thing."

He said under a Joint Missile-Space Command "the arguments between the services would be settled before the projects began, instead of having them go on all through the life of a system."

Medaris smiled thinly.

"The trend, of course, is going the other way," he said. "I seem to hold a minority opinion."

• **Root of the trouble**—Then he returned again to the Administration's basic attitude.

"Here's the fundamental question," he said. "We were dragged into this space business from the beginning and we still act that way. We ought to be in this argument. But, instead, we're still half-way in and half-way out."

Medaris smiled again, but his expression made clear that he didn't see anything very funny at all.

Maj. Gen. John B. Medaris is stepping down as chief of the Army Ordnance Missile Command and retiring from the Army almost two years to the day since the launching of America's first satellite and four years since he assumed command of the then newly-established Army Ballistic Missile Agency.

ABMA officially opened for business Feb. 1, 1956.

ABMA's Explorer I *was launched into orbit Jan. 31, 1958.*

MAJ. GEN. John B. Medaris stands before giant Saturn static test stand at Huntsville in this picture taken a few days before retirement. He is holding a *Nike-Zeus* model. In the background are other Army missiles.

AF Gets Plans for Storable *Atlas*

Fully loaded ICBM's would be hard-based and ready to go. Proposal expected to touch off another round of debate between Titan/Atlas

by Frank G. McGuire

LOS ANGELES—Plans for a completely storable *Atlas* ICBM which would require no changes in fuel or missile design have been handed to the Air Force by Convair, MISSILES AND ROCKETS has learned.

The proposal—said to be less expensive than present plans to insure a short reaction time for the missile—is now under study. The Air Force says, however, that a storable *Atlas* "is not presently programmed."

Under the Convair proposal, all *Atlas* missiles would be hard-based in underground silos, complete with propellant. Each would be equipped with a clamshell device embracing the liquid oxygen tank area in a blanket of insulating materials.

Such a system would be effective for extended periods of time, the proposal says, due to the extremely low LOX boil-off experienced with the insulation method.

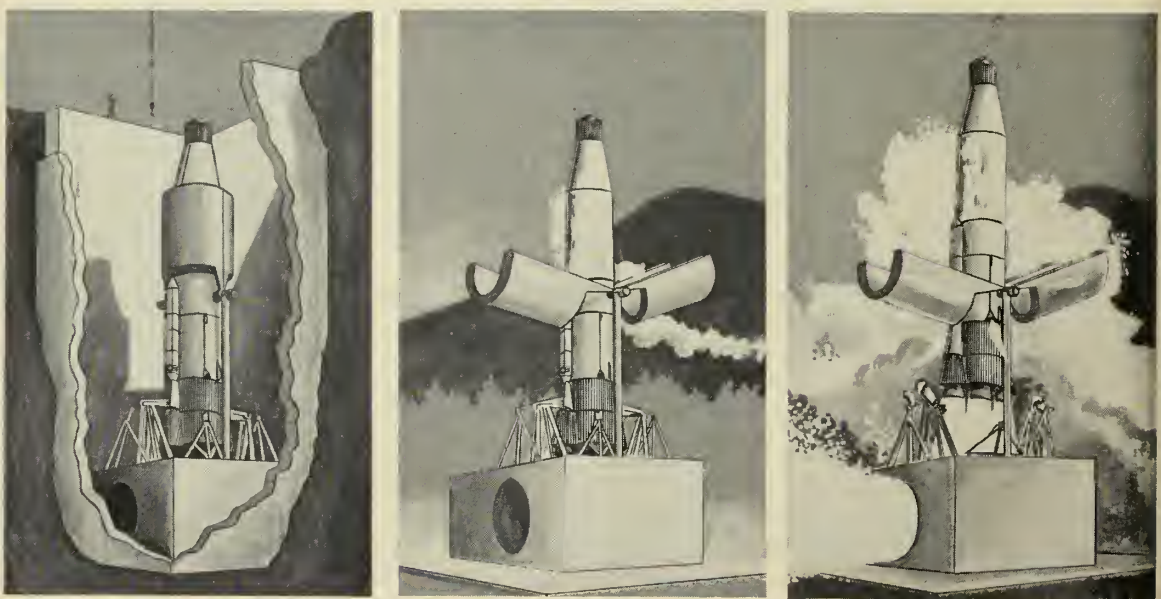
The company is believed to have solved problems involved in such a scheme. One cost advantage is that it would eliminate the need for expensive high-speed propellant-loading equipment. Convair has conducted extensive tests to evaluate the effects of such long-term cold storage on valves and pumps in the missile. These have shown a stabilization of materials after about 15 minutes exposure to LOX. After this initial period, reaction to the exposure levels off.

• **Two-hour hold**—It is pointed out that missiles have been launched after a hold of as much as two hours on the pad, and that other tests have been conducted for over 24 hours, with no detrimental effects on valves and other components.

The insulation proposed for use with the clamshill device is a Stryofoam material, augmented by circulating liquid nitrogen. In addition to the clamshell unit, a cryogenerator would be needed to replace boiled-off nitrogen.

• **Further discussion**—News of the storable *Atlas* proposal is expected to touch off another round in the bitter debate between *Atlas* and *Titan* supporters. Martin Company favors an early switch of *Titan* to storable fuels (nitrogen tetroxide/UDMH-hydrazine). But the *Atlas* plan, its backers assert, would give the Convair missiles all the advantages of a storable *Titan*, without

stored . . . ***ready . . .*** ***going . . .***



CONVAIR'S STORABLE *Atlas* would have a clamshell insulator of liquid nitrogen and styrofoam to embrace the LOX tank and curtail boil-off. Elevator would raise bird and shell above ground for firing. Each silo would be hardened.

requiring costly modification of the missile itself.

Atlas proponents charge that the *Titan* conversion will cost as much as $200 million and require hundreds of full-duration engine firings for qualification. An Air Force source says the number of engine firings required to check out a storable *Titan* might be as high as 700. Queried by M/R, Martin Co. refused comment on costs of the conversion.

Denser nature of the non-cryogenic storable fuels for *Titan* will require structural modification of the missile to take the extra weight. An Air Force spokesman, queried on this, said the necessary modifications would be "substantial." An up-rated Aerojet-General engine is expected to be available, however, to provide necessary additional thrust. "But the result," pro-*Atlas* people say, "is a completely new missile . . . and since this is not required, why spend the money for it?".

The nature of the N_2O_4/N_2H_4-UDMH propellant combination would nominally limit the *Titan* to 80% of its tank capacity before a structural beef-up would be required. However, so many engineering factors enter the picture that this cannot be considered an unbreakable limit. Only the missile designer could determine the actual load limit imposed by denser fuels in a unmodified tank structure.

Present Air Force plans call for non-storable *Titans* in the first six squadrons. Conversion would begin with the seventh of 14 programmed squadrons, if maximum savings are to be realized, the Air Force maintains.

• **Keyed to Congress?**—The Air Force, as well as *Titan,* came in for some sharp attacks during M/R's roundup of military and industry opinion of both the *Atlas* storable proposal and the plans for conversion of *Titan* until after budget hearings by Congress.

The implication is that Congress, considering the expense, might strongly challenge the need for the *Titan* conversion. This, in turn, would eliminate a strong argument for *Titan* itself. The need for *Titan* already is expected to be a subject of Congressional investigation.

Martin advocates point out that the clamshell system proposed by Convair could be adapted for *Titan,* although it would be somewhat more complex due to the need for insulating LOX tanks in both stages of the *Titan.*

Martin believes, however, that its proposed change to new propellants would result in a more effective and less complicated weapon system—even allowing for a more extensive modification of the missile.

Large R&D Contract for Douglas ALBM Expected Soon

Program before DOD for final review. Large production contract to follow with use on B-52 and other aircraft

by William J. Coughlin

Announcement of a large-scale research and development contract for the Douglas Aircraft Co. *GAM-87A* air-launched ballistic missile program is expected shortly.

Backed strongly by the Air Force, the program now is before the Department of Defense for final review. Scheduling of the program calls for the R&D contract to be followed by a large production contract.

The ALBM program, mating the Douglas-produced missile with the Boeing B-52 bomber, will provide Strategic Air Command with a new missile capability similar in strategy to that of the Navy *Polaris* program but—the Air Force believes—more flexible.

Douglas was awarded a sizable six-month study contract for *GAM-87* last May: it has since been extended. The award followed an industry-wide competition entered by some 20 firms.

GAM-87A, known as the *Sky Bolt,* is a two-stage solid-propellant hypersonic missile with astro-inertial guidance. Range is 1000-1500 mi. Re-entry speed at 1000 mi.-range is about 10,000 ft./sec., about half that of an IRBM. A B-52, with only slight modification, much of it common to the North American GAM-77 *Hound Dog* program, can carry two or more *Sky Bolts.*

• **One of the last**—Award of the *GAM-87* contract is expected to be one of the last large contracts in the current missile program. It will, in fact, take the largest portion of Air Force R&D funds in the Fiscal 1961 budget.

Douglas is developing missile airframe and rocket engine casings. Aerojet-General Corp. is subcontractor on the propulsion system, providing engines and propellant as well as a large part of the design of the missile. General Electric is subcontractor on the re-entry body and Nortronics on guidance. Boeing Airplane Co. is an associate contractor.

Much of the effort under the study contract has gone into guidance. At the ranges contemplated, other portions of the program are well within the current state of the art and even the missile-borne portion of the guidance system does not represent any considerable problem. Accuracy required of the final-stage guidance system is less than that now required of an IRBM.

While second-stage guidance is the most critical from an on-target standpoint, the programmed first stage also carries some additional guidance. Most difficult development problem is that of the Nortronics computer system carried by the B-52, a system somewhat more complex than the submarine position-computing system for the *Polaris* program. Not only must position be computed more rapidly but speed of the aircraft at launch becomes a factor.

Nortronics already is building facilities and hiring additional engineers required in the large-scale program. While this is the firm's first contract on ballistic missile guidance, it had considerable success in development of the Mark I star-tracking system for the air-breathing *Snark.*

Northrop also has carried out development work on the A-8 interplanetary star-tracking system and the A-5 star-tracking system. In addition, it has done work on inertial systems. It is thus in a position to be familiar with astro-inertial systems, a combination of the two.

Douglas, with missile airframe design and production experience in the *Thor* program, has built test hardware for the *Sky Bolt* and conducted an extensive wind tunnel test program. No launch hardware has been built.

• **"Whole new realm"**—Gen. Thomas D. White, Air Force Chief of Staff, said recently that prototype tests have proved that a *Sky Bolt* can be launched from aircraft at both subsonic and supersonic speeds. This presumably was a reference to the *Bold Orion* program, from which much *Sky Bolt* data was obtained.

"The advent of long-range air-to-surface weapons launched from aircraft presents us with a whole new

realm of possibilities," Gen. White stated.

Strong Air Force backing for the *Hound Dog* and *Sky Bolt* programs stems from the additional weapons life which they will provide for the manned bomber, in which SAC has a considerable investment.

Air Force believes the air-launched ballistic missiles will provide a flexibility for the manned bombers which will outmatch that of the *Polaris* submarines, while not requiring the expensive initial investment in an entirely new weapon system. Both will be able to lob ballistic missiles at the enemy from outside his defense perimeter and from positions which he cannot predetermine.

• **Low budget item**—Launch platforms for the *Sky Bolt*—the B-52—already exist in large operational numbers while those for the *Polaris,* the nuclear-powered submarines, do not.

For this reason, funding proposed for the ALBM program is considerably less than that for the *Polaris, Atlas, Titan* or *Minuteman* programs.

Obviously, ALBM-equipped B-52's will be less restricted than *Polaris* submarines in their approach to Soviet frontiers. In addition, the B-52's cannot only fire their missiles from beyond the perimeter defense system, as could the submarines, they also will be able to penetrate the homeland itself.

A major advantage possessed by the air-launched missile in contrast to missiles such as the *Atlas, Titan* and *Minuteman* is that of "recall-ability," it is pointed out.

An air-alert of ALBM-equipped bombers avoids the vulnerability of hard-based ICBM's, proponents of the system note. "What you really need is inevitable response, not instantaneous response," one says. "The ALBM provides that."

Bases of ALBM aircraft are, of course, more vulnerable than the *Polaris* submarines or the hard bases of ICBMs. But this danger can be somewhat lessened by worldwide dispersal.

The proposal to mate the ALBM with a nuclear-powered aircraft in later stages of the program reduces this danger even further.

Need for an ALBM has been questioned in some quarters in the light of the development of an extended-range *GAM-77 Hound Dog.* In answer to this it is noted that intercept of a ballistic missile is considerably more difficult than that of a Mach 3 jet-powered missile or of a low-altitude device such as those being developed under projects SLAM and CLAM.

• **Ready for go-ahead**—Douglas' work on the *GAM-87* program has reached the point where the company is ready to undertake a full-scale development program. Due to the high level of funding of the study contract, it has been possible to take the missile to an advanced design stage and bring subcontractors into the program in considerable depth.

Major subcontractors also have been enabled to carry out their own subcontracting arrangements. Although contractually the other major firms in the program are subcontractors, their position has been more that of associates in a system integration. This has enabled them to contribute to the design program to a greater extent than normal under a study contract.

Douglas *GAM-87A* program manager is John Gorgenson, who coordinates the weapon system office with such activities as purchasing, inspection and manufacturing to provide overall company support. Chief project engineer is John Solvason.

Air Force management of the program rests with the *GAM-87A* weapon system office composed of personnel from the Air Research and Development Command directorate of system management and the Air Materiel Command aeronautical systems center, both at Wright-Patterson Air Force Base, Ohio.

'Built-in' Damping Developed

High-frequency structural vibrations, a prime contributor to low electronics reliability in space vehicles, can be reduced to a new low by building the damping characteristics right into the fabricating material.

Engineers at Barry Controls, Inc., Watertown, Mass., have come up with "Rigidamp," a process of incorporating a viscoelastic damping medium into ordinary structural materials. The development is based on a theory of optimum damping formulated by J. E. Ruzicka and R. D. Cavanaugh at Barry.

Sheets and thin rectangular section beams are laminated of conventional metals or plastics separated by a layer of the damping medium. I-beams, channels and angles are cellular rather than laminar. Longitudinal cells are formed throughout the length of the member. Each cell contains an insert separated from the walls by the damping medium.

The usual resonant responses of "Rigidamp" structures range from 5 to 10 times the excitation vibration throughout the frequency range encountered in current-environments. This is in comparison with conventional structures which respond with am amplication from 60 to 300 times the excitation vibrations, based on the nature of the material and its vibration input.

Barry spokesmen say that this is the first practical application of the inherent damping theory in which all portions of the structure act as load-carrying members and structures are designed for virtually optimum damping characteristics in all of the frequencies normally present in modern dynamic environments.

• **Longer life**—In addition to reducing the damaging vibrations to sensitive components, "Rigidamp" is expected to substantially increase the fatigue life of the structure. Barry damped materials have exhibited an extremely flat vibration response up to 2000 cps.—and in most cases this can be extended.

The damped structure will have a slightly smaller load-carrying capability than its conventional cousin. A slight increase in weight will be necessary to attain identical stiffness. But Barry scientists point out that there are many instances where structural designs are based on dynamic stress levels and it is possible that no weight increase would be necessary in view of the built-in damping qualities.

J. E. Ruzicka explained that the concept involves the design of specific structural configurations with sufficient damping incorporated therein to produce a maximum effect.

The nature of the damping viscoelastic medium was not revealed by the company. Ruzicka indicated that the medium has adhesive qualities but it must also exhibit certain ranges of viscosity and shear effects in order to function as an effective damper.

Barry Controls has several types of damped structures in production. The firm has supplied a stable platform for the Air Force's *Bomarc* missile.

Brazing Chamber Slashes Honeycomb Production Time

A new brazing chamber turns out stainless honeycomb panels in 30 minutes instead of the 23-hour cycle required by conventional furnaces.

Developed by Rohr Aircraft Corp. engineers at Chula Vista, Calif., the patented chamber contains a graphite cloth heating element devised by the National Carbon Company, a division of Union Carbide.

The chamber can heat panels to 1680°F in as little as three minutes. Various sized panels have shown uniform braze quality.

Another Success for *Little Joe*

by C. Paul Means

The fourth of six *Little Joe* tests launched last week at Wallops Island was completely successful, giving credence to the prospect that the final test with the McDonnell Project *Mercury* capsule on top is not far off.

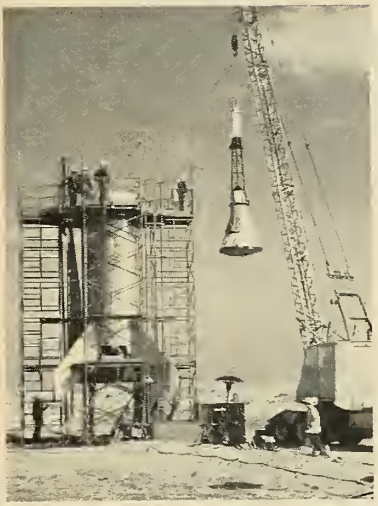
Also successful was the Air Force's School of Aviation Medicine's monkey test—not a part of Project *Mercury*—which was conducted on a space-available basis.

Purpose of last week's test was to study the functioning of the escape system and the aerodynamic stability of the capsule under a maximum "Q" abort situation.

In an era when most U.S. space programs have been marked by launch failures and delay, the *Little Joe* program has progressed like clockwork since the program's first hair-raising experience (when the capsule's escape rockets prematurely fired, lifting it into the air and leaving the booster behind). Since then, successful launches have occurred on Oct. 4, Nov. 4, Dec. 4 and Jan. 26.

The boiler-plate capsule launched last week was lifted by two Pollux and four *Recruit* solid rocket motors produced by Thiokol. The final version of *Little Joe* also uses Thiokol's *Castor* motor.

When the booster had lifted the capsule to an altitude of 36,500 ft., the Grand Central Rocket escape system ignited and burned for about one second, lifting the capsule away from the booster at the rate of 200 ft. per sec. to an altitude of 48,900 feet.



TECHNICIANS hoist capsule atop the fourth *Little Joe* booster at Wallops.

The monkey and capsule were subjected to 9 g at launch and to a peak of 19 g at separation.

• **Back after launch**—At the top of the trajectory, the tower was automatically jettisoned by a timer mechanism, and seven seconds later the drogue chute was deployed. At 10,000 feet the large cargo parachute was deployed, letting the capsule down for a soft landing in the Atlantic. The monkey, called Miss Sam, to denote the School of Aviation Medicine, was picked up by a helicopter 10 minutes later and was back in the hands of her keepers just 30 minutes after launch.

The booster produced a little more thrust than expected. NASA officials before launch had predicted that the top of the trajectory would be only 38,000 ft. rather than the 48,900 ft. actually achieved.

The AF School of Aviation project strapped a 6-lb., 3-year-old female rhesus monkey into the capsule within a 100-lb. container. The monkey used a form-fitting couch similar to the type that will be used by the *Mercury* astronauts.

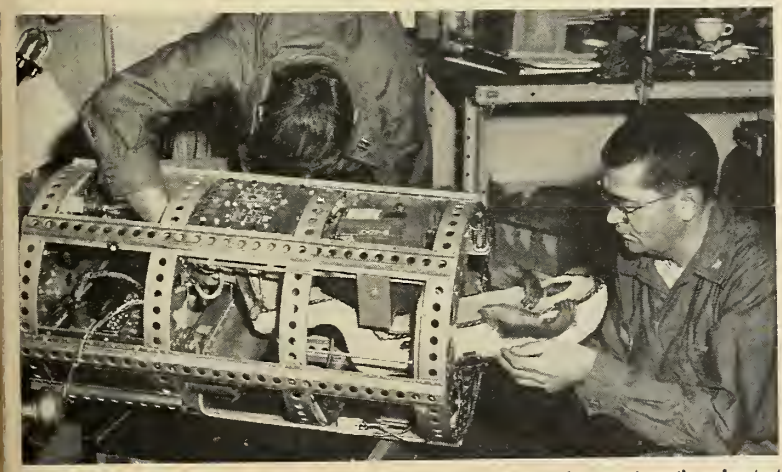
• **Weaker sex?**—Tests taken immediately after recovery indicated that the monkey had survived the jolting ride in good shape, and—for what its worth—in better shape than a male monkey, Mr. Sam, had been after his trip in *Little Joe III*.

During flight, Miss Sam had been trained to test her stresses under rocket flight by pulling a lever 100 times a minute every time a red light flashed over her head. A camera also recorded her reactions during flight. There was no immediate indication whether the lever-pulling stunt was a success.

The animal was immediately flown back to the School of Aviation Medicine's laboratories at Randolph Field, Tex., for further study.

Evolution—After two more *Little Joe* flights—the last with the McDonnell *Mercury* capsule on top—Project *Mercury* will go into high gear this spring with *Redstone*-launched flights 100 miles up and 100 miles down the Atlantic Missile range. Some of these flights will contain animals, and some are scheduled to contain the Project *Mercury* astronauts themselves.

Estimates as to when actual manned orbital flight will take place range from late 1961 to early 1963.



LITTLE MISS Sam is placed in environment container prior to insertion in test capsule. The container was developed at the USAF School of Aviation Medicine.

Demand for Missile Forgings Grows

Higher strength-weight ratio requirements spur need for applying blacksmith's art to exotic and common metals; Ladish, Wyman-Gordon lead field

by Jay Holmes

Forging, a process that originated before the dawn of recorded history, is in increasing demand for forming parts of the most advanced missiles and space vehicles.

Forging gives a metal shape and adds to the strength of soft portions of a casting. Rocket designers are turning to forging in increased amounts to meet the demands for ever higher strength-weight ratios.

Despite the antiquity of the process, many problems are new. Much is known about forging iron, standard steels, copper, aluminum and other common metals. But the missile and space vehicle demands application of the blacksmith's technique to the new high-strength steels, beryllium, titanium, magnesium and the refractory metals. Months or years of R&D work may be necessary before any one of these can be successfully forged.

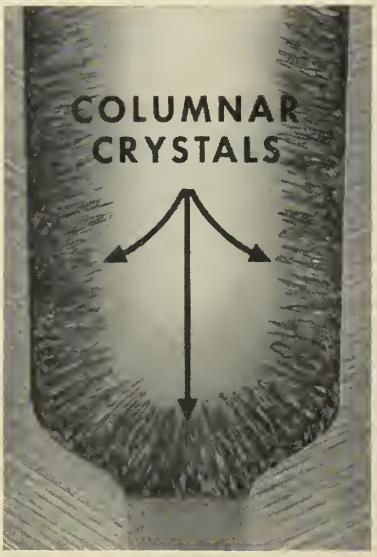
• **Two leaders**—In the United States, hundreds of companies, big and small, are in the forging business. But very few have large enough equipment or are able to work to the exacting tolerances set by the missile, nuclear and aircraft industries. Two concerns, the Wyman-Gordon Co. of Worcester, Mass., and the Ladish Co. of Cudahy, Wis., do the bulk of the missile forgings. Each is recognized industry leader in one of two competing forge methods. Ladish specializes in hammer forging—Wyman-Gordon in press forging.

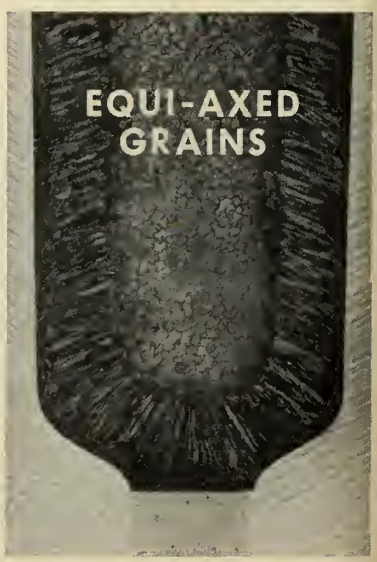
Other industry leaders supplying missile forgings include Baldwin-Lima-Hamilton Co., Midvale-Heppenstale Co., Canton Drop Forging Co., Taylor Forge Co., Harvey Aluminum, Aluminum Co. of America, Kropp Forge Co., the Hufford Corp. and Arturus Manufacturing Division of Airite Products.

Why forge at all? The fundamental reason lies in the nature of the casting process. As any molten metal cools, the metal near the walls crystallizes first, forming a thin, tough crust. As the hot metal gives its heat to the mold, the liquid inside this layer solidifies more slowly. Crystals in this zone form at right angles to the surface and are fairly strong.

But at the middle of the ingot, crystallization takes place almost instantaneously, producing a coarse, equi-axed grain that lacks strength. At the corners of the mold, the longitudinal crystals may meet at a sharply defined line of cleavage. Such a line obviously is weaker.

After the metal solidifies, but while it is still plastic, the constituents may separate into small bodies of segregates with non-metallics and impurities distributed in varying degrees. The uneven

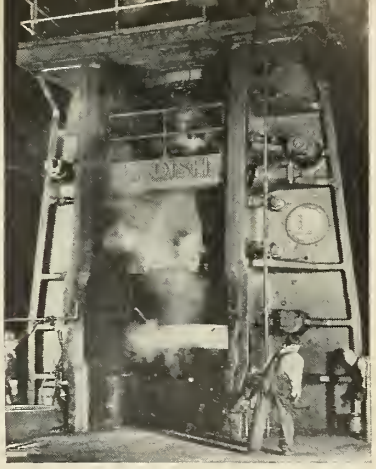




WHY FORGE? These Ladish Co. photos show how any casting forms from molten metal. First, strong chill crystals form at surface. Then, columnar crystals solidify slowly and lend strength. At center, weak, equi-axed grain forms quickly. Another

LEFT — HYDRAULICALLY-OPERATED press at Wyman-Gordon Co. is five stories high, runs 10 stories underground.

RIGHT—WORLD'S LARGEST closed impression die forging hammer at Ladish Co. can exert a 100,000-ton force.



distribution introduces further weaknesses in the metal.

The only way these characteristic casting properties can be modified and improved is by working the metal. By hot-working, grain structure is broken up and refined. Any cavities that exist are compacted and welded together. Segregates are broken up and the grain fibers are aligned.

The forging industry says forging makes possible a controlled improvement of metallurgical characteristics. Casting or machining by themselves are limited in the amount of grain structure control possible.

• **Missiles' special need**—Many industries, of course, demand the extremely high metal strength that can be produced by high-quality forgings. Automobile crankshafts must have tremendous strength at the bend points. Aircraft landing gears require great impact resistance. Jet engine parts have stringent strength requirements for very unusual shapes.

But the forging industry contends missiles and space vehicles have an even more urgent need of high metal quality. For a missile must not only have extremely high strength, its weight must be kept to a minimum. Unlike a bridge builder, a missile designer is not always free to add reinforcement to possible weak area. The extra metal may add too much weight.

To do the job on large pieces of metal, huge machines have been installed in some plants. In World War II, The Air Force built a 50,000-ton closed-impression hydraulic press at the Wyman-Gordon Worcester plant. The Aluminum Co. of America has built a similar sized press, used mainly for aluminum, at Pittsburgh.

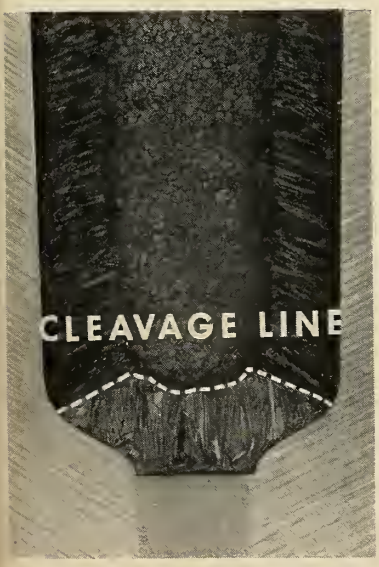
The largest closed-impression die forging hammer in the world was put in operation last year by the Ladish Co. at its plant in Cudahy, Wis. The counterblow hammer, rated at 125,000 meter-kilograms, has a 96″ vertical stroke and exerts a force of more than 100,000 tons at the moment of impact.

• **Place for both**—There is some disagreement in the industry about whether the hammer or press method is better. However, partisans of both methods feel there is a place for both press-forging and hammer forging.

Wyman-Gordon spokesmen say that, given equal technical ability and equal physical capability, a forging can be accomplished equally well on a hammer or a press. However, they say that hammers in existence do not have the physical capability of doing the jobs that can be done by huge presses on metal pieces larger than 14″ in diameter. Wyman-Gordon says it uses hammers for some small jobs for economy.

Ladish Co. engineers maintain that the limitations of large hammers have been removed by introduction of the two-way counterblow hammer. The counterblow design, they say, permits directing all the energy to the forging blank and eliminates the effect of shock on neighboring areas.

The Ladish 125,000 meter-kilogram forging hammer extends the inherent advantages of hammer forging to sizes in excess of 20,000 lbs. in carbon, alloy and stainless steel, in sizes up to 200″ long and 70″ in diameter, Ladish says.



area subject to fracture under stress, is cleavage line from corners.

Wyman-Gordon says magnesium, beryllium, super-nickel base alloys, some refractory metal alloys and all-beta titanium alloys press-forge better than they hammer-forge.

• **Throughout the missile**—Forgings are used from one end of the missile to the other. Wyman-Gordon reports it has forged copper heat shields 65″ in diameter and weighing 2000 lbs. for the *Atlas;* several large hollow beryllium objects with wall thickness about 1″ and weighing 160 lbs. for a classified customer; magnesium and aluminum rings for re-entry vehicles; aluminum and magnesium pieces for *Hound Dog;* solid propellant motor casing cylinders, forward domes, aft heads and closures of steel and titanium; and outer nozzles of steel and titanium; molybdenum throat inserts and liners.

Tantalum and tantalum alloy forgings are being developed for use as throat inserts and liners. Tungsten also is in development but in a very early stage. In the liquid rocket systems, Wyman-Gordon is producing titanium and stainless steel forgings for helium pressure bottles. Turbine wheels for turbopumps on the big Rocketdyne and Aerojet engines are forged of Rene 41, a nickel-based alloy.

Ladish reports it has forged forward domes, aft closures, bulkheads, body adapters and nozzle throat inserts. Parts have been supplied for *Minuteman, Titan, Thor, Polaris, Atlas, Sparrow, Bomarc, Hawk, Nike-Ajax, Hercules* and *Zeus, Talos, Terrier, Jupiter, Lacrosse, Little John, Matador* and *Honest John.*

The Wisconsin company says it has experience in working such "exotic" metals as titanium, tungsten, tantalum, beryllium, niobium (columbium), molybdenum, magnesium and its patented D6, a low-alloy die steel that has been used with great success in missile applications.

Wyman-Gordon has forged nylon

TITANIUM MOTOR CASING CLOSURE forged at the Wyman-Gordon—U.S.A.F. plant in North Grafton, Mass., weighs 441 lbs. and has 41.16" O. D.

Some Applications of Press-Forging

Metal	Forging Temp. (°F)	Typical Applications
Aluminum: 2014, 7075, 7079, *2025, X2219	700-850	Frame members, structural parts, bulkheads, closures. *Warm compressors and inducers.
Magnesium: ZK60, AZ80, HM21, HK31	600-800	Fittings, control linkages, wheel rims, electronic assembly frames and covers, frames and bulkheads.
Low Alloy Steels: AISI 4140, AISI 4340, AMS 6418, AMS 6304	2100-2300	Outer nozzles, fittings, frame parts, connecting rods and crankshafts. Shaft and gear assemblies.
Hot-work Die Steels: AISI 9310, Nitralloy	2000-2250	Motor closures, fittings, frame parts for higher temperature applications than the low alloy steels.
Stainless Steels: 304, 321, 325, 329, 347	2000-2250	Engine parts, valves, nuclear reactors.
17—7PH, AM 355, 17—4PH		Low temperature pressure bottles, frame parts requiring strength and heat and corrosion resistance.
Iron Base High Temperature Alloys: AMS 5735, A-286, Inco 901, M-308, V-57, W-545	1900-2100	Turbo-pump components for liquid rocket engines, bolts, rings.
Nickel Base High Temperature Alloys: Waspaloy, Nimonic 80A, René 41, Astroloy, Inconel X	1900-2100	Turbo-pump components for liquid rocket engines, same as iron base high temperature alloys except these alloys have higher operating temperature ranges.
Titanium: 6Al-4V, B120VCA	1350-1950	Motor closures, pressure bottles, frame parts.
Molybdenum and Molybdenum-Tungsten	2100-2600	Rocket nozzle throats and liners and rings.
Tantalum & Tantalum-Tungsten Alloys	2100-2300	Rocket nozzle throats and liners and rings, nuclear reactors, re-entry vehicle skin and structures.
Tungsten	Above 2500	Re-entry vehicle skin and structures.
Niobium	2100-2350	Nuclear reactors, re-entry vehicle skin and structures.
Beryllium	1600-2000	Re-entry heat shields, payload structures, guidance components.
Copper	1400-1750	Re-entry heat shield.
Hafnium	1800-2000	Nuclear reactor control rods.

on an experimental basis and is interested in forging Teflon. The Massachusetts company believes there is a field for forging plastics.

• **Reducing welds**—The forging industry is convinced that some of the trouble with solid-fuel rocket cases in the early days was caused by an excessive amount of welding, particularly on the longitudinal seam. Girth welds can be troublesome too but the geometry of a cylindrical pressure vessel puts only half as much stress on a girth seam as on a longitudinal seam.

Welders maintain that by good technique and reinforcement they can eliminate weld weaknesses. But the forging industry contends it is impossible to eliminate the possibility of a mismatch in metal grain and the associated stress concentrations. Spokesmen say a case with the minimum number of welds has the highest reliability and the maximum burst strength.

• **Exploring new fields**—The "exotic" metals are receiving much attention by the forging industry. Both major companies are forging beryllium guidance components. The metal is chosen not only because of its density but also for its high modulus of elasticity. Furthermore, its coefficient of thermal expansion is close to that of steel.

The refractory metals also are receiving much attention. Besides Ladish and Wyman-Gordon, Cameron Iron Works reports success in forging unalloyed cast molybdenum, 90% tantalum, 10% tungsten, and zircaloy-2, a zirconium-base alloy used for nuclear applications. Super-Temp Engineering & Manufacturing of Los Angeles says it has developed techniques for forging large diameter pure tungsten and molybdenum-tungsten billets.

Wyman-Gordon metallurgists feel there is a good future also for the all-beta titanium alloy B120 VCA (vanadium, chromium and aluminum added). They say it can be developed with a minimum 180,000 psi yield strength at 4% to 6% elongation, the equivalent of steel at more than 280,000 psi.

Ladish is betting on its D6 steel, which was developed originally for use as a forging die and kept secret for almost 15 years. Other popular low-alloy forging steels are 300M (also known at Tricent), H-11 (Vascojet 1000) and U. S. Steel's X-200.

Regardless of the missile market, forging industry executives foresee substantial business gains this year. A year-end survey by the Drop Forging Assn. revealed that several major forging plants report the largest backlog of orders in many years. Some executives expect gains of as much as 25% over last year.

Reds Charge:

Project *Mercury* Is 'Sheer Sensationalism'

Soviet space experts leveled a severe blast at Project *Mercury* on grounds that the United States does not have solutions to many problems involved in orbiting and recovering a man from space.

Prof. Y. A. Pobedonostsev, in a discussion by Soviet space scientists and legal experts reported in the Russian "International Affairs" magazine, labels U.S. aspirations as "sheer sensationalism." First, he argues, the U.S. is far from able to provide adequate protection for the human occupant of a capsule which would heat up to 3000° or higher during re-entry.

In addition, he contends, no parachute has yet been constructed by the United States that could provide a safe descent from a high altitude. Cloth would char or burn if used at an altitude of 60 miles above the earth. This will continue to be a major problem, he states, since even if the capsule has an initial speed of zero, its orbit velocity would probably be about 1.6 miles per second, making most materials unusable.

At the same meeting, a Soviet legal expert accused the United States of planning to use celestial bodies as testing grounds for nuclear weapons and eventually as bases for dropping nuclear bombs on earth.

Dr. G. P. Zadorozhny labeled the U.S. "Man in Space" program as a means to acquire ownership of the moon for military bases. He accused the U.S. of changing its attitude toward the legal question only when it looked as though America might not be first on the moon.

Another Soviet legal specialist, G. P. Zhukov, claimed that the U.S. was already making illegal attempts to use space for military purposes. He urged that agreement be reached on banning all military activity in space, and making international agreements limiting the sovereignty of each nation to a "relatively low limit" above the earth.

Computer Conference

The Seventh Annual Symposium on Computers and Data Processing has been set here for July 28 and 29. Sponsored by University of Denver Research Institute, the symposium will present papers in components and devices, logic design, and philosophy of computer design. Deadline for uninvited papers is April 1.

Process Makes Unusually Flat Ti Alloy Sheets

Large titanium alloy sheets, heat treated to strengths in excess of 190,000 psi, have been made through a new process at Republic Steel Corp. of Cleveland.

The alloy, RS-140 (5.0% Al; 1.25% Fe; 2.75% Cr), is available in gages as light as 0.010 in. and in sheet sizes up to 48 x 120 in. in the fully heat-treated condition.

An unusual degree of flatness—2.3-2.5%—has been achieved, Republic reports. Best flatness obtained to date in other methods ranged between 8 and 10%.

The firm uses a five-zone, electrically heated, continuous roller hearth furnace which provides a high degree of heat uniformity—each zone maintaining a ±10°F variation. Coated sheets of titanium alloy are heated for short periods between 1400 and 1700°F depending upon the alloy grade. This is followed by water quenching in a continuous roller unit. The coating prevents contamination by atmospheric and other gases and can be cleaned without molten caustic.

After treatment, the sheets are soft and may be either hot- or cold-formed, then aged for several hours around 900°F to high strength levels. Republic metallurgists attribute the flatness to the electric platen aging methods employed.

NASA Backs Study of Metal Pumping Cavitation

The problem of erosion and cavitation in the pumping of liquid metals is being investigated at the University of Michigan's Research Institute, Ann Arbor, Mich., under a $93,710 grant from the National Aeronautics and Space Administration.

Directed by Dr. Frederick G. Hammitt of the Mechanical and Nuclear Engineering Department, the investigation will provide insight into the behavior of liquid metals as heat removal media and working fluids in nuclear powerplants.

Hammitt explained that cavitation is the result of pressure depression near a pump's vanes, because of their movement through a liquid. These "bubbles" move into a pump's high-pressure region and collapse in a violent reaction which can break down the strongest material.

Cryogenic Gyro Seen from GE Project

Superconductive coil which creates a magnetic field and can remain constant indefinitely should provide gyro with more accuracy and higher reliability

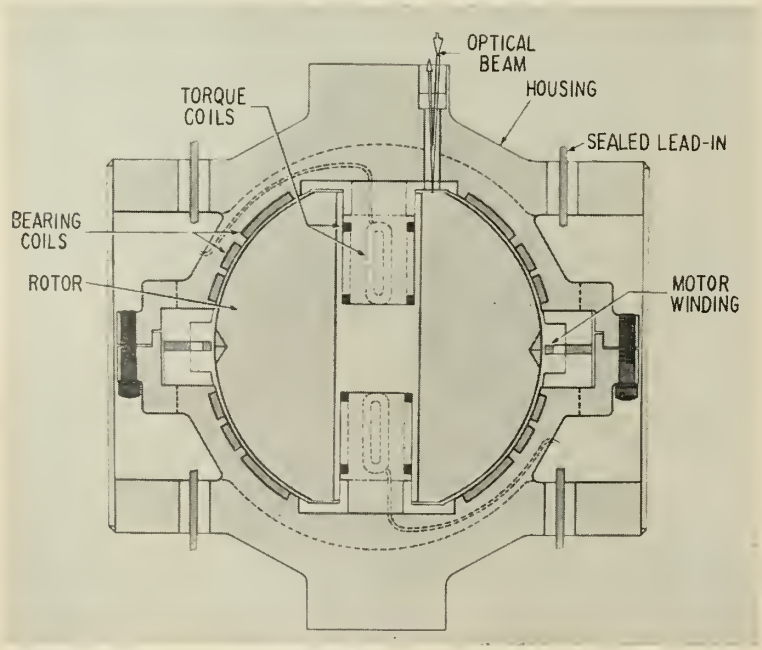
A cryogenic gyroscope that will be many times more accurate, and of higher reliability, than any existing gyro is expected to result from "Project Spin" at General Electric's General Engineering Laboratory in Schenectady, N.Y.

The key is in superconductivity, a phenomena first observed by Onnes in 1911, when he found that the electrical resistance of mercury approached zero at —452.3°F. Essentially this means that a current in such a conductor will flow forever unless interrupted.

Resistivity can be introduced by raising the temperature above a critical point characteristic of the particular metal, or if the material is placed in a significantly strong magnetic field at a lower temperature.

Since a current can be effectively trapped in a superconductive coil, a magnetic field can be created which will remain constant indefinitely. The current will remain constant if the dimensions of the coil do not change. This is the heart of GE's superconductive gyro.

One version of the basic concept, operated at liquid helium temperatures, was designed around a cylindrical shell rotor. The rotor operated, magnetically suspended in space, for many hours at a very high speed, in a high vacuum. The only known loss was due to imperfections in the vacuum.



CRYOGENIC gyroscope under development at GE features a rotor designed for rotation at high speed inside a vacuum.

Many experiments have demonstrated the feasibility of suspending and rotating a metal body within a vacuum for long periods, the only means of support being a frictionless magnetic field. The ultimate coast-down time of such an object has not yet been determined, but James F. Young, the Laboratory's General Manager, said that it should spin freely for many months and possibly years.

These feasibility studies led to a development contract with the Army Ballistic Missile Agency in March 1959, identified as "Project Spin."

Principles of the device are being used in laboratory work on the gyroscope under the "Spin" project, sponsored by GE's Ordnance Department.

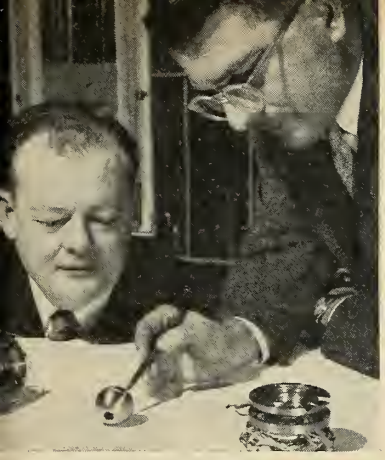
The anticipated accuracy of the gyro is a result of the elimination of the principal sources of unpredictable gyro errors-friction and electrical losses. Its reliability is based on the dimensional stability induced by cryogenic temperatures.

Utilizing liquid helium, a small sphere is currently being prepared for advanced tests at rotation speeds up to 20,000 RPM, within a high vacuum.

• **Other uses**—Company spokesmen point out that the full impact of cryogenic research in this area has many increasingly beneficial aspects in varied applications.

A superconductive magnetic lens applied to an electronic microscope would permit a tremendous increase in resolving power. The possibility of actually "seeing" atoms in this manner is real.

A signal source could be fed into a lossless, superconductive control winding. The flux from this winding



THIS GOLFBALL-SIZED sphere is suspended solely by an invisible magnetic field near temperatures of absolute zero.

could be chopped by a rotating superconductive disc consisting of segments which act as magnetic insulation. In a second winding, an AC voltage and output power would be produced—thus an AC to DC amplifier having no zero drift and no noise.

The late Dudley A. Buck developed the cryotron—a device which employs two superconductors of different materials. When current is applied to one, it sets up a magnetic field which induces resistivity in the other—thus acting as a two position switch. GE scientists say that all basic types of computer circuits could be built from combinations of these cryotrons—making small, highly accurate computers possible.

In oscillators, resonant cavities with very little damping are possible with superconductors because of their very small surface resistance at high frequencies. It would seem possible that frequency standard oscillators using such cavities could be made with accuracies approaching those of atomic clocks. The main drawback here seems to be that increasing the cavity frequency decreases the effectiveness of the superconductor.

• **Only beginning**—GE scientists say that the entire field of cryogenics is in its infancy. Much has to be done in both research and development. Most of the 23 or so materials found to be superconductive have to be cooled to about the temperature of liquid helium—creating a definite problem of temperature maintenance. Indicative of this is that if a substance can be made a superconductor at the temperature of liquid hydrogen or liquid nitrogen, practical usage of superconductors in special transformers, generator stator windings, large particle accelerator coils and large energy storage and discharge systems would be economically feasible.

Biomedical Tests Made in Race Car

First test of a Northrop biomedical instrumentation system designed to telemeter physical and emotional reactions of spacemen to earth was made at Riverside, Calif., in a 170-mph racing car.

Instrumentation included a "bio-pack" to pick up and amplify body reactions and Ampex Corp. airborne flight test recorders. Key elements in the bio-pack are miniature Litton Industries bio-amplifiers.

Two-man crew of the Lotus XV racing car was connected by electrodes to instruments recording pulse, breathing, heart and brain reactions to stress. Also recorded was galvanic skin resistance to indicate emotional changes.

Accelerometers measured the forward and lateral acceleration of the car and an electric eye recorded revolutions of the driveshaft to provide exact speed readings.

This information was coordinated with the biomedical readings to provide Norair engineers with crew reactions at any given speed or in emergencies such as a skid.

Tape-recorded information recorded in the track runs was processed in Norair's computing and data reduction facilities at Hawthorne.

The system is designed to give ground-based flight surgeons instant and continuous readings of the physical and emotional condition of crews during space flights.

This was its first test on a human under prolonged stress conditions. The racing car was piloted by Jay Chamberlain, 1957 winner of the 1100 cc. class at Le Mans.

Lectures Series Set for Missile/Space Support

A series of 18 lectures on support systems for missile and space vehicles has been scheduled statewide in the University of California extension program at Los Angeles.

The lectures will deal with management concepts, operational procedures, subsystem development, logistical considerations and other aspects of the field.

Speakers will be drawn largely from Space Technology Laboratories and RAND Corp.

First of the lectures is scheduled for Feb. 8 in San Diego, Feb. 9 in Los Angeles, Feb. 10 in Riverside, Feb. 11 in Lancaster and Feb. 13 in Palo Alto.

Small Firm Wins Ion Engine Contract

Electro-Optical beats out big companies and will make first ion engine for space; NASA engine will be more sophisticated but longer in arriving

The first ion engine to be used in space will be a product of a 200-employe company in Pasadena, Calif. The Air Force has awarded a contract for "quick and dirty" construction of an ion device to Electro-Optical Systems Inc. of Pasadena.

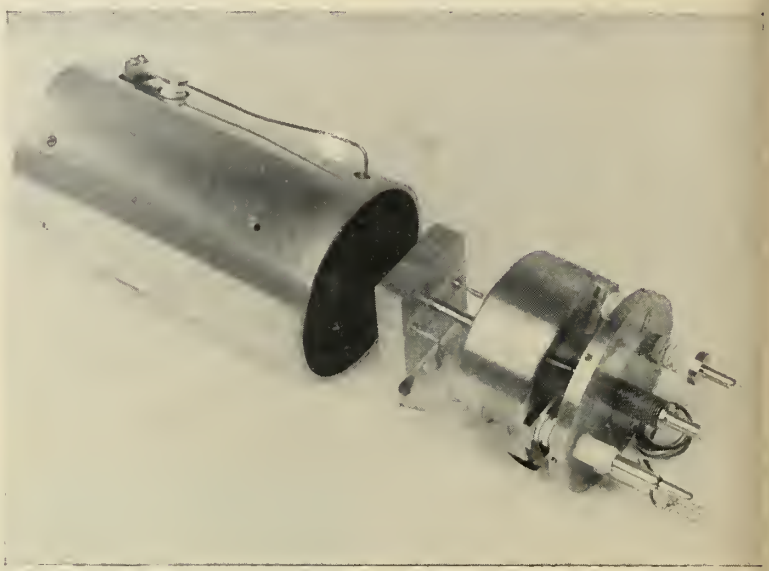
EOS beat out such industry giants as Rocketdyne, Aerojet-General, General Electric, Lockheed, Avco and United Research, among others, in the competition.

While no timetable for the Air Force program using an ion engine was announced, it has been estimated that a useful ion device could be developed and placed into orbit, assuming full financial support, in from 1½ to 3 years. This does not take into account the development time required for a flyable nuclear reactor that would provide sufficient power for such a device.

In addition to the Air Force program, being handled by Air Research and Development Command, the National Aeronautics and Space Administration also is developing an ion engine. The NASA engine will be more sophisticated, but will take longer to produce.

• **NASA involved**—Both NASA and ARDC's Wright Air Development Command have produced workable small ion devices in-house. The NASA machine was built at Lewis Research Center in Cleveland. The ARDC device was built at WADC Command headquarters in Dayton. In addition, Army Ballistic Missile Agency, soon to be transferred to NASA, has been doing continuing research and has let small research contracts to Electro-Optical, High-Voltage Engineering Corp. and General Electric.

Within the next week or two, NASA plans to circulate a contract calling for development of components and eventual construction of a device that draws 30 kilowatts of power. Assuming specific impulse of 5000 sec. and efficiency of 50% (which experts in the field believe to be reasonable assumptions), this would generate about 0.1 lb. of thrust. However, the first device under the NASA contract will not be flyable. It will be a laboratory device designed to demonstrate thrust. Another NASA contract will call for development of a small one-kilowatt device.



EXPLODED VIEW of .002-lb-thrust ion propulsion engine under study at Electro-Optical. Left to right: ionizer surface, cesium reservoir and plugs connecting it to advance power supply. Ribbon along side carries current to ionizer.

The design of the proposed Air Force engine will be based on a prototype engine that has been under study at Electro-Optical. This engine, with .002 lbs. thrust, is 7½" long, 4" in diameter and about 2 lbs. in weight, exclusive of power supply. The Air Force version will undoubtedly be an advanced model of this device with higher thrust. Reports in industry have put the Air Force thrust requirement at 0.1 lb.

• **Small market, big potential**—In addition to the ion devices, NASA is receiving bids shortly on two small plasma propulsion devices. As in the case of the ion devices, neither NASA nor those bidding are willing to give any indication of the amount of money involved. However, an informed guess would be that the figure in each case is in thousands rather than millions of dollars.

One indication of the size of the market is the NASA budget for electrical propulsion. For the 1960-61 fiscal year, NASA is asking about $6 million, roughly twice the amount it is spending in the current fiscal year. This includes NASA's in-house efforts, of course. No such breakdown of Air Force funds is available, but it is believed unlikely that AF is spending any more than NASA in this area.

Despite the relatively small size of the market, industry is very interested. The reason is its great potential. The devices are just coming from the research phase into R&D, but eventually large devices will be built for satellite

orbit correction and spaceship propulsion. It seems a good bet that such lucrative future contracts will go to companies that are now pioneering in the field.

Industry observers expect the six companies mentioned earlier, as well as Electro-Optical, to bid on the upcoming NASA contract. Others interested in ion or plasma propulsion include Tapco Group of Thompson-Ramo-Wooldridge, Goodrich, High Voltage Engineering, Borg-Warner, Republic Aviation and Giannini Plasmadyne.

• **Cesium-powered**—An ion engine uses the rare metal cesium as a propellant. A member of the sodium-potassium family, cesium has the lowest ionization potential of any element with the possible exception of the radioactive element francium (No. 87), which is so rare that its ionization potential is not listed in standard reference works.

The cesium is vaporized and brought into contact with tungsten, where each atom loses its valence electron. The positive ions are then attracted toward a negative electrode in the rear. Many ions sweep past these electrodes and provide propulsion.

In a device operating at 30 kilowatts, about .01 lb. of cesium per hour would be consumed. The metal costs between $600 and $1000 per lb. However, a large deposit of pollucite, an aluminum-cesium silicate, is being developed in Southern Rhodesia and quantity production is likely to bring the price down.

Plasma production, on the other hand, operates on a principle of electromagnetically accelerating a highly ionized but electrically neutral mixture of particles to obtain thrust. Assuming a specific impulse of 1000 to 1500 sec., the plasma device thrust would be about three to five times higher than that of an ion engine, given equivalent power sources and efficiency.

Electro-Optical's two-millipound prototype ion engine uses a lightweight steel casing with a tungsten mesh ionizer surface and graphite accelerating electrodes. However, it is not limited to these materials. Later models may use beryllium or tantalum accelerating electrodes. These would not be as seriously affected by sputtering—the erosion of a surface because of ion impact.

• **Problems remain**—A number of major problems remain to be solved, including the neutralization of the positively-charged ion beam, and the control or elimination of sputtering. Neutralization must be accomplished, otherwise there would be no flow of ions from the accelerating chamber into space.

The efficiency of the two-millipound prototype is 72½%. An efficiency of almost 100% is possible, with the perfection of techniques.

The research embodied in the development of an ion engine at Electro-Optical has recently been aimed at component development and engineering. The company feels a number of problems must be solved "before sound engineering decisions can be made."

To provide cesium vapors to the surface of the ionizer, vapor pressure has been utilized, providing a stable, reliable source. To provide a valve and metering capability, however, a new method is being developed. This system would use a cesium glass, through which the cesium vapor would be electrolytically diffused, such as with a membrane, thereby giving an accurate and controllable vapor flow.

EOS plans to use the new method for evaluation of the efficiency of various ionizer surfaces and configurations, i.e., porous tungsten, staggered ribbon, or woven tungsten.

In designing accelerating systems, EOS used two types: parallel plate and the Pierce system. The former was utilized mainly in the study of ionizer characteristics, and the latter to evaluate the staggered ribbon source, and in neutralization studies. The Pierce system of linear acceleration was modified to include two focusing electrodes which would minimize ion interception by the accelerating electrodes, thus reducing sputtering.

The neutralization problem, one of the major stumbling blocks in the ion engine development, was attacked with two different methods: Injection of electrons into the ion beam; and that in which atoms are sent across the beam to neutralize it by charge exchange. The latter is not considered feasible for space flight, because of the undesirable effect on the accelerators, although results of the electron injection are viewed with cautious optimism.

• **A long life**—Thrust ratings for ion engines and similar thrust devices appear almost negligible when compared with chemical rockets, but their duration of operation is the key to many applications.

Correction of satellite orientation and orbit are the most likely uses in the immediate future, and sustained-thrust applications for pushing large payloads about space is a later probability. In the first application, it has been estimated that ion systems are superior to chemical or compressed gas sources if the total velocity increment to be generated over the lifetime of the satellite is 100 meters per sec. or more. If less than this is required, a compressed gas or chemical source is lighter.

Accelerometer Claimed to Be Smallest

A subminiature self-generating accelerometer, less than 0.1" in height, 0.5" in diameter, and weighing ¾ gram, has been developed by the instrumentation Division of Gulton Industries, Inc. The unit is believed to be the thinnest and lightest accelerometer commercially available today.

It is particularly suited for use in wind tunnel testing of simulated aircraft where weight is an important factor in selecting an instrument to determine wing flutter, tab buzz or control system response. Featherweight construction and cement-down mounting also allows the accelerometer to be used on miniature electronic components without materially changing the characteristics of the component involved.

The minute profile of the accelerometer permits it to be inserted between the skin and strut of a plane or missile. In addition, it can be built into many types of electronic gear, as a permanent installation. This permits periodic checks of vibratory conditions, as well as making it unnecessary to disassemble the equipment to remove the accelerometer after it has served its purpose. The unique isolated bender design provides low acoustic response and low transverse sensitivity as well as eliminating torque sensitivity.

Housed in aluminum, the Model A-31109 accelerometer has an acceleration range of 0.5 to 500 g and has a useful frequency range of 3 to 4000 cps and a sensitivity of 2 mv/g minimum. Its operating range is −65°F to +250°F. Resonant frequency is 12 KC minimum.

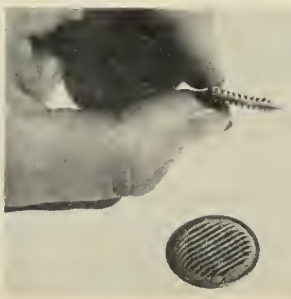
Each accelerometer is equipped with a permanently attached four foot length of Glennite Blackline Low Noise Cable fitted with a C5P connector. Calibration data and mating connector is supplied as well.

The new Gulton Accelerometer is also available in another model, designated the A-3108, which weighs two grams and is enclosed in a brass housing. It features greater sensitivity and broader frequency response than the lighter model A-3109.

Circle No. 225 on Subscriber Service Card.

Stainless Steel Filter Cleans Exhaust Bleed Gas

A special disc type stainless steel wire cloth filter for use in the *Sidewinder* missile is announced by Bendix Filter Division of Bendix Aviation Corp.



The filter was designed to clean exhaust bleed gases from the rocket motor to actuate control surfaces. Filtration allows smooth operation of the control surface actuating system and is important in attaining requiring flight accuracy.

The filter is rated for continuous operation up to 1200°F. Bendix rates it at 5 microns, and says it has a very low pressure drop, long storage life and simplified installation.

A soft copper ring, crimped to the edges of the pleated wire cloth disc, provides rigidity and a smooth sealing surface which eliminates the need for any gaskets or seals.

Circle No. 226 on Subscriber Service Card.

Tube Removal Without Circuit Shift Possible

Instruments for Industry, Inc., has designed a tube socket for the General Electric GL6299 UHF planar triode that enables the designer to realize practical UHF lumped constant circuitry with assurance of bandpass stability as tubes are changed.

Designated as XV-100/6299, the socket permits tube removal and replacement with absolute seating every time. Precise engineering and design techniques permit the miniaturized tube socket to be used to 1000 mc or higher with no resonances over the band.

Problems of poor grounding and high contact inductance which seriously limit upper operating frequency are said to be eliminated, as well as the problem of varying circuit values resulting from shift of contracts, circuit parts and poor seating.

Since the 6299 tube socket is primarily intended for grounded grid service, it provides a minimum of inductance for the grid return path to ground. The ground plane provides isolation between input and output for amplifier stability.

Allied applications for the tube socket are for broadband circuitry and receivers, amplifiers, mixers—or where both frequency stability and low noise factors are important.

Circle No. 227 on Subscriber Service Card.

Dynameter Measures to 200,000 lbs. of Force

Two new capacities, 150,000 and 200,000 lbs. have been added to W. C. Dillon & Co. Inc.'s line of direct-

reading, traction-type Dynamometers (portable force-measuring instruments). Fifteen capacities from 0-500 lbs. up to 0-200,000 lbs. are now available.

Both new units have a net weight of 23 lbs., independent of shackles, pins and shunt bar, and have highly visible 10" diameter dials. All parts of the Dynamometers are made to withstand rough usage. The case is heavy metal—dial is 22-gauge brass, protected by a ¼" thick plastic crystal. These instruments are designed to withstand roughest weather for field work, as well as the strain of heavy industrial applications.

All Dillon Dynamometers incorporate the following features: resetable red maximum hand which "remembers" point of peak load; removable clevises of drop forged alloy steel; ultrasensitive mechanism produces a full-scale reading with only .040" deflection of the special alloy steel beam regardless of capacity; fatigue-tested beam retains its resiliency indefinitely without creep or hysteresis; overload protection built into the beam sustains appreciable surges without damage to calibration; individually calibrated to an accuracy of 2% plus or minus full-range. Measures torque, traction, tension, compression or weight.

Circle No. 228 on Subscriber Service Card.

Alkaline Method Patented For Derusting of Steel

The Endox process, a patented, alkaline method for derusting and descaling of steel and activating it for plating, has been annuonced by Enthone, Inc., subsidiary of American Smelting & Refining Co. The process removes rust, scale, carbon smut, oxides and light soil from iron and steel alloys by electrolytic treatment in an alkaline solution at room temperature.

Acid pickling with its accompanying attack of the work and surrounding equipment and its production of carbon smut on the steel surface is eliminated. Acid dips in plating lines are also eliminated due to the deoxidizing and activating ability of the Endox process. Complete preparation of steel for plating in one simple step is possible with this alkaline process.

Either of two new products, Endox 209 or Endox 214, can be used to make up the processing solution. Both are completely prepared, powdered materials which need only be dissolved in cold water and concentrations of from 1 to 3 lbs/gal. to make up the bath. No other salts are required. Endox 209 is superior for scale removal while Endox 214 is preferable where heavy rust is present. Electrolytic treatment with either direct or periodic-reverse current can be employed.

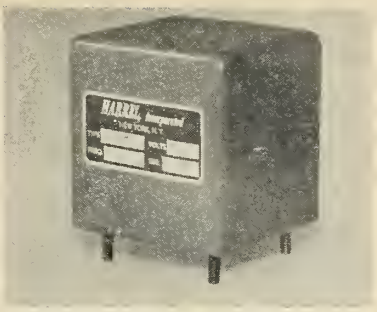
The Endox bath can be maintained indefinitely by periodic analysis and replenishment and by occasional removal of precipitated sludge. Since the bath is seldom dumped, it is very economical to operate.

Circle No. 229 on Subscriber Service Card.

Gyro Temperatures Kept Within Close Tolerances

Extremely close temperature control of high precision floated gyroscopes and accelerometers is achieved by the new TC200 series of proportional temperature controllers announced by Harrel, Inc. Using semiconductor switching techniques, the new unit achieves a power output of 100 watts or more at an efficiency of better than 94% overall.

The proportional nature of the control eliminates the dead zone characteristic of relay type controllers and allows extremely close control of temperature. At the same time, the response time of the controller is a fraction of a second, allowing the gyro to adjust rapidly to changes in ambient conditions. This rapid response also eliminated destructive overshoots in temperature during initial warm-up of the gyro.



The controller is completely solid-state and is furnished in a hermetically sealed enclosure with 7 pin terminal header, to meet all applicable MIL specifications. Forms can be furnished in special enclosures for production missile or airborne systems.

Circle No. 230 on Subscriber Service Card.

Miniature Crystal Can Solderer Introduced

An automatic miniature crystal can solderer has been produced by Reeve Electronics, Inc.

The unit, consisting of an induction heating generator with special tooling, is said to eliminate time and expense

of soldering miniature crystal cans, and provides a decrease in rejects, due to heat-caused frequency changes.

The basic equipment consists of: an induction generator; a special variable speed, motor-driven, 16 station turntable on which the generator is mounted and connected; special spring-

loaded holding jigs into which the crystals are assembled and held; a special two-stage heating coil where soldering takes place; a special fluxing assembly which applies the proper amount of flux to the outside of the assembly after the first heating cycle; and operator controls and switching circuitry to synchronize the generator and turntable.

Circle No. 231 on Subscriber Service Card.

Alternative Installation Permitted by New Relays

A new development in printed circuit relays is announced by C. P. Clare & Co., manufacturers of relays and allied electronic components. It consists of an assembly which permits single or multiple installation of Clare mercury-wetted contact relays in the small space of a printed circuit board. It plugs into a console in the same manner as the logic circuit it serves.

The individual switch capsules and coils are affixed to the printed circuit board and sealed from dust, moisture and tampering by the application of "Skin-Pack," a tough vinyl coating.

Customers' printed circuit boards may be adapted to include either the standard Clare HG mercury-wetted contact relay, or the ultra-high-speed HGS, as well as other selected components.

Circle No. 232 on Subscriber Service Card.

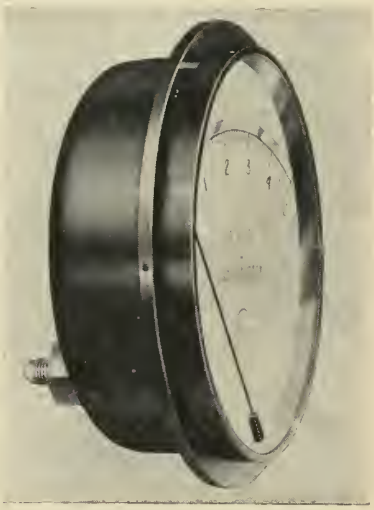
Pressure Gauge Designed For Use in Laboratory

A permanently accurate pressure gauge bearing the Bourdon-Helix trademark, specifically designed for laboratory use, is now being offered by Glassco Instrument Co.

The regular recalibration schedule, for years the bane of laboratory technicians, is no longer necessary. Manufacturer states this new Bourdon-Helix gauge will retain its accuracy permanently, with no maintenance or recalibration required throughout its life, even when exposed to extreme shock, vibration, and line pressure surges.

The new gauges are individually calibrated by dead weight tester to a guaranteed accuracy of ±¼ of 1%, including calibration and hysteresis variation throughout the entire scale. They are now available in pressure ranges from 0-100 to 0-10,000 psi, with a 6″ dial and mirror reflection band behind the needle to eliminate parallax error.

The Bourdon-Helix pressure gauge has only one moving part, a helically wound bourdon tube connected direct-



ly to the pressure source. Internal pressures cause the tube to unwind sweeping the pointer, at the free end, across the dial face. One permanently efficient moving part replaces linkage and componentry which so often affect accuracy in conventional gauges.

Glassco Bourdon-Helix pressure gauges were originally custom designed to meet the most demanding requirements of the missile and spacecraft industry, such as in the *Talos* and *Nike-Hercules* missiles, and the Lockheed F-104 Starfighter. These same characteristics are now available for laboratory application with the new Glassco gauges.

Circle No. 233 on Subscriber Service Card.

Lightweight Cryogenic Couplings Available

Lightweight U.S. Army Ordnance cryogenic couplings are now available from Futurecraft Distribution Corp. The couplings are screw-type, a new style that permits quick, easy and safe connection of flex lines, tubing, and pipe. Futurecraft says the couplings have been proven in ground support equipment service on Army Ordnance projects and are pressure rated at 150 psi operating, 300 psi proof, and 450 psi minimum burst.

Low torque is all that is required to seal Futurecraft cryogenic couplings fluid-tight. They are available in sizes from 1″ to 4″, in ½″ increments, right-hand or left-hand thread, and LOX cleaned and packaged. Installation tools are available.

Circle No. 234 on Subscriber Service Card.

Cleaner Restores Filters To 'Like New' Condition

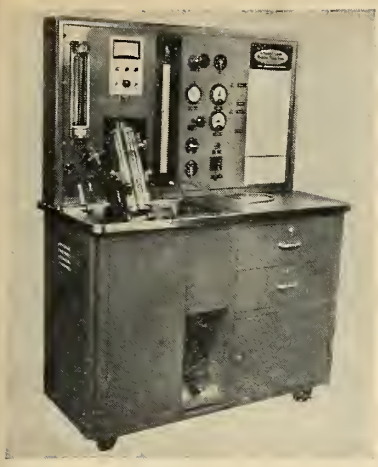
Used filter elements can now be cleaned to their original differential pressure and dirt-holding capacities by means of the Pall-Cavitron HIPS equipment. The unit is a joint development of the Pall Corp. and Cavitron Equipment Corp.

HIPS, HyperIntense Proximal Scanning, produces the maximum ultrasonic cleaning intensity that can be created in a liquid. It places a hyperintense field over a small portion of the surface of the filter at one time.

The filter element is rotated through this hyperintense proximal field until the entire surface of the element is cleaned. Particles are flushed away continuously as they are loosened. It takes less than 10 minutes to clean most filter elements to a "like-new" condition.

The basic ultrasonic generator and transducer used in the Pall-Cavitron HIPS system are modifications of the same "Cavitron" system in use for many years for the ultrasonic machining of metals and ceramics.

In addition, Pall-Cavitron HIPS contains bubble-point test equipment to test largest particle passed by the



cleaned filter, and equipment to measure pressure drop of a filter element. Both measurements are necessary to insure that the element is satisfactory for re-use.

Circle No. 235 on Subscriber Service Card.

Garrett Develops Two Valves for *Polaris*

Two new valves, designed for the *Polaris*-firing submarines, have been developed by the AiResearch Industrial Division of the Garrett Corp.

Both are integral parts of the launching system. One is a single stage pressure regulator that provides air at a constant, low pressure from a high pressure storage system. Part of this air is used to maintain proper pressure in the *Polaris* tubes prior to launch.

The second valve-type regulates the compressed air used to control the rapid movement of large volumes of ballast water to trim the boat when a missile is fired.

The valves have passed high impact and hydraulic shock tests and meet the stringent leakage requirements. They operate silently and occupy minimal space.

Circle No. 236 on Subscriber Service Card.

Data Processing System Called One of Fastest

The prototype of a new high-speed, fully transistorized data-processing system being built by Ferranti Ltd. is claimed to be one of the fastest and most powerful in the world.

Named Orion, it includes facilities for automatic sharing of the time of the central computer between several programs, so that it is fully engaged even when peripheral transfers are taking place, and peripheral equipment is kept working at maximum speed. Automatic safeguards prevent interference between programs.

Orion includes a magnetic core working store (capacity up to 16,384 words) backed by several magnetic drum units. Speeds are 36-38 microsec. for addition and subtraction, 60-200 microsec. for multiplication, 300-900 microsec. for division; up to 4.5 million words/min. can be read or written. Cost of the production model will be between $300,000 and $850,000 according to size and scope.

Circle No. 237 on Subscriber Service Card.

New Literature

HONEYCOMB. Hexcel Products, Inc., has just completed a 45-page brochure which is, in effect, a handbook on how to design with honeycomb. Entitled "Honeycomb Sandwich Design," the brochure offers a convenient summary of sandwich design methods complete with formulas and worked-out examples for stress computations on typical sandwich structures. Included are large sections on such aspects of honeycomb construction as Sandwich Theory, Impact, Fatigue, Creep, Environment, Selection of Facings, Selection of Adhesives, Selection of Core Material, Surface Preparation for Bonding, Tooling Methods, Quality Control and many other considerations vital to honeycomb design.

Circle No. 200 on Subscriber Service Card.

SPACE CALENDAR. A "space calendar," listing all U.S. and foreign space shots and supplying a log for similar activities in 1960 has been published by the Avion division of ACF Industries, Incorporated. Avion calls its unique booklet the "Avion Space Year IV 1960 Calendar and Pocket Memo Book" and claims it is the only publication of its type. The inside front cover of the booklet lists all space shots since the first *Sputnik*—October 4, 1957—while the inside back cover is a launch log for shots during Space Year IV (1960). A page is devoted to each month and is marked off with memo space provided for each day. Instead of bold-face marking of such anniversaries as the Fourth of July, Washington's Birthday and so forth, the space calendar is annotated for each space shot during the months they took place.

Circle No. 201 on Subscriber Service Card.

Dr. Donald F. Mitchell: Joins the Astro Systems and Research Laboratories of Northrop Corp.'s Norair Division as a bio-astronautics scientist.


MITCHELL

Dr. Mitchell, who has done extensive research work in genetics, biological effects of radiation, meteorology and botany, will participate in an experimental research program on systems to support human life in outer space.

James D. McLean: Former president of Hoffman Laboratories division of Hoffman Electronics Corp., joins General Dynamics Corp. as president of its Stromberg-Carlson division. Also becomes a senior vice president of General Dynamics and a member of the corporation's board of management. Will assume duties February 15. He succeeds **Robert C. Tait,** who will be associated with the corporate office.

Allan R. Shilts, controller, named to the newly created post of vice president and general manager of the division.

Richard B. Leng: Will head the new defense and industry group concerned with advanced military and industrial electronics at Packard Bell Electronics Corp. The group encompasses the Technical Products Division, the Packard Bell Computer Corp. and the Technical Industries Corp. The new group vice president formerly served as vice president in charge of the Technical Products Division.


LENG

Roger H. Mason: Appointed manager of the newly-formed special products division of Hathaway Instruments, Inc., developers, designers and manufacturers of transistorized inverters, converters and special purpose filters. Was formerly assistant general manager of Hermetic Seal Transformer Co.


MASON

Eugene V. Thatcher: Formerly senior guidance engineer, appointed associate head of the *Atlas* project office of Flight Test Operations at Space Technology Laboratories, Inc.

Previous posts: Western Electric Co., test equipment design; Farnsworth, special projects and mobile communications; Fairchild Guided Missiles Division, *Lark* project, telemetry, controls and guidance radar; and Republic Guided Missiles Division, acting head of electronics section.

Rear Adm. Raymond H. Bass (USN ret.): Joins Bendix-Pacific division of Bendix Aviation Corp., as a staff assistant to R. C. Fuller, vice president and divisional general manager. Adm. Bass' duties will involve anti-submarine warfare and submarine projects currently under way and planned.

Lloyd R. Everingham: Named director of Ryan Aeronautical Co.'s Space Laboratory, with responsibility of operating the newly acquired, wholly owned subsidiary, Aerolab Development Co. of Pasadena. Was formerly vice president-research at Radiation, Inc. and prior to that associated with Cornell University's Aeronautical Laboratory, as a member of the scientific staff and management and as a consultant to the Dept. of Defense, directing numerous studies concerned with missile and warfare system concepts.


EVERINGHAM

R. D. Ginter, *Bullpup* senior project officer and **D. F. Spencer,** *Bullpup* electronics engineer and coordinator of the missile guidance system development and evaluation, received a joint award of $4500 for introducing a radical "no-test-equipment" concept in the *Bullpup* guided missile program. The award was presented by **Rear Adm. Paul D. Stroop,** USN, Chief of the Bureau of Naval Weapons.

William F. Bailey, Richard J. Farber and **Donald Richman:** Appointed associate directors of research at Hazeltine Research Corp.

Bailey will be responsible for military electronic apparatus research; Farber will direct the industrial research division and Richman will head the systems research division. All three have been awarded U.S. and foreign patents for their work in electronics.

Henri Busignies: Holder of more than 100 patents and vice president- and general director of International Telephone and Telegraph Corp., elected a Fellow of the American Institute of Electrical Engineers. The Fellowship was conferred for outstanding contributions in the fields of electronic direction finding, air navigation, radar and radio communications.

James E. Longenecker: Appointed chief mechanical engineer for Magnetic Metals Co., manufacturers of electromagnetic cores and shields for the electronics and communications industries, replacing **Cortis F. Sherman,** retired.

Also, **Henry Kipp** named chief mechanical design engineer, **Eugene Schofield,** chief industrial engineer, and **Raymond Goebel,** tool engineer.

Robert N. Carson, A. Richard Hammer and **Paul E. Pazurek:** Appointed project engineers in the Inet Engineering Department of Leach Corp.

Carson was formerly with International Minerals and Chemical Corp., Libby, McNeill & Libby Co., and Nadar Engineering Co. Hammer was previously with Atomics International, Swanson Engineering & Manufacturing Co., and Midland Rubber Corp. Fisher comes from Rocketdyne Division of North American Aviation, Inc., and the Fisher Body Division of General Motors Corp.

George T. Krinopolis: Named manager, of the Laboratory for Electronics' Computer Products Division's Magnetic Devices Operation. Was previously with Raytheon's components department and prior to that, Brush Electronics.

Edward R. Elko: Former chief engineer at Aerojet-General Corp.'s Systems Division, chosen operations manager-Azusa Operations.

He joined Aerojet in 1947 as a design engineer at the firm's high-thrust engine test station; served as project engineer on the *Nike-Ajax* propulsion system; chief development engineer on the Bomarc propulsion system and was associated with the *Vanguard* satellite program and the Air Force *Thor-Able* and lunar probe vehicles.

William F. Cords: Joins Fruehauf Trailer Co.'s Missile Products Division, manufacturers and designers of ground support equipment.


CORDS

Cord, who assumes a customer relations position in the western division, was formerly director of sales at Airtek Dynamics, Inc., and still earlier, manager of Solar Aircraft Co.'s engine and missile sales division.

Dr. W. M. Lair: appointed director of research and development and **A. H. Haroldson,** associate director of Continental - Diamond Fibre Corp.'s newly completed research and development center in Newark, Del.


LAIR

Dr. Lair was previously technical director at Wrenn Paper Co. and a senior product engineer in development of printed

circuits with General Electric Co.

Haroldson, holder of twelve patents, was formerly manager of research and development at the Newark laboratory.

Robert E. Ringle: former advisor to the general manager, named manager-marketing for Northrop Corp.'s Nortronics division.

RINGLE

Previous positions: executive vice president of Hydro Metal Spinning Corp., general sales manager of Grant Oil Tool Co. and research associate at the California Institute of Technology.

Raul H. Frye: Appointed general manager and **J. Alan Stewart,** operating manager of Sparton Corp.'s Electronics Division.

Frye, formerly assistant general manager and marketing manager of Fairchild Camera & Instrument Corp.'s Defense Products Division will direct divisional sales and marketing programs. Stewart, former production manager at Loral Electronics Corp., is responsibile for the general administration of in-plant operations, including manufacturing and administration of military contracts.

Jennings David: Named vice president-Engineering for Summers Gyroscope Co. Was previously one of the engineers who developed the *WAC* and *Corporal* missiles.

Stanley E. Rendell: Elected vice president and assistant general manager of The Hallicrafters Co. Prior to joining the firm in 1956 as director of manufacturing, he was chief industrial engineer with Belmont Radio Corp.

Victor H. Soucek (Capt. USN ret.): named to the new post of manager of special projects for Sanders Associates, Inc., responsible for special development programs for weapon systems and missile defense.

Ernest N. Robinson: Former director of marketing appointed general manager of the Alemite and Instrument Div. of Stewart-Warner Corp., succeeding **W. A. Brown, Jr.**

H. Paul Sherlock: Elected sales manager of ENFAB, Inc., manufacturer of moulded compressible fiber-glass.

Dr. Murray Bloom: Formerly with American Potash & Chemical Co., joins Pacific Semiconductors, Inc., to assist **Dr. T. C. Hall** in semiconductor surface research studies.

George E. Stoll and **A. P. Fontaine:** elected executive vice presidents of Bendix Aviation Corp. Both are directors of the corporation and members of its administration committee.

Stoll will direct 24 U.S. divisions and subsidiaries, with headquarters in Detroit.

Fontaine will be responsible for many staff functions, including engineering and research, sales, planning, product development and patents.

The following appointments have also been announced:

Raymond C. Culbertson: named general manager of the defense products division of American Air Filter Co., Inc.

Milton B. Ames, Jr.: former assistant director of research for Aeronautics and Flight Mechanics, elected deputy director of the office of Advanced Research Programs at NASA.

E. Haynes: former deputy director of Aeronautical Sciences, USAF Office of Scientific Research, ARDC, becomes program manager, Exploratory Research and Reliability Branch, ARPA.

Samuel J. Levine: Manager of General Electric's Aircraft Nuclear Propulsion department test operation at Idaho Falls, Ida., named manager-projects for the department. **Dr. John W. Morfitt,** manager of ANPD nuclear development laboratories will succeed Levine.

Frederick M. Geiger: appointed manufacturing manager-potentiometers and **Joseph Katona,** manufacturing manager-instruments and systems at Daystrom's Pacific Division.

Howard T. Sterling: elected chief engineer of EPSCO, Inc.'s Worcester division.

Kenneth A. Dunn: named manager of administration for range systems operations at Aeronautics division of Ford Motor Co.

John D. Van der Veer: appointed to the newly created post of manager of government relations at Tung-Sol Electric Inc.

W. Lawrence Brantley: elected manager of Giannini Controls Corp.'s Washington district.

Dr. Nils L. Muench: formerly a senior research engineer with Humble Oil and Refining Co.'s production research division, named chief scientist of the Army Rocket and Guided Missile Agency.

Joseph M. Dukert: becomes manager of Information Services for the nuclear division of The Martin Co.

S. P. Smith: elected assistant director-engineering at Bendix Aviation Corp.'s products division. **R. A. Trapp** succeeds Smith as manager of engine equipment sales.

Computer Control Co., Inc., announces the following appointments: **D. J. Ryan,** formerly with AVCO's research and advanced development department, Administrative Staff Engineer; **L. A. Gutwill,** of M.I.T. Instrumentation Laboratory, to Development; **A. J. Winitzer,** formerly with American Standard's Military Product Systems Design department, Systems Project Engineer; and **R. Capraro** of ACF's Avion division, as electrical engineer assigned to systems.

AAS Hits Variety of Space Subjects

The Sixth Annual Conference of the American Astronautic Society in New York, Jan. 18-21 saw a good variety of technical papers presented on the astronautical sciences.

As a service to MISSILES AND ROCKETS readers, the papers have been condensed into abstract form for easier reading. Copies of the papers may be obtained from AAS's New York office.

Transmission Efficiency Between Simple Antennas on the Basis of Orientation and Polarization, John B. Rankin, RCA Laboratories, Princeton, N.J., Preprint No 105.

The object of this project is to determine the effect of random orientation of simple antenna systems, such as might be used on a satellite, on transmission efficiency and hence communication reliability.

Some Control-Display Aspects of Manual Attitude Control in Space, Malcolm L. Ritchie, Lewis F. Hanes, Ritchie and Associates, Inc., Dayton, Ohio, and Thomas E. Hainsworth, Lear, Inc., Preprint No. 60-14.

An investigation was conducted to determine the ability of a human operator to control the attitude of a simulated exo-atmospheric vehicle using several different combinations of displays, controllers, and control systems. The displays were a three-axis, moving sphere-type attitude indicator with and without body-axis rate indicators. Three controller arrangements were studied —individual hand controls for each of the three axes, a three-axis integrated controller, and a combination of the integrated controller and foot pedals. Proportional and on-off controls were used with the integrated controller.

The operators were instructed either to (1) stop the attitude spin or to (2) stop the spin at a particular attitude. They were able to stop the spin with an efficiency of about 90% and in less than 10 seconds with the best control-display combinations.

On the Simplification of the Attitude Equations of a Satellite, C. T. West and R. Goodstein, Boeing Airplane Company, Seattle, Preprint No. 60-13.

A technique for the simplification of the attitude equations of motion of a satellite, for the purpose of synthesizing an optimum control system, is discussed and illustrated.

The low torque levels involved in applied, inertial reaction, and cross-coupling terms require consideration of the complete equations of motion for each mathematical model selected. The resulting equations can be reduced to workable size by comparing the magnitudes of terms in order to select a set of simplified equations.

Application of Lunar Theory to the Motion of Satellites, Paolo Lanzano, Space Technology Laboratories, Inc., Los Angeles, Preprint No. 60-33.

The Lunar Theory of Celestial Mechanics is applied to the problem of establishing a permanent artificial satellite on a periodic orbit around a planet.

Using a method developed by C. L. Siegel, in his "Vorlesungen uber Himmelsmechanik," the Hill's equations of the Lunar Theory are solved to obtain the coordinates of the periodic trajectory as Fourier series of the time with respect to a rotating system of reference. A recurrent procedure is obtained for evaluating the coefficients of the series in terms of the period of revolution. The Jacobi constant of the motion is also expressed as an infinite power series of the period. The convergence of such expansions can be ascertained for small values of the period. A numerical example for a satellite of Venus is furnished.

An error analysis is undertaken by studying solutions of Hill's equations lying in a neighborhood of a periodic orbit and corresponding to the same value of the total energy. The coordinates of such neighboring trajectories are determined as isoenergetic displacements referred to the intrinsic reference formed by the tangent and normal lines at the various points of a periodic orbit. This procedure leads to a differential equation of the Mathieu type whose solution is obtained as a series expansion valid for small values of a parameter.

Kinematics of Planetary Ballistic Probes (Comparative Results of Keplerian ARCS vs. 3-Body Problem), M. Yachter, ARMA Division, American Bosch Arma Corporation, Garden City, N.Y.

This paper deals with the determination of theoretical relations and procedures of calculation leading to the determination of proper injection conditions for ballistic planetary probes on an interception course.

The Effect of Non-uniform Magnetic Fields on Internal Flows of Conducting Fluids, A. Sherman, Flight Propulsion Laboratory Department, General Electric Company, Cincinnati, Preprint No. 60-56.

The paper considers the flow of an inviscid, electrically conducting fluid through a straight two-dimensional channel subject to a non-uniform magnetic field. The fluid is assumed to be incompressible, have constant properties and a zero Magnetic Reynolds number. A solution is obtained for the 1st order approximation and the equations for higher order approximations are given. Numerical results are presented which describe the velocity and temperature throughout the flow field. In particular, the velocity, temperature and pressure along the wall where the interaction is greatest is presented.

An Astrovehicle Rendezvous-Guidance Concept, R. S. Swanson, N. V. Petersen, L. R. Hoover, Astrosystems & Research Laboratories, Norair Division, Northrop Corp., Hawthorne, Calif., Preprint No. 60-12.

A system concept utilizing a moderately sophisticated control-computer system is proposed for the rendezvous operations required for space station assembly, maintenance, repair and modification of orbital devices, and for resupply of manned and unmanned space systems. The proposed rendezvous guidance system is fairly tolerant of launch guidance errors, especially of the delays in launch time which will probably cause difficulty during the early attempts at rendezvous operations.

The proposed concept, defined as a quasi-optimum rendezvous guidance system (QORGS), allows the use of efficient orbital maneuvers for correction of the larger injection guidance or launch time errors, as well as the less efficient homing-type guidance for the final "docking" phase of the rendezvous operation. Rendezvous operations are expected normally to be completed in one satellite orbital period, using the proposed system concept.

The Oblatory Perturbations of Satellite Orbits, N. S. Hall, H. F. Gawlowicz, General Electric Company, Defense Systems Department, Syracuse, N.Y., Preprint No. 60-29.

The results of a mathematical study of the orbits about an oblate earth are given. These results were obtained by a modification of the method of variation of parameters which avoids the singularity at zero eccentricity normally associated with such techniques. Dependence of the variables upon initial conditions is completely given.

Comparison with numerical integration is shown which indicates errors of .03 nautical miles for very small eccentricities over 60 circuits of the orbiting vehicle. Since the results are in the form of a truncated power series in e, and J^2 is neglected, these errors increase to .2 miles on the fortieth circuit for e = .1 and .5 miles on the first circuit for e = .25.

The use of Vegetable Cultures as the Photosynthetic Component of Isolated Ecological Cycles for Space Travel, Linvil G. Rich, William Marcus Ingram, and Bernard B. Berger, Preprint No. 60-25.

Man's exploration of space will be limited by his physiological requirements. Although dehydrated foods and tanked water and oxygen will suffice for space flights of relatively short duration, long-term operations will be possible only if these necessities can be derived from the environment within the space vehicle. Conservation of environmental mass will make mandatory some type of closed ecological system kept in operation by a source of continuous energy. Conceivably, such a system will involve a carbon-dioxide exchange between humans and plants, waste reutilization, and the growth of plants for human consumption. Items on the original inventory will be used again and again for the continued sustenance of man.

Higher plants have long been a primary source of human food material. Many people exist entirely on vegetable diets, the preparations of which require only cleaning and cooking. Moreover, the growth of some higher plants in soilless culture under partially controlled conditions is already accepted commercial practice.

It appeared desirable to make a study of the use of higher plants as the photosynthate in the human sustenance system. The present paper discusses the results of such a study.

Heat Rejection From Space Vehicles, Daniel P. Ross, Edward Ray, and Henry C. Haller, Space Power Systems Group, Research and Engineering Requirements Tapco Group, Thompson Ramo Wooldridge Inc., Cleveland, Preprint No. 60-39.

The discussion devotes major emphasis to heat rejection from a vapor power cycle, considering both the condenser and radiator. Information is also presented which is applicable to heat rejection from other powerplant cycles, or from other space cooling applications. Data is presented to indicate important parameters and trends associated with space radiators.

Basic Requirements for the Exploration of Jupiter and its Moons, Warren H. Straly, Robert G. Voss, Preprint No. 60-57.

This paper is concerned largely with the compilation of knowledge made available from studies of physical phenomena concerning Jupiter, and the application of this knowledge to the areas of space-flight mechanics and space system design. These two broad areas serve to form a basis for the investigation of the requirements

necessary for exploration.

Communications and data transmission, guidance and control, auxiliary power sources, and flight environment are examined in the light of energy requirements, trajectories, orbital navigation, large transfer times, vehicle capabilities, mission objectives, and payload characteristics.

Ecological Criteria for an Interstellar Rocket Relay Station, R. E. Ross, General Dynamics Corporation, Electric Boat Division, Groton, Conn., Preprint No. 60-23.

The problem of assessing the overall efficiency of men and mechanical equipment confined in a limited space such as an interstellar relay station requires a precise workable approach. The rewards for making the problem accessible to mathematical treatment are several. Not only may a general formula for approximating spatial requirements be derived, but it is also possible to set up dependable functional equations for such seeming imponderables as human caprice, chance interactions between men and equipment owing to externally-induced accidents, and system depreciation.

By appropriately varying the values of coefficients and weighted exponents in a large-scale factorial design, by testing simulated models of man-machine interface, and by monitoring the analogs of pulsed synapses (varying the time and the induced-effect inputs), one can determine a system's operating potential, information entropy, and economic value.

A Celestial Moving Target Indicator, H. Dubner, Manager, Advanced Development Laboratory, Avion Division ACF Industries, Inc., Paramus, N.J., Preprint No. 60-19.

Existing state-of-the-art components are available to provide a Celestial Moving Target Indicator with a 30-degree field of view. The most serious single degrading factor is the persistence characteristic of the P-7 phosphor. Development of a special phosphor more suited for this application would extend the range capability from the order of thousands of miles to tens of thousands of miles. The technique offers sufficient promise to warrant continued development toward demonstration equipment.

One-Way Reconnaissance to Mars, J. Victor Hughes and George N. Nomicos, Republic Aviation Corporation, Scientific Research Staff, Farmingdale, N.Y., Preprint No. 60-50.

A one-way reconnaissance mission to Mars, starting from the earth's surface and placing a payload (including guidance and control equipment) of 6000 lb into an orbit round Mars, is considered. Take-off from the earth's surface may use a chemical or a nuclear rocket, while the interplanetary journey may use a chemical or a nuclear rocket, or an electric propulsion system (plasma engine or ion engine). The total take-off weight is calculated for each likely combination of these engines.

A nuclear rocket for take-off gives a take-off weight about one-fifth of that needed when using a chemical rocket. Least take-off weight is required by a system using a restartable nuclear rocket engine for all stages, but it is unlikely that such an engine will be available in the foreseeable future. The most attractive combination, from joint consideration of low take-off weight and reasonable availability date, is:

Nuclear rocket to place the vehicle in an orbit round the earth, with electric propulsion for the remainder of the journey.

Navigation and Energy Display Requirements for Pilot-Controlled Satelloid Flight, R. C. Kaehler, Consultant, S. Romano, Program Manager, Avion Division ACF

Industries, Inc., Paramus, N.J., Preprint No. 60-26.

This report covers a discussion of information requirements for a piloted satelloid system while on an orbital bombing mission. Recent experimental data are presented regarding pilot capabilities for vehicle reentry control and problem solving activities while exposed to high-magnitude accelerations.

Special emphasis is given to combining present and future navigation and energy information for the re-entry and approach-for-landing phases of flight.

An Earth-Oriented Communication Satellite of the Passive Type, Warren Gillespie, Jr., NASA Langley Research Center, Langley Field, Va., Preprint No. 60-4.

A passive communication satellite for global communication is described in which the reflecting surface is an erectable spherical segment of a very large sphere (which as a complete sphere would be impractical to build) and the segment is oriented continuously toward the center of the earth. Use of the spherical segment is proposed as a compromise between the low reflecting efficiency of a smaller complete sphere and the high pointing accuracy required for a plane reflecting surface.

A Survey of Ion Sources for Electrical Propulsion, K. M. Foreman, Republic Aviation Corporation, Farmingdale, L. I., New York, Preprint No. 60-7.

A brief introductory analysis of electrical propulsion for space travel shows that flight duration is inversely proportional to the square foot of thrust. The engine thrust appears to be a strong function of ion accelerating potential, ion chamber size, and to a lesser degree the ion charge. The effect of ion mass on thrust is shown for various design considerations such as fixed geometry and exit velocity, fixed chamber geometry and accelerating potential, and constant ion current and accelerating voltage. Space charge effects are also considered.

Ion source requirements are: a) high purity, b) low power consumption, c) excellent stability, d) simple control, and e) large current density.

An historical review of five types of ion production is presented along with salient features of each method.

Nuclear Rocket Engine Control Problems in an Upper Stage Interplanetary Vehicle, B. P. Helgeson, Reaction Motors Division, Thiokol Chemical Corporation, Denville, N.J., Preprint No. 60-9.

It is assumed that the mission for a nuclear rocket upper stage is the transportation of a sizeable payload from a 300-nautical-mile earth orbit to a 300-nautical-mile Mars orbit.

A nuclear engine system of the solid-fuel, heat exchanger type is assumed and briefly described.

Problems of ground checkout, boost, duty cycle and shut down are discussed.

The generalized thrust duty cycle is characterized by rapidly applied values of impulse in the initial and terminal phases with intermediate navigational requirements for low-power operation. The inherent flexibility of operation of the nuclear engine is shown to be attractive for this mission. The need for a simple controls system which does not detract from the characteristic high performance of the nuclear engine is emphasized.

The Operational Support of Space Vehicle Missions, Herbert S. Dordick, Airborne Systems Division, Defense Electronic Products, Radio Corporation of America, Camden, N.J., Preprint No. 60-52.

This paper describes an operational analysis program which is presently underway, and which projects maintenance and support requirements for future space vehicle systems.

Vehicle mission profiles are defined and classified into families according to the electronic system complexity and maintenance requirements. Much can be learned about the support and maintenance philosophy most suitable for a family of vehicles without a detailed knowledge of specific equipments. The inter-relationships among the support goals, cost, logistics, and reliability are delineated. Some of the key trade-offs developed are shown and discussed. The logical extension of the program is discussed and some future results are predicted.

Nuclear Power Plants for Space Vehicle Application, Sherman Naymark, Atomic Power Equipment Department, General Electric Company, San Jose, Calif.

The author says nuclear energy appears to be the most suitable source for auxiliary power in space vehicle. Nuclear power sources produce more power per weight and lifetime than comparable energy sources.

A long-life auxiliary power plant on a space vehicle will have a marked effect on the utility of that vehicle and in many respects will determine the feasibility of its mission. Both dynamic and static conversion equipment can be used with nuclear heat sources.

Methods of Predicting Radiation Dosage in Space Flight, Angus F. Bond, Michael G. Del Duca, and Andrew D. Babinsky, Advanced Systems Group, Research and Engineering Requirements Tapco Group, Thompson Ramo Wooldridge Inc. Cleveland, Preprint No. 60-21.

This paper presents suggested computational methods for evaluating whatever techniques may be provisionally selected. Some of these methods point toward development of vehicle instrumentation which may eventually become operational for man's defense against the radiation danger. Systems for early warning to the crew and guidance corrections for radiation avoidance or for trajectory optimization, on the basis of newly received information, are among the concepts used.

Aerobic Biological Degradation of Human Waste in Closed Systems, Richard H. Bogan, University of Washington, Seattle, Wash., David D. Chapman, Boeing Airplane Company, Lowell H. Ericsson, Boeing Airplane Company, Seattle, Wash., Preprint No. 60-27.

The demonstration that activated sludge cultures can function at some 300 times the concentration of normal sewage, constitutes a basis for the view that reliable biological methods of waste reduction, with small weight, space and power requirements, can be developed for extended space flights or for extraterrestrial manned stations.

Multistage Rocket Staging Optimization, Ramon L. Chase, Chrysler Corporation, Missile Division, Detroit, Mich., Preprint No. 60-41.

This paper presents equations for optimizing vehicle staging on the basis of maximum performance. It is believed that this optimization technique is unique in that the usual assumption of constant required characteristic velocity is not utilized. The interdependence of the required missile characteristic velocity, V_r, and the staging is included the use of a truncated Taylor expansion of V_r. The inclusion of the dependence of V_r on vehicle staging enables the trajectory and vehicle to be optimized as a single system for the first time.

The results of this technique are illustrated by the optimization of a three-stage escape vehicle.

Equations are also presented for the optimization of staging on the basis of minimum cost per pound of payload.

propulsion engineering . . .

By JAY HOLMES

Four key Aerolab executives . . .

are moving over to Atlantic Research. General Manager Hal F. Halstead and three others will set up an Atlantic Research space vehicle group at Pasadena. They will be put to work on plans for staged vehicles based on available rocket motors able to attain orbital trajectories and escape velocities.

Obviously, Halstead's team is leaving as a result of the sale of Aerolab to Ryan Aeronautical last month. Others in the group are David Benun, chief engineer; John W. Reed, Jr., sales manager; and Joseph Baltrush, comptroller.

The Aerolab team gained fame last year for its part in the Jason phase of the Project *Argus* nuclear explosions in space. Aerolab vehicles were used for probes that measured the effects. They also assembled the *Javelin,* a four-stage rocket consisting of an *Honest John,* two *Nikes* and an *X-248* with a 1000-mile vertical range, and the *Journeyman,* a combination of a *Sergeant,* two *Lance* motors and an *X-248* with a 2000-mile vertical range.

Atlantic Research proposes to make use of the Aerolab team's know-how in assembling its own multi-stage vehicles. The market for sounding rockets is growing, Atlantic Research says, and it wants to capitalize on it. There is some speculation that ARC rockets might be staged too. However, the staging of end-burning rockets might introduce problems.

Speaking of sounding rockets . . .

Thiokol reports its *Cajun* rocket engines are now available for immediate delivery off the shelf from its Elkton, Md., division. Cost: $1286 apiece. Production of the 1000th *Cajun* was recently announced.

The rocket comes in three models. Model I, 108" long and weighing 172 lbs., was used extensively in the International Geophysical Year program. Model II, 107" long and weighing 171 lbs., was developed with General Electric Co. for rocket sled propulsion. Model III, 104" long and weighing 166 lbs., was designed for use in the *Pogo-Hi* target missile system. All are 6¾" in diameter and generate 8100 lbs. thrust for 2.8 sec.

Mach 7 wind tunnel velocities . . .

have been achieved at the Naval Supersonic Laboratory at the Massachusetts Institute of Technology. These speeds, which double the velocities previously achieved in the tunnel, were made possible by placing a small hypersonic tunnel into an existing lower-speed supersonic tunnel. Installation of the hypersonic nozzle cost about $150,000.

Titanium mill shipments rose 20% . . .

in 1959 as prices continued downward, Titanium Metals Corp. reports. About 15% of the metal shipped was earmarked for missiles and another 15% went for civilian applications. The remainder of the market was manned military aircraft, which creates uncertainty in the 1960 market. Mill shipments in 1959 totaled 3100 tons. The composite price, based on sheet, strip, bar and billet was $7.22 per lb. at the year's end, compared with $8.66 at the end of 1958.

Disintegration barrier . . .

a hitherto unrecognized barrier to space travel, has been pinpointed by Dr. Elliot T. Benedikt, a Northrop Corp. physicist. Benedikt told the American Astronautical Society space ships would disintegrate on reaching a certain critical velocity as a result of collisions with microscopic intersteller dust particles.

The barrier is no problem with presently projected vehicles, however. It comes into play only at 99.5% of the speed of light.

$30-Million *Mercury* Range Contract Signed

Cost of the globe-girdling *Mercury* tracking range has been placed at about $30 million under the terms of a cost-plus-fixed-fee contract signed by NASA and a team headed by Western Electric. Negotiations were completed Jan. 18.

The 18-site network to track the first U.S. astronaut in orbit is to be completed in 1961. Major members of the team are Bell Laboratories, Bendix Aviation and Burns and Roe Inc.

Western Electric is responsible for managing the project as well as the design and implementation of ground communications. The company also will make arrangements for intersite communications and train the operations and maintenance personnel.

Bell is handling the basic systems engineering for communications and visual presentation of the manned capsule. It also is in charge of equipment compatibility and will provide consultation in radar.

Two divisions of Bendix are involved in the project. The Radio Division is providing ground-to-capsule voice communications equipment, radar equipment and ground command links. The Bendix-Pacific Division will provide the telemetry receiving system, associated command-display consoles, and data-processing equipment for the entire network. The system will utilize more than 90 data channels.

Burns and Roe, an architectural and engineering firm, is the designer and general contractor for all construction, including two shipboard installations. The 18 sites are located at Cape Canaveral, Grand Bahama Island, Grand Turk Island, Bermuda, the Canary Islands, Western Australia and Southern Australia, Canton Island, Hawaii, White Sands, N.M., in southern Texas, Eglin AFB, Fla., at two locations in Africa, at two locations on the West Coast of the United States, and aboard two radar picket ships—one in the Atlantic and the other in the Indian Ocean.

A computing and communications center for the network will be located at NASA's Goddard Space Flight Center, Beltsville, Md. The control center will be at the Cape, which is the launch point.

Lacrosse Gone to Canada For Joint Arctic Testing

HUNTSVILLE, ALA.—The Martin *Lacrosse,* surface-to-surface field Army missile, has migrated to Fort Churchill, Manitoba, during January and February for tests under arctic conditions.

Aerojet to Build 2n

ABOVE: Interior view of the cast and cure building at Aerojet-General Corp.'s Sacramento plants. Upper level is 3700 sq. ft., removable platforms total 3700 sq. ft., and lower level is 7750 sq. ft. BELOW: Note huge earthworks.

Aerojet-General Corp. will produce the second-stage propulsion unit of the *Minuteman* ICBM, subject to successful tests of hardware, the Air Force announced last week. Thiokol Chemical Corp. drops to a limited technical backup.

The amount of money involved in the second stage was not disclosed, but Aerojet said last year it had been awarded an $85-million contract for R&D on all three stages of *Minuteman*. At the time, Aerojet had a limited backup on the first stage. Last fall, however, AF made Thiokol sole source.

Early last month, AF reportedly decided that Aerojet would have sole-source status on the second stage. The decision was delayed for two weeks after congressmen and other Utah political leaders protested.

Congressional sources said AF felt that Aerojet and Thiokol work was about on a par. Aerojet was chosen, these sources said, because it was thought both stages should not be concentrated in the same company and the employment involved should be spread to as many areas as possible.

In its announcement, AF said the Thiokol first-stage plant at Brigham City, Utah, will employ 1300 to 1500 at peak production, and the assembly facility at Hill AFB, Ogden, Utah, will employ over 800.

Aerojet and Hercules Powder Co. still are in contention for the third stage. Other *minuteman* contractors are Boeing, assembly and test; Avco, nose cone; and American Machine & Foundry and ACF Industries, railroad cars for mobile version.

Aerojet will produce *Minuteman* second stages at the ultramodern Sacramento, Calif., facilities shown in the accompanying photographs.

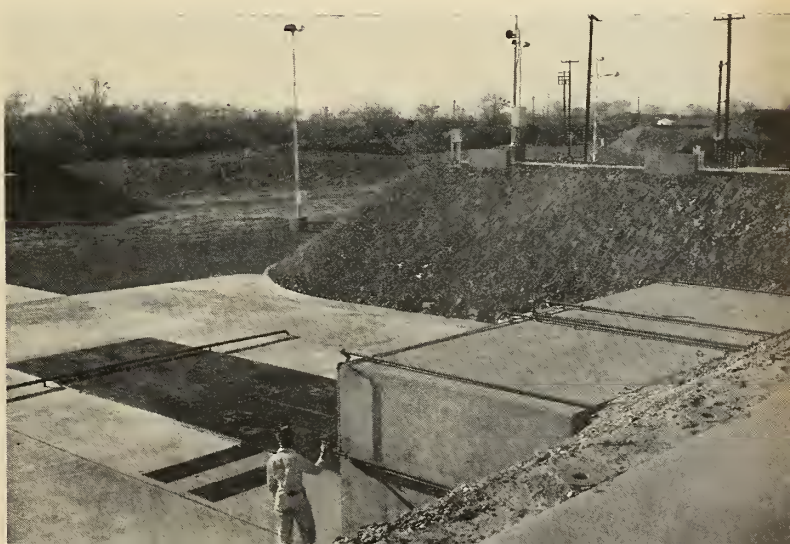
tage of *Minuteman*

A look at its huge casting, curing and core preparation complex

CONTROL CENTER from which Aerojet operates three static test stands for the *Minuteman's* solid rocket motors. The center uses the most advanced instrumentation equipment. Test results, monitored on 300 channels, can be available to the test engineer in less than four hours.

LEFT: One of the static test bays. Head wall, at center, is 8 ft. high, 11 ft. thick and made of poured concrete reinforced with steel rods. Concrete floor is 6 ft. thick.

RIGHT: Close-up of bay. During testing, motor is bolted to black motor stand and connected to white head wall thrust plate. Plate is four-in.-thick steel to take force of blast.



by M/R Staff
From Official Translations

Meteorite Information

Some meteorites have been found to contain minerals not present in the Earth's crust, the USSR Meteorite Commission was recently told.

I. A. Yudin, Candidate of Geological and Mineralogical Sciences reports that these minerals have been formed artifically during metallurgical processes. Through study of this phenomena he hopes to provide an answer in regard to the formation of meteorites, asteriods, and planets. *(Sovetskaya Rossiya, Dec. 13, 1959, p. 4, cols. 5-6.)*

Titanium Electrolysis

Several laboratory experiments have demonstrated the possibility of refining titanium by electrolysis of molten media with soluble anodes. A. B. Suchkov reports complete separation of binary Ti-Fe, Ti-Si and Ti-Nb alloys in molten alkali chlorides, electrolysis of enriched and deoxidized high-Ti materials such as ilmenite slags or ore concentrates, electrolysis of titanium oxide, carbide or nitride, and the processing of metallurgical slags with high Ti content. (Tsvetnyye metally No. 6 and No. 8, 1959.)

Thermoelectric Cooler

A Soviet Authors' Certificate has been issued to A. G. Shcherbina, A. G. Tauber, and I. G. Mushkin for a small thermoelectric cooler which reportedly facilitates a more complete and reliable removal of heat from the warm lower junctions of the thermoelectric pile.

The specific feature of the unit, according to an article in Byulleten' izobreteniy (No. 16, 1959, p. 81), is a system of air radiators—located around the operating chamber in an open housing—which is fanned with a vane-type fan fixed on the axis of an electric motor.

Lithium Resistance

According to an article by Yu. F. Bychkov, A. N. Rozanov, and V. B. Yakovleva in the journal *Atomnaya energiya* (Vol. 7, 1959, pp. 531-536), experiments have been conducted on uranium, zirconium, iron, nickel, titanium, molybdenum, niobium (columbium) and beryllium in liquid lithium at 700-1000°C to determine the solubility of these metals and their resistance to liquid lithium.

The mechanism of corrosion also was studied. The experiments were conducted with materials specially purified in a device described and illustrated in the source.

The experiments consisted in filling crucibles (made from the metal to be tested) with lithium in an inert atmosphere of argon, and heating them for several hundred hours at a given temperature. The transfer of impurities and dissolving of the metals onto the inner surface of the crucibles was observed with crucibles made of "Armco" or some Soviet stainless steels.

It was further observed that lithium can be purified by using zirconium and uranium.

The results, according to the article, permitted classification of the tested metals according to their solubility in lithium. Nickel and beryllium were determined to be of high solubility of the order of 0.1%. Iron, zirconium, titanium and uranium proved to be less-soluble (hundredths of thousandths of 1%). Niobium (columbium) and molybdenum proved to be highly insoluble, less than 10^{-4}%.

Nickel Base Alloys

When complex nickel-base alloys are cooled from high temperatures, a partial decomposition of the solid solution occurs under precipitation of a phase with the same lattice parameters as those of the basic solution, but with a different content of alloying elements.

According to an article by I. I. Titarenko and B. M. Rovinskiy in the Fizika metallovi metallovedeniye (Vol. 8, No. 5, 1959, pp. 731-734), diffusion occurs at 1125°C, causing separation of the lattice. Holding at 1200°C causes some of the components of the precipatated phase to diffuse back to the basic solid solution.

Cold Welding Aluminum

I. M. Stroyman in Svarochnoye proizvodstvo, (No. 12, 1959, pp. 6-9) states that experiments at the All-Union Scientific Research Institute of Electric Welding Equipment reportedly demonstrated the feasibility of cold spot-welding for sheets of an aluminum alloy consisting of 4.80 magnesium, 0.43 manganese, 0.44 vanadium, in thicknesses up to 2+2 mm.

The maximum weld strength corresponding to 80-90 percent of thickness reduction is achieved at 20 kg/mm² of specific pressure. The yield strength of the base sheet is 16 kg/mm².

Another alloy with 6.80 magnesium, 0.62 manganese, and 0.23 titanium, showed considerably poorer weldability.

Double-Message Modulation

The Soviet publication *Elektrosvyaz'* (No. 12, 1959, pp. 17-27), discusses the basic principles and merits of double-message amplitude modulation for simultaneous transmission of two signals by one carrier.

Designated "dvustoronnaya modulyatsiay," in this type of modulation all positive half-waves of the carrier are modulated by the first signal to be transmitted and all negative half-waves by the second signal.

The signals are separated in the receiver by two oppositely connected detectors.

According to the article, a Soviet patent for this method was originally issued to V. K. Kenigson and G. N. Markov in 1936, but did not find practical application because it required a wide frequency band. Recent interest, according to the article, is explained by "the appearance of several problems related to the simultaneous transmission of two signals where double-message modulation may lead to successful solutions."

High-Power Tubes

According to an article by P. N. Andreyev and N. V. Zaryanov in the Soviet publication *Svyaz'izdat* (1959, p. 110), Soviet specialists have developed two new high-power transmitting tubes. One, designated PT-500, is for broadcasting and communications. The other, 20-C-300, is for short-wave communications. Basic electrical data on these tubes are:

PT-500

Filament voltage	30v
Filament current	700a
Plate voltage	10v
Saturation current	350a
Transconductance	150ma/v
Gain 28	
Maximum dissipated plate power	300 kw
Maximum dissipated grid power	35 kw

20-C-300

Filament voltage	33v
Filament current	500a
Plate voltage	10-20 kv
Saturation current	100a
Transconductance	60ma/v
Gain	45
Maximum dissipated plate power	150 kw

Under "favorable conditions," the PT-500 series reportedly can deliver 500 kw of h-f power. The cathode system is of a three-phase type, advantageous because of the considerable decrease in hum, produced by the pulsation of filament current. Parallel distribution of filament groups in each phase was recommended for minimizing the magnetron effect by mutual compensation of the magnetic fields.

The 20-C-300 tube under optimum conditions can obtain h-f power of 300-500 kw. Cathode life is rated at 5000 hours. Special measures have been taken to minimize parasitic inductances for successful operation in the 8-10-m band.

The development of the new tubes was credited to scientists and engineers A. L. Mints, A. M. Kugushev, S. A. Zusmanovskiy, N. I. Oganov, P. N. Andreyev, M. I. Karpovskiy, and M. I. Basalayev.

Thermal Expansion Tests

An accelerated method of determining the thermal expansion of some metals, alloys, and ceramics has reportedly been found, according to an article by V. G. Bravinskiy and Ye. G. Bravinskaya in the publication *Savodskaya laboratoriya* (Vol. 25, No. 11, 1959, pp. 1336-1338).

Among the metals tested, molybdenum, Kovar and "Khronin" (otherwise unidentified) are mentioned. According to the table of results given, the coefficient of thermal expansion of "Khronin" is about three times higher than that of molybdenum.

Among ceramics an alumosilicate and a cordierite were tested. The report states that the alumosilicate was very close in expansion properties to molybdenum, while codierite showed much lower results.

Materials were tested in the temperature range of 20-500°C on a universal Leitz dilatometer. Deviation from results obtained by standard methods did not exceed 3.10^{-7} per $°C^{-1}$.

The advantage of the method, according to the article, is that it saves considerable time. It is said to take only 40 minutes instead of the normal 8¼ hours for glass or ceramic, and 2¾ hours for metal. Moreover, the same device can be used for both types of materials to give comparable results.

soviet affairs . . .

By DR. ALBERT PARRY

The Pacific Ocean may be . . .
a new target area for Russian rocket explosions, but it is not new territory for Russian sub and rocket bases. In addition to the missile installations known to exist on Russia's own Far Eastern shores near Vladivostok, we have it on Nikita Khrushchev's authority that Red IRBM's are in position in China, facing the ocean.

He revealed this . . .
last June 23 to Averell Harriman, during the latter's visit in Moscow. Khrushchev declared that he had sent numerous rockets to Red China, and these had been installed in the hinterlands behind the coastline, with enough range to blast the Chinese Nationalists on Formosa and to threaten, "immobilize and, if necessary, destroy" the U.S. Seventh Fleet patrolling the Formosa Strait.

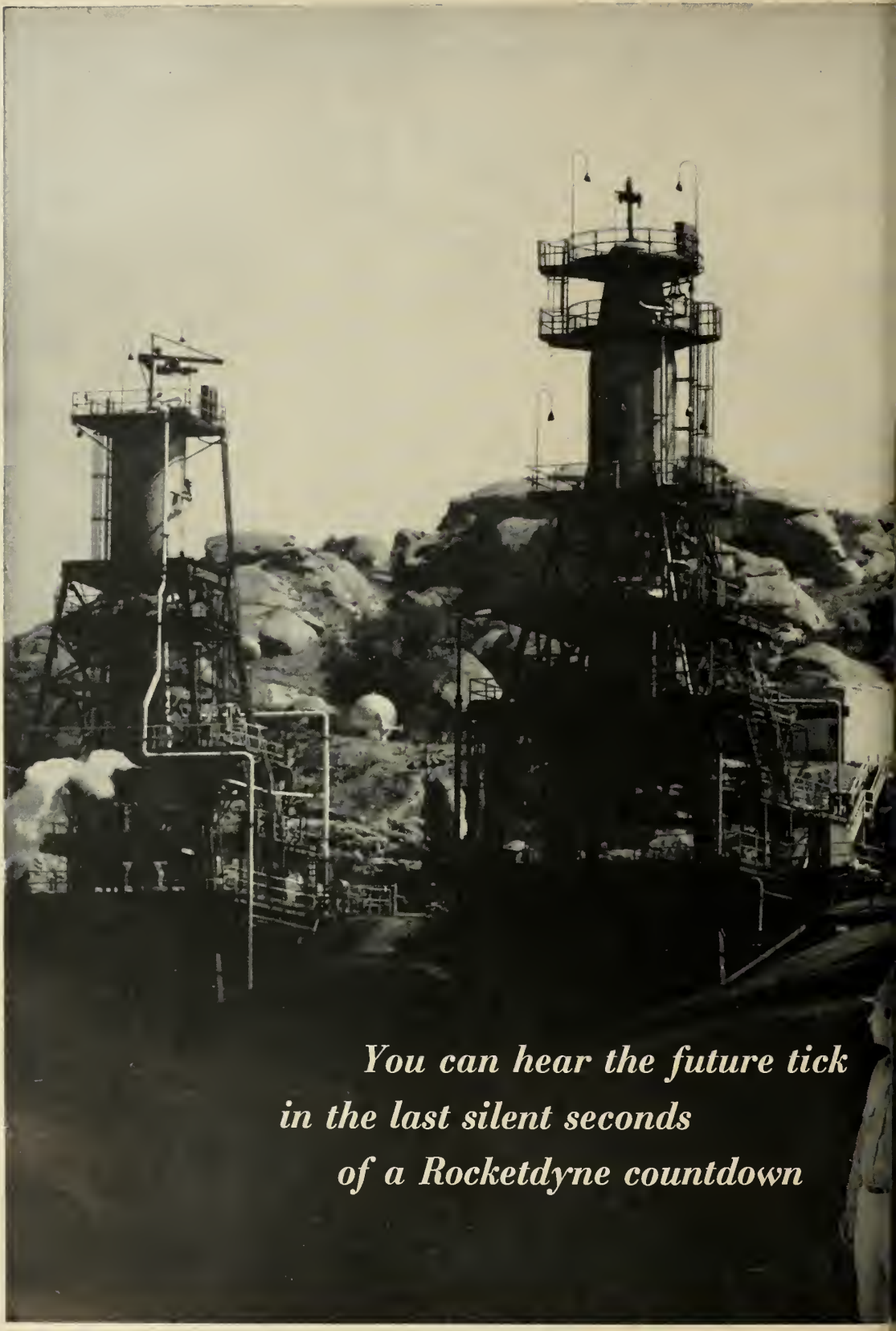
Less publicized are the reports . . .
from sources other than Moscow that farther south along the Pacific shore the Reds have bases for submarines, and that some of these subs are missile-equipped. According to Western intelligence sources, one such base was established in the mid-1950's, soon after the Red victory in North Indochina, when the former French naval station at Haiphong, southeast of Hanoi, was handed over by the Communist government of Ho Chi Minh to the Russians.

The Haiphong base . . .
was at once utilized by the Soviets for their submarines, now lying in a river delta amid dense jungle affording good camouflage from any hostile or prying aircraft. Another such Red point of departure in the Pacific is the Coushan Islands, near Shanghai, given by the Red Chinese to the Soviets for a strong naval base, particularly for submarines and their missiles. At about the same time the Soviet government "turned over" to the Red Chinese a few of its submarines. It is possible, however, that most of the crew members on these "Chinese" subs are Russians, or that at least the subs' commanders and key missile-handling personnel are Russians.

Indonesian ports . . .
are among the latest points of interest for the Soviet military. Last November a squadron of Russian cruisers based at Vladivostok visited Djakarta and other ports along Indonesia's shores. Much was made of this trip by Soviet propagandists accompanying the squadron, and by the Indonesian Communists and fellow travelers awaiting them. Articles in the Moscow military press describing the allegedly overwhelming success of this visit to Indonesia inevitably included anti-American sallies, chiefly on the subject of the "waning" of U.S. influence in the Pacific. Typical was Lt. Col. A. Leontyev's article. "In the land of 3000 Islands," which appeared in *Krasnaya Zvezda*, the main organ of the Soviet Ministry of Defense, for last December 13.

This Red naval excursion . . .
into the Pacific is presented by the Soviet colonel and other Russian writers as an entirely peaceful enterprise. We can be sure, however, that rocketry specialists were included on the staffs of the Red squadron, and that much valuable reconnoitering was done in that area of the Pacific, no less than in other parts of the ocean, prior to the announcement that Soviet rockets would from now on begin to explode so far away from Russian shores.

Old Russian exploits in Hawaii . . .
are now being recalled by Moscow's men as their rockets reach into Central Pacific. In 1815-17 Dr. Georg Anton Scheffer, a German adventurer in Russian employ, built forts on Hawaiian shores and raised the Russian flag over them. He swore a native ruler, King Tomaree, into allegiance to Tsar Alexander I, and wrote to the tsar: "The Sandwich Islands are the keys to China, Japan, the Philippines, India and the Northwest Coast of North America. By holding Honolulu, Russia can . . . control the entire Pacific." But the tsar felt his navy was not strong enough to hold Hawaii against Americans and British. He turned down the offer.


You can hear the future tick
in the last silent seconds
of a Rocketdyne countdown

FOUR...THREE...TWO...ONE... a moment of silence. Then a giant speaks—and a bolt of man-made lightning flashes.

Nearly every hour of every day, Rocketdyne technicians near that dramatic moment as they test and tune the space engines of today.

The best-equipped test facilities for high thrust rocket engines in the nation are at their command. Rocketdyne's finely instrumented test structures are located in California's Santa Susana Mountains; Neosho, Missouri, and McGregor, Texas.

Rocketdyne engines have powered most of the military and scientific projects conducted by the Air Force, Army, and NASA. Now huge boosters of one and a half million pounds of thrust are emerging from the technical heritage of Atlas, Thor, Jupiter, and Redstone.

And even while today's countdowns go on, plans for tomorrow's assault on space are being made. At Rocketdyne, engineers and scientists are investigating such advanced forms of propulsion as ion engines, nuclear engines, plasma jets, and magnetohydrodynamic engines. Meanwhile other groups are at work on high-energy liquid and solid propellants, and dramatic new devices for both liquid and solid propulsion systems.

Rocketdyne, a 12-year pioneer in rocket technology, was first with power for America's long-range ballistic missiles—first with power for Outer Space.

MEGABOOM—a giant solid propellant rocket motor produced at Rocketdyne's McGregor, Texas, solid fuel facility—delivers 100,000 pounds of thrust, boosts test sled to 1,200 mph.

FIRST WITH POWER FOR OUTER SPACE

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

Canoga Park, California; Neosho, Missouri; McGregor, Texas

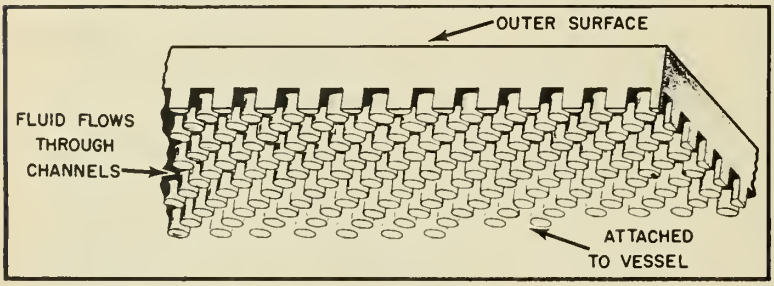
Turbulence Drag Drastically Reduced

Missile, aircraft, torpedo and submarine speeds may be advanced through 'porpoise-like' effect created by thin rubber skin on outer surfaces

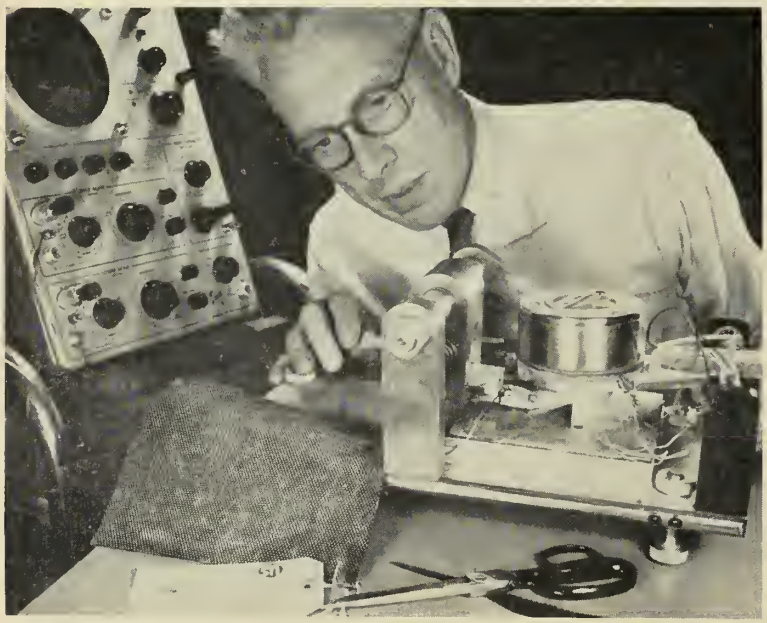
by John F. Judge

NEW YORK—First indications of a solution to the problem of propelling bodies rapidly through water have been revealed by Dr. Max O. Kramer, Vice President of Coleman-Kramer, Inc., Los Angeles.

Dr. Kramer's invention attacks the question by significantly reducing the drag effect due to the turbulence caused by the passage of an object through water. Underwater vessels actually use 70 to 90% of their propulsive energy to overcome this drag.



HOW RUBBER coating is attached to vehicle surface.



ABSORPTION OF energy in coating is measured by a U.S. Rubber research scientist investigating drag reduction in submarines.

Maximum speed in water or air is usually achieved by vehicle smoothness and shape. The new factor is the elimination of flow turbulence through the damping properties of a special coating.

The coating consists of a thin outer skin of rubber supported by a multitude of tiny rubber "pillars" attached to the surface of the vehicle. A free flowing viscous liquid is contained in the pillar area.

As the object moves through water, small disturbances next to the skin create an unstable boundary layer flow which in turn is responsible for the drag effect. When the outer skin is that of the Kramer device, it actually draws energy from the liquid flow, converts some of it to heat which is dissipated and thereby exerts a stabilizing influence on the passing water reducing the drag. Dr. Kramer says that, apparently, a significant effect is produced even if the energy removal is small.

The reason for the presence of the fluid, usually silicone oil, is primarily as a shock absorber—similar to the principle involved in the familiar automobile part. The Navy is keeping an eye on development of the system.

The scientist, a leading authority in the field of antiturbulence, explains that this is but scratching the surface. A great deal of testing and evaluation remains to be done, in both materials and theory. Theoretically, the drag can be reduced to a tenth of its present effect. Current experiments have been able to reduce the effect by 50% on underwater measuring devices.

• **Dolphins studied**—The coating, officially termed "boundary layer stabilization by distributed damping," is the result of many years of work. The last link was supplied by an examination of the skin of a porpoise. Biologists have pointed out that the tremendous

speed of this fish could not be due to any muscular or internal source but rather to some boundary flow effect. Engineers have denied this.

Dr. Kramer's investigation of the skin supported the biologists' view and supplied him with the concept of the smooth outer surface. The incorporation of this element into the system led to the finalization of the damping coat after many compounds and designs were tried. Realizing that rubber would play a large part in the development of his invention, Dr. Kramer joined forces with the scientists of U.S. Rubber's Research Center at Wayne, N.J. early in 1957.

Although the greatest potential of Lamiflo, the trademark name for the coating, lies in underwater use, U.S. Rubber expects to market it commercially for surface pleasure craft.

The inventor, who designed the German remote controlled dive bomber, Fritz 10—two of which sank the Italian flagship "Roma" in twenty minutes in 1943, explained that the configuration of the coated vehicle is extremely important. A World War II torpedo would not gain any advantage from Lamiflo because of its shape—blunt nose, long, straight cylindrical body and short, sharply tapering tail.

The ideal configuration is basically that of a fish—long a familiar shape in the air age. If applied to underwater missiles considerations of cleanliness and delicacy would be necessarily added to the problems of handling. And the application would vary from case to case since the coating would have to be designed to fit the particular factors present. Dr. Kramer feels that a drastic change in design would have to be made to take full advantage of his work. Submarine speeds up to 70 mph with current power plants would be possible with the development of a successful "skin."

Research is continuing in all areas, including possible application to rockets and planes in flight and to liquids flowing through pipes.

STREAMLINED TEST device is placed in water. Coating developed by U.S. Rubber has brought about 50% reduction in drag underwater.

UN Meeting on Space Sciences Seen

COSPAR may assist in its organization. Four hundred attend Nice meeting with U.S. scientists presenting bulk of technical papers

by Anthony Vandyk

NICE, FRANCE—A United Nations meeting on space science may be organized next fall or winter with the assistance of COSPAR, the Committee on Space Research established by the International Council of Scientific Unions. The prospect of such a meeting was the main subject of informal discussion among delegates to the COSPAR-organized First International Space Science Symposium here. Some 400 delegates from all of the world's astronautically active countries participated in the five-day symposium.

Prior to the symposium the following members of the COSPAR bureau were elected:

H. C. van de Hulst, Netherlands, representing the International Astronomical Union, president; A. Blagonravov, Soviet Union, representing the Academy of Sciences of the Soviet Union, vice-president; R. W. Porter, U.S., representing U.S. National Academy of Sciences, vice-president; and E. Bucara, Czechoslovakia, representing Czechoslovakian Academy of Sciences; H. Massey, United Kingdom, representing Royal Society; M. Roy, France, representing the International Union of Theoretical and Applied Mechanics; W. Zonn, Poland, representing Polish Academy of Sciences.

Nations whose national scientific institutions are now represented in COSPAR include: Argentina, Australia, Belgium, Canada, Czechoslovakia, France, West Germany, Italy, India, Japan, Netherlands, Norway, Poland, South Africa, United Kingdom, United States, Union of Soviet Socialist Republics and Nationalist China.

While the largest national group was comprised U.S. scientists and the majority of important papers were delivered by Americans, participation by other nations was considerable. The presence of Russia's Professor Blagonravov succeeded in getting world press publicity for the meeting which would otherwise not have been achieved. Most of the delegates were from universities and government research establishments. Only a handful of industry representatives were on hand.

The majority of the papers were of a purely scientific nature and the sessions were devoid of the thinly-veiled company propaganda which scientific papers at some meetings represent. The physical arrangements for making available reprints and abstracts to delegates were good. In the meeting halls some delegates were in-

convenienced by the lack of translation facilities, but nearly all knew sufficient English to obtain clarification on points they had not understood.

These papers were read to the symposium: "Pictures of the Earth from High Altitudes and Their Meteorological Significance," H. Wexler; "Recent Extensions to Meteorological Measurements to Rocket Altitudes," L. M. Jones; "Density and Heat Conduction in the Thermosphere," M. Nicolet; "Method for Determining the Change in Satellite Orbits Due to Air Drag," D. G. King-Hele.

"Results of IGY Atmospheric Density Measurements above Fort Churchill," H. E. LaGow, R. Horowitz and J. Ainsworth; "Temperature and Winds in the Mesosphere Over the Arctic and Equatorial Regions," J. W. Townsend and E. B. Meadows; "Polarimetric Measurements of the Zenith Brightness from High Altitudes," A. Hata and K. Saito.

"Wind and Temperature Results Obtained in *Skylark* Experiments," G. V. Groves; "Measurements and Control of Rocket Attitudes," J. J. Gait; "Winds and Diffusion Rates in the Atmosphere from 80 to 230 km," by E. R. Manring; "Essai de determination de la temperature de la haute atmosphere," J. Blamont; "Measurement on OH and Na in the Upper Atmosphere," R. F. Chinnick; "L'etude spectroscopique du sodium projete dans la haute atmosphere a l'aide de fusees," A. Vassy; "Sodium Seeding by Rockets," J. A. Rees; "Utilisation d'un missile experimenta pour l'evaluation des concentrations en aerosols radioactifs artificiels en haute altitude," M. Labeyrie and M. Le Boiteux.

"Deviations angulaires theoriques dues a l'ionosphere pour des frequences de 20, 40, 108 MHz," H. Carru, R. Gendrin and M. Reyssat; "Determination of Electron Content by the Observation of Faraday Fading," W. T. Blackband; "Results from the First Combined Retarding Potential Analysis of Photo Electrons and Environmental Charged Particles Up to 234 km," H. Hinteregger; "Some Effects of the Ionosphere on Signals from Earth Satellites," W. C. Bain and E. Golton; "Two High Altitude Rocket Experiments," J. H. Chapman; "Ionospheric Electron Content Distribution Determined from Satellite Observations," O. K. Garriot; "A Determination of the Physical Properties of the Ionosphere Through the Phenomena of the Self-Demodulation of Radio Waves," M. Cutolo.

"The Use of Polarization Fading of Satellite Signals to Study the Electron Content and Irregularities in the Ionosphere," R. S. Lawrence and C. G. Little; "Ionospheric Measurements Using Environmental Sampling Techniques," R. E. Bourdeau, J. E. Jackson, J. A. Kane and G. P. Serbu; "Probe Method for the Measurement of Ion Density of the Ionosphere," T. Ichimiya, K. Takayama and T. Aono; "Ionospheric Positive Ions," C. Y. Jonhson and J. Holmes; "Enhanced Ionization in the Polar Ionosphere and Solar Corpuscular Emissions," T. Obayashi and Y. Hakura; "Some Properties of Shock Phenomena in Magnetofluid Dynamics," L. Napolitano.

"Origin and Nature of the Geomagnetically Trapped Radiation," J. A. van Allen; "Geophysical Evidence Bearing on Orbital Variation of Satellites and on the Radiation Belts," J. Bartels; "Physical State of Outer Atmosphere and Origin of Radiation Belts," T. Obayshi; "Physical Properties in the Outer van Allen Belt and Their Relation to the Phenomena in the Exosphere," Y. Inoue; "Electric Field Modulation of Cosmic Rays," A. Ehmert; "Some Problems of Geomagnetically Trapped Radiation," F. S. Singer.

"The Ultraviolet Spectrum of the Sun," R. Tousey, J. D. Purcell and D. M. Packer; "Profile of Solar Lyman-Alpha," R. Tousey and J. D. Purcell; "Photographing the Sun in Lyman-Alpha," J. D. Purcell, D. M. Packer and R. Tousey; "Ultraviolet Radiation in the Night Sky," T. A. Chubb and E. T. Byram; X-ray Radiation of the Sun," C. de Jeger; X-ray Emission Accompany Solar Flares," H. Friedman, T. A. Chubb and R. W. Kreplin; "Telemetering Monochrometer Measurements of Solar 304A Radiation and its Attenuation in the Upper Atmosphere," L Heroux, H. Hinteregger, K. R. Gamon and L. A. Hall; "Solar UV Spectroscopy and Applications to Problems of the Upper Atmosphere and the Solar Corona," W. A. Rense; "Correlation Between Fluctuations of Cosmic Radiation and Satellite Drag Data," E. G. Houtermans; "Certains aspects de l'activite solaries lies a la production derayons cosmiques par le soleil," J. F. Denisse; "Direct Measurements of Particle Fluxes in and Near Auroras," L. H. Meredith, L. R. Davis and O. E. Berg; "Direct Measurement of Protons and Electrons in Visible Aurorae," C. E. McIllwain; "Solar Flares with Type IV Radioburst and Transient Phenomena of Cosmic Rays," A. M. Conforto; "The Telluric Hydrogen Corona and Some of Its Consequences," F. S. Johnson; "The Solar Wind," J. A. Herring and A. L. Licht.

"Lines of Evidence Regarding the Composition of the Moon," H. Urey; "Some Current Problems of Lunar Topography," Z. Kopal; "Exobiology—a New Experimental Science," J. Lederberg; "Discussion Remarks on Contamination of Planets," M. Florkin; "Resultats d'observations indiquant la vie sur la planete Mars," A. Dollfus; "An Infra-red Mars Probe Experiment for Gathering Evidence of Extra-Terrestrial Life," R. W. Davies and M. Gumpel; "Extra-Terrestrial Life—Some Organic Constituents of Meteorites and Their Significance for Possible Extra-Terrestrial Biological Evolution," M. Calvin and S. K. Vaughn; "Experimental Problems in Space Biology," O. H. Schmitt.

"Micrometeorites," G. Best; Recent Direct Measurements of Cosmic Dust in the Vicinity of the Earth Using Satellites," H. E. La Gow and W. M. Alexander; "IGY Micro-Meteorite Measurements," M. Dubin; "The Density and Mass Distribution of Meteoritic Bodies in the Neighborhood of the Earth's Orbit," H. S. Brown; "Intensity of Cosmic Radiation in Space at Present and in the Past from Isotopic Data from Meteorites," J. Geiss and H. Oeschger; "The Origin of Tektites," J. A. O'Keefe.

"Upper Atmosphere Wind Measurement in the Antarctic," W. G. Elford and E. L. Murray; "Upper Atmosphere Structure Parameters According to Investigation Data Obtained on Rockets and Satellites in the USSR during IGY," S. M. Poloskov; "Calcul de la vitesse d'un engin ballistique en fin de course active," R. Genty; "Cosmic Ray Measurements in Australia," J. J. Quenby; "Cosmic Rays and Interplanetary Magnetic Field," J. J. Quenby; "Terrestrial Corpuscular Radiation and Cosmic Rays," S. N. Vernov and A. E. Chudakov; "Radiation Measurements during the Flight of the Second Soviet Space Rocket," S. N. Vernov, A. E. Chudakov, P. V. Vakneov, Y. I. Logachev and A. G. Mikolayev; "Cosmic Ray Investigation by the Second Cosmic Rocket Landed on the Moon," L. V. Kurnosova, V. I. Logachev, L. A. Rasorenov and M. I. Fradkin; "Measuring the Magnetic Fields of the Earth and Moon by Means of *Sputnik III* and Space Rockets I and II," S. S. Dolginov, E. G. Eroshenko, L. N. Zhuzgov, N. V. Pushkov and L. O. Tyurmina; "Photographs of the Reverse Side of the Moon," by A. A. Biaganravov; "On Corpuscular Radiation of the Outer Atmosphere," V. I. Krassovsky; "X-ray Measurements at 40 km Height in the Auroral Zone," K. Anderson; "Cosmic Rays Emitted by the Sun," A. N. Charakhchiab, V. F. Tulinov, and T. N. Charakhchian; "Results of Research of Meteoric Dust with the Help of *Sputnik III* and Cosmic Rockets," M. Nazarova.

7600-lb. More Payload Possible With Big Solid

A solid propellant-boosted three stage vehicle weighing one million pounds can place 7,600 more pounds of payload into a 300 mile orbit than a comparable liquid vehicle.

Giulio C. Panelli of Lockheed Aircraft Corp. told the annual meeting of the Institute of Aeronautical Sciences in New York that the solid vehicle can be built at the present time with no further advances in technology.

The scientist offered several practical vehicle designs but said that further economic and logistic analysis is required for a specific choice.

In another session of the space oriented meeting, W. H. Bostick announced the construction of the world's smallest electric rocket motor.

The high speed-pulsed plasma motor has an efficiency of 41%, an average speed of about 6 miles per second and is practical enough to be used in the altitude and position correction of satellites.

The scientist from Stevens Institute of Technology said the propellant speed of the motor can be adusted to higher values when the necessity demands.

The motor has an instantaneous thrust of 130 lbs. and with 100 pulses per second it will produce an average thrust of 0.04 lbs. This would give a 400 lb. satellite an acceleration of 0.0001 G's.

Bostick explained that this advance placed plasma propulsion in a better competitive position, with the ion rocket than was previously believed.

Project *Mercury* was the subject of a single evening session under Chairman Abe Silverstein, NASA Space Flight Development Director.

NASA scientists explained the workings of the capsule, reported on the *Mercury* research and development program and reviewed the operational plans for the orbital mission.

John F. Clark of NASA, in a session devoted to satellites, said that future experiments will emphasize earth-sun relationships in atmospheric, ionospheric, and energetic particle physics.

The role of the satellite in space was thoroughly explored by Fred L. Wipple of Harvard University.

Other papers included a study on the feasibility of thermally protecting cryogenic propellants on round trips to Mars and Venus. Arrangements of vehicle components, multiple reflective foils and insulation, and vehicle orientation were some of the methods suggested by G. R. Smolak and R. H. Knoll of NASA.

The problems and motivations involved in a manned lunar mission were explained by D. E. Serrill and H. J. McClellan of the Boeing Airplane Company. The propulsion requirements stressed were large, high energy boosters, throttleable landing engines and high reliability. The scientists pointed out that a good start has already been made in each of these fields.

Rear Adm. Paul D. Stroop, chief of the newly organized Bureau of Naval Weapons, spoke on the functioning of that organization. He told his luncheon audience that there were to be no drastic changes in the new bureau but there would be an emphasis on improved coordination. The bureau chief said that there would also be an increased level of effort at the various naval ordnance laboratories.

President Backs New 'Gap' Estimate

by William E. Howard

New U.S. intelligence evaluations minimizing the Soviet missile threat have spun Washington into a major political battle.

President Eisenhower lunged into the controversy in support of the new estimates of Russian strength—based suddenly on "intentions" as well as capability—only to be met by a stinging backhand from congressional Democrats.

Sen. Stuart Symington (D-Mo.) charged the Administration had deliberately "juggled" the estimates to help balance the FY 1961 budget. Symington and Sen. Richard B. Russell (D-Ga.), Chairman of the Senate Armed Services Committee, both declared that despite what the Administration said, a Missile Gap still exists.

Contending that Russia now holds a greater than 3 to 1 lead over the U.S. in missiles of all types, Symington said that "the Administration is apparently going to permit this gap to increase." He said this is true "even when one uses the smaller Soviet figures derived from their intent instead of capability."

Conceding that the dispute had political overtones, Russell said "it will be discussed in the campaigns and the people will decide. I hope no one will deal with it in terms of political gain."

The President entered the fight at his news conference Jan. 26, contending that there had been "misinterpretation" of the statement on the new intelligence appraisal given to Congress by Defense Secretary Gates—the statement which touched off the running debate.

The President did not mention the 3 to 1 estimate of Soviet missile superiority given by defense officials last year. Nor did he say if a Missile Gap exists today. Instead, he recalled that "subsequent intelligence" had shown that an "outcry" over an "alleged" Soviet bomber superiority three or four years ago had been wrong. He noted that the dispute resulted in Congress' adding $900 million to his budget for bomber appropriations.

• **Boiled-down position**—Although far from clear, Administration assessment of Soviet strength last week appeared to boil down to this: Any number of Soviet IRBM's and ICBM's by 1962 will be offset by the overall deterrent power of U.S. bombers and missiles.

Allen W. Dulles, Central Intelligence Director, told the Institute of Aeronautical Sciences in New York that the Russians are trying to exploit their missile and space successes with propaganda to make "the unsophisticated" believe they have an overall military superiority. He said such superiority "does not exist."

Claiming that CIA agents know a great deal more about Kremlin military plans than is made public, Dulles said his agency has not downgraded its estimate of Soviet missile capabilities. But he said it was wrong to let Russian leaders talk the world into believing ICBM's are the only weapons that count.

Answering criticism, directed at Gates, that the U.S. was now guessing Russian intentions, Dulles said his agency tries to determine how the Soviets intend to use a weapon once they have developed it. He added that the fact that "in later years of development we can crank into our estimates more of the elements of programming and future intentions than we can at the beginning, does not indicate any change in the intelligence approach to the problem."

At one point it appeared the battle would center over Senate confirmation of Gates, who had been serving under a recess appointment since the resignation of Neil McElroy as Defense Secretary. However, opposition to his appointment was suddenly withdrawn the same day as the President's news conference and the Senate confirmed him without debate or reference to the dispute.

NASA Contracting Methods Are Criticized

• **Does** NASA tell Congress and the U.S. General Accounting Office enough about its contract negotiations so that a proper review can be made?

This controversy raged before the House Space Committee last week.

Touching it off was NASA's recent refusal to give the Committee and GAO certain documents relating to negotiations which resulted in award of the *Nova* engine contract to Rocketdyne and the *Mercury* capsule contract to McDonnell.

The controversy ended in a stalemate, with the Committee emphasizing that the space agency was required by law to submit such contract documents to GAO, and NASA maintaining that it does not have to give up the documents under the Constitutional Authority of executive privilege—and that the Committee and GAO don't need this information anyway.

Both the Committee and GAO emphasized that they had no reason to believe there were any improper actions either by NASA Administrator T. Keith Glennan or the companies involved, but that it was necessary for Congress and its accounting arm to have this information to do their jogs properly.

Principal charges made by the Committee and GAO were:

• NASA had refused to give them certain documents pertinent to selection of the Rocketdyne and McDonnell proposals—notably the reports of the Chairman of the Source Selection Board;

• Access to these documents is essential to proper review of these contracts, and GAO has legislative authority to demand them;

• NASA is inconsistent because the same type of information was forwarded to the Committee on the *Little Joe* booster contract.

NASA officials argued that:

• NASA doesn't have to give up these documents under the authority of executive privilege;

• GAO and Congress do not need the reports, since the Administrator makes the contract decision, and is willing to give in full detail his reasons for doing so;

• NASA doesn't release these documents because they are the personal judgment of NASA subordinates in preparing recommendations for the Administrator;

• If such information were released, it might make NASA employes tend to soften criticism and in general offer a more restrained opinion.

Major reason for the present deadlock is that there are no court decisions testing the effectiveness of GAO's legislative authority or NASA's Constitutional executive privilege.

Rep. B. F. Sisk (D-Calif.) told Glennan that before the Committee authorizes NASA's $802-million budget, "we are going to have to get this thing straightened out."

GE Tells of Cheap Plug Nozzle Engine

General Electric Co. this week reported its long-secret plug nozzle engine is particularly suited to quick, cheap development to many million pounds of thrust.

The company disclosed details of the radical engine desigend (mentioned in M/R almost a year ago), which completely does away with the conventional inverted-cone liquid rocket thrust chamber.

In the new design, propellants would be ignited in a ring of small, segmented chambers around the outside base of a large conical spike or plug. Unlike clustered rocket designs now under development, combustion cells would be designed specifically to be integrated into a single power package.

A large portion of the gas expansion would occur outside the thrust chambers, following the contour of the plug, GE said. Since these supersonic gases would be self-adjusting as surrounding air became increasingly rarified during rocket ascent, the configuration would be more efficient at lower altitude than a conventional clustered engine, such as *Saturn*. This is the basis for the GE claim that the plug nozzle is particularly suited to use as a booster.

Developing a plug nozzle engine takes less time and is much cheaper than a conventional single-chamber engine because the single segment can be developed at low cost and then meshed together. Testing can be done on the single sections. It is cheaper than a six-engine or eight-engine chamber if the plug has more than that number of openings.

GE also says the plug nozzle design should also make possible significant space and weight savings over a conventional cluster, which would increase payload capacity. This results from the use of tankage, pumps, gimbal controls and other supporting hardware jointly, rather than separate hardware for each chamber.

Louis Michelson, manager of GE's rocket engine section at Evendale, Ohio, said extensive company-funded investigation of the plug nozzle concept has been under way for some time. The concept is also being explored further under a $400,000 contract awarded last July by the National Aeronautics and Space Administration.

The engine can be adapted to a wide variety of rocket requirements with a "substantial reduction in long and costly development required to build new propulsion systems," Michelson said. On completion of hasic engine development, the design can be readily and inexpensively scaled to virtually unlimited multi-million-pound-thrust levels, he added.

So far in America's rocket programs, he noted, propulsion system designers have encountered combustion phenomena and other problems that have largely defied logical scaling from small to larger units of the same design. Thus all meaningful testing has been conducted with experimental units of final thrust size.

——more about the missile week——

• **Washington**—NASA Administrator T. Keith Glennan told Congress the space lag between the U.S. and Russia is "four to five years." Other points made before the House Space Committee included: *Saturn* will get more money in a supplemental budget, and the development of its booster will be speeded by one year; Project *Mercury's* manned orbital flight should take place in 1961; and the ill-fated *Atlas-Able* moon orbiting payload will be attempted again in April.

• **Washington**—President Eisenhower said this company had an "admirable" record in the exploration of space and Americans had no reason to bow their heads in shame.

This was countered by Sen. Symington. (D-Mo), who said the Russians were "three to five years" ahead in space and the margin promises "to get worse instead of better." He also called it "perfectly ridiculous to say, as President Eisenhower has said, that the conquest of space has no military significance."

• **Washington**—Gen. Thomas D. White, Air Force Chief of Staff, told Congress that in spite of the growing missile threat, "the Soviet Air Force is the USSR's most dangerous weapon." This was seconded by Air Force Secretary Dudley C. Sharp, who said "the prime threat to our security is Soviet ability to attack us by manned bombers now, aircraft and ballistic missiles in the near future, and aircraft, missiles and orbital vehicles in the more distant future."

• **Portland, Ore.**—Defense Secretary Gates revealed some missiles of the first combat *Atlas* squadron at Warren AFB, Cheyenne, Wyo., will become battle-ready in April. He said the *Titan* ICBM will be operational in the summer of 1961.

• **Cape Canaveral**—A malfunction in the first-stage engine a split-second after ignition washed out a third attempt to launch a *Titan* and fire its second stage. The missile was saved when the engines cut off automatically. The failure Jan. 27 came less than 12 hours after successful *Atlas* shots here and at Vandenberg AFB. A *Jupiter* IRBM was successfully tested Jan. 25 at the Cape.

• **Edwards AFB, Calif.**—With a fifth shot of a *Minuteman* mockup prototype from its underground launcher, the Air Force announced that the basic configuration of the silo had been determined. Thus, the way is open for preliminary design of *Minuteman* bases. The shot Jan. 27 sent the missile 2000 ft. into the air where it was arrested by a nylon tether.

• **Washington**—A scientific advisory committee of the Democratic Party called for high priority development of weapons that can knock hostile military satellites out of the heavens. The group also said thre should be an immediate re-orientation of the entire U.S. space program to emphasize projects of immediate military and scientific benefit.

• **Washington**—The U.S. and Britain have agreed to launch cooperatively from Wallops Island, Va., a *Scout* rocket containing a scientific satellite. The experiment next year will measure electron temperatures and concentration, the ion mass spectrum, electron density, solar radiation and primary cosmic rays.

missile business . . .

By WILLIAM E. HOWARD

Choose a subcontractor like a wife—carefully.

Get allowable costs written down in detail at the front end of a missile contract, not the back end. It can save you money.

Spares and repair parts are extremely critical. If you can't support your product in the field—you haven't got a product.

These blunt nuggets of advice were passed out by an industry expert on DOD procurement the other week to a group of businessmen—all concerned with furthering their own company interests by learning more about the highly complicated art of defense contracting. The occasion of this rather unusual gathering (for many of those present were actual or potential competitors) was the first working session of the newly-organized Government Contract Management Association of America Inc., 425 Park Ave., New York City.

GCMA is an interesting experiment based . . .
upon the principle that industry—and the nation—will be better off if the people in industry all understand the basic facts of life about the management and administration of government contracts. Far from being a swap-shop for trade secrets, GCMA is viewed by its founders as a unique method for unraveling the complexities wound around any DOD contract. For the problems are tackled through a "mutual interchange" of experience and knowledge.

Thirty-five companies are represented in this non-profit association. And William F. Hurley, advertising director of American Machine & Foundry's defense products group and public relations man for GCMA, says the idea is catching on. Numerous requests for permission to open chapters have come in from the West Coast, Midwest and the South, according to Hurley. GCMA now plans to assimilate these chapters on a charter basis.

The first GCMA "short course" offered in . . .
a two-day seminar probed in depth into government procurement regulations, selection of sources, preparation of bids, analysis of bids, vendor proposals, methods and objectives of negotiation, definitization of contracts and approvals, budget control and financial monitoring and monitoring the contract. Future seminars will go into contract termination, pricing of contracts, negotiation techniques.

True to company predictions last year . . .
Douglas Aircraft Co. wound up FY 1959 on Nov. 30 with a loss. The amount: $33.8 million. This compares to a net profit of $16.8 million for the previous year. Sales of $863.8 million were also down from the $1.2 billion of a year ago. The company attributes the loss to charge-offs of $87.8 million in its DC-8 program. On the cheerier side, Douglas expects sales this year to climb over $1 billion.

Bendix Aviation Corp. is upgrading its *Talos* . . .
manufacturing facility at Mishawaka, Ind., to divisional status in step with "its greatly expanded activities and growing importance in the corporate structure." Formerly the facility was operated as part of the Bendix Products Division at South Bend. At the same time, the company named Arthur C. Omberg, Mishawaka general manager, assistant group executive to supervise the new division and Bendix's Hamilton, Ohio, division.

Also creating a new division is ACF Industries . . .
The company has merged its Avion and Nuclear Products-Erco Divisions into a new ACF Electronics Division. The move is expected to strengthen the company in the missile electronic field.

Latest U.S. firm to make a tie-up abroad . . .
is Magnavox, with the purchase of controlling interest in the Collaro Co.—an electronics manufacturer—from Great Universal Stores Ltd. The move is preparatory to organizing a British subsidiary, to be called Magnavox Electronics, Ltd., for development and sale of the company's products throughout Europe.

—letters—

No Problem

To the Editor:

My company, Major Tool & Machine, has subscribed to your book for some time and we are much impressed with the coverage you display on the Missiles and Rockets industry.

With this in mind, I thought I would contact you inquiring as to whether you have available a chart or information indicating Missile and Rocket prime contractors and that also might include the major subcontractors for each prime.

Jack Briere
Director of Sales
Major Tool & Machine, Inc.
1717 North Cornell Ave.
Indianapolis, Ind.

A copy of our Astrolog is in the mail.—Ed.

Microwave Hazards

To the Editor:

In reference to "Microwave 'Hazards' are Exaggerated" (M/R Dec. 14) you are right that Microwave hazards have been exaggerated in some news reports, but the material included in your article under the heading of Research at Participating Universities is evidence enough to make thoughtful people cautious.

The results of the investigation by Dr. Deichmann at Miami at 24,000 mc (1.25 cm wavelength) requires a re-evaluation of the conclusion that frequencies above 3000 mc. cause surface heating only. As Dr. Ely said while addressing the 12th Annual Conference on Electrical Techniques in Medicine and Biology, Nov. 11, 1959, "These effects are not as simple as these curves indicate. It gets me, those rats died."

Dr. Deichmann reported that post mortems revealed the same types of damage to the internal organs and veins of all the rats.

To me, this indicates a need to investigate further, considering the fact that although blood in a vein may be a poor dielectric waveguide by communication standards, it still may be a waveguide capable of delivering a lethal does of r.f. energy to an internal organ before it fails.

Many have drawn the conclusion that heating is the only effect of microwaves, but I predict that the acceptance of this conclusion will decrease. Dr. Carpenter's work at Tufts is strong evidence that there are non-thermal effects and that they appear to be cumulative. Further evidence may be expected because more investigators are considering such effects as probable and will be more likely to recognize them when they occur.

I will appreciate it if you will point out to the "many who feel that sufficient money has been spent in research" that results are just beginning to be reported from work done at a few spot frequencies and there is evidence that frequency may be an important variable, also. In addi-

tion, the biological work using pulsed sources has just started. It should be considered that therapeutic as well as harmful effects may be discovered if research is encouraged.

It will be found that even the measuring of r.f. field strength at the exposure level is not as simple as many have assumed. Our experience indicated that there is significant room for development work on the basic design of r.f. field strength indicators, particularly in applications where the whole equipment is subjected to the r.f. field or otherwise placed under severe overloads.

As one works on instruments to measure their fields, he gets a healthy respect for them.

Harry R. Meahl
High Frequency Measurements Engineer
General Engineering Laboratory
General Electric Company
Schenectady 5, N.Y.

Missiles and Morale

To the Editor:

The countdown proceeds—Ten, Nine, Eight . . . *Zero.* Zero is the crucial moment; a few moments later it is even a more crucial moment.

To begin with, if a million dollars worth of rocketry even lifts off the launch pad there is some jubilation among the scientists, engineers and technicians who willingly sweated through long and tedious hours to perfect the launching. I speak of R&D programs, of course, because after the missile package is perfected to the point of being operational the tension is relieved. Previous successful tests will naturally tend to build such confidence among missile men.

And how does human morale enter into the picture? As an individual . . . among those who have lost track of how many hours make up a day, who find that food is something you obtain from a "Roach Coach," that reading material is something contained in a test procedure, and that a wife and children are something very dear—at home, which seems to be in another world—may I say that the morale of the test crew is the key to any successful test . . .

How many of us have seen a top test team wrecked only because someone of the administrative type made some screwball changes without knowing the facts. It takes an expert psychologist . . . with some good knowledge of the missile business . . . to run the show. Politics have to go out the window in choosing personnel for testing and firing a missile. Missile men absolutely hate politics for cramping their work . . . they were chosen for their particular job because of their knowledge . . . to have to stand by and see their efforts wrecked and a good team scattered to the winds at the whim of some half-cracked ambitious individual is the end itself . . .

Elmer J. Gabel
Resident Engineer
Martin Co., Vandenberg AFB
Assoc. Mem. AIEE

contracts

NASA

$29,701—The R. Hansen Co., Cleveland, for alterations to the altitude wind tunnel test rig area at Lewis Research Center.

MISCELLANEOUS

Cross-Malaker Laboratories, Inc., Mountainside, N.J., for development of classified equipment for advanced missiles. Amount not disclosed.

Texas Instruments, Inc., Dallas, for development and production of 24 telemetry systems for the *Centaur.* (Two contracts, amount not disclosed.) Subcontracts from **Convair Astronautics.**

$741,000—Servomechanisms, Inc., Hawthorne, Calif., for production of air data computer test sets. Subcontract from **Hughes Aircraft Co.**

NAVY

$4,500,000—Texas Instruments, Inc., Hawthorne, Calif., for production of the apparatus division of an advanced antisubmarine warfare system.

$121,167—Bogue Electric Mfg. Co., Paterson, N.J., for power supplies, metallic rectifiers input and output with different volts, phases, cycles and watts.

$102,422—Transdyne Corp., Albertson, N.Y., for maintenance of training aid systems.

$77,000—Hermes Electronics Co., Cambridge, Mass., for design and manufacture of two systems, consisting of comb sets of crystal filters for the *Eagle.* Subcontract from **Sanders Associates, Nashua, N.H.**

$69,954—Farrand Optical Co., Inc., New York City, for investigation, head set control of wide angle television presentation.

$68,100—Integron, Inc., Waltham, Mass., for speed resolver computer production.

$39,631—Operations Research, Inc., Silver Spring, Md., for psychological study of space flight training, biomechanics of space flight.

AIR FORCE

Aerojet-General Corp., Azusa, Calif., received a multi-million-dollar contract for production of the second-stage propulsion unit for the *Minuteman.* **Thiokol Chemical Corp.** was retained as technical backup.

Texas Instruments, Inc., Dallas, for the production of 37 telemetry systems for the *Bomarc C-2.* Amount not disclosed. Subcontract from **Boeing Airplane Co.**

$3,000,000—CompuDyne Corp., Hatboro, Pa., for operational propellant-loading systems and an alarm system equipment at four *Titan* bases.

$1,042,200—Electronic Communications, Inc., St. Petersburg, for transmitter equipment.

$351,516—Purolator Products, Inc., New York City, for filter element assemblies and replacements.

$274,999—Goodyear Aircraft Corp., Akron, Ohio, for repair and maintenance of *Mace* map synthesis equipment.

$250,000—Waste King Corp., Technical Products Div., Los Angeles, for manufacture of air data probes.

$33,000—University of California, Berkeley, for research on "Chemical Kinetics at High Temperatures."

$32,530—Yale University, New Haven, Conn., for research on "Mechanical Properties of Intermetallic Compounds."

ARMY

$7,000,000—Land-Air, Inc., Chicago, for engineering and instrumentation services at White Sands Missile Test Center.

$3,337,718—The Martin Co., Orlando, for services and materials on the Missile Master system.

$500,000—Sylvania Electric Products, Inc., Special Tube Div., Mountain View, Calif., for production of beacon magetron tubes for surveillance drones.

$390,000—Hayes Aircraft Corp., Birmingham, Ala., for engineering and design services, ground support equipment, Saturn.

$192,910—Western Electric Co., Inc., New York City, for *Nike* spare parts and components.

$161,000—Sperry Utah Engineering Labs, Salt Lake City, for repair parts for *Sergeant* system.

$134,559—Douglas Aircraft Co., Inc., Santa Monica, for *Nike* replacement spare parts.

$121,590—The Martin Co., Orlando, for replenishment spare parts and components for *Lacrosse* missile.

$120,000—Chatham Electronics Div. of Tung-Sol Electric, Inc., Newark, N.J., for electron tubes.

$117,610—Lockheed Missiles & Space Div., for basic studies of a new solar energy technique.

$109,942—Gilfillan Bros., Inc., Los Angeles, for replenishment repair parts for *Corporal* missile.

$108,500—North American Aviation, Inc., Canoga Park, Calif., for design and development of rocket engines. (Two contracts.)

$100,000—Columbia University, for analysis of radar noise in the *Nike* and related systems.

ASME-AIEE Meeting to Discuss Solar Space Power

Solar power for space vehicles will be the general subject for the Feb. 11 joint meeting of the American Society of Mechanical Engineers and American Institute of Electrical Engineers, in Washington, D.C.

T. F. Nagey, Allison Division Research Director for General Motors, will speak on solar mechanical-conversion power systems, and Niles F. Schuh will discuss solar static-conversion power systems. Schuh is Manager, Space Technology, Aircraft Equipment Department, Westinghouse Electric Corp.

The conference will be held at 8 p.m. in the Department of the Interior Auditorium. A joint ASME-AIEE dinner for members, guests and ladies is planned at the All States Dining Room, 514 19th St., N.W. at 6:30 p.m., preceding the meeting.

—when and where—

FEBRUARY

Chemical Institute of Canada, Toronto Section, Symposium on Gas Chromatography, Seaway Hotel, Toronto, Ont., Feb. 1.

Instrument Society of America, Houston Section, Instrument-Automation Conferences & Exhibit, Rice Hotel & Sam Houston Coliseum, Houston, Feb. 1-4.

Society of the Plastics Industry, Inc., Fifteenth Anuual Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Feb. 2-4.

Sixth Annual Midwest Welding Conference, sponsored hy Armour Research Foundation of Illinois Institute of Technology; Cbicago Section; American Welding Society, Illinois Tech Chemistry Bldg., Chicago, Feb. 3-4.

Institute of Radio Engineers, Professional Group on Military Electronics, 1960 Winter Convention on Military Electronics, Biltmore Hotel, Los Angeles, Feb. 3-5.

Institute of Radio Engineers, American Institute of Electrical Engineers, Seventh Annual Solid-State Circuits Conference, University of Pennsylvania, Philadelphia, Feb. 10-12.

Annual Meeting of American Institute of Mining, Metallurgical and Petroleum Engineers, Sheraton Atlantic Hotel and Statler Hilton Hotel, New York City, Feb. 14-19. **(Metallurgical Society Forum on Navy Materials Problems,** Feb. 15).

Third Annual Missile/Space Industry Conference, National Rocket Club, Sheraton Park Hotel, Wash., D.C., Feb. 16-17. **(Dr. Rohert H. Goddard Memorial Dinner,** Feb. 17).

First National Symposium on Nondestructive Testing of Aircraft and Missile Components, sponsored by Southwest Section, Society for Nondestructive Testing; Southwest Research Institute, Hilton Hotel, San Antonio, Feb. 16-18.

AIEE Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia, Feb. 18-19.

National Society of Professional Engineers Winter Meeting, Broadview Hotel, Wichita, Kan., Feb. 18-20.

Engineering Materials and Design Exhibition, Industrial and Trade Fairs, Ltd., Earls Court, London, Feb. 22-26.

National Association of Corrosion Engineers, Tulsa Section, 11th Annual Short Course, Mayo Hotel, Tulsa, Feb. 24-26.

MARCH

Navy League Seapower Symposium, Sheraton Park Hotel, Washington, D.C., Mar. 1-3.

ASME Gas Turbine Power and Hydraulic Conference, Rice Hotel, Houston, Mar. 6-9.

Heat Transfer Symposium, Mecbanical Engineering Dept., University of Florida, Gainesville, Mar. 7-8.

Society for Aircraft Material and Process Engineers' Midwest Chapter Symposium, "Processing Materials for Reentry Structures," Miami Hotel, Dayton, Ohio, Mar. 9-10.

Mechanical Properties of Engineering Ceramics, sponsored hy North Carolina State College Scbool of Engineering, and Office of Ordnance Research, U.S. Army, N.C. State College Campus, Raleigh, N.C., Mar. 9-11.

Institute of the Aeronautical Sciences, National Flight Propulsion Meeting, (Classified), Cleveland, Mar. 10-11.

Electronic Industries Association, Defense Planning Seminar, Statler Hilton Hotel, Washington, D.C., Mar. 15.

Symposium on Optical Spectrometric Measurement of High Temperatures, sponsored hy University of Chicago's Applied Science Laboratories, Jarrell-Ash Co., National Science Foundation, University of Chicago, Mar. 23-25.

American Power Conference, American Society of Mechanical Engineers, Sherman Hotel, Chicago, Mar. 29-31.

APRIL

Sixth Annual Advanced Statistical Quality Control Institute, University of Connecticut, Storrs, April 3-15.

1960 Nuclear Congress, "What Will the Future Development of Nuclear Energy Demand from Engineers?," sponsored by 28 engineering, scientific, management and technical organizations. Includes 6th Nuclear Engineering and Science Conference, 8th NICB Atomic Energy in Industry Conference, 6tb International Atomic Exposition, New York Coliseum, New York City, April 4-7.

American Cbemical Society, 137th National Meeting, Cleveland, April 5-14.

American Rocket Society, Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif., April 6-8.

Institute of Environmental Sciences, 1960 National Meeting, "Hyper-Environments—Space Frontier," Biltmore Hotel, Los Angeles, April 6-8.

ASME-SAM Management Engineering Conference, Statler-Hilton Hotel, New York City, April 7-8.

Symposium on Chemical Reactions in the Lower and Upper Atmosphere, sponsored hy Stanford Research Institute, Mark Hopkins Hotel, San Francisco, April 18-20.

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editorial . . .

Doolittle's Formula To Win Cold War

Speaking before Silver Quill dinner guests in Washington recently, Lt. Gen. James H. Doolittle gave a summary of our situation vis-à-vis the Russians—and a formula for maintaining our world leadership. One of the major items he dwelt on was the space race. The attitude of this national hero, military airman, civilian flyer and businessman seemed, to listeners, considerably at odds with that of the Administration.

He listed six fundamental factors which, he felt, must be considered if we are to deal intelligently with the Soviets:

1. There is no sound indication that they have abandoned or even altered their basic objective of world Communism and world domination.

2. Our military might has to date deterred them from quickly achieving their objective by force of arms.

3. They will continue to endeavor to advance the cause of Communism by propaganda, infiltration, subversion and, if permitted, by limited warfare.

4. Over the long haul, economic warfare may well offer the best means of achieving their objective.

5. The present Soviet "peace offensive" must be considered in the light of their desire to reduce military expenditures, strengthen their economy and improve their present low standard of living.

6. "Peaceful coexistence," to the Soviets, means the eventual imposition of Communism by means other than all-out war.

He noted a "startling fact":

"The Soviet economy is, in effect, a space economy *now* while ours is largely a consumer economy. They are concentrating on the space race as much of their scientific, technological and economic resources as they think necessary to win it.

"I'm sure they don't expect to win converts to Communism on the moon or Mars. They are using their space 'firsts' in an effort to win converts here on earth—in the Middle East, Asia, Africa, Europe and the Americas.

"The Soviets measure the value of their space ventures, regardless of any other results, primarily in terms of waging and winning the cold war."

General Doolittle, presently head of Space Technology Laboratories, quoted Walter Lippmann: "The critical weakness of our society is that our people do not have great purposes which they are united to achieve . . . the public mood is defensive, to hold on and to conserve, not to push forward and create." Then he named five ingredients which he felt were essential to achievement of a national purpose:

1. An appreciation of moral values and a commitment to live in accordance with them.

2. Support for education, a revival of scientific learning.

3. Concentration on science and technology.

4. A sound and growing economy.

5. Dedication to national security.

The fifth, national security, he described as overriding. He added:

"The problems of national security take on new dimensions in the Space Age. For one thing, deterrent power that really deters has to exist in a state of split-second readiness. It has to be safeguarded against a surprise first strike with nuclear weapons.

"The importance for the race for space comes into sharper focus when we consider the need for perfected satellites for reconnaissance, communications and early warning systems."

He noted that we "allowed Stalin a nearly uncontested eight-year head start on rocket and missile development. We could lose *all* by allowing an adversary to gain technical advantage in space weapons."

We would like to see some of the James Doolittle feel of danger, appreciation of values, sense of urgency and some of his drive communicate itself to the public, which must take a great share of the blame for our national "lack of purpose." And to the Administration, which has failed both to direct and to lead.

Clarke Newlon

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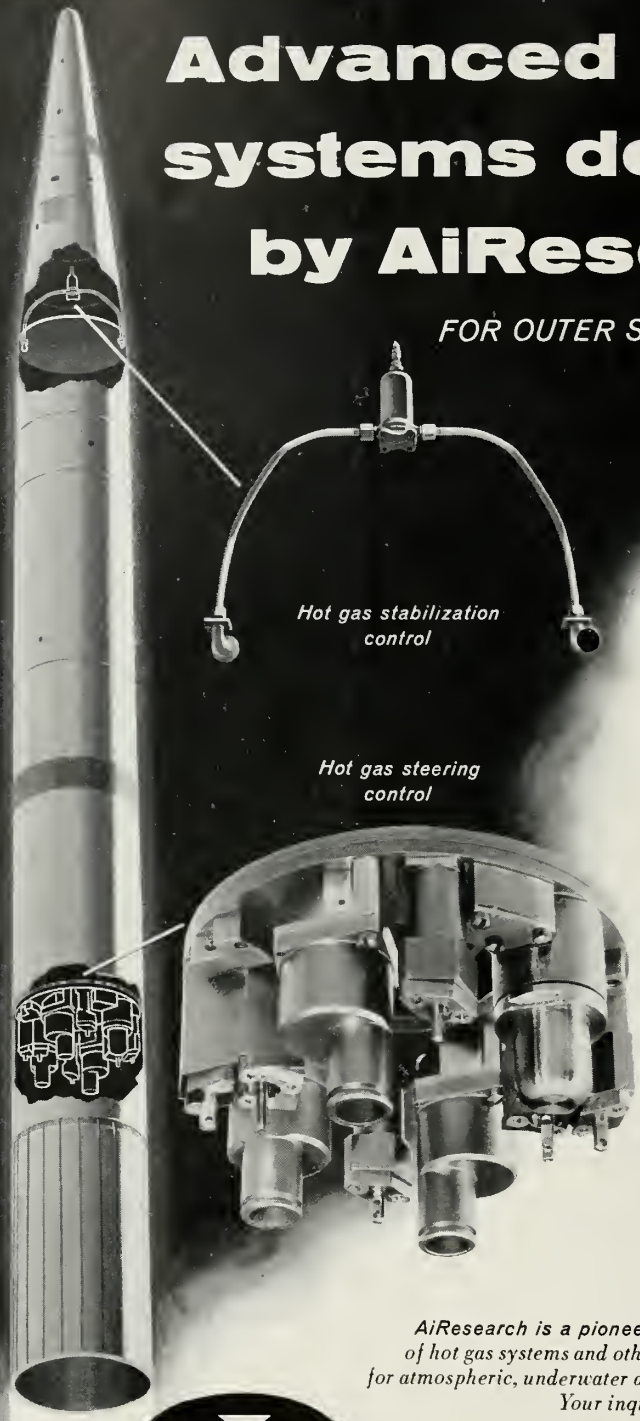

AiResearch is now in production on two greatly simplified hot gas steering control systems: a reaction control system for outer space flight stabilization and a hot gas actuator control system for terrestrial steering (in the atmosphere and under water).

Both systems eliminate any need for pumps, heat exchangers, accumulators and other apparatus required in earlier control systems. And both systems utilize hot gas, operating off either the main engine or a separate fuel source.

The gas in the outer space reaction control system is fed into a set of nozzles which imparts spin to the missile to stabilize its flight through space.

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AiResearch is a pioneer, leading developer and manufacturer of hot gas systems and other nonpropulsive power systems for atmospheric, underwater and outer space missions. Your inquiries are invited.

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