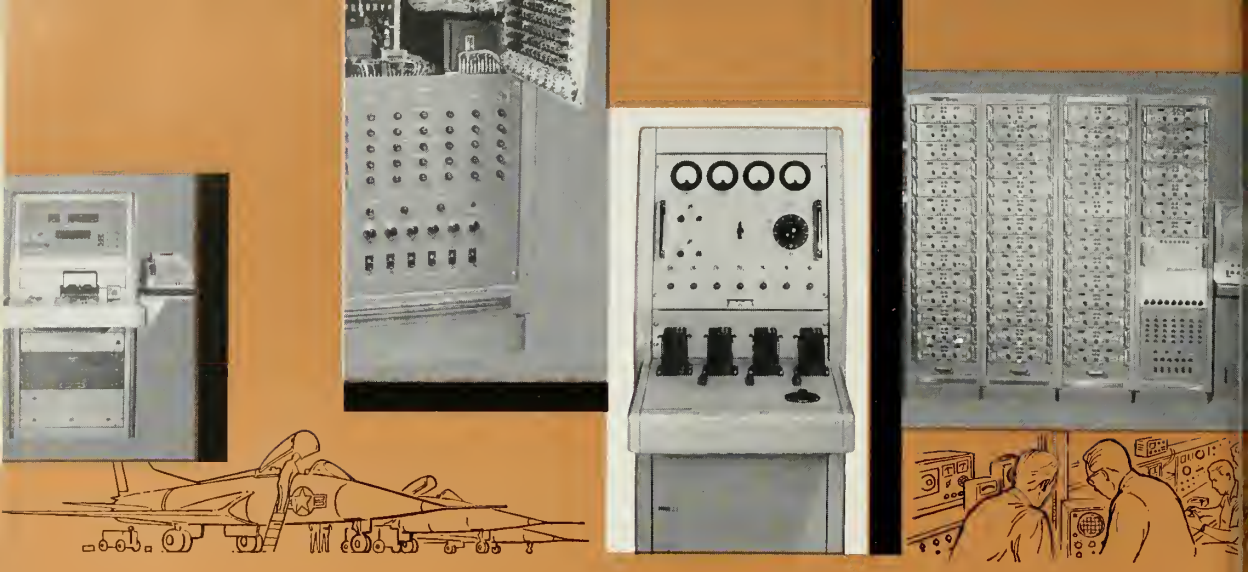
DECEMBER 14, 1959

TING ZEUS AT GRAND CENTRAL

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION



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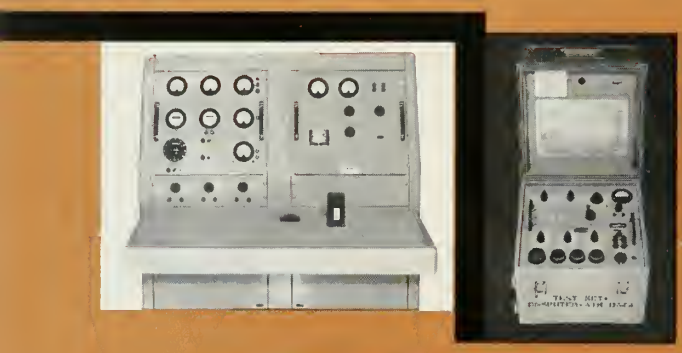

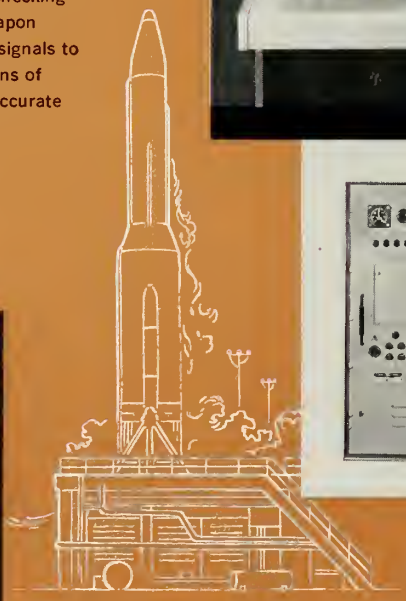

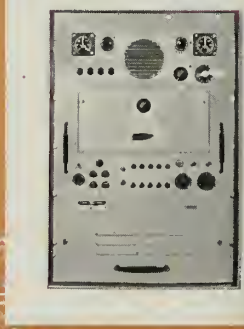

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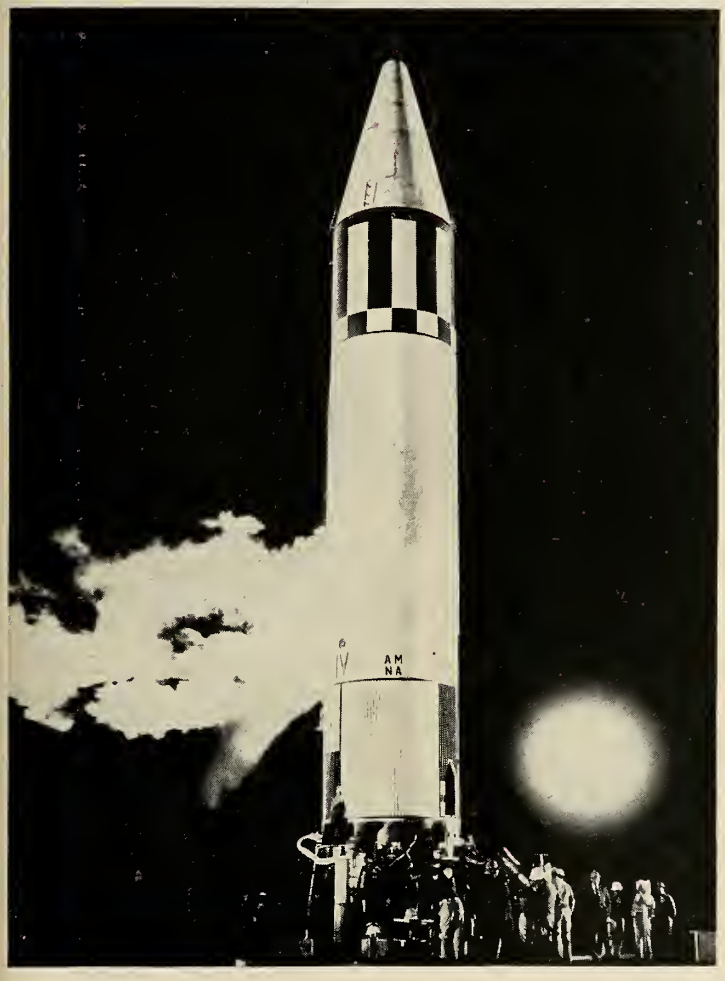
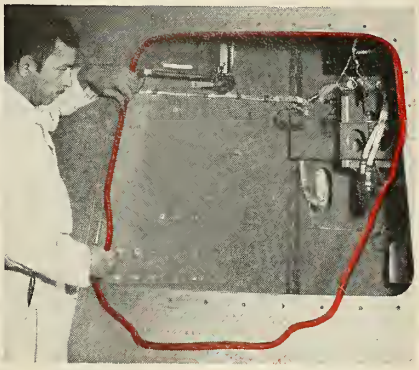
Sealing Zero...and 500 F





Silastic was specified for the Jupiter's instrument compartment access door seal. The Silastic seal has better storage properties and can better stand high skin temperatures. Wire bundle clamps in the compartment also utilize Silastic.

In the cooling system for Jupiter's instrument compartment, low pressure liquid nitrogen vapor is carried by these ducts. Made of Silastic and glass cloth, they're light in weight, and are designed to meet specs of —75 to 600 F performance.

SILASTIC SILICONE RUBBER withstands storage, cold, re-entry

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COVER: The *Nike-Zeus* sustainer unit, which has a propellant weight of probably 7000 pounds, is lowered into casting oven at Grand Central Rocket Co. The Redlands, Calif., firm has the world's largest solids mixer.

CONE SAMPLE in first shock node of jet stream during tests at The Research Institute of Temple University. For a report on the institute's study of high temperature flames, see p. 17.

LIQUID propellants for this Pratt & Whitney *XLR-115* engine, which will power the upper stages of the *Atlas-Centaur* space vehicle, are pumped with unusual system. See p. 19.

LOAD CELL calibrated by the National Bureau of Standards is used in missile test stand to measure rocket thrust. Other Bureau services to missile/space programs are described in story starting on p. 30.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

32,000 copies of this issue printed

DECEMBER 14 HEADLINES

ASTRONAUTICS ENGINEERING

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ASTRIONICS

MISSILE SUPPORT

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NEW MISSILE PRODUCTS

THE MISSILE WEEK

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Advanced degree preferred with background in one or more of the following areas: flight test analysis of reentry trajectories and/or systems evaluation; flight test analysis of trajectories and separation evaluation; theory of subsonic and hypersonic aerodynamics; underwater stability and control hydrodynamics; aerodynamic preliminary design studies; research in gas dynamics studies of thrust vector controls, stage separation, propulsion systems analysis, and rocket nozzle design; or wind tunnel studies and testing.

ANALOG COMPUTING

Advanced degree required with real time experience with analog computers. For the solution of problems in flight controls; guidance; aero and thermo dynamics; dynamic analysis and process controls.

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Ph.D. preferred, advanced degree required, with strong research background for development work in fuel cells; batteries; the direct conversion of electrochemical energy; electrode kinetics; catalysis; photochemistry; thin film; and solid state. Work concerns both military and commercial applications.

Advanced degree required, Ph.D. preferred with background in either physical-organic chemistry; inorganic chemistry; analytical chemistry; or electrochemistry for research and development work in such areas as: instrumental analytical techniques including infrared, ultraviolet and mass spectroscopy; gas solid reaction kinetics; microchemical analysis techniques; surface treatment of metals and surface reaction kinetics; molecular resistance of substances to various environments including formulation of elastomers; or reinforced plastics.

INFRARED

Advanced degree in E.E. or physics preferred but not required, with experience in infrared systems research and development, or electrical engineers with background in electronics information theory; servomechanisms; specialized circuitry, as in low-level voltage circuits, or physicists with background in optics or semi-conductors. For work in infrared physics research; advanced systems development; or physical measurements in infrared.

TELECOMMUNICATIONS

Degree in E.E. or communications with background in design of UHF, VHF and RF transmitters; telemetry systems and components; circuit design or logical design components.

LOGICAL DESIGN

Background of graduate work in E.E. or math., with interest in advanced areas of computer research in such efforts as: pattern recognition; automata studies; logical design and switching theory; information retrieval; and behavior patterns of artificial neurons patterned closely after those of the human brain.

MECHANICAL DESIGN

Advanced degree in M.E. preferred with background of mechanisms and small structures desirable. For research in experimental design and the development of a variety of research test models.

Advanced degree in M.E. preferred with experience in the design of aero and thermodynamic missile scale models including previous work in wind tunnel model design and test. Shop liaison experience desirable.

METALLURGY

Advanced degree preferred for basic and applied research in one or more of the following areas: metallurgical behavior and mechanisms concerning high temperature and advanced missile materials with interest in metal physics; deformation and fracture; phase equilibria; transformations; or diffusion. Also, to conduct basic and applied studies in refractory metals; dispersed phase systems; fiber metallurgy; ceramics and thermal protective materials systems. Also, for X-ray and electron diffraction research and studies in single crystals; point defects; parameter measurements; pole figure determinations.

MICROWAVE

Experience required in MASER amplifiers and variable reactance parametric devices, for experimental research in microwave.

ORDNANCE

Degree in E.E. required and several years' experience in developmental testing of ordnance and pyrotechnic devices, preferably in the missile field, with complete familiarity with high speed oscillography; pin techniques; pulse circuitry techniques; high speed photography; and instrumentation methods for recording pressure; shock; velocity and temperature for the development of ordnance equipment for missiles.

SOLID STATE DEVICES

Advanced degree required and Ph.D. preferred in E.E., physics or chemistry and evidence of creative, original work through published articles, patents or superior Ph.D. theses for research work in one or more of the following: thermoelectric; photovoltaic; lumistor; ferrite; logic component; sensor; thermistor; or cryogenic devices. Also, materials analysis and evaluation; processing techniques design and development of novel electronics devices and components; circuit analysis; circuit topology; or microminiaturization.

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Washington Countdown

IN THE PENTAGON

Postponement of *Nike-Zeus* . . .
production for at least one year could mean a loss of up to two years in the program. That means that the big **Western Electric** AICBM cannot be operational before 1965—after the coming Missile Gap.

• • •

The double loss . . .
for *Zeus* results from the Army's cramped R&D budget. The Army had $135 million set aside for long-lead-time *Zeus* production items. Now that money is expected to be spent on R&D missile projects and other advanced weapons.

• • •

Military missile launchings . . .
from Cape Canaveral during the second half of December are expected to include:

. . . A **Martin** *Titan-C.*
. . . A **Chrysler** *Jupiter.*
. . . Two **Lockheed** *Polarises,* one from the **Loewy-Hydropress** ship motion simulator.
. . . A **Douglas** *Thor.*
. . . A **Norair** *Snark.*

• • •

The next Air Force *Discoverer* . . .
launching is expected next month at the earliest. It's understood that no decision has yet been made on whether it will involve only another attempt at recovering a capsule from orbit . . . or possibly a more advanced experiment.

• • •

Air Force money shortages . . .
are holding up award of contracts on two big projects—the hardening of NORAD facilities and *Quickglobe.* The latter involves presentation of large amounts of data for rapid decisions during an attack.

• • •

The latest ARPA shakeup . . .
is a clear-cut victory for Pentagon R&E Chief Herbert York. The agency, which has operated on equal terms with the three military services, is now responsible to York and is headed by his former military assistant—Brig. Gen. A. W. Betts.

• • •

Project *Vela* . . .
is an ARPA program aimed at developing devices for detecting nuclear explosions. ARPA has been working on the previously-secret project for the last few months.

AT NASA

The civilian space budget . . .
for FY '61 is now pegged at about $750 million. However, some top NASA officials are secretly in hopes that Congress will override the White House-enforced budget in the face of continued Soviet space successes.

• • •

Another delay for *Scout* . . .
the so-called poor man's rocket, is in the works. Originally initial flight tests for the **Chance Vought** vehicle were scheduled for September. Then they were postponed until January. Now they're expected in March.

• • •

A big liquid hydrogen engine . . .
development program is scheduled to be started by NASA in FY '61. The new NASA budget will include initial funding for development of the clustered half-million-pound thrust-engine. Total expected eventual cost: about $100 million.

ALONG EMBASSY ROW

The third BMEWS station . . .
is expected to be built in the wild Scottish highlands. The huge RCA facility—to be operated jointly by Britain and the United States under a recently-announced agreement—will tie in with the other two ICBM early-warning stations at Clear, Alaska, and Thule, Greenland. The long-range radar net—scheduled to be operational by 1961—is designed to give a 15 to 20 minute warning of a Soviet ICBM attack.

• • •

Japanese missilemen . . .
have established Japan's first missile air defense unit outside of Tokyo. The 145-man unit is part of Japan's Ground Self-Defense Force.

AROUND TOWN

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

. . . The Democrats are having trouble on agreeing what is the best way to attack the Administration's space program.

. . . Russia is continuing to lob its ICBM's over the Japanese Islands into the Pacific.

• • •

Incidental space intelligence . . .
An enterprising merchant in Cheyenne, Wyo.—center of the nation's first complex of *Atlas* squadrons—has dubbed his business: Bart's *Atlas* Pawn Shop.


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Industry Countdown

MANUFACTURING

ICBM bases are hard hit . . .

by the strike-caused shortage of structural steel. Construction of the launch facilities for the second *Atlas* squadron at Warren AFB is being delayed now and officials say the program will be "in real trouble" if the steel strike is resumed.

• • •

Convair has edged out . . .

General Electric in the dragged-out competition to develop the Army's *Mauler* surface-to-air missile. The initial contract for the IR-guided weapon is expected to run over $10 million.

• • •

Willow is a new . . .

missile project just unveiled by the Army in the award of a $500,000 R&D contract to **Chrysler Corp.** Work on the classified program will be done at the Michigan Ordnance Missile Plant in Detroit.

• • •

Expect the DOD budget squeeze . . .

to result in a sharp cut-back in government financing of defense plants. The Air Force now is telling contractors it will invest its funds in "brick and mortar" facilities only in extreme cases. If this policy is pursued, it could exert considerable pressure upon Congress to revive the fast amortization program which expires this month.

• • •

Big recruiting drive . . .

for scientists and electronics engineers will be staged by **Boeing Airplane.** The company needs 1300 persons in these categories, largely for its *Bomarc, Minuteman* and *Dyna-Soar* programs.

PROPULSION

Insulation difficulties . . .

apparently have been overcome in the second-stage case of the *Minuteman* ICBM. The lining burned out in an early test of the case—manufactured by **General Electric**—but survived when it was successfully fired at **Thiokol-Utah** on Dec. 3.

ASTRIONICS

Reports of injury . . .

to personnel from microwave energy are being debunked by Col. George M. Knauf, tri-service coordinator for investigation into microwave energy hazards. Knauf says there are "no proven" cases to date (see page 20).

• • •

Gallium phosphide . . .

is a new metal developed by the Army Signal Corps for diodes which can withstand temperatures seven times higher than the maximum for silicon or germanium—up to 1500°F. The Army believes GP may solve the heat problem in missile nose cones.

• • •

"Clo" as a measure . . .

of clothing warmth for astronauts is suggested by a University of California associate professor—J. W. McCutchan. One "clo" would be that quantity of clothing that will maintain a comfortable heat balance for a man sitting at rest in a room with a 70°F temperature, less than 50° humidity and a 20 fpm air movement.

WE HEAR THAT—

Despite steel shortages . . .

outfitting of the *Titan* silos at Vandenberg AFB is proceeding on two shifts a day and may soon swing into three shifts . . . The Navy will soon let contracts for the conversion and instrumentation of a third Victory class ship to be used in the Pacific Missile Range . . . **Minnesota Mining & Mfg.** is building a $10 million, 14-story administration building at its St. Paul research center . . . Switching the name of its Research Department to Research Laboratories, **United Aircraft Corp.** says the East Hartford, Conn., facility will now concentrate more on fundamental research —including solid-state physics and plasmas and ionized gases . . . **Fruehauf Trailer Co.** has established an integrated missile products division in Los Angeles entirely separate from commercial production . . . In the press center of the 706th Strategic Missile Wing at Warren AFB there is a picture on the wall of an *Atlas* blasting off its pad. Under the picture someone has inscribed: "If you care enough, send the very best."

More About the Missile Week on Page 42

FABRICATION TESTS SHOW...

New Titanium alloy takes t

...in strength...in weight...in reliability...in pr

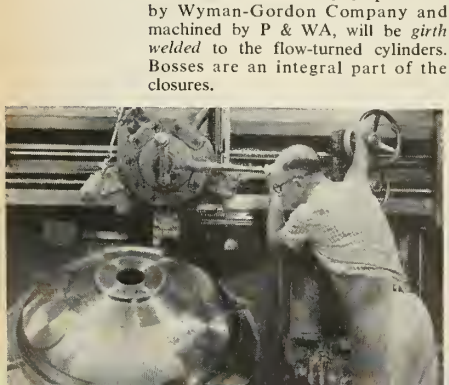
Titanium rocket-motor cases can be built at least 30 percent stronger (or tighter) than best available alternate metals; provide permanent corrosion resistance without protective coatings; withstand temperatures from −400°F to +800°F; will not absorb moisture which distorts critical parts in storage.

Completed assemblies give a spectacular two-way pay-off . . . immediately; provide a growth potentiat virtuatty unlimited.

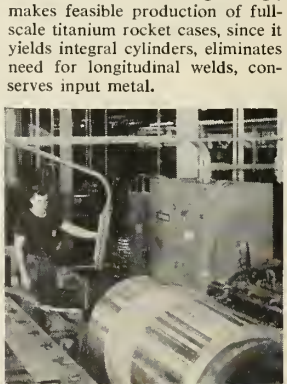
The alloy: Ti-13V-11Cr-3Al, the beta titanium alloy. Now available from Titanium Metats Corporation of America at commercial lead-times (billet, 2-3 weeks), beta may well become the metals story of the year.

Welding of titanium at P&WA is based on the company's experience in production of more than 5800 jet engines containing titanium parts. Weld strength of beta titanium alloy is considerably improved by cold working the weld.

End Closure Titanium Forgings produced by Wyman-Gordon Company and machined by P & WA, will be *girth welded* to the flow-turned cylinders. Bosses are an integral part of the closures.



Flow-turning from roll-forged rings, makes feasible production of full-scale titanium rocket cases, since it yields integral cylinders, eliminates need for longitudinal welds, conserves input metal.



Pilot rocket-motor cases manufactured b P & Whitney Aircraft from beta titaniu Ti-13V-11Cr-3Al have been consistently tested at levels in excess of 235,000 psi – strength/density ratio of 1,340,000.

So successful has been its titanium pr that Pratt & Whitney Aircraft consider production of full-scale titanium cases easily realized. Estimated initial burst stre a conservative 180,000 psi – a burst str density ratio of 1,000,000. Readily attai 1,250,000.

Reasons for optimism, spelled out by P. engineers are:

1. **"The welded beta titanium alloy is capa considerable plastic deformation prior t ture. As welding has improved, the ti origins have moved into the thin wall case itself). With beta titanium, the case but doesn't fragment.**

2. "We have successfully tested small scale ti cases with a steel equivalent yield streng beyond the 300,000 psi point. Considerin the metallurgy of metastable beta titanium is not far beyond its infancy, conservative would predict strengths substantially highe the 320,000 psi equivalent as being possible.

3. **"Beta titanium has to develop (only) 140,0 to be equivalent to 220,000 psi steel (wh almost near steel's top limits). But tita great potential above other alloys is refle the high figure for practical (based elongation) yield strength. At 180,000 titanium is equivalent to steel at 280,000 200,000 psi, beta titanium is equivalent to s 320,000 psi. 200,000 psi in beta titanium is ble, and obviously would mean substantia creased payload to the moon or out into**

4. "Apart from the strengths attainable in th titanium alloy, there is another property o siderable significance. Like other titanium it has excellent resistance to corrosion normal atmospheric conditions, in salt wa well as in many other media.

"In considering the long time storage pro with rocket cases — a pit in a thin-walled can be catastrophic — we would regard th titanium alloy, as the outstanding ma under consideration."

ead in rocket case construction

PRATT & WHITNEY AIRCRAFT SURVEY OF ROCKET CASE MATERIALS

GENERAL PROGRAM

The goal: "A material capable of reaching 300,000 psi yield strength in steel, with a considerable development margin."

The result: "While this goal had to be modified for steel cases, we have successfully tested small scale titanium cases with a steel equivalent yield strength well beyond the 300,000 psi point."

Conclusions: 1. "By exercising reasonable care, the development of full scale (steel) cases at 240,000 psi is perfectly feasible.

2. "Small scale (titanium) cases have been burst at stress levels as high as 260,000 psi . . . we are convinced that reliable cases can be manufactured (from titanium) at yield strength levels of 180,000 psi and over . . . at 180,000 beta titanium is equivalent to steel at 280,000 psi.

"At 200,000 psi beta is equivalent to steel at 320,000 psi. 200,000 psi beta is possible and obviously would mean substantially increased payload to the moon or out into space."

SPECIFIC COMPARISON: Corrosion Resistance

Steel: "All of the low-alloy constructional steels which have been discussed are subject to general rusting and, far more serious, to pitting type corrosion during machining, welding, heat treatment, pressure testing and final storage. Corrosion pits can act as severe stress-raisers and, in conjunction with hydrogen, have been demonstrated to cause catastrophic failure. It therefore goes without saying that pitting corrosion is a serious hazard."

Titanium: "Like other titanium alloys, the beta titanium alloy has excellent resistance to corrosion under normal atmospheric conditions, in salt water as well as in many other media.

"In considering the long-time storage problems with rocket cases—a pit in a thin-walled casing can be catastrophic — we would regard the beta titanium alloy as the outstanding material under consideration."

SPECIFIC COMPARISON: Strength

Alloy	Density	Practical Yield Strength (5% elongation)
Ti-6Al-4V	0.161=/in.³	155 ksi = steel at 270 ksi
Ti-13V-11Cr-3Al (Beta)	0.175=/in.³	180 ksi = steel at 280 ksi
		190 ksi = steel at 305 ksi
		200 ksi = steel at 320 ksi

Burst Test Results show titanium has provided consistent burst strengths of 235,000 psi — a burst strength/density ratio of 1,340,000. Failure occurs in the wall of the case itself — not the weld zones. Titanium cases do not fragment.

• Reliability and growth . . . the parallel

Pratt & Whitney Aircraft data reveal rocket-cases can *now* be built from beta titanium at strengths 17 percent greater than alternate metals, with beta titanium's strengths bounding forward under a minimum of development.

A striking parallel exists in liquid-fueled rocketry where titanium alloy Ti-6Al-4V was selected for helium storage bottles in the Atlas missile because of its strength/density ratio. Airite Products, Inc., a leading supplier of the titanium vessels, reports:

"Minor modifications in processing techniques and continuous tightening of tolerances and other variables have shown an increase from the original 5400 psig average burst pressure to the present average which is in excess of 9000 psig.

"This has been done without increasing the weight of the article by one ounce. Weight of the unit, incidentally is controlled to a tolerance of plus or minus one-half pound, on a weight of 79 pounds, and volume is controlled and guaranteed to plus or minus one percent."

While the performance of the titanium pressure vessels has been almost doubled, the price has been reduced almost 50 percent — and the missile has become operational.

• When a case fails, so does the missile

The price of completed beta titanium rocket-cases is now estimated at 2½ times the price of other metals, with titanium cases virtually in their infancy. Should the titanium cost difference remain, the pay-off would still be two-fold:

1. **Cost:** engineering time, would be greatly curtailed; expensive fuels (for example, 30 pounds of fuel are required in earlier stages for each additional third-stage pound) would be saved.

2. **Reliability:** titanium cases simply will not pit, rust, deliquesce, or become hydrogen embrittled.

Added together, these elements mean feasibility—feasibility supported by the commercial availability of the metal itself. Beta titanium alloy Ti-13V-11Cr-3Al is available from Titanium Metals Corporation of America at these lead times: billet, 2-3 weeks; bar, 3-4 weeks; flat-roll, 5-6 weeks. TMCA's metallurgical experience with the alloy is yours for the asking.

For further information, write for TMCA Data Bulletin *All-Beta Titanium for Solid Rocket Pressure Chambers.* Extensive welding information is included.

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its pad in a 60-mile gale, let go
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arms, each a stubby 3-feet long, th
clasp 40-foot Bomarc around its ta
Unlike systems that release duri
countdown, whether or not the bi
goes, this system releases only o
positive, upward movement th
actuates a valve in the pad. B
because all mechanical devices c
fail, an emergency release syst
was also needed...

So, he put a small lever at the e
of each arm. This lever makes act
contact with the bird. As Boma
moves up, these levers rotate with
After an inch of movement, th
automatically snap the arms out
the way if the basic system has
already done so. Even in a wind th
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DOD Funds Will Be Tight in '60

Many 'marginal' programs will be cut back and foreign missile competition will be stiffer; mergers, consolidations are likely

by Betty Oswald

WASHINGTON—In Calendar 1960, the sprawling U.S. missile industry will face the countdown of its life.

Lines will hold tight on availability of funds, and they are likely to get tighter as the Administration and Congress gird for the next national election.

U.S. missile makers will face increasing competition from foreign manufacturers.

The year will see the cancellation or sharp curtailment of many "marginal" programs.

Industry will have to merge and consolidate in an effort to provide new capability in some program areas.

The Administration is firmly committed to a spending program in both Fiscal 1960 and Fiscal 1961 of about $41 billion for defense. And there is very little chance that Congress will change the numbers much, even though it would take $45 billion in FY 1961 —and even more in years to follow— to adequately fund more than 25 peaceful space missions and some 65 missile programs.

The principal effort of Congress will probably be to see to it that spending plans are kept flexible, to take advantage of breakthroughs or changes in technology which might reduce the now almost certain long period of catching up with Russia.

• **Tightening belts**—This means that Calendar 1960 will be increasingly a time of "selection", reducing the total number of programs. It means, too, that competition will increase for the dollars which are almost certain to get scarcer for research and development in new program areas; mergers and consolidations will be required in order to achieve the goals that both Pentagon and NASA will demand. A company will be increasingly unable to "go it alone," providing on its own the skills or managerial talents required to keep its place in the industry—let alone to strengthen its position.

A look at the foreign market is even more disheartening. France has some 14 missiles under development and is acquiring a good in-house capability, particularly in instrumentation and solids propulsion. Great Britain is producing some seven different missiles, and—putting a reverse twist on "buy American"—has succeeded in selling its anti-aircraft missile, *Bloodhound,* to both Sweden and Australia. Even the neutral Swiss and Swedes are coming up with missiles of their own. To meet this competition from abroad, U.S. manufacturers will be faced with establishing more branch offices in Europe, increased sales pitches to NATO, and licensing agreements with more foreign manufacturers.

• **Limiting decisions**—A major factor is, of course, the continued increase in costs of new systems which must be fitted in under the tent of the U.S. budget ceiling. This means that judgments must be made earlier than the decision makers like. It means that parallel approaches to a single problem can't be taken unless an extraordinary need exists. And this, in turn, means that decisions which should be made promptly probably won't be made because nobody will want to guess wrong.

Choices will be made not only on numbers of missiles and space vehicles to be produced, but also between programs. The decisions will be ones of emphasis—that is, the forces and weapons required for strategic deterrence, for air defense, for antisubmarine warfare, for limited warfare.

In the area of strategic deterrence, big long-range surface-to-surface missiles—*Atlas, Titan* and *Polaris*—are all moving rapidly into the production-for-inventory category with all of the accompanying costs for base construction, ground support, spares, maintenance and training. All anyone can look for in this field for the next year or two are so-called product improvement programs rather than new missiles.

• **Some exceptions**—There is one important exception—in the area of propulsion. Neither the Air Force nor the Navy is satisfied that the answers are all in yet on solid propellants; there will be money available for pushing forward in this field. Also, ways and means will have to be found to reduce the CPE (circle of probable error) on the small warheads—*Polaris, Minuteman.* It's in this area, Air Force and Navy officers say, that the continued ban on nuclear testing is hurting badly. Nevertheless, Defense Secretary McElroy, now resigned, told a farewell news conference that a *Polaris* weapon system would be delivered approximately every four months for the foreseeable future once an initial operational capability was acquired in late 1960. *Minuteman's* future also looks bright with McElroy promising "optimum" funding in the new budget to provide missiles in place by 1963.

In the case of *Titan* there will be "at least" 11 squadrons. And, after the sixth, AF hopes to have a usable, storeable liquid propellant, and to fire the missile out of its silos.

• **Missiles for troops**—While the Army is out of the big surface-to-surface missile business, it has a big stake in missiles for use by the troops and Dr. Herbert York, Defense Dept. Research and Engineering chief, is said to have a more "imaginative" approach to the problems of limited war.

Pershing, the successor to *Redstone,* solid-propelled, is in the last stages of development, with $130 million for the missile in Fiscal 1960, compared with $100 million in Fiscal 1959. A second missile, *Sergeant,* also a member of the new generation, will take the place of *Corporal* sometime in 1960.

And Army has some even newer missiles coming along, including *Lobber, Mauler, Shillelagh* and *Red Eye.*

It's in the area of air defense and, later, space defense that the biggest question marks exist. A sign of the times was the recent decision to stop work on the new underground head-

quarters for NORAD, admittedly a prime target for any attacking force.

• **Air defense uncertainty**—Another and perhaps even more important sign is that there is a new move to revise the "Master Air Defense Plan" under which the Army's *Nike-Hercules* and the AF's *Bomarc* program were cut back last year. There is strong feeling at the Pentagon that there is no immediate prospect of finding a solution, either partial or total, to the air defense problem. Even in the "good old days" of the B-29, the prediction was that a very substantial part of the attacking force would get through, and with missiles instead of aircraft carrying megaton loads a partial defense isn't considered good enough. Hence, the argument that reliance ought to be placed almost entirely on retaliatory forces, with little or no money made available for air or space defense. Advocates of this doctrine got strong support last year from Project *Argus*, which showed how a space explosion might wreck the communications on which air defense is based.

This doesn't mean, however, that the problem of air defense is being completely overlooked. *Nike-Zeus* won't be put into production or readied for production. However, it will receive "generous" funding for research and development—just in case.

Bomarc B will be funded through Fiscal 1960, which ends next June 30. At that time a program—although not the production one—for about 30 units of equipment (missile installation) will be funded out, even though production and construction for the job won't be complete. Plans to put SAGE underground—plans on which *Bomarc* is at least partially dependent—won't be carried forward unless a major change is made in current thinking on air defense.

And *Bomarc* and *Nike* are not the only two victims of the growing uncertainty of air defense. Navy *Terrier* and *Talos* missiles are likely to be cut back following a decision to go slow on building ships which would use these anti-aircraft missiles.

The F-108, Mach 3 long-range interceptor, was also a victim. While it is now considered possible that AF might buy a proposal for a "technically uncomplicated" F-108, the future of the super *Falcon (GAR-9)* which would have armed the F-108 hasn't been decided—despite a decision to continue development funding on a limited basis.

• **Limited future**—Development and production of such missiles as *Sidewinder, Bullpup*, and *Sparrow III* will be continued. Here, however, the problem is what comes afterwards, since it's a virtual certainty that there won't be any new interceptors of any important range after the F-106 and the Navy's F4H. This leaves it open to question whether Navy will get the funding to push the *Eagle* project beyond its present level.

Similarly—since the future of the bomber fleet will be in doubt after the current family of B-52's, a limited number of B-58's and F-105's and the Navy's A3J—there's some question as to the value of the air-launched-ballistic missile contract recently awarded to **Douglas Aircraft.** As matters stand now, *ALBM* will be funded in research and development—but only with the *Hound Dog* scheduled to go on the B-52. McElroy told his news conference that the U.S. was counting heavily on the *Hound Dog* in the era ahead when a missile gap in favor of Soviet Russia is a virtual certainty. AF choice will be between product improvement of the *Hound Dog*, which now has a range of some 500 miles, and development of *ALBM*. Odds favor *Hound Dog*.

• **Drones & ASW**—There will, however, be work in one field of air defense. Army will continue development and production of missiles for the defense of troops, with major emphasis on the *Hawk*. It will also continue development of drones to survey enemy terrain, take pictures and return to land by parachute. All three services are interested in drones. Navy sees their possibility as a tool of antisubmarine warfare. AF wants them for targets and Army wants them for both targets and reconnaissance. It's an area in which development dollars will be spent in substantial quantities next year, even though no firm figures are available.

Another area in which funding can be expected is that of anti-submarine warfare. There is a slow growing realization both in the Pentagon and on Capitol Hill that if *Polaris* submarines are as effective as we like to believe, this kind of weapon is even more dangerous in the hands of the Russians. At least three major projects are under way, all highly classified. Here, there is the warning of Rear Admiral Paul D. Stroop, first chief of the newly created Bureau of Naval Weapons, that decisions will be made at the conclusion of research and development—that the Navy can't afford a diversity of weapons in inventory.

• **Space for civilians**—Beyond missiles, there is, of course, space. Looking at it only from the Pentagon's point of view, there is still no clear-cut opinion on the value of space for military operations. Interest centers in such projects as the reconnaissance satellite, now known as *Samos;* the early warning satellite for missile attack, *Midas;* and the communications satellites. As of now, the feeling is that space explorations will be civilian in character—that current boosters are adequate to meet military needs. Change can come only after the *X-15* and perhaps later *Dyna-Soar* make the first excursions into space.

In the meantime, the danger facing the National Aeronautics and Space Administration and its contractors is that Congress has almost always taken the attitude of "millions for defense" and non-defense activities have always been cut to fit into fiscal plans—whatever they might happen to be. As one informed source put it: "How much will the people of the United States pay for prestige unless the value of space is defined in language that they can understand?"

SEPR Advances

French Firm Develops Solid-fuel Engines

PARIS—**SEPR (Société d'Etude de la Propulsion par Réaction),** a French company specializing in the manufacture of rocket engines, is now going ahead with development of solid-propellant rocket engines. At its test benches at Istres, SEPR recently fired a rocket loaded with one ton of solid propellant, an achievement believed to be unsurpassed in Europe.

Details have been released about the *Matra 511* air-to-air missile which is now in production to arm the latest French fighter types (Vantour, Super Mystere, Mirage III). The missile has a length of 3.10 m (10′), a diameter of 0.26 m (10″) and its launching weight is 180 kg (397 lbs).

It has a two-stage, solid-propellant engine, the first stage delivering a thrust of 1.600 kg (3.527 lbs. during three seconds), the second stage 200 kg (440 lbs.) during 13.5 seconds. The range is between five and seven km (3.10 to 4.35 mi.). The speed of the missile related to that of the fighter is of 280 m/sec. (92 ft./sec.). The *Matra 511* has been developed for either infrared or electromagnetic self-guidance. An Andyar battery supplies the power.

Temple Studies High Temperature Flames

Aerodynamic heating over 4000°K created to determine effects and nature of combustion processes

CONE SAMPLE is shown in the first shock node of a jet stream. The exposure used is 1/250 that of normal daylight.

by William L. Doyle*

ELVERSON, PA.—The Research Institute of Temple University has long been investigating high temperature flame studies of a premixed bunsen burner type to determine the effect on materials and the nature of combustion processes.

As a result of these investigations, early in 1955, conferences were held between personnel of Redstone Arsenal and the Research Institute of Temple University. Purpose was to explore the possibilities of actually constructing a rocket test facility using substances from pre-mixed flame studies which would produce supersonic jet streams for aerodynamic heating tests.

It was then decided to design, build, and operate a test facility for a small rocket motor with a 2″ diameter circular exit. The jet stream produced by this rocket motor would provide aerodynamic heating in excess of 4000°K (6740°F) by combusting hydrogen cyanide with an equimolar mixture of fluorine and oxygen as indicated in the following equation:

$$2HCN + F_2 + O_2 = 2CO + 2HF + N_2$$
(Equation 1)

This system became known as the liquid hydrogen cyanide system.

The calculated flame temperature of this reaction, at the stoichiometric point, is 4410°K (7480°F) at 300 psia chamber pressure for the substances in their liquid states.

After considering the handling, metering, and other problems associated with this propellant combination, it was decided to flow them in their respective liquid states. It became necessary to ignite the propellant combination when the reactants were in gaseous states, at pressures slightly greater than atmospheric.

It was predicted—and later found true—that this combination would be hypergolic in the liquid state, due to the tremendous increase in atomic concentration. The first test was completed in July, 1956 and since that time approximately 200 have been run with this system at 300 psia chamber pressure and several at 500 psia.

Another propellant combination was considered in the early plans, namely, the liquid cyanogen-liquid oxygen system, which reacts as follows:

$$(CN)_2 + O_2 = 2CO + N_2$$
(Equation 2)

and became known as the liquid cyanogen system.

The flame temperature for this reaction, at the stoichiometric point and 300 psia chamber pressure, is 4860°K (8288°F). This system has the advantage of containing no HF in the jet stream, i.e., the behavior of the gases in the jet stream would more nearly approach those of the atmosphere. This latter combination, however, is nonhypergolic, and a flourine ignition system had to be employed.

Since cyanogen was available only in very small quantities (which were sufficient to carry on the pre-mixed flame studies at the main laboratory), the liquid cyanogen-liquid oxygen system was not considered for the initial tests. The **American Cyanamid Company** did construct a pilot plant at Stamford, Connecticut, which produced enough cyanogen to begin initial testing by the end of 1956. Since that time approximately 100 tests have been completed at 300 psia.

Most of the tests have been at approximately 300 psia chamber pressure and both will be increased to 500 psia chamber pressure. These aerodynamic heating tests are used for materials testing and both conical and flat plates have been placed in the jet stream.

A probe was used for determining relative heat fluxes of the nozzle jet stream under various conditions. The absolute values of the streams were determined by very complicated molybdenum calorimeters. These calorimeters have been fabricated at the Army

Director, High Temperature Test Area, Research Institute of Temple University

Ballistic Missile Agency. Purpose of the simplified probes was to correlate the results of varying conditions with those of values obtained from Redstone calorimeters. Test results, are still being evaluated. Heat probe tests from issuing jets from contoured nozzle chambers were not completely streamlined, but were nearly uniform in heat flux output. This is in contrast to jets from standard conical type chambers where the heat flux outputs were more than 50% less in the area one half the distance from the nozzle to the first shock nodes as compared to the output in the shock node.

• **Methane system**—Initial tests on a third system—the methane-oxygen-fluorine system—which reacts according to the following equation:

$$2CH_4 + O_2 + 3F_2 = 2CO + 6HF + H_2$$
(Equation 3)

have been performed here recently, and is designated as the methane system. This system was chosen because it had approximately the same chamber temperature as the hydrogen cyanide system, but a much higher jet velocity. Hence, it should shed some light on the effect of jet velocity on the heat flux output to a sample. In Equation 3 we plan to alter the proportions of fluorine to oxygen. The amount of oxygen will always be sufficient to oxidize the carbon to carbon monoxide.

This methane system presents a very interesting picture. For it and the other two high temperature systems, have carbon monoxide or nitrogen, as reaction products. These are the most stable molecules known and no appreciable dissociation occurs with below 4800°K (8180°F) at 300 psia chamber pressure. Therefore, CO and N_2 act as diluents below 4800°K while HF can be considered a diluent and is only partially dissociated at the chamber temperatures of the systems considered. CO and HF act as diluents to the free hydrogen in Equation 3 to cause its further dissociation at a particular chamber temperature and pressure. Further, the dissociated hydrogen would tend to repress the dissociation of the HF. Obviously, the energy gained by the recombination of the dissociated chamber products during the expansion process are not considered in frozen calculations and hence such values would be low and unrealistic.

In earlier fluorine work done at Ohio State University, not only was the density of fluorine in question but also its heat of dissociation. It was found that the density of fluorine was increased by 1.108 g/ce to 1.51 g/cc (at–188°C) (–306°F) and that the heat of dissociation of 64 Kcal/mole was to be reduced to 32, 35.5, or 36.6 Kcal/mole.

The latter value is used here. In NACA theoretical studies the value of 35.5 Kcal/mole was used. The difference in these two values would cause a difference of 50°K (90°F) in the chamber temperature.

Since the heat of dissociation of HF has a marked effect on chamber temperature of all fluorine systems, it is expected that there would be a much greater effect on the methane system. If it were found that the higher value for the heat dissociation of fluorine was correct, the increased chamber temperature would allow for a greater amount of methane to be used with the oxidizer.

The oxidizer would contain more oxygen resulting in formation of more free hydrogen. This, in turn, will have a more pronounced effect in the methane system than in the liquid hydrogen-liquid fluorine system since in reality the methane system is a partial "atomic hydrogen" propellant system and doesn't have to boil its diluted hydrogen from a very low temperature.

The early results from the methane system indicate it to be one of the top chemical performers. This system will bear close scrutinization from both the standpoint of a fundamental understanding of the problems associated with high temperature and also the problems associated with dealing with high heat flux outputs to materials placed in the jet stream.

• **Ozone**—The liquid hydrogen cyanide system referred to as Equation 1 was the original propellant system tested here. The stagnation temperatures were increased from 4410°K (7478°F) to 4470°K (7856°F) by increasing the chamber pressure from 20.4 to 34.0 atmospheres assuming a value of 36.6 Kcal/mole for dissociation of fluorine. The chamber temperature of this system can also be increased about 150°K by substituting ozone for oxygen in Equation 1 with no increase in chamber pressure. The possibility of using ozone in this system has been enhanced because of results of recent tests at the main laboratory of the Research Institute where ozone has been found to be miscible with fluorine in all proportions.

This is in contrast to an ozone-oxygen solution which has a maximum of 18% ozone in liquid oxygen at –196°C (–321°F). Further, the work included small micro rocket tests using ozone and fluorine mixtures plus ozone-oxygen-fluoride mixtures. These tests, while on an extremely small scale, indicate that ozone may be considered in larger scale tests as the scale used at the High Temperature Test Area. It is noteworthy that the main laboratory also has found a method of storing pure ozone in cylinders without decomposition for a considerable period of time.

If a well-designed injector is used, the cyanogen system produces characteristic velocities of 5500 ft/sec without corrections to the coolant water. This value is a little over 90% of the theoretical which is in contrast to approximately 100% theoretical for HCN system under the same conditions (frozen equilibrium calculations).

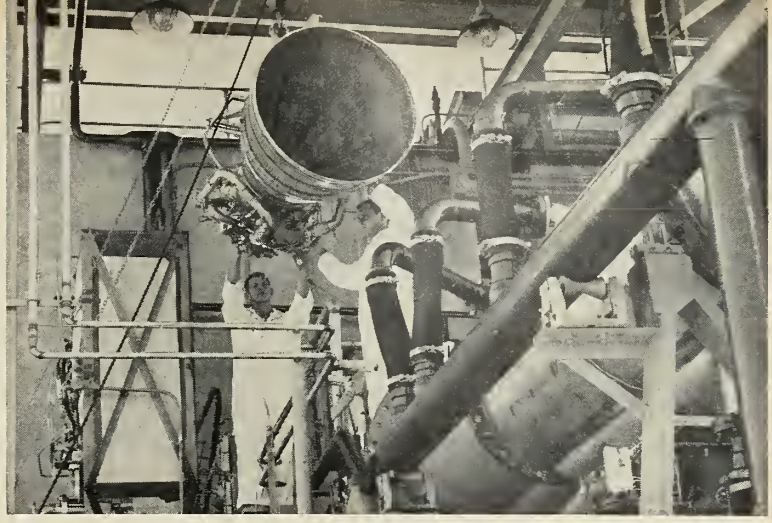
When the cyanogen system is slightly over-oxidized, naturally there is a decline in chamber temperature due to heating and dissociating the excess oxygen. However, the heat flux to the motor walls always increases. This is another proof that chamber temperature was not necessarily the principal criteria for the difficulty in cooling the motor, since not only conduction, convection, and radiation contribute to the heat flux to the chamber wall but also a fourth, and possibly controlling, factor—the heat released by recombination of dissociated molecules on these chamber walls.

The chamber temperature of the cyanogen system can be raised but very slightly by pressure. However, the substitution of ozone for oxygen in Equation 2 would yield a chamber temperature of 5500°K (9440°F) which is the approximate surface temperature of sun. These statements on chamber temperatures are made to stress the point that only by working with the high temperature systems will we learn how to handle them. There is no doubt that other factors which we are not aware of at the present time will make the handling of much higher chamber temperatures possible and practical. We must not take the attitude of a defeatist and sacrifice performance by lowering the temperature, especially when we are dealing with nuclear systems.

It will be noted that in discussion of all the propellant systems, the important fact—above all—is the use and handling of high flame temperature. It seems apparent that high temperature is the key to high energy regardless of whether we are talking in terms of chemical or nuclear systems. By probing these high temperature systems at elevated pressures fundamental knowledge may be gained which will make breakthroughs in true high energy systems possible.

Extra I_{sp} . . .

Novel P&W Hydrogen Pump Cycle



PRATT & WHITNEY *XLR-115,* **the nation's first liquid hydrogen rocket engine, is hoisted to test stand at company's West Palm Beach research & development center.**

WEST PALM BEACH, FLA.—**Pratt & Whitney** has developed an unusual "bootstrap" system of pumping liquid propellants for its hydrogen-oxygen engine without using a gas generator.

The P&W *XLR-115* engine, which will power the upper stage of the *Atlas-Centaur* space vehicle, operates its turbopump by harnessing the evaporation of liquid hydrogen used to cool the thrust chamber jacket. Here is how it works:

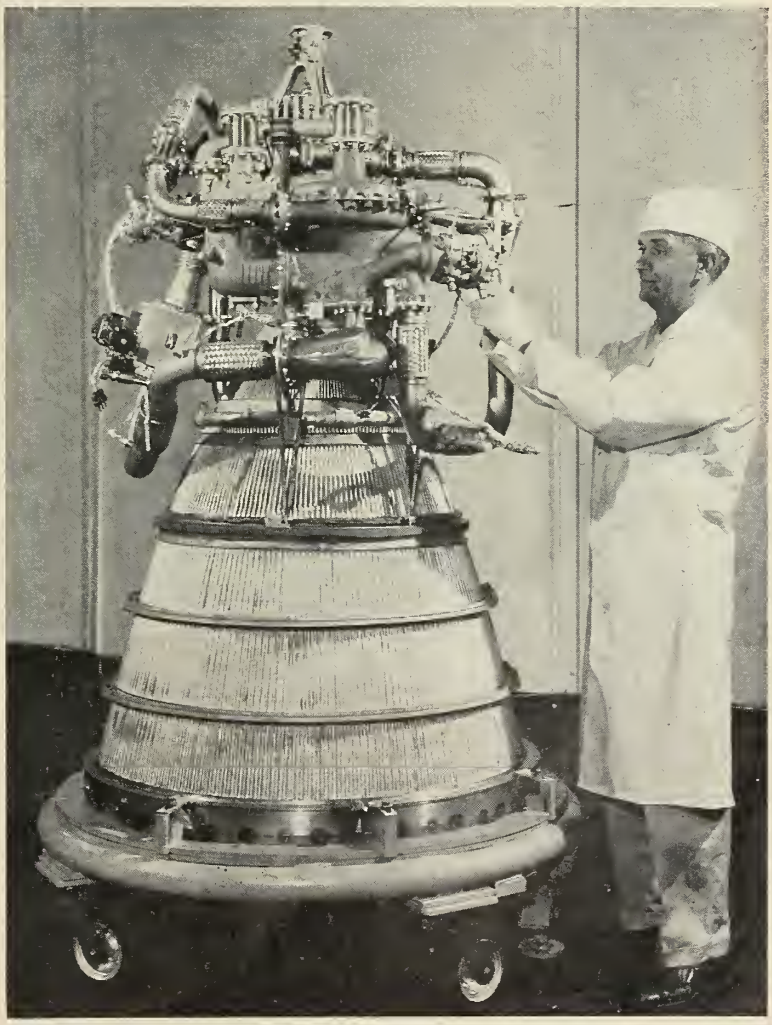
Liquid hydrogen enters the cooling jacket at a temperature of —423°F. Hydrogen and oxygen burn inside the thrust chamber at 5500°F. The hydrogen in the cooling jacket picks up heat and boils. It then flows into a turbine that furnishes power to pump more liquid hydrogen and LOX into the system.

The fuel thus plays three roles: cooling the thrust chamber, driving the pump system and burning in the thrust chamber.

Charles T. Roelke, general manager of P&W's Florida research and development center, said the engine has been tested numerous times at its rated thrust of 15,000 lbs. for several minutes at a time under simulated space conditions. He said the specific impulse has been found to be more than 30% higher than that for conventional kerosene-oxygen engines. There is no technical reason why much larger hydrogen-oxygen engines cannot be built, he added.

The *Centaur* engine will be a combination of two *XRL-115*'s, generating 30,000 lbs. of thrust. Its first use will be atop an *Atlas*. Later, it will be used as third stage of the *Saturn* system.

The P&W report was the second in recent weeks on progress in liquid hydrogen-burning engines. On Nov. 19, **Aerojet-General** said it has developed a pump that makes feasible hydrogen-fueled space engines up to 500,000 lbs. of thrust and could eventually produce thrusts up to 10 million lbs.



FIRST PICTURE showing details of the *XLR-115,* **which will power the upper stage of** *Centaur* **and the third stage of** *Saturn,* **was released for publication last week.**

Microwave 'Hazards' Are Exaggerated

The misunderstanding concerning biological effects of high power fields has plagued both the military and industry—research is providing the answers . . .

by Charles D. LaFond

WASHINGTON—A greatly exaggerated problem has harassed both the military and industry for the past few years—the hazards to personnel of relatively high-power microwave energy fields. The problem today is not nearly so much the possibility of physiological damage by radio-frequency energy as it is a case of widespread ignorance of the extent of the problem. As is true in most human endeavor, a lack of understanding results in a fear of the unknown.

Before we go farther, let us clear the air of one continuously perpetuated and apparently unsupported belief. According to Col. George M. Knauf, tri-service coordinator of the whole microwave bio-effect program, *there has not been one medically substantiated case of human injury from microwave energy to date.*

Somehow, the problem is too often confused with the dangers of ionizing radiation.

There is no reason to believe that there is any problem connected with r-f energy that is not related to heat. Heat, in turn, is related to the average power emitted by an antenna. Average power then is a function of power density. The amount of power to a unit of area and exposure time are the principal factors in tissue damage. The kind of tissue is another variable.

The fact that system power is on the increase does not mean that power density also rises at the same rate. As power output has increased, so has antenna size—and power density has followed only a slowly rising curve.

For safety's sake, an arbitrary maximum allowable exposure level was established—0.01 watt/cm². It has since been determined that this is an absolutely safe power level for personnel.

• **Some danger**—It is true that an element of danger exists for operating personnel in the close vicinity of high-power ionospheric-scatter and radar antenna installations. With paralleled transmitters, some scatter systems produce an average output power in excess of 100 kw. Several defense radar systems put out concentrated beams of 600 kw. Even the relatively low power (10-kw) of some tropospheric-scatter stations can be a problem because of the power concentration radiated from smaller dishes.

But even with our current incomplete knowledge of the problem we know that simple caution and the observance of a few safety principles can insure a relatively harmless working environment. Thus, accidental exposure probably will be the cause of any injuries that may occur today or in the future.

Knowing that the problem will continue, the military services are maintaining intensive research programs. These are not being publicized in an attempt to avoid unrest with operating and maintenance personnel in the field. Cost of the whole program is approximately $300,000 a year.

• **Slow start**—To a small degree, all three military services have been interested in the bio-effects of microwave energy for many years. Support for such research efforts had been very limited. In 1956, the Air Force was given tri-service coordinating responsibility for this area of study. In 1957, the first tri-service conference was held to discuss the then current research efforts, results, and needed research areas.

Following the conference, the program began to really roll. One year later, a second conference was held to bring together members of the military, universities, and industry now involved in the vastly matured effort. By this time, the field of biology, physics, engineering, medicine, and psychology had been integrated into the overall program.

One thing should be remembered when discussing the research efforts of today: Attempts are being made to find out what may lie ahead in time if power outputs continue to increase. Because of this, there is a wide gap between today's power levels and those of the future. The levels used in experiments in the laboratory under test conditions are far greater than the capability of present equipment. Col. Knauf has stated this in another way: "An effect does not become a hazard until man is exposed to such an effect, and with the equipment of today this possibility is remote."

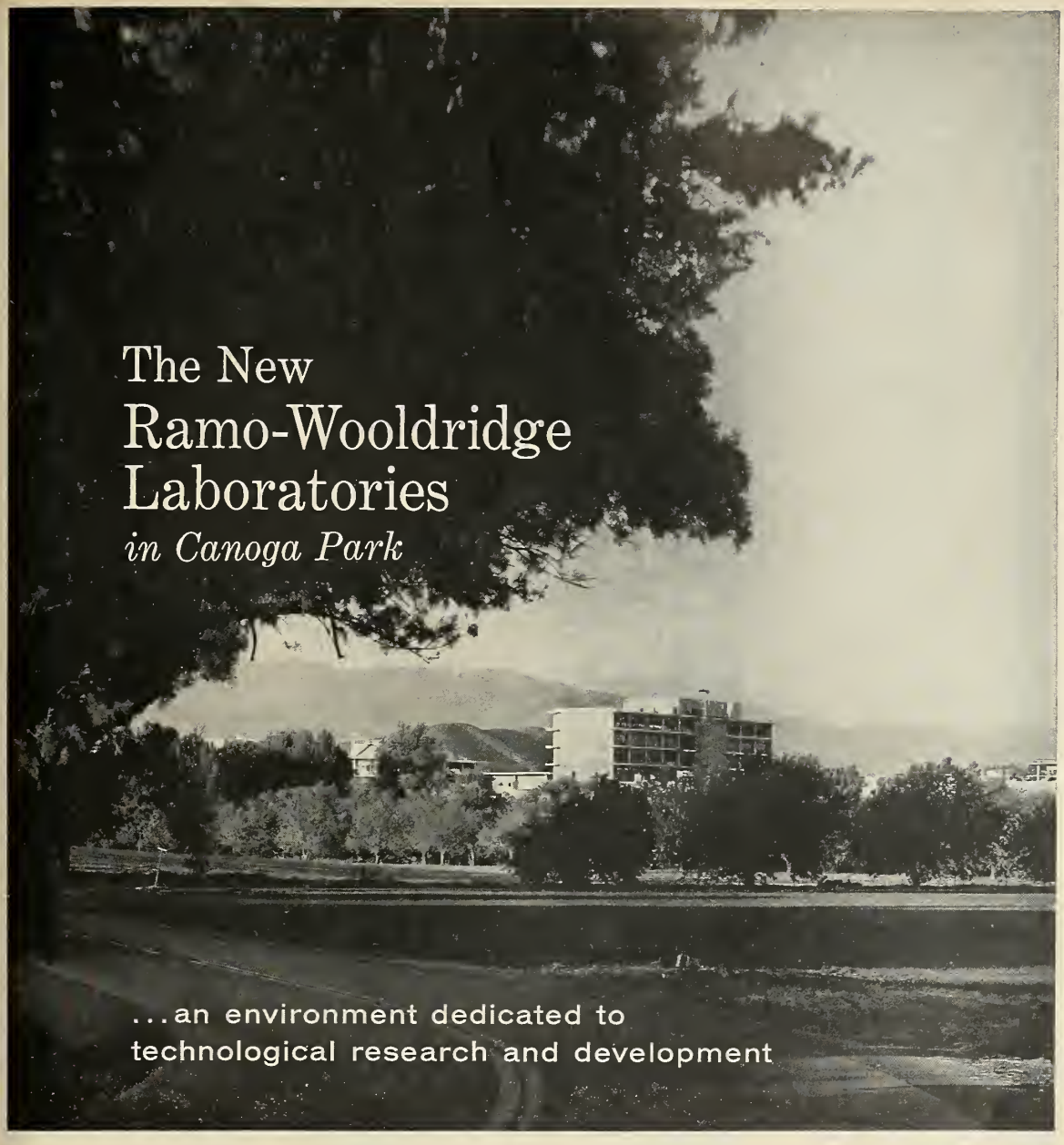
• **R-f effects**—In the electromagnetic spectrum, the microwave region extends roughly from below 1000 to 300,000 mc (30 to 0.01 cm in wavelength). R-f energy has been found to penetrate animal tissue to a depth of from 0.1 to 0.01 the wavelength of the radiation.

The amount of power absorbed by the body varies with the frequency. Above 3000 mc and below about 400 mc, about half of the incident power is absorbed. Total absorbed radiation between 1000 and 3000 mc approaches 100%.

Above 3000 mc, energy produces a considerable rise in surface skin temperature; below 1000 mc, internal heat to a depth of nearly four inches can be developed.

At this time, many feel that sufficient money has been spent in research and that now is the time to provide protection for the very few people who because of their jobs, must expose themselves to higher than safe microwave fluxes.

• **Materials**—A limited effort has gone into the development of protective equipment and shelters. Shielded passageways for example, will be used at the three BMEWS stations. But the



The new Ramo-Wooldridge Laboratories in Canoga Park, California, will provide an excellent environment for scientists and engineers engaged in technological research and development. Because of the high degree of scientific and engineering effort involved in Ramo-Wooldridge programs, technically trained people are assigned a more dominant role in the management of the organization than is customary.

The ninety-acre landscaped site, with modern buildings grouped around a central mall, contributes to the academic environment necessary for creative work. The new Laboratories will be the West Coast headquarters of Thompson Ramo Wooldridge Inc. as well as house the Ramo-Wooldridge division of TRW.

The Ramo-Wooldridge Laboratories are engaged in the broad fields of electronic systems technology, computers, and data processing. Outstanding opportunities exist for scientists and engineers.

For specific information on current openings write to Mr. D. L. Pyke.

THE RAMO-WOOLDRIDGE LABORATORIES

8433 FALLBROOK AVENUE, CANOGA PARK, CALIFORNIA

BASIC BUILDING BLOCKS FROM KEARFOTT

FLOATED RATE INTEGRATING GYROS

Specifically designed for missile applications, these Kearfott miniature gyros operate efficiently at unlimited altitudes. Their outstanding accuracy and performance make them superior to any comparably-sized units on the market. Hermetically sealed within a thermal jacket, these gyros are ruggedly designed and completely adaptable to production methods. Performance characteristics that are even more precise can be provided within the same dimensions.

TYPICAL CHARACTERISTICS

Mass Unbalance:
Along Input Axis: 1.0°/ hr maximum untrimmed

Standard Deviation (short term):
Azimuth Position: 0.05°/hr
Vertical Position: 0.03°/hr

Drift Rate Due to Anisoelasticity
Steady Acceleration:
.015°/hr./g² maximum

Vibratory Acceleration:
.008°/hr./g² maximum

Damping:
Ratio of input angle to output angle is 0.2

Characteristic Time:
.0035 seconds or less

Weight: 0.7 lbs.

Warm-Up Time:
10 minutes from −60°F

Life: 1000 hours minimum

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT

20 SECOND SYNCHRO

This synchro, just one of a broad line offered by Kearfott, provides the extreme accuracy required in today's data transmission systems. Kearfott synchro resolvers enable system designers to achieve unusual accuracy without the need for 2-speed servos and elaborate electronics. By proper impedance, matches up to 64 resolver control transformers can also operate from one resolver transmitter.

TYPICAL CHARACTERISTICS — SIZE 25

	Transmitter	Control Transformer
Type Resolver		
Part Number	Z5161-001	Z5151-003
Excit. Volts (Max.)	115	90
Frequency (cps)	400	400
Primary Imped.	400/80°	8500/80°
Secondary Imped.	260/80°	14000/80°
Transform. Ratio	.7826	1.278
Max. Error fr. E.Z.	20 seconds	20 seconds
Primary	Rotor	Stator

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT

MINIATURE VERTICAL GYRO

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

TYPICAL CHARACTERISTICS

Free Drift Rate:
Within 0.5° in one minute time.

Shock:
The gyro operates satisfactorily without damage after 60g shock of .015 seconds duration.

Hermetically Sealed:
These instruments are hermetically sealed and are not affected by sand, dust, sunshine, rain, humidity or fungus conditions.

Operating Temperature Range:
Gyros operate in ambient temperatures below —20°C to +100°C. A maximum of 3 minutes of operation at 400°F will not damage these gyros nor impair their accuracy.

Weight:
5.5 lbs. approximately.

Write for complete data.

Time Index Digitalizer

Precise Angle Indicator

Size 8 Integrating Motor Generator

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

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chief method of protection other than this in the future probably will be some type of easily donned apparel.

There are three ways, essentially, of providing protection from microwave incident energy: reflection, absorption, or a combination of the two. Normally, the reflection method would be expected to be cheaper and less bulky.

Several net-like fabrics have been tested successfully although research to date has not been rigorous. One material, worn like a bee-keeper's net from a pith helmet, uses a silver-impregnated nylon thread. Protection is adequate, visibility is not overly impaired, personnel movement is not hindered. Other materials of a similar nature are being tested.

According to Dr. R. W. Wright, Naval Research Laboratory, a resonant transparent shield can be made by modifying the technique used to give low reflections in a bead-supported coaxial line. By using dielectric material ¼ wavelength thick, maximum reflection from a single layer can be achieved. Multiple layers, a half-wavelength apart, will provide greatly increased reflection.

Another easily obtained material for shielding, according to Dr. Wright, is ordinary salt water. Both absorption and reflection can be provided with a relatively narrow layer of the liquid. This could be used as part of a screen room or even in a reflecting suit. Ocular protection without visual impairment would be achieved.

Research at Participating Universities

• **Pennsylvania**—Under the direction of Dr. H. P. Schwan, lab work at the University of Pennsylvania has been directed to the study of microwave absorption characteristics of body tissues. This has been a seven-year program surveying characteristics of various tissue types, including all major types. From data collected over the frequency range of from 40-30,000 mc, Dr. Schwan has drawn several conclusions:

• Dielectric properties vary with types of tissue with extremes provided at one end by the glass body or vitreous humor of the eye (highest) and yellow bone marrow. Properties of the same types of muscle tissue vary within 10% while those of fatty tissue vary by a factor of 5. This has been shown to reflect the variability of water content.

• Frequencies above 3000 mc cause surface heating only. Penetration increases with lower frequencies, particularly below 1000 mc for all tissues.

• Because of standing wave patterns, the use of standard, portable, personnel dosimeters for warning or data indication would be fruitless. For the same reason, energy flux in the body cannot be used as a measure of dosage. Dose or dose rates must refer to the field or flux values in the distant field defined far enough from the body to be affected by its presence.

• **Tufts**—In the Department of Biology at Tufts University, the principal research effort has been the study of microwave energy effects on the human eye. According to Dr. R. L. Carpenter, group director, the fact that lens opacities could result from microwave radiation had been established previously. Thus, for the past three years, his group has performed a detailed study of the conditions under which such cataracts are produced using a specific frequency of 2450 mc.

Time and power threshold exposures, the cumulative effects of repeated subthreshold exposures, and the effects of pulsed-wave versus continuous-wave radiation have been investigated with the following results:

• As might be suspected, the higher power applied, the shorter the time required to develop a lens opacity. More specifically, it was found that the power necessary was inversely proportional to the square root of the time. Power levels from 0.12 to 0.4 w/cm² were developed with the exposure periods up to 55 minutes. Six minutes was found to be the minimal exposure period for developing opacity.

• The cataractogenic effect of CW microwave radiation at first appeared to be a thermal effect. A critical temperature was determined to be approximately 50°C. When pulsed-wave radiation was used, the thermal effect was found to be related to average power density of the r-f field. But the relationship of peak power density to opacity was established by virtue of a reduction in the exposure time necessary to develop a cataractogenic effect. This suggests then that the thermal effect is not primarily the cause of lens opacity.

• Repeated exposure at individual time periods of 5 minutes or less did produce opacities and thus there exists a cumulative effect. It is not yet known what time interval is required to prevent a cumulative effect.

• **St. Louis**—Primarily employing a test frequency of 2450 mc in its studies, the St. Louis University's School of Medicine has been investigating a variety of test subjects—tissue from various animal organs and limbs, chicken eggs, vegetable seeds, and whole body tests on rats.

Dr. A. W. Richardson, who leads the research group, has had notable success in developing the Richardson dosimeter. This is a small, portable, low-cost unit that uses a gelatin mass (simulating an avascular body structure) and a thermistor-amplifier-meter arrangement to indicate temperature change in an electromagnetic field. A prototype has been tested aboard the U.S.S. Forrestal (by Dr. T. S. Ely, Office Naval Research) and although it performed reasonably well in indicating the existence of a relatively high r-f field, it also had certain shortcomings. These Dr. Richardson believes will be modified to improve performance.

Experiments by the Richardson group have included high-power-level exposure and long-time exposure extended to terminal death in rats. Considering the limited data obtained in these tests, the group has determined that excessive microwave exposure effects may be more complex than previously believed, and continued research is necessary.

• **Rochester**—The Medical Div. of the University of Rochester has maintained a cooperative effort with the Air Force in studying whole body bio-effects of microwave energy on dogs. Primary aim has been to establish a safe exposure level for personnel working with microwave sources. It has used a radar set (AN/MPS-14) operating at a frequency of 2800 mc with an average power of approximately 2 kw. Pulse emission (2-μsec pulse width, 360/sec repetition freq.) was employed and power densities used in the test chamber varied from 0.05 to 1.2 watts/cm² depending on the subject location from the antenna. Exposure periods were 60, 90, 120 minutes.

Preliminary results obtained in the highly controlled experiments have indicated thermal body effects only, and these have been transient with complete recovery following exposure. No residual effects have been demonstrated.

• **Buffalo**—Studies of bio-effects of a 200-mc frequency were performed by the University of Buffalo. Two transmitters were used: one a pulse type providing a low peak power density of 0.045 watt/cm² (too low for thermal effect but suitable for athermal study); the other a continuous wave type producing an average power density of from 0.015 to 0.6w/cm², depending on distance from the antenna.

Extremely varied repetitive exposures for different test groups were employed over long periods of total

time. Test subjects were mice and guinea pigs.

Results: no evidence of lens changes in any of the animals as a result of microwave exposure.

More recent tests with a cw transmitter providing average power densities from 0.04 to 0.6 w/cm² and different time periods of up to 4 hours have provided similar results. Only an increase in body temperatures was noted. Really long-term effects have not been evaluated.

Limited tests using larger animals showed only an increase in body temperatures—no athermal effects.

• **Tulane**—For the Navy, Tulane University has been broadly investigating the effects of 3000-mc and 10,000-mc microwave energy on mice.

Using a wide variety of dosages, researchers noted no significant change in body tissue as a result of microwave exposure.

At 10,000 mc and average powers of 0.02 and 0.06 w/cm², two groups of mice were exposed once for over 3 minutes. Both groups showed first a growth rate retardation, then a marked acceleration which surpassed non-exposed control groups. (The lower power was considered to produce no tbermal effect.) Because of tbe similarity in results, it appears that the effect is not related solely to either heat rise or magnitude of exposure.

Similar growth was obtained at 3000 mc and multiple exposures, but multiple exposure at 10,000 mc resulted in progressive weight loss. Studies are continuing to determine further the mechanics of exposure effects on cells.

• **Miami**—Employing a frequency of 2400 mc, researcbers at tbe University of Miami have done considerable work in studying lethal microwave dosages and exposure times on rats. Most experiments were on the whole body in fields having power densities from 0.020 to 0.26 w/cm² and time periods from 4 to over 480 minutes.

Principal aim was the establishment of minimum letbal dosage times at different power levels. Thus, at one extreme, minimum lethal exposure time proved to be only 4 minutes in the "near zone" when power density exceeded 0.3 w/cm². On the low-power-level end of the scale, minimum lethal exposure time at 0.028 w/cm² was 139 minutes. Below tbis level and at considerably larger exposure periods, the subjects survived. One conclusion seems fairly evident: minimum exposure time increases almost logarithmically as power level is decreased.

• **California**—Using radiation fluxes from 0.05 to 0.5 w/cm² at a frequency of 10,000 mc, a University of California research team has been studying internal temperature rise and tolerance levels in mice. Results so far are comparable to those described above.

• **Iowa**—The University of Iowa is a pioneer in the field of microwave bio-effect studies. Its first program was maintained from 1946 to 1949. Tbese early tests proved the damage potential of higb-intensity exposure to both local tissue and the whole body.

The group currently is studying these effects on the organs of the hollow viscera (using freq. of 2500 mc).

No results so far indicate other than thermal effects as a cause of damage.

• **Southwest Research Institute**—SRI has been investigating the feasibility of using the "electron paramagnetic resonance" technique to determine lens change in the eye of a rabbit. Preliminary experimentation bas shown the study to be promising; research will continue.

T. I. Transponder System Used to Track *Thor-Able*

DALLAS—The use of an all solid-state, 440-mc beacon transponder system to track a *Thor-Able* missile was announced recently by **Texas Instruments, Inc.**

Installed in tbe missile used for project *Transit* (navigational satellite wbich failed to achieve orbit on Sept. 17), the beacon transponder system responded from 1300 miles in space to an MIT Lincoln Laboratory radar antenna at Millstone Hill, Mass. Tbe system tracked tbe missile from horizon to horizon during 14 minutes of its flight.

Reportedly, this marked the first time that the Millstone station has been used successfully beyond skin-tracking ranges. The radar-beacon transponder combination is believed capable of tracking distances much greater than the 1300 miles acbieved in the Sept. 17th attempt, according to T. I.

Based on range information deduced from the transponder's signals, Millstone site personnel were able to predict the missile's final trajectory early in flight without the usual wait for final accumulation and processing of all data from down-range tracking stations.

Developed and built by T. I.'s Apparatus division for **Douglas Aircraft Co.**, the 6.3-lb. system has a total volume of 0.058 cu. ft. and is capable of 40 hours continuous operation on self-contained batteries. A new series of UHF transistors was used to permit complete miniaturization of the transponder.

NBS Improves Accuracy of Attenuator Measurement

BOULDER, COLO.—The National Bureau of Standards Radio Standards Laboratory here has developed a method for calibrating the lower ranges of a microwave variable attenuator to accuracies better than 0.0001 decibel (10 microbels). This accuracy exceeds the precision to which available attenuators can be set and read, and is the most accurate measurement of microwave attenuation yet made by the Bureau.

Dictionary Published By Portuguese Society

LISBON—Ccntro de Estudos Astronauticos, a member society of the International Astronautical Federation, has published the first Portuguese dictionary of rockets, missiles and astronautics with the corresponding Englisb terms.

According to Director Eurico Fonseca, the society on request will send copies of the dictionary to United States governmental agencies and industries which are interested. The society, which now has over 200 members, recently sponsored two colloquiums—one on lunar rockets and the second on space law.

Self-igniting Combination Fuels Offer Much Promise

BATON ROUGE, LA.—Smaller, more powerful rocket engines may be the result of self-igniting combination fuels containing boron or aluminum.

Dr. H. A. Beatty of the **Ethyl Corp.** told the 15th Southwest Regional Meeting of the American Chemical Society that such fuels can release energy more rapidly than present ones with correspondingly higher heats of combustion and flame speeds.

The scientist said potentialities of these fuels have yet to be exploited.

William A. Bishop of the **Copolymer Rubber and Chemical Corp.** presented the details of a stop-action study of rubber decay during oxidation.

Analysis of the revealed oxidation rates could be a guide to more efficient rubber-based propellants.

Bishop's method involves the recording of "slow motion explosions" with a high-speed infrared technique.

Making a Spaceworthy Magnetometer

Arnoux Corp. has in prototype stage a device which should meet the low weight, small size and other demands of missiles and small space vehicles

Los Angeles—If a magnetic sensing device is to be incorporated into a missile or a small space vehicle, low weight and small size are prime requisites. Other desirable properties would include capability of detecting very small magnetic anomalies of one gamma or less (1 gamma = 10^{-5} gauss), simplicity in design and circuitry, low power consumption, and the presentation of the obtained data in the form of a continuous signal of suitable amplitude to be fed directly into telemetry systems or recording devices.

A magnetometer which should meet the above requirements is being investigated by the **Arnoux Corporation of Los Angeles.** The device, which is now in the prototype stage, presents the data either in digital form, as an alternating electric potential whose frequency varies directly and linearly with the polarity and magnitude of an ambient magnetic field, or in analog form as an a-c signal whose phase varies in accordance with the magnetic field.

The device appears suitable to place in missiles or small space vehicles where it can be used to measure not only the magnetic field of the earth and other planetary bodies, but the magnetic fields associated with currents moving through the ionosphere and the magnetic fields in deep space, due to streams of charged particles emanating from the sun, or other extra-systemic sources.

In the digital mode of operation, the direct output from the magnetic sensing head consists of an a-c potential of about 1 volt peak amplitude (whose frequency may be pre-determined within very wide limits by circuit considerations), and which may lie between several hundreds of cycles per second and several hundreds of kilocycles per second.

A typical experimental model, now operating in Arnoux laboratories, exhibits these characteristics:

Sensitivity, as determined by deviation from a center operating frequency, is 250% per gauss, or 2.5 parts in 10^5 per gamma.

The dynamic range, over which there is a linear relationship between frequency and magnetic field strength, is approximately ± 0.3 gauss (30,000 gammas). However, this range may be extended to several gauss, provided that lower sensitivities can be tolerated.

Operating at a sensitivity of 7 parts in 10^6 per gamma, the dynamic operating range becomes ± 1.0 gauss.

The same instrument, operating in the analog mode, exhibits a sensitivity of approximately $\pm 4°$ of phase per gamma, with a dynamic range of not more than ± 20 gammas.

Although these performance figures are typical, digital operation has been obtained, under laboratory conditions rather than operational conditions, with sensitivities approaching 1 part per 10^4 per gamma. Conversely, it is possible to reduce the sensitivity to about 1 part per 10^6 per gamma, with a correspondingly greater operating range, i.e. ± 4 gauss.

It has not been found possible to date to operate this type of magnetic sensing head over wider ranges of magnetic field strength and presently it cannot be used for measuring high field strengths.

• **Up to hundreds of Kc**—Although the model under investigation operates in the comparatively low-frequency range (approximately 1000 cycles per second), the device can be made to function up to several hundreds of kilocycles per second. Accurate determination of the frequency may be carried out by a modified counter or period meter.

Excluding whatever method may be used for determining the frequency, or any recording or telemetry equipment, the total power consumption of the device is only 0.8 watts, which may be supplied from a stable source giving 4 volts d-c at 200 milliamperes.

The size and weight of the actual sensing head may be very small—approximately 4 cubic inches and 8 oz. The associated circuitry reportedly is so simple that the device is practically fool-proof. It is envisaged that a cost figure of less than $100 can be reached under production conditions.

Although there are other types of magnetic sensing devices available, which produce a frequency proportional to the magnetic field strength, such as the proton resonance and electron resonance magnetometers, these devices require a considerable amount of power, and in the former case, does not generate a continuous signal.

• **Drawbacks**—Both suffer from the disadvantages of delivering a low amplitude signal, necessitating amplification, and of being unable to produce a coherent signal when operated in the neighborhood of steep magnetic gradients. For instance, it is found that difficulties arise in the proton magnetometer when the gradient exceeds 20 gammas per foot.

Unlike the above magnetometers, which measure total field strength, the device is cosine directional and may be used to measure individual components of the magnetic field.

Essentially, it is a modified magnetron operating under rather unusual conditions. It is not novel to use a magnetron for the measurement of magnetic fields, and several schemes have been put forward, using both the static and dynamic characteristics of magnetrons, which include the measurement of the cyclotron frequency (as a dynamic method) and the determination of the cut-off point (as a static method).

Neither of these methods have proven successful in operational usage, since many factors contribute to the

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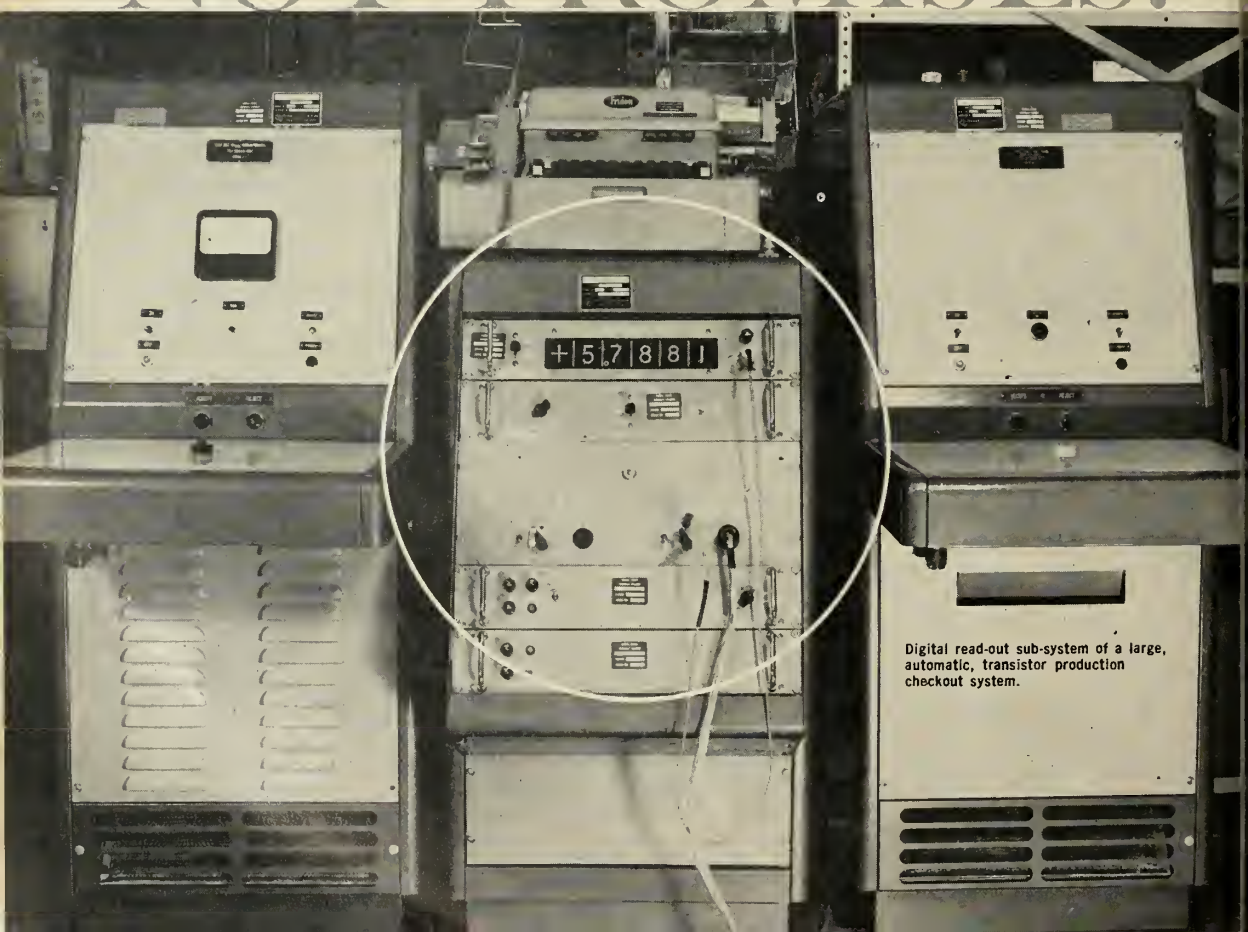
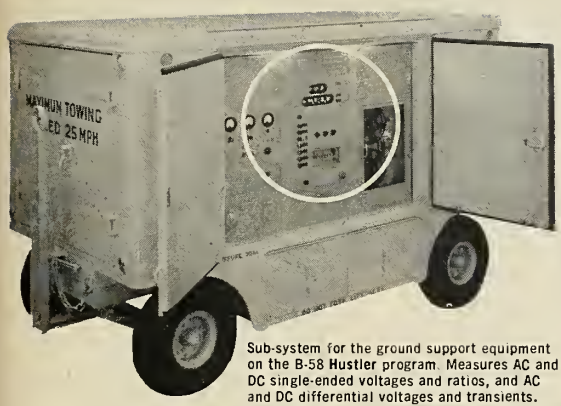
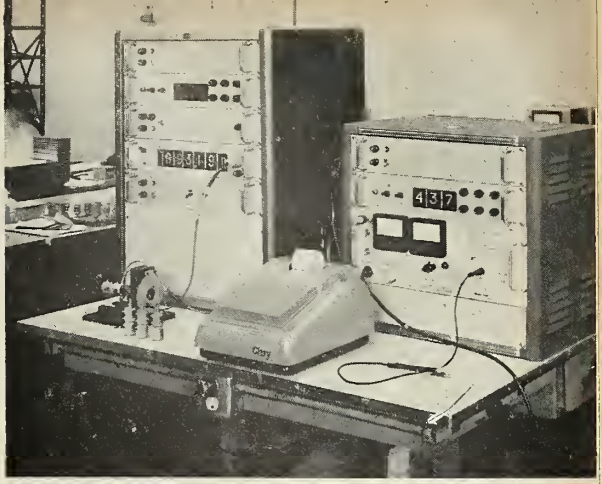


Digital read-out sub-system of a large, automatic, transistor production checkout system.



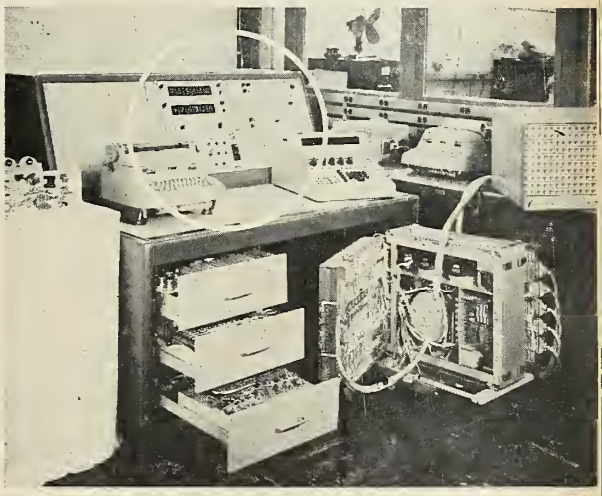
Sub-system for the ground support equipment on the B-58 Hustler program. Measures AC and DC single-ended voltages and ratios, and AC and DC differential voltages and transients. Chosen for its excellent operating characteristics under adverse environments.



Resistance measuring system — Used as a secondary standard to make accurate, resistance measurements required for checking linearity of multi-turn potentiometers.

Systems shown here are typical of more than 200 designed and built by EI and now in use. They range in complexity from data logging systems for automatic scanning, measurement and recording of data from multiple transducers... to high speed, automatic checkout systems for missile and aircraft...to systems for automating industrial processes.

Because of the EI modular design approach, many of these systems can be delivered on virtually an off-the-shelf basis, eliminating the long delivery times usually associated with system development. This approach also results in a low cost system because the modules are manufactured in large quantities. Cost is almost a linear function of performance capabilities desired.



Multi-purpose digital measuring and recording system measures AC volts, DC volts, ohms and ratios. Prints and punches information for immediate reading by the operator and subsequent data reduction.

you get MORE with EI systems!

MORE VERSATILITY

AC and DC voltages, AC and DC voltage ratios, ohmic resistances, capacitance, frequency, phase, inductance, time, or combinations of these basic input quantities can be accepted by the EI system.

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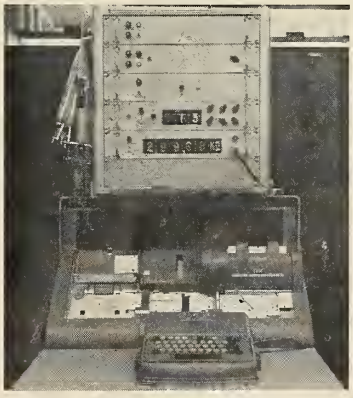
Expansion of the EI system can be made by simply adding appropriate new modules. This approach eliminates new engineering development costs each time needs change; minimizes system obsolescence.

Why not talk over your digital system requirements with your EI Sales Engineer? His system experience will be a valuable help in solving your problem.



Resistor scanning unit — Scans large numbers of resistors, measures values from 0.1% to 0.01% and records the information on punched cards. Operation is automatic and operates entirely unattended.

Electro Instruments, Inc.

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OPERATION

On the Atlantic Missile Range, operation is precise execution. Here thousands of engineers and scientists, scores of corporations, and dozens of government and military agencies work together, in concert, to achieve significant advances in rocketry and astronautical exploration.

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If you are one such man, we invite you to investigate these openings by addressing Mr. J. B. Appledorn, *Director of Technical Employment*, Pan American World Airways, Inc., Patrick Air Force Base, Florida, Dept. B-14.

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determination of the cut-off point other than the theoretical considerations of electron velocities and strength of the magnetic field at right angles to the direction of electron propagation.

Theoretically this "cut-off" should be extremely sharp, provided that the electrons have a singular velocity and that an ideally symmetrical structure is obtainable. In practice, however, the required geometrical symmetry of the magnetron structure, and the perfect axial alignment of the applied magnetic field, is not possible. Further, the accelerating potential and the polarizing magnetic field must be kept extremely constant.

Net result is that the cut-off point no longer becomes clearly defined and exhibits a measurable slope. An added complication is that oscillations may take place in the region of the cut-off which increase the cut-off broadness.

When the collector potential, which accelerates the electrons, is reduced to a very low value, or zero, it may be seen that the cut-off becomes impossibly broad, since the electrons no longer have a singular velocity, being emitted with a wide distribution of initial velocities. Thus the static cut-off method cannot be used with any degree of accuracy.

Early in magnetron development it was found that if the surrounding collector cylinder was split into two semi-cylindrical segments it was possible to generate oscillations in an inductive and capacitative circuit connected between the two segments due to the formation of a negative resistance characteristic. The frequency of this oscillation was determined primarily by the parameters of the external circuit and only to a very slight degree, if any, by the magnetic field strength or collector potential, and this mode of magnetron operation could not be used to measure ambient magnetic fields.

• **Combines principles**—This device, however, makes use of both the principle of self-oscillation by negative resistance, and the broadening of the cut-off point encountered when the collector potential is reduced to vanishingly small values.

Basically, the device creates a "dynamic capacitance" whose value is dependent on the magnetic field strength. Over the oscillating range it is found that, with suitable circuit parameters and suitable magnetron design, the frequency will vary directly and linearly with the applied magnetic field strength.

Iroquois Packs Six *SS-11's*

by an M/R Correspondent

FORT WORTH—"The slickest ever." This is what the Army calls **Bell's** new missile-carrying HU-1A Iroquois.

Now undergoing tests at the Army Aviation Center at Fort Rucker and Redstone Arsenal, the turbine-driven craft packs a punch of six **Nord** *SS-11* missiles.

The French-built weapon is a self-propelled, remote-controlled rocket weighing 62.83 pounds. It's 45.91 inches long and is controlled in flight to the target by the helicopter copilot-gunner.

The missile, using solid propellant, can carry antitank, antipersonnel, smoke or inert warheads, used in practice. The rocket builds up to a speed of 600 feet per second or about 410 miles per hour. With a range of more than 3500 yards, it can be fired by a regular 28-volt aircraft battery.

The missiles are attached to the helicopter on 30-inch racks connected to six-foot outriggers on each side of the fuselage. After the missile's impact, a green plastic assembly package drops off with the wire connection that guides the weapon.

The vital mechanisms in the system consist of three explosive bolts.

Bolt number one fires automatically in this manner: the copilot presses the firing button, exploding the bolt. This causes the arm holding the missile to kick up and get out of the way. The upflinging arm depresses a microswitch which fires up the propellant.

Bolt number two drops the plastic box containing the guiding wire. This one is fired manually by the copilot.

Bolt number three holds the entire assembly. The firing of this one allows the whole assembly, racks and all if necessary, to be jettisoned. The third bolt is also fired manually.

The missile assembly is furnished by Nord and is adapted to the helicopter by Bell. Project engineer for the adaptation is W. L. Cresap.

Bell built the outriggers and ran the wiring to them for the control system.

The HU-1A has a 480-pound turbine engine which can develop 860 shaft horsepower and pull the new missile platform along at 125 miles per hour.

The Army, at least for the present, doesn't foresee the helicopter as a direct counterweapon to tanks. The added firepower, rather, will enable it to carry out its original missions of reconnaissance, medical assistance and general troop support.

Guerrilla-style, the 'copter will use its mobility to pop up behind cover, fire and vanish.

Lab Curiosity May Be Useful in Rocket Work

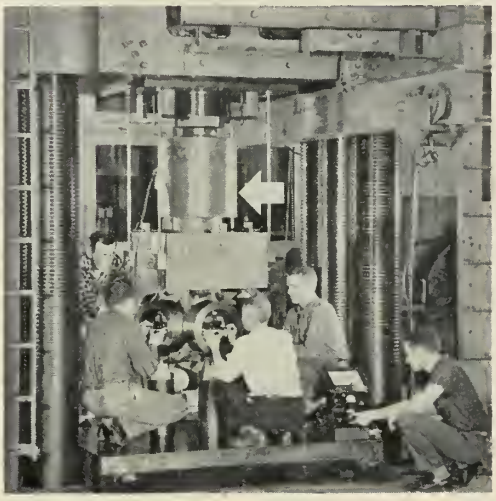
PORTLAND, MAINE—A laboratory curiosity which may have some application in rocket technology was revealed by Dr. Jerome R. Tichy of the **Maine Medical Center.**

While investigating reactions between ammonia and phosphorus pentachloride, Dr. Tichy obtained an explosively exothermic result when he substituted urea for the ammonia, in a solid mixture, and applied gentle heat.

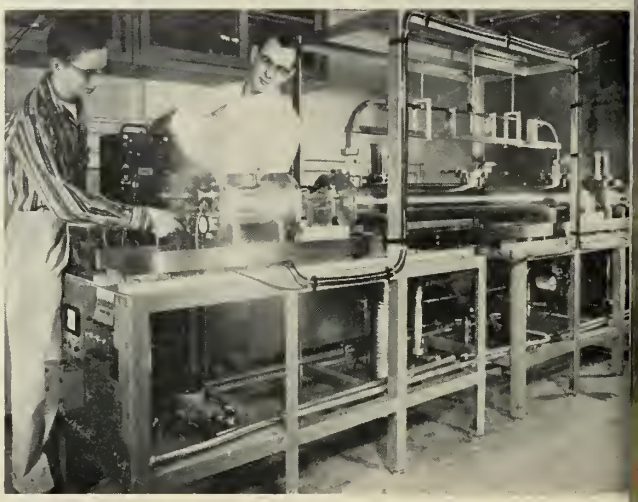
Approximately 50% of the products were gases and, depending on the reactant ratio, the residue was either a dense white solid stable to 360°C, or a sticky, water-soluble liquid. The liquid acts as a glass adhesive when heated.

From a chemical viewpoint, the reaction is extremely complex, involving an unexplained loss of some phosphorus, carbon, hydrogen and chloride.

NBS Needs Funds to Improve Services



USE OF present equipment degrades accuracy. Here a 1.5-million-lbs. load cell is measured with five previously calibrated 300,000-lb. proving rings.



BUREAU'S cesium beam frequency standard is used to check accuracy of other types of atomic clocks. Ultraprecise time (or frequency measurements are demanded in space-time relativistic clock tests

by Hal Gettings

WASHINGTON—Demands for extreme accuracy and reliability in missile and space programs is putting an almost intolerable burden on present methods of calibration and measurement.

These requirements cover a fantastic range—from an accurate measurement of one millionth of an inch up to the measurement of two million pounds of thrust. And adequate measurement standards to cover these requirements are just not available. The lack is seriously hampering missile and space programs and is causing widespread concern among those connected with these programs.

Our one source of basic calibration measurements is the National Bureau of Standards. But even the Bureau doesn't have the facilities and equipment to meet new demands. Only recently were they able to devise a technique for measuring the required one-millionth-inch accuracy of standard gauge blocks, and this only on a complicated laboratory basis. Efforts are under way, however, to expand the services offered by the Bureau and to be able to offer the services demanded by new technology. Here, as in many other places, there's a lag between the job needed and the money necessary to do the job.

Last year the Bureau's budget was around $35 million. Of this amount, $15 million was supported by NBS appropriations. The balance came from other Federal research and development programs and services to industry. These services include calibration, testing and the sale of standard materials samples.

The Bureau's Jobs

Briefly, as defined by Congress, the responsibilities of the Bureau are: 1) development and maintenance of national standards of measurement and provision of means for making measurements consistent with these standards; 2) determination of physical constants and properties of materials; 3) development of methods of testing materials, mechanisms and structures, and the making of such tests; 4) cooperation in the establishment of standard practices; 5) advice to government agencies on scientific and technical problems, and 6) invention and development of devices to serve special needs of the government.

Facilities of the Bureau are divided between the primary laboratories and headquarters in Washington, and the laboratories at Boulder, Colo. Plans have been approved by Congress for a new facility at Gaithersburg, Md. But to date only $4 million of the necessary $90 million for the facility has been appropriated. Design is near completion and Bureau officials are urging a go-ahead on construction. Two of the main features and most urgent building needs are a force-measuring installation far beyond that presently available in the Washington lab, and construction of a linear accelerator.

Bureau of Standards services cut across almost all fields concerned in the missile and space business. They include, generally, electricity and electronics, optics and meteorology, heat, atomic and radiation physics, mechanics, radio standards, metallurgy and materials, and chemistry.

As mentioned before, one of the top priority items for the Bureau is the expansion of deadweight testing facilities. Such facilities are particularly vital in missile/space vehicle development and are absolutely necessary to calibrate force-measuring devices to the required accuracies. During 1959 900 such calibrations were made.

Present capability is limited to machine of 111,000 lbs. New design

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on the board for the Gaithersburg facility will include machines with 300,000 and 1 million lb. capacity.

Indicative of the need for a new super-heavyweight machine, the Bureau has just completed tests on a 1.5 million pound load cell for **Rocketdyne** which will be used in thrust-measurement tests of large rocket engines. A 2-million-lb. cell is presently under construction and this, of course, will have to be calibrated.

Present techniques without the facilities needed involve a complicated process of calibrating proving rings and using these in turn for the final calibration. Consequently several steps are involved with a significant loss of accuracy in each step. Load cells of 3-million-lb. capacity are now calibrated to an accuracy of 0.4% in a compression machine. This accuracy, however, is not sufficient for the missile/space industry.

Industrial weighings require accuracies of 0.05 to 0.2%, and accuracies of 0.1% or better are needed for measuring thrusts of large rocket engines. Calibration accuracies with the new machines should be well within these requirements.

During Fiscal 1959 the Bureau provided 65,401 separate calibration services. These provided an income of over $1.25 million. During the same period, they tested 61,000 samples of materials and devices, the value of which amounted to $1,378,000. The Bureau also sold a wide range of samples ranging from resolution test charts for optics to uranium isotopes standards. The value of these samples was approximately $300,000. (More than 550 different standards of metals, ores, ceramics, chemicals, and hydrocarbons are available for distribution.)

• **Atomic and radiation physics**—The Bureau has been under an ever-increasing demand for services and information relating to atomic and nuclear physics. To meet these needs, research, development, and standardization programs are carried out on a wide scale. This work includes spectroscopic research, free-radicals studies, semiconductor analysis (M/R, April 27, 1959) and many other aspects of the behavior of electron particles and radiation.

• **Chemistry**—NBS does extensive work in both basic and applied research in chemistry as applied to the missile field, most importantly in materials research. Work has included research on alloys, boron compounds as potential fuels, and plasma jet studies.

• **Development, improvement and maintenance of standards and the measurement of mechanical quantities**—Basic to the Bureau's program. Some areas here relating to the missile/space business include calibration of high-acceleration vibration pickups, the setting of standards for magnetic tapes used in recording telemetered data from missiles and satellites, pressure measurements, and performance testing of telemetering transducers.

The Bureau has done both fundamental and applied research on a wide variety of materials vital to missiles and space. One area of attention has been ferroelectrics which are used in accelerometers, as dielectrics, and as memory devices in electronic computers. Extensive work has been done also in ceramic dielectrics. Further work in this area has included high-temperature coatings for supersonic vehicles.

• **Data-processing systems**—The Bureau has provided research, development, systems design, and analysis as well as technical advisory services, for both digital and analog computer technology. This has included work on high-speed automatic data processing systems and processors, analog computers, and considerable work on the computer components techniques—as well as on core circuitry, rapid access, digital systems, and advanced computer simulation systems.

• **High-pressure standards**—The pressure standards program has been recently expanded to include development of improved standards and techniques for measuring very high pressures. Extreme pressures offer great promise in treating new materials to meet some of the most severe military and industrial requirements. Remarkable changes in physical properties often appear when materials are subjected to high pressures. Some familiar electrical insulators become semiconductors, and some familiar semiconductors become conductors. Experiments have been conducted at pressures up to almost 2,000,000 psi.

• **Cryogenic engineering**—The Bureau's cryogenic engineering program is located at the Boulder laboratories. Research in this area is particularly vital to the missile industry, not only in the production and handling of cryogenic fuels, but also research into the behaviour of materials at extremely cold temperatures. The Boulder cryogenic facility's basic function is to acquire and disseminate basic engineering data on materials, processes and equipment used at temperatures as low as −456°.

• **Standards and calibration in radio and electronics**—Space exploration, automation, and miniaturization are subjecting electronic equipment to new and complex uses as well as to extreme environments where the need for accuracy and reliability becomes increasingly important. In the missile field, for example, it is estimated that reliability above 90% can be achieved only if each component has not more than 1 to 1000 probability of failure. To produce components with the necessary uniformity and accuracy requires a chain of calibration leading from the assembly line back ultimately to NBS's precise electrical standards.

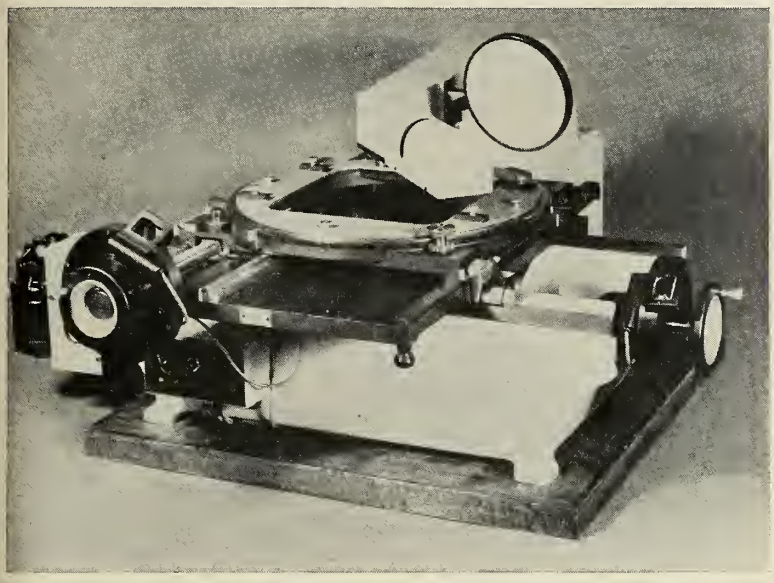
As indicated by a recent Aerospace Industries Association survey, the precision needs of the military services and industry are outstripping the availability of standards and calibration services in the radio-electronics field. Manufacturers have attempted to fill the gap by calibrating their own working standards, but these lose much of their value if they are not calibrated in terms of national standards.

The Bureau's Radio Standards Laboratory at Boulder is expanding its program of standards research and calibration services to provide standards measurement techniques and associated instrumentation needed for all radio frequency and microwave quantities.

At present, standards are being established or improved for frequency, power, attenuation, voltage, noise, field strength, interference, conductivity, dielectrics and magnetics. In addition, a new laboratory using advanced techniques, has recently been activated to study radio properties of materials. (A survey of RSL work was carried in the Nov. 17, 1958, issue of M/R.)

One of the primary functions of the Boulder lab is work in radio propagation. This includes work on finding the origin and structure of the ionosphere and its influence on radio communication, and the propagation of low and very low frequencies over the earth and through the upper atmosphere. They operate here a radio "weather" service which issues predictions for optimum frequencies for radio transmissions, and forecasts radio transmission disturbances. From this work comes information that assists government agencies in allocating frequency spectrum assignments on the most efficient basis. Another service of RSL is the monitoring of radio-standard frequencies with atomic standards making comparisons to one part in 100 billion.

Far more than merely establishing basic standards, Bureau activities have contributed directly to many aspects of our missile and space programs. Even greater returns can be reasonably expected with increased support from government and industry.



Satellite Orbits Plotted by Comparator

A two-coordinate precision screw comparator called Model 422D specifically designed to facilitate operator handling and to give extreme versatility in use is announced by **David W. Mann, Inc.**

Applications of Model 422D are exceptionally varied, ranging from medical, chemical and ballistics research to the study of survey and space measurements. The Smithsonian Astrophysical Laboratory used it to plot the path of *Sputnik I* and *Explorer I* when the satellites first went into orbit. It was also used in Project *Vanguard* to calibrate the Minitrack system.

The two coordinate comparator accomodates plates and films to 10″ x 10″ with a measurable area of 9″ x 9″. It has a range of 265 mm in the X-Coordinate and 250 mm in the Y-Coordinate. Illuminated dial units provide direct reading accuracy to one micron in both coordinates.

Offering operator convenience, a unique two-stage projection system combines plate image with measuring mark, projecting it on a screen at 22X magnification. The top stage rotates through 360° with vernier readings on the precision circle to 20 seconds. The front surface projection system produces large clear images, reducing error and fatigue.

The operator is provided with the added convenience of direct viewing without the confining position of direct viewing systems. Slides may be moved by precision screws or disconnected and actuated freely for quick alignment of widely separated points.

Circle No. 225 on Subscriber Service Card.

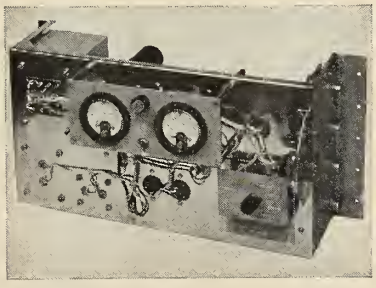
Transistor Power Supply Has Low Thermal Drift

A transistorized, regulated power supply, Model PS4023, is available from **Power Sources, Inc.**

Operating at an input voltage of 105-125 volts at 57-63 or 380-420 cps, it puts out 100 to 200 volts at up to 400 ma load current. The output voltage is selectable by a six-step range switch, while a vernier potentiometer is provided for exact adjustment of output voltage.

Regulation performance is such that there is less than 0.03 percent change in the set output voltage for any combination of input voltage or load current conditions.

Thermal drift is held to a minimum. There is less than 0.006 percent per degree Centigrade change in output voltage. Total ripple and noise is less than 2.5 rms millivolts.



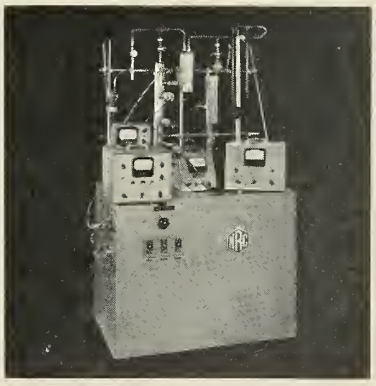
Recovery time with the vernier set at the low end of the range is 20 milliseconds, while with the vernier at the high end, recovery time is only 150 ms. Special circuitry prevents damage to components when the output is dead shorted.

Circle No. 226 on Subscriber Service Card.

Test Bench Simplifies Vacuum Gauge Calibration

A universal test bench that can be used to calibrate vacuum gauges with ranges from atmosphere down to as low as 10^{-5} mm Hg. pressure has been developed by **NRC Equipment Corp.** for use in industrial plants and in industrial, university and military laboratories.

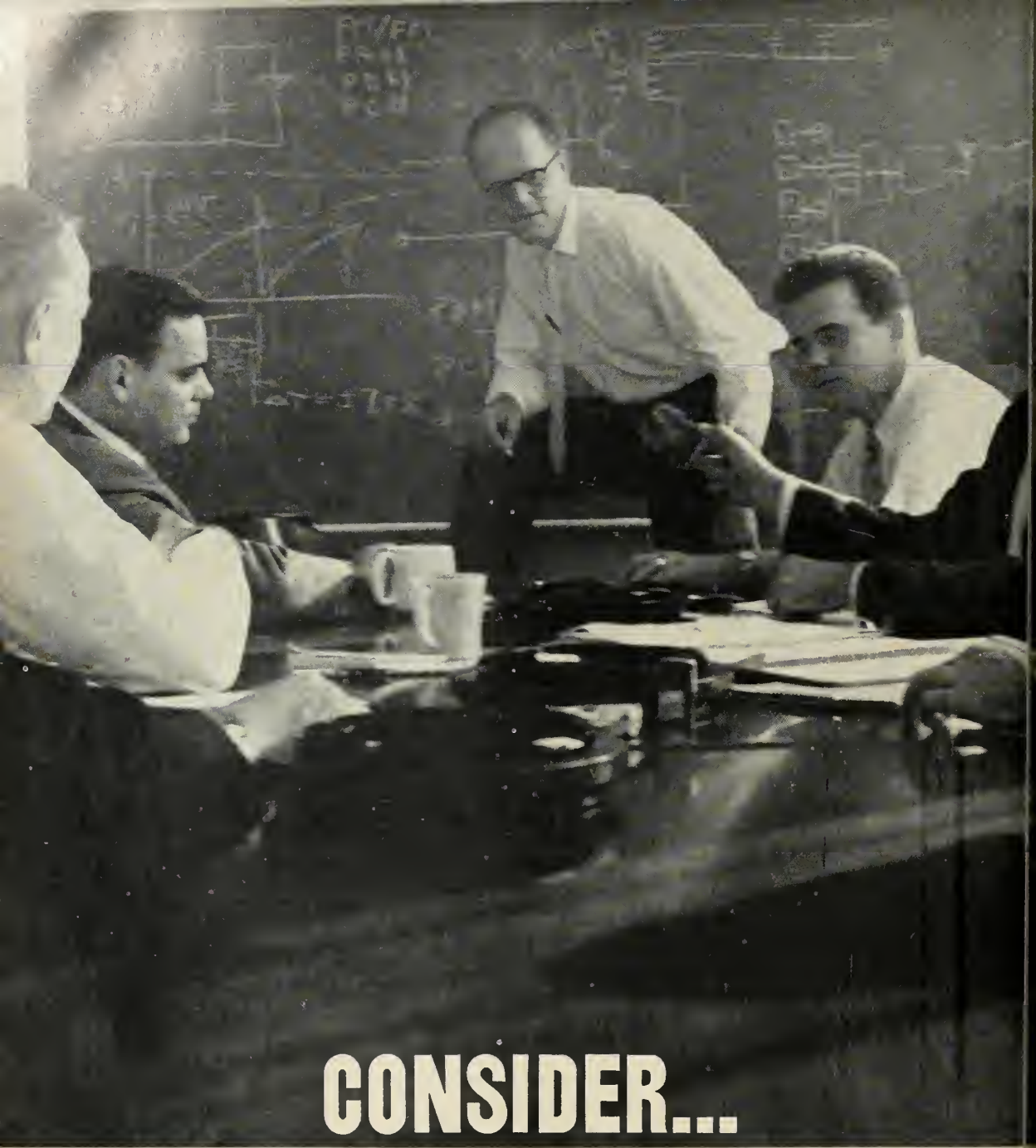
The completely self-contained system is expected to eliminate the problem of shipping gauges back to the manufacturer for calibration and thus to contribute to more accurate control



of vacuum processes and research studies.

The apparatus consists of a 2″ high vacuum pumping system complete with air drying column, pressure regulating needle valve, and liquid nitrogen traps; a vertical manifold with individually valved gauge ports; a three-range McLeod gauge with associated CO_2 driven mercury system; and a precision manometer. All components are mounted in or supported on a compact cabinet.

The manometer covers the range from atmospheric pressure to 5 mm Hg and can be read to an accuracy of 1 mm Hg or better. The multi-range McLeod gauge, used because of its reported accuracy and stability over long periods, will read from 17 mm Hg to 0.03 microns; ranges are 3.5 to 17 mm



CONSIDER...

Lockheed for telemetry

Out of Lockheed creative engineering sessions such as this come advanced design and proven performance in the field of telemetry. Lockheed's pioneer work on the X-17 project resulted in the first successful telemetering of vital data during re-entry. Research continues to provide even greater reliability of performance to meet present requirements.

The Lockheed Electronics and Avionics Division (LEAD) is currently conducting research in Frequency Modulated and Pulse Modulated Systems for industrial and military needs.

For proven reliability in telemetry components and systems, consider LEAD.

Look to Lockheed for LEAD*ership in Electronics*

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Hg; 0.815 to 5 mm Hg; 0.264 to 1.59 mm; and 0.03mm to 1.13 mm. It is also available with ranges of from 0.004 to 5 mm Hg.

Accuracy of the McLeod gauge is said to be one percent of scale reading, and both it and the manometer are equipped with mirrors to eliminate parallax.

The unit is shipped partially assembled—all that remains for the operator to do is to connect the glass ware by means of a set of waxed spherical joints. Complete instructions are provided for this, and there is no need for outside field men to be involved in the assembly.

Among the gauges for which the Model 904 is adaptable are thermocouple, thermopile, and Pirani gauges, Phillips and Aphatron Ionization Gauges and, over part of their range, hot wire ionization gauges. It also can be employed for mechanical gauges by use of a pipe adapter in the manifold.

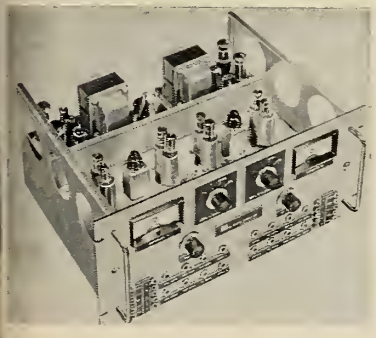
Circle No. 227 on Subscriber Service Card.

Adaptability Features In Servo Controller System

New, high-performance electronic servo-controller combinations for use in dynamic process control systems have been announced by the **Compu-Dyne Corp.**

They are described as the first dynamic feedback control loop components to be developed that easily can be adapted to the individual requirements of practically any given system.

The units, identified as Series 800,



can fully reproduce the transfer functions described by a typical, high-grade analog computer. Each unit, comprising a controller, servo-amplifier, and power supply, is capable of performing any of the three basic control functions: summation, integration, and derivative. In addition the equipment is designed so that signals and functions can be added, eliminated, or varied according to the requisites of the system.

The Series 800 Servo-Controller combinations can be applied to the control of any electrically-measurable variable. They are most frequently used with electro-hydraulic actuators, especially where large mass positioning in the final control element is necessary. However, units include provisions for use with electrical and pneumatic actuators.

The three basic sections of each Series 800 unit (controller, servo-amplifier and power supply) are custom assembled according to the demands of the particular system. All units, however, are adaptable to any form of start-up, operational and shut-down programming, and include a mode-selector switch with settings for "automatic," "automatic balance," "manual balance," and "manual." There is provision for individual balancing of each amplifier in multi-amplifier units.

Circle No. 228 on Subscriber Service Card.

Silicon Mesa Transistor In UHF Available

Texas Instruments Inc. has announced that two silicon mesa transistors featuring high power combined with high frequency are available in production quantities.

The new TI silicon mesa transistors, the 2N715 and 2N716, are capable of a guaranteed minimum power output of 500 milliwatts at 70 megacycles. These devices will deliver approximately 50 milliwatts at 200 megacycles. The inherent high-dissipation capabilities of transistors produced by the TI diffusion process permit both the 2N715 and 2N716 to be packaged in the subminiature JEDEC-outline TO-18 case.

Both transistors have a guaranteed beta spread of 10 to 50 and a collector reverse voltage of 50 and 70 volts (for the 2N715 and 2N716 respectively). Collector reverse current at 25°C is 0.5 microamps maximum and 50 microamps maximum at 150 C. Temperature limits are at –65°C and 175°C.

Circle No. 229 on Subscriber Service Card.

Console Interprets Data In Layman's Terms

A control and display console, which enables anyone to operate a computer and which interprets data in nontechnical language has been introduced by the Intellectronics Laboratories of the **Ramo-Wooldridge Division** of **Thompson Ramo-Wooldridge Inc.**

The R-W Analysis Console can be connected to any data processing system. Through the use of a simple keyboard arrangement, operators may con-

trol the computer, to which the console is attached, and demand a display of data either in graphic or in understandable printed form on the console's video screens.

This means an individual may search the computer to which the console is connected in his own language, and receive the answer in his own language. It is not necessary to be familiar with the technical computer code.

Circle No. 230 on Subscriber Service Card.

Recorder To Telemeter Manned Satellite

Giannini Controls Corp. announced the development of a new simplified, self-contained inertial platform system for short range ballistic missiles.

This non-servoed system fills the vital requirement for a really small (2¾" dia. x 4½" long), low cost guidance package that will eliminate misalignment and dispersion problems during the high acceleration boost stage of flight.

System components consist of a free gyro and two subminiature accelerometers. The accelerometers are mounted on the gimbals of the gyro with the sensitive axes oriented perpendicular to the gyro spin axis. The gyro spin axis then described the line space along which the rocket is guided. The system is highly accurate and fully operative within 5 seconds after power is applied.

Circle No. 231 on Subscriber Service Card.

Recorder To Telemeter Manned Satellite

A magnetic tape recorder/reproducer built by the DataTape Division of **Consolidated Electrodynamics Corp.** has been delivered to the National Aeronautics and Space Administration to record telemetered data from Project Mercury, the nation's first manned orbital space flight.

The ground recording station is a CEC Type 5-752 Recorder/Reproducer modified to direct record or play back

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five channels of analog data, two of FM and two of PDM simultaneously. Special PDM electronics techniques with high accuracy make possible playback at 1-7/8 inches per second. Such accuracy is essential for multiplexed data because of the difficulty of accu-

rate time correlation during reconstruction at faster speeds. The tape transport can also operate at 15 ips.

Circle No. 232 on Subscriber Service Card.

New Literature

MICROWAVE DIODES. A technical booklet on microwave diodes has been made available by **Sylvania Electric Products Inc.** The 12-page booklet contains complete electrical and mechanical data on all microwave diodes manufactured by Sylvania as well as a replacement guide to nearly 200 widely-used diode types.

Circle No. 200 on Subscriber Service Card.

INSULATORS. A revised bulletin on "High Purity Insulators for Sheathed Thermocouples" has been published by **Norton Company.** It describes the uses and technical specifications of fused magnesium oxide, aluminum oxide and zirconis thermocouple tubing used in connection with aircraft turbines, atomic reactors and other situations where accurate temperature measurement is important.

Circle No. 201 on Subscriber Service Card.

CHRONOGRAPH. A two-page bulletin by the **Computer Equipment Corp.** describes the operational characteristics and technical specifications of the Millimicrosecond Quantizer, an electronic chronograph that measures the time between events to a resolution of 20 millimicroseconds with an accuracy of 1 part in 10^7 per day.

Circle No. 202 on Subscriber Service Card.

URETHANE FOAMS. Blowing urethane foams with fluorinated hydrocarbons is presented in a new publication by **Pennsalt Chemicals Corporation.**

Circle No. 203 on Subscriber Service Card.

soviet affairs...

By DR. ALBERT PARRY

Rare-earth elements . . .
as a subject of U.S. Space Age research was one of the less-publicized items on Nikita Khrushchev's list of inquiries during his American trip last September. He did not personally visit the laboratories of the University of Iowa at Ames, whose experiments in rare elements are of such interest to the Soviets. But he did send a metallurgist from his traveling staff, 58-year-old Prof. Vasily S. Yemelyanov of the Soviet Academy of Sciences, head of the USSR Council of Ministers' Main Office for the Utilization of Atomic Energy, to observe the Iowa experiments.

"Most interesting" . . .
were those experiments, the Russian scientist reported one month later in *Izvestia*. In his article Prof. Yemelyanov noted that, for their study of the properties of the elements, the Ames researchers "separate them in their pure form, which then, as a basic element, reaches 99.99 per cent." He praised the special laboratory equipment at Ames which results in the yield "of several tons of rare-earth elements a year." Wistfully he proposed Soviet-American collaboration in this as well as other fields of scientific research.

What rare rocket-age metals . . .
especially interest the Soviets? One answer was given sometime ago in *Komsomolskaya Pravda* by L. Tisov, an engineer and a geologist, who in a detailed article named the following rare and scattered elements which "await their future": Niobium, tantalum, lithium, beryllium, zirconium, boron, germanium, gallium, thallium, and thulium. More recently, in another *Komsomolskaya Pravda* article, A. Presniakov mentioned hafnium among several much-valued metals that some day in the future "may be grown as vegetation." He referred to French research with plants known to accumulate tiny stores of metallic elements in their roots, stems, branches or leaves. Using these French experiments as his base, the Russian author boldly predicted "A Garden of Metals" (the sensational title of his article) where man tomorrow would grow and harvest "not fruit or berries, but metals," particularly such rare ones as hafnium, lithium, and zirconium.

Gallium, meantime, is produced . . .
prosaically, along with other rare metals needed by the Soviets that cannot wait for those fantastic gardens of the future. We read in *Krasnaya Zvezda* that Hungarians are now obtaining gallium, this "extraordinarily rare metal," not from any trees or bushes, but as a by-product of their aluminum industry. Hungarian scientists and engineers are reported by the Red army newspaper to have evolved a new method of treating the remnants of alumina after the latter is processed into aluminum, with the result that the alumina waste yields the greatly desired gallium.

A special gallium factory . . .
has been built in Hungary for this purpose, producing nearly 15 kilograms of gallium annually. Pointing to the high cost of gallium on the world market ("worth more than diamonds"), the Russian military daily says: "The atomic industry is the most important field where gallium finds its application." That the Hungarians are producing gallium for the needs of the Soviet empire, and not for themselves, is quite evident.

A Space Age substance called "sitall" . . .
is announced by Moscow's Tass News Agency as the latest proud achievement of Soviet scientists. A glass microcrystalline material, it is described as lighter than aluminum and more durable than steel. It can stand temperatures of 1000°C (1832°F), and has "high mechanical, thermal and electrical properties."

contracts

NASA

$25,690—**ITT Corp., Industrial Products Division**, San Fernando, Calif., for oscilloscope display for monitoring tunnel tests.

$25,312—**Midwestern Instruments, Tulsa**, Okla., for direct recording oscillograph for Lewis Research Center. Cleveland.

NAVY

$500,000—**Northeastern Engineering, Inc.**, Manchester, N.H., for furnishing an undisclosed quantity of high-speed electronic frequency counters, used for missile checkout, for calibrating single side band communications and for similar systems.

$149,008—**North American Aviation, Inc., Autonetics Div.**, Downey, Calif., for design, development and furnishing of two Verdon computers.

$53,303—**Commercial Engineering Corp.**, Houston, for design, development, and construction of one variable depth sonar-towed vehicle.

MISCELLANEOUS

ALWAC Computer Div., El-Tronics, Inc., Hawthorne, Calif., has received a contract from **Marquardt Corp.**, for a special on-line data reduction system. Amount not disclosed.

$400,000—**Flite-Tronics, Inc.**, for design and manufacture of laboratory test equipment. Subcontract from **Hughes Product Div., Hughes Aircraft Corp.**

$392,000—**Hoffman Laboratories Div., Hoffman Electronics Corp.**, for maintenance and operation of TACAN air navigation equipment, ARN-21, and associated equipment.

$270,000—**Sylvania Research Laboratories Div., Sylvania Electric Products., Inc.**, for research and development on high-temperature materials for use in solid-fuel rocket engines.

AIR FORCE

$26,546,250—**International Business Machines**, for installation, on-site maintenance and logistic support of the computer systems at SAGE sector sites.

$15,000,000—**Raytheon Co.**, Waltham, Mass., for development of a radar system to track intercontinental ballistic missiles thousands of miles away and to identify their warheads.

$6,627,092—**Philco Corp., Government & Industrial Div.**, for engineering, furnishing and installation of equipment for the Quick-Fix phase of AIRCOM integrated communications system.

$4,815,000—**Avco-Everett Research Laboratory**, a division of **Avco Corp.**, for the continuation of basic studies applicable to ICBM re-entry vehicles, and other classified areas of work.

$3,940,000—**Radio Corp. of America**, for work on a new Pacific Ocean research center that will seek new ways to detect and identify incoming missile warheads.

$1,250,000—**Hughes Aircraft Co.**, Culver City, Calif., for continued development of AN/ASG-18 fire control system and *GAR-9* air-to-air missile.

$929,210—**International Business Machines Corp.**, for SAGE system engineering program.

$618,835—**Columbia University**, New York City, for continuation of research on a MASER to amplify or oscillate at infrared frequencies.

$268,928—**Collins Radio Co.**, Cedar Rapids, Iowa, for components of the MA-1 flight director system.

$84,760—**Cornell University**, Ithaca, N.Y., for continuation of research on new solid defect structures.

$64,798—**C. P. Bauman & Son**, Champaign, Ill., for modification of building to provide facilities for *GAM-77* training.

$47,400—**Johns Hopkins University**, Baltimore, for continuation of a "Study of the Spectra of the Triply Charged Rare Earth Ions."

$40,003—**Boeing Airplane Co., Pilotless Aircraft Div.**, Seattle, for reproducible copy applicable to the *IM99A* missile.

$44,000—**The Institute of Advanced Study**, Princeton, N. J., for continuation of work on "Advanced Mathematical Research."

$39,716—**Yale University**, New Haven, Conn., for research on "Electron Nuclear Interactions and Related Aspects of Nuclear Structure."

$32,570—**Arthur D. Little, Inc.**, Cambridge, Mass., for performance of research and preparation of reports relating to a space environments simulation facility.

$27,522—**Litton Industries, Electronic Equipment Div.**, Beverly Hills, Calif., for performance of research and preparation of reports relating to a space environments simulation facility.

$25,000—**California Institute of Technology**, Pasadena, for continuation of research on "Equations for Viscous Fluids."

ARMY

$22,143,981—**The Martin K. Eby Construction Co.**, Wichita, Kan., for *Atlas* missile facility construction at Warren AFB, Cheyenne, Wyo.

$11,889,500—**Western Electric Co.**, for improved capability of the *Nike-Hercules* missile system.

$3,000,000—**Western Electric Co.**, for repair kits for the *Nike-Hercules* missile system.

$2,100,000—**Ramo-Wooldridge, Div. of Thompson-Ramo-Wooldridge, Inc.**, Los Angeles, for automatic data processing system test facility.

$2,050,000—**Chrysler Corp.**, Detroit, for deployment of *Jupiter* missile systems to overseas installations. Two contracts.

$1,722,000—**Esso Research and Engineering**, Elizabeth, N. J., for continuation of a program of advanced research on solid rocket propellants.

$1,584,555—**Varian Associates, Palo Alto**, Calif., for tunable high-power klystron tube for the *Nike-Zeus* acquisition radar transmitter and ancillary items.

$1,032,480—**Arrow Construction Co.**, for construction of drone assembly building, Fort Huachuca, Ariz.

$589,355—**Philco Corp.**, Philadelphia, for basic and logical processor and computers for automatic data processing system.

$550,135—**John C. Abbott**, Vero Beach, Fla., for construction of Navy Fleet ballistic missile facilities and buildings at Air Force Missile Test Center, Cape Canaveral Missile Test Annex.

$460,000—**The Fruehauf Trailer Co.**, Detroit, for the manufacture of 111 antenna carriers used as part of the ground support equipment for the *Hawk* missile.

$400,000—**Langley Corp.**, for development and production of *Atlas* ground support equipment. Subcontract from **Convair-Astronautics.**

$300,000—**Collins Radio Co.**, Richardson, Tex., for services and materials for one primary and two secondary satellite tracking stations.

$300,000—**Radiation, Inc.**, Melbourne, Fla., for ground stations for *Courier* communication satellite system, satellite checkout facility.

$252,448—**Electron Tubes Div. RCA**, Harrison, N.J., for services and materials for research and development directed toward fulfillment of SCTR entitled "A Reliable Long Life Pencil Triode for a Communications Satellite."

$129,847—**North American Aviation, Missile Division**, Downey, Calif., classified.

$71,000—**General Electric Co.**, Syracuse, for repair parts for radar sets.

$57,198—**Eitel-McCullough, Inc.**, San Carlos, Calif., for electron tubes.

$56,150—**Collins Radio Co.**, Cedar Rapids, Iowa, for development of improved tactical antenna system.

$50,000—**ITT Labs, Div. ITT Corp.**, Nutley, N. J., for ground stations for *Courier* communication satellite system.

$49,408—**Motorola, Inc.**, Phoenix, Ariz., for testing AN/MRC-66 automatic electronic switching equipment.

$44,000—**Molybdenum Corp. of America**, Washington, Pa., for 25,000 lb. molybdenum (contained).

reviews

SOVIET NUCLEAR PROPULSION, Triumph Publishing Company, Washington, D.C. 45pp. $2.85.

This study of Soviet developments in nuclear transportation and propulsion was originally translated from the Russian for U.S. Intelligence purpose.

Published as an aid to U.S. research and development, the pamphlet is a general survey of Soviet proposals and concepts. Partial contents include: "Nuclear Engines," "Nuclear Submersibles," and "Nuclear Rocket Propulsion."

HIGH TEMPERATURE CRITICAL SYSTEMS, Harry L. Reynolds, Lawrence Radiation Laboratory, Livermore, Calif. Order ARS 1014-59 from American Rocket Society, 500 5th Ave., New York 18, N.Y.

Over the past few years, the laboratory has been involved in the measurement of critical masses for "clean" systems at room temperature. A "clean" system is a critical assembly of very simple geometry such as rectangular parallelipiped containing only the fuel and moderating materials.

The moderating materials used in these "clean" experiments were graphite, beryllium, and beryllium oxide; all useful materials for high-temperature propulsion reactors.

Criticality in the Hot Box was attained for the first time in February of this year. The concept of studying "clean" systems has been continued. At the present time, a BeO-moderated, graphite-reflected system is under study. The graphite reflector is maintained at a temperature 800° lower than the BeO core.

SYSTEMS FOR IGNITION OF SOLID PROPELLANTS, J. W. Rabern, Olin Mathieson Chemical Corporation. Order ARS 977-59 from American Rocket Society, 500 5th Ave., New York 18, N.Y.

The design of ignition systems for solid rocket engines is primarily based on empirical approaches and past performances of other ignition systems.

Design problems frequently encountered in ignition programs include: envelope for the ignition, reproducible ignition delays, controlled chamber pressure during ignition, determination of propellant ignitability, ignition of aged propellant, low-temperature ignition without overpressurization of chamber at high temperature, control of debris from inert igniter components, vibration, drop test and autoignition requirements.

The historical development of ignition compositions and of igniter designs is described.

R. F. AMPLIFIERS, Edited by Dr. A. Schure, John F. Rider Publisher, Inc., N.Y., $2.40

Volume 27 of the Electronic Technology Series, this book covers the design and theory of a wide range of both low- and high-power r-f voltage and power amplifiers. It treats all classes of v.t. and transistorized amplifiers and includes practical design examples.

propulsion engineering...

By JAY HOLMES

A big development contract . . .
in the offing is the half-million-pound-thrust, second-generation liquid hydrogen-LOX engine. NASA is planning to ask for funds in the 1961 budget to start work on the $50-100 million job.

As a result, major rocket companies have begun to make claims and counterclaims about their capability for work with hydrogen, the ultimate chemical fuel. **Pratt & Whitney, Rocketdyne** and **Aerojet** all have made statements recently aimed at calling attention to their qualifications. In addition, **General Electric, Bell Aircraft** and **Thiokol's Reaction Motors** are known to be interested. **Curtiss-Wright** is a seventh possibility.

Performance details are classified . . .
although any engineer with a slide rule could calculate that the optimum thrust for a high-energy second stage atop *Saturn* is between 500,000 and 600,000 lbs. But this doesn't mean that a single chamber of such huge size will be developed.

In all likelihood, the engine will be a cluster. One guess might be a cluster of four in the 125,000-150,000-lb. class. The most commonly mentioned development time is about three years. This would make the hydrogen engine available for housing in a vehicle at about the same time the *Saturn* booster is ready.

The 30% impulse rise . . .
that results from burning hydrogen as a fuel is the basic fact underlying NASA's interest. Substitution of hydrogen for kerosene as fuel in any stage makes possible a 50% increase in payload. Substitute hydrogen in two stages and you more than double the payload.

Surprisingly, materials are less of a problem. The temperature of a hydrogen-oxygen flame is less than 6000°F, more than 200° less than the temperature of an oxygen-RP flame. The added impulse of hydrogen results from the fact that the product molecules, mostly H_2O, are much lighter. Some of the hydrogen isn't burned. Instead of a stoichiometric mixture of 8 parts oxygen to 1 of hydrogen (by weight), the optimum combination is in the range of 5-7/1. The unburned hydrogen, with a molecular weight of 2, thus adds tremendously to the average velocity.

Who's on first in hydrogen engines? . . .
Any list would have to start with Pratt & Whitney, which just last week announced successful tests of the 15,000-lb. *Centaur* engine (see page 19). Pratt & Whitney estimates it has put $8 million of company money into facilities and development, in addition to the government funds it has received through a contract first with the Air Force and now with NASA.

Rocketdyne points out that the biggest engineering problem is the pumps—because the low hydrogen density entails such a large volume of liquid—and that it has built what it calls the biggest liquid hydrogen pump in the free world. Rocketdyne developed the pump for AEC and NASA under the nuclear rocket program. Rocketdyne, which has been working on liquid hydrogen for four years, says it has spent more than $250,000 of its own funds to develop all the components necessary for a big LOX-hydrogen engine, including gas generator, turbines, thrust chamber and controls.

Aerojet cites its experience under an Air Force contract, now phasing out, through which it investigated the feasibility of a hydrogen-burning engine with more than 100,000 lbs. of thrust. Aerojet has fired brief bursts from such an engine, the largest on this side of the Iron Curtain. More than $400,000 of company money has been spent on the Aerojet engine's pump feed and regenerative cooling system.

Why is hydrogen so special for space? . . .
One intriguing advantage is that it could be stored on the moon, where there'd be no problem in maintaining the vacuum necessary for insulation.

Air brake for a spaceliner

The earth's atmosphere, one of the biggest obstacles to getting into outer space, can be one of our biggest assets coming back. At Douglas we are investigating how we can use its braking effects on rockets returning from deep space trips at far faster than ICBM speeds. Success will allow us to increase payloads by reducing the weight of soft landing systems. This technique also will aid us in pinpointing landing areas. Current reports show real progress. Douglas is engaged in intensive research on every aspect of space planning, from environmental conditions on other planets to the destroyer-sized space ships necessary to get there. We invite qualified engineers and scientists to join us. Some of our immediate needs are listed in the column on the facing page. Please read it.

Arthur Shef, Chief, Advanced Design Section, Missiles and Space Systems, irons out a problem with Arthur E. Raymond, Senior Engineering Vice President of **DOUGLAS**

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT

NASA, DOD Streamline Booster Effort

by C. Paul Means

WASHINGTON—The nation's space program was reorganized last week in an effort to streamline the space rocket booster programs and to coordinate civilian and military efforts in this vital area.

The results of a joint action taken by the Department of Defense and the National Aeronautics and Space Administration were to:

- Establish a new department in NASA to direct the space booster program;
- Appoint Air Force Major General Don R. Ostrander—presently Deputy and Acting Director of ARPA—to head the new organization as Director of Launch Vehicle Programs;
- Downgrade the status of ARPA by requiring its director to report to Pentagon R&E chief Dr. Herbert York rather than to the Secretary of Defense;
- Appoint Army Brig. Gen. Austin W. Betts—presently Dr. York's military assistant—to take Gen. Ostrander's place as Director of ARPA.

Gen. Ostrander will take his new job Jan. 1. He will remain on active duty with the Air Force.

The Ostrander agency was carved out of the organization presently headed by Dr. Abe Silverstein. Under the new set-up, Gen. Ostrander will be in charge of the booster and launching developments (including Project *Saturn* and the ABMA's Development Operations Division when transferred) and Dr. Silverstein's Space Flight Development Team will be in charge of upper stages, envelope, payloads, mission planning and inflight research and operations.

MAJ. GEN. Don R. Ostrander, who takes over the top space booster job at NASA.

Gen. Ostrander, 45, was picked for the new job because of his close association with the Air Force missile programs during the past 15 years. Before coming to ARPA he was assistant to the NATO assistant secretary general for guided missiles production in Paris, and he has also held a number of administrative posts in the Air Force's ARDC.

The Pentagon's decision to downgrade ARPA made it merely an arm of York's office of Research & Engineering. Originally established after *Sputnik I* as the nation's prime space agency, ARPA held equal status with the three military services and its Director reported directly to the Secretary of Defense.

After experiencing great difficulty in obtaining a successor for ex-ARPA director Roy Johnson, the Pentagon apparently has decided to put the agency under the direct control of Dr. York. Gen. Betts, in his new post, will continue to report to Dr. York, just as he has during the time he has served as York's military aide.

Before he became the R&E chief's assistant, Betts was deputy director of ARPA's guided missile division.

When the military services take over operational control of ARPA's military satellite project, the agency will be left with four advanced research projects costing about $150 million a year. These include a missile defense program, a solid propellant program, a materials research program, and a research project investigating ways to police a nuclear test ban.

Navy Seeks Anti-missile Birds

by James Baar

WASHINGTON—The Navy has officially disclosed that it is developing a *Super Talos* anti-missile missile.

It also made it clear that it is working on the problem of developing missiles capable of destroying Soviet IRBM's shortly after they are launched from Soviet submarines.

The disclosures came in the release of secret testimony given before the House Space Committee in June.

The Navy only a few months ago denied the published report (M/R, Sept. 21) that it was developing an anti-missile missile.

The report disclosed that the *Super Talos* was being developed for use against air- and surface-launched missiles fired at surface ships. It said the advanced **Bendix** *Talos* also might eventually be used for defense against submarine-launched missiles and possibly against ICBM's.

The House committee heard Vice Adm. J. T. Hayward, Deputy Chief of Naval Operations for Development, and Rear Adm. Rawson Bennett, Chief of the office of Naval Research, testify on the Navy's anti-missile missile program. Both admirals appeared at a closed hearing.

The heavily censored testimony did not mention *Super Talos* by name, but merely spoke of improvements in *Talos*. However, it made clear that the improved models are being designed to defend the U.S. fleet "against short and intermediate range" ballistic missiles.

The testimony stressed that work on "various means" of knocking down missiles shortly after they are launched from submarines was still in the study stage.

The need for a defense against submarine-launched missiles as quickly as possible has become increasingly evident in recent months.

Top Navy officials have confirmed unofficial but reliable reports that the Russians already have the capability of launching missiles from their fleet of large diesel-powered submarines. Moreover, the Russians are reported to have a number of nuclear-powered submarines under construction. Within the next few years, both the Atlantic and the Pacific coasts of the United States are expected to be bracketed with Soviet missile-launching submarines on station.

Missiles launched from Soviet submarines would skirt BMEWS—the ballistic missile early warning system still under construction—and strike U.S. SAC bases without warning.

Super Taloses could be deployed aboard the Navy's new fleet of missile cruisers, most of which are still being converted. They might also be deployed on converted battleships.

Low Estimate?

To the Editor:

Your Sept. 28 issue carried an article telling about the growth of the electronics industry in the Los Angeles area emphasizing "The Move into San Fernando Valley."

It is a good wrapup of the expansions and moves by the "big ones." However, it underestimates the size of the industry by stating that there are 461 plants here when there is approximately 600.

The map accompanying the article is somewhat misleading. Mount Wilson, Whittier, Bell, San Gabriel, Hollywood and Los Alamitos are not "some of the main industrial centers in the . . . area." Glendale, North Hollywood, El Monte, Lawndale, Downey, Alhambra have a better claim.

Jules Greenblatt,
2404 W. Seventh St.
Los Angeles 57, Calif.

Special Materials Issue

To the Editor:

R. C. Ramé of our technical staff submitted to you an article on Teflon hose, which appeared on page 52 of your Nov. 23 issue on materials. The original copy contained the figures 623°F and 650°F as temperatures at which Teflon begins to decompose, but the final text appeared as reading "623°F to—650°."

I am sure your readers will recognize the typographical nature of this error, but whether they will be confused by the presentation of these figures in connection with the operating characteristics of Teflon hose remains a question which you may wish to clarify.

J. M. Sayre
Manager
Advertising and Public Relations Department
Resistoflex Corp.
Roseland, N.J.

Indeed we do wish to clarify an apparent discrepancy of 1300°F.—Ed.

To the Editor:

Our sincerest congratulations on your special missile/space materials issue of Nov. 23. Your staff did an excellent job on assembly and presentation of a vast amount of information.

H. Lane Losey
Supervisor
Marketing, Industrial Heating
Selas Corporation of America
Dresher, Pa.

To the Editor:

You are to be specially commended on the special issue of Nov. 23 on missile/space materials. I do not think we have had a better coverage with a summation of the problems of the missile and rocket field in such a brief, concise and complete form prior to this time. I also wish to add that we of the **Reinforced Plastics Department** of **Raybestos-Manhattan, Inc.,** feel that your reporting on the missile and rocket field is very current, accurate and interesting. In fact, all of our salesmen handling products for the rocket and missile field are required to subscribe to and read the weekly issues.

On the other side of the fence, we . . . were disappointed not to take part in your section on "Missile Suppliers Speak." We have, and are marketing, very successful materials in the ablation-resistant, insulation, and high strength-to-weight ratio fields. Tons of these materials are being used in current missile programs and it is very disconcerting to an asbestos concern to see little emphasis and favorable reporting given to asbestos-reinforced plastics when there are so many successful applications in the field . . .

M. M. Gibson
Product Manager
Reinforced Plastics Department
Raybestos-Manhattan, Inc.
Manheim, Pa.

M/R plans to report on missile and space vehicle uses of asbestos in an early issue.—Ed.

• **United Nations, N.Y.**—Soviet bloc countries will be given seven of 24 seats on a permanent U.N. body to regulate peaceful uses of outer space under a tentative agreement worked out between the United States and Russia. The remainder of the group will include representatives from 12 Western nations and five neutral countries.

• **London**—Britain is being advised by the government-sponsored Advisory Council on Scientific Policy to stay out of the space race, except possibly for minor participation in cooperation with the United States or on some international project. The Council said it would be "folly" to seek national prestige through costly space programs when the money would be better spent on helping the Commonwealth's underdeveloped colonies and partner nations.

• **Washington**—Several multi-million-dollar missile contracts were announced by the Defense Department. **Douglas Aircraft** received a $4.5-million award for kits to convert *Nike-Hercules* missiles for use at semi-mobile installations . . . **Western Electric** received a $11.9-million contract for improvements on the *Nike-Hercules* system and a second $3-million contract for *Nike* repair parts . . . A $2.3-million contract for continued R&D of the Army's *Sergeant* missile was awarded the California Institute of Technology . . . **Bendix Aviation,** Baltimore, has a $15-million Army contract for work of a classified nature . . . For Project *Defender,* **Raytheon Co.** has a $14-million tracking radar contract and **Radio Corp. of America** has a $3.9-million contract for modifying BMEWS units . . . and **Avco-Everett Research Laboratory** has an Air Force contract for $4.8-million to continue ICBM re-entry vehicle studies and other classified work.

• **London**—Russia now has about 100 principal missile bases and 200,000 missilemen, according to an Institute of Strategic Studies report sponsored by the Ford Foundation. The missiles—*T-3* ICBM's and *T-2* and *T-4* IRBM's—were said to be concentrated along the Baltic coast, in East Germany, in the southern Ukraine and in the Carpathian Mountains.

• **Burbank, Calif.—Lockheed** is forming a new subsidiary—**Lockheed Electronics Co.**—which will be comprised of its recently acquired **Stavid Engineering Inc.** and the Lockheed Electronics and Avionics Division (LEAD). These will become the Stavid Division in Plainfield, N.J., and the Newport Division in Newport Beach, Calif. Former Stavid president David F. Sanders will head the new company.

• **Tokyo**—Despite strong opposition from residents, the Japanese Defense Agency plans to start building a $766,000 missile testing ground on Nijima Island, 100 miles south of here, by next fall.

• **Azusa, Calif.**—Development of two solid-state precision timers with three-pole double-throw contacts which eliminate the need to have relays for additional contacts is announced by **Aerojet-General Corp.** The two units are a 30-millisecond to 30-second short period timer and a 30-millisecond to 30-minute long period timer.

• **Washington**—Mergers & expansions: **Harris-Intertype Corp.,** Cleveland, is acquiring **Polytechnic Research and Development Co.** from Polytechnic Institute of Brooklyn . . . Robinson Technical Products Inc., Teterboro, N.J., and **Kensico Tube Co., Inc.,** Mt. Kisco, N.Y., have agreed on a merger . . . **Dynatran Electronics Corp.** is a newly formed company joining the semiconductor field . . . and **Convair** is building a $276,000 engineering space research lab at San Diego which will be equipped with two 12-by-20-foot vacuum tanks to simulate space environments.

Monkey Returns Safely From *Mercury* Escape Test

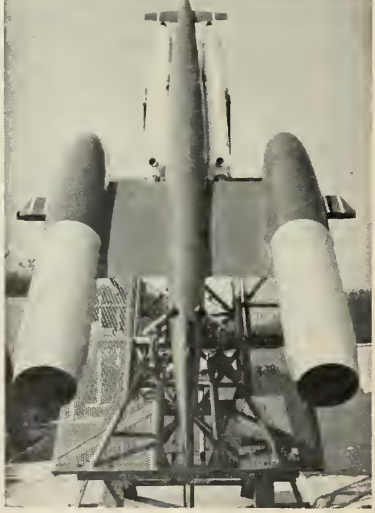
WALLOPS ISLAND, VA.—The National Aeronautics and Space Administration on Dec. 4 successfully recovered a 2½-year-old, seven-pound rhesus monkey from the ocean after it had flown to an altitude of 55 miles in a Project *Mercury* capsule.

The monkey, named Sam, apparently suffered no ill effects.

The capsule was lifted by the *Little Joe* vehicle built by the Missile Division of **North American Aviation.** It is powered by four Castor and four Recruit solid-rocket motors manufactured by the **Thiokol Chemical Corporation.**

Purpose of the flight was to test the **Grand Central Rocket Company's** pilot escape system at high altitudes, and to observe the monkey's reaction to high acceleration and weightlessness.

The capsule was picked up in the Atlantic 200 miles from Wallops Island by a destroyer.



NORD AVIATION'S CT-41 target missile will be made under license in Britain by Hawker-Siddeley. The supersonic bird has two wingtip-mounted ramjets and is controlled from the ground.

Hébert Group Releases Bahamas Guest List

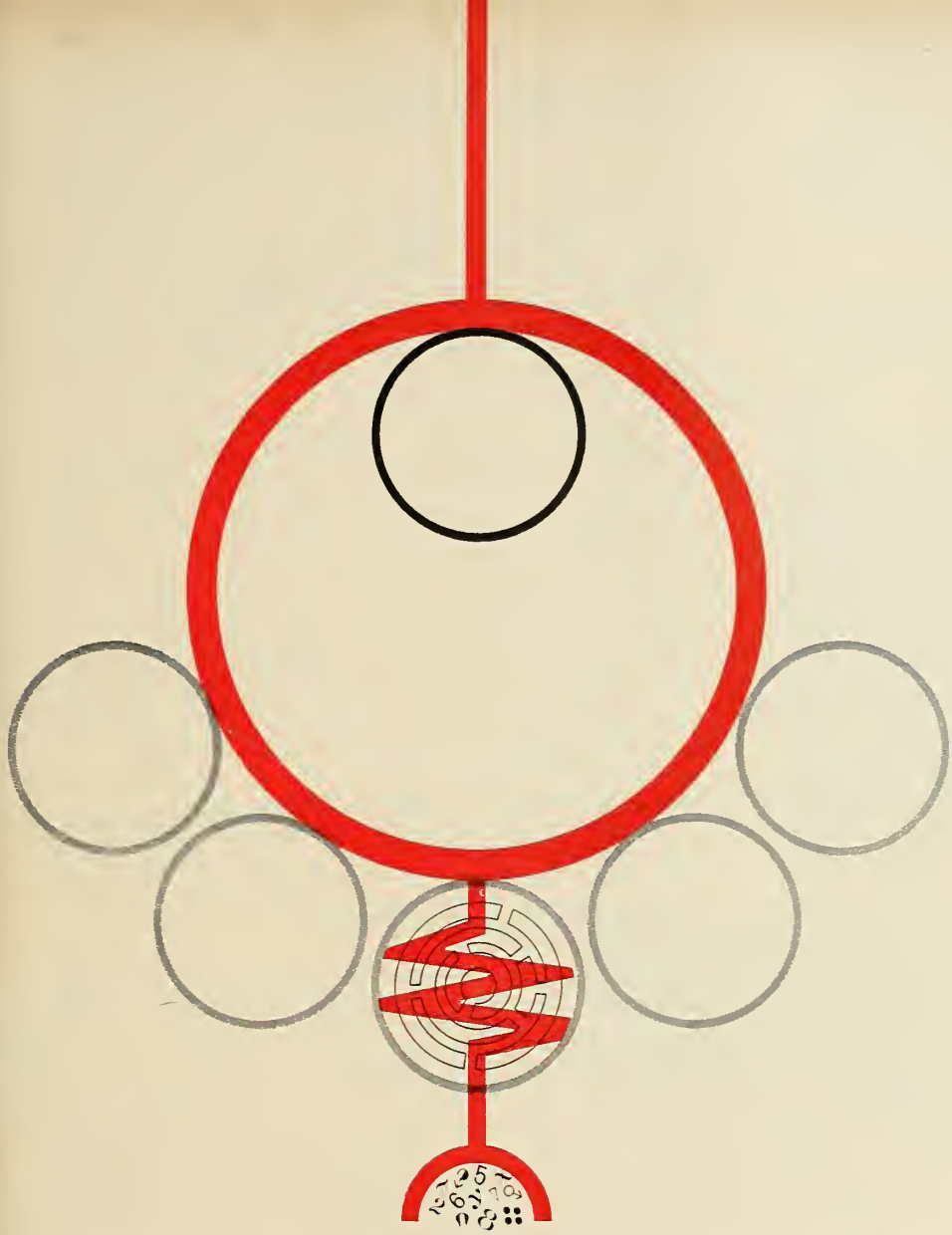
WASHINGTON—The House Armed Services Investigations Subcommittee this week made public the following list of persons entertained by **The Martin Company** at the Cotton Bay Club in Eleuthera.

Civilian governmental officials: AF Secretary James Douglas (who confirmed he had been a guest, but paid his own expenses) and FAA Administrator Elwood Quesada.

Air Force: Generals Nathan F. Twining, F. F. Everest, Emmett O'Donnell, S. E. Anderson; Lt. Gen. John K. Gerhart; Major Generals H. M. Estes, James Ferguson, J. E. Smart, E. J. Timberlake; Col. I. F. Larkey.

Navy: Vice Adm. J. T. Hayward; Rear Admirals C. D. Griffin, W. K. Mendenall, Jr., C. B. Martell, C. J. Pfingstag, W. A. Schoech, T. B. Clark, F. M. Hughes, D. L. McDonald; Captains Frederick A. Bardsbar, M. V. Beebe, H. D. Helfrich, T. W. South; Col. J. K. Dill, USMC, Lt. Col. J. B. Berteling, USMC.

Other guests: Harold Stuart, former Assistant Secretary of Air Force; Lieutenant Generals Richard Sutherland, and Joe Smith, USAF retired; Maj. Gen. K. McNaughton, USAF retired; retired AF Colonels Thomas Belsbe and A. R. Christie; golf professionals Gene Sarazen and Max Elbin; and Norman Hayes, NAA; Dan Kimball, Aerojet-General; Alex M. Knapp, insurance consultant; L. D. Lyman, United Aircraft; Watson Newhall, Flight Refueling, Inc.



COMPUTATION — PRIMED FOR THE TEAM PROGRAM

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west coast industry . . .

By FRANK G. McGUIRE

There are some interesting breakdowns in the $1.8 billion in contracts now outstanding which were let through the Los Angeles Ordnance District. This office buys about $400 million yearly for the Army and ABMA. Of this, the bulk is on behalf of the Army Rocket and Guided Missile Agency, and officials expect the amount of ammunition and related ordnance items to triple in the coming year. One third of the total contracts are for R&D work, the remainder for production. Another interesting point is that one third of the total were originally let in the East, but for various reasons were transferred to the West Coast for performance.

The 1600 active contracts administered make it the largest ordnance district in the country. Covering southern California, the office also has jurisdiction over Utah, New Mexico, Arizona, and parts of Texas and Nevada. Despite this spread, 95% of the district's business is placed in the Los Angeles area, where facilities and talent abound. Parts for every Army missile system are bought here. Col. Paul H. Scordas, Chief of the LAOD, sees the trend increasing business on the Coast.

Summers Gyroscope Co.'s first profitable month . . . since January, 1957, was October. November was also in the black. The company, a holding of the **Atlas Corp.,** feels it has reached the turning point in its financial history, and hopes to be in the black next fiscal year beginning Feb. 1. The possibility of a merger for Summers has been cropping up, but apparently no firm moves have been made as yet.

Aerojet's twist on a Madison Avenue trick . . . was introduced in a company film on the hydrogen-fueled engine under development. During post-firing inspection of the engine, a white-gloved engineer ran his hand over the inside of a rocket engine recently fired with hydrogen, then a similar test on the chamber fired with hydrocarbon fuels. The difference in cleanliness was obvious, they say.

Sandia Corp. is considering moving . . . its range at Salton Sea in southern California, because of the encroachment of civilization upon its facilities. The firm may shift operations northward to the area around Tonopah, Nev.

Humane Society of the U.S. . . . has filed a complaint through its California Branch, against space research conducted with animals which results in cruelty. Emphatically disassociating itself from antivivisectionist groups, HSUS, objects to unnecessary cruelty attendant to legitimate biomedical research. Attempts are being made to persuade Congress that a rider be included in every government research grant involving animals, that proper anti-cruelty measures be established and maintained.

Leach Corp. is intensifying development . . . of power equipment, through its **Inet Division.** The company, a leader in power generation and control equipment for ground support, has been accelerating development and reliability programs in all its divisions as part of an expansion into the electronic components and systems field. The company recently instrumented Air Force Captain Kittinger in his 76,400-foot drop from a balloon gondola.

Western Gear Corp.'s new metrology lab . . . is in operation at the firm's Lynwood facility. The lab has ultra-precision capabilities, necessitated by the company's expanded activities in tracking antennas, radio and radar telescopes and other space guidance devices.

Navy has been plagued by security gaps . . . resulting from a main railroad line running through its top-secret activities at Point Arguello. Passengers have an unobstructed view of things, so Navy is not-too-seriously thinking of building a solid line of billboards along the tracks, and selling space to missile contractors.

Donald M. McGrath has been appointed vice president and general manager of the Hufford Division of The Siegler Corp. In his newly created post, McGrath will be responsible for administration, engineering, production and sales.

Prior to joining the firm, he served nearly three years as plant manager of Solar Aircraft Co. Before that, he was associated for 21 years with Bendix Aviation Corp.

Jack J. Bromberg, who directed development of the *Thor* missile program for the Douglas Aircraft Co., has been named program manager for the company's *Nike-Zeus* activities.

Paul Swan, another pioneer missileman with Douglas, will serve as assistant *Zeus* program manager.

Dr. Nisson A. Finkelstein has been appointed assistant vice president and director of research of the Stromberg-Carlson division of General Dynamics Corp. He succeeds **Lynn C. Holmes,** who has been elected director of engineering operations.

Prior to joining the firm, Dr. Finkelstein was assistant director of the scientific bureau of Bausch & Lomb Optical Company, a position he had held for the past three years. He joined Bausch & Lomb in 1950 as a research physicist.

Gene L. Armstrong, chief applied mechanics engineer for Convair (Astronautics) Division of General Dynamics Corp., has been promoted to the post of senior project engineer for airborne systems on the *Atlas* missile program.

He was an aerodynamicist with Boeing Airplane Co., a specialist in the field of automatic control and servomechanisms with North American Aviation Co., and became a design specialist for Convair-San Diego in 1954.

Dr. William Walton Carter has recently been named chief scientist of the Army Ordnance Missile Command at Redstone Arsenal. Dr. Carter came to the AOMC post from the Los Alamos Scientific Laboratories of the Atomic Energy Commission, where he was director of the Experimental Physics Group, Weapons Division.

David J. Barnett has been appointed assistant project manager to **Abraham Lazar,** project manager, for the development work conducted at Bulova Research & Development Laboratories, Inc., on the *Pershing* ballistic missile warhead section.

Barnette had been a project engineer in the Labs' *Pershing* design group and served with the Navy as a nuclear weapons instructor.

Hercules Powder Company's Chemical Propulsion Division has announced the addition of three rocket and missile propellant specialists to the staff of the Plans and Program Group: **Austin B. Chappelle,** former Martin Co.-Orlando, chief engineer for propulsion; William D. Kelley, Jr., previously manager of quality control for Thiokol Chemical Corp.'s Utah Division, and **John A. Scherer,** formerly with Westinghouse Electric Corp.

Nicholas H. Johns has been named executive engineer for Data-Control Systems, Inc.'s research and development department. He was previously associated with Electro-Mechanical Research, Inc., in environmental test and redesign work for tbe *Titan* program.

C. P. Clare Transistor Corp. has announced the election of **Amos Kaminski,** former chief research scientist with General Transistor Corp., as president. The new firm is a sister company to C. P. Clare & Co., manufacturer of relays and allied electronic components.

EXPLORE NEW AREAS AT IBM IN RESEARCH AND DEVELOPMENT OF

IBM's explorations in the semiconductor field include theoretical and experimental studies in basic semiconductor science as well as development of advanced devices and technologies. In one current research project, for example, a better physical understanding of the origin of the negative resistance characteristic of the Esaki diode is being sought. At the same time, development engineers are exploring applications of this device and have already produced a new solid state oscillator of exceptional simplicity in the 3,000 megacycle range. To date, this represents the deepest incursion into the microwave region via semiconductor electronics. In another project, an NPN double-diffused high-speed drift transistor has been developed that will greatly accelerate logical switching and high-power core driving. Both exploratory investigation and development of these and related electronic devices are expanding at a rapid pace at IBM. To further these programs, well-qualified specialists are required for all areas of device exploration.

An outstanding education program heads the list of benefits available to IBM employees. You'll find that an unusual potential exists for rapid advancement, due in part to an exceptional record of company growth and in part to promotion from within. Working alone or on a small team, you will be asked to assume considerable responsibility in advanced technical projects.

people...

Royal Industries, Inc., has announced the appointment of **Harry Houdyshell** as chief engineer and **Dean Oleson** as assembly superintendent of the company's Pacific Electronic Controls Division.

Houdyshell is former chief product engineer of the Helipot Division of Beckman Instruments, Inc., and Oleson was formerly factory supervisor of the Poco Tiempo Division of Helipot.

Paul F. Ziegler has been named technical director of Johnston & Funk Metallurgical Corp. and will supervise all research and development programs.

For the past seven years Ziegler has been associated with Fanstell Metallurgical Corp. as a metallurgical engineer.

Dr. Maurice Nelles has joined American Electronics, Inc., to fill the newly created position of Vice President-Engineering. He will direct the engineering planning for the corporation and its nine divisions.

Prior to joining the firm he was Vice President-Research and Development, and Chairman of the Corporate Product Planning Committee of Crane Co.

Houston Fearless Corp. has elected **John A. Beckman,** formerly of Hughes Aircraft Co., manager of its communications and space projects. Beckman, who has been with the Hughes communications division since 1953, has recently managed systems development and the advanced projects department, being responsible for technical direction of data transmission and processing systems.

Prior to his association with Hughes, he served seven years with the National Security Agency, supervising development of electronics security systems.

Anthony Del Duca has been appointed chief engineer at Metrolog Corp., a division of Air Logistics Corp.

Del Duca's previous positions included chief engineer for electronics at Beckman Instruments, senior engineer in charge of advance transistorized circuitry on the *Terrier* at Convair, and senior research engineer in the Radar and Fire Control Group at Autonetics.

Dr. Jacob P. Den Hartog, professor of mechanical engineering at the Massachusetts Institute of Technology, has accepted the position of guidance test manager with the Air Force Central Inertial Guidance Test facility at the AF Development Center, Holloman AFB, N.M.

J. R. Madigan has been named senior scientist at the Roy C. Ingersoll Research Center of Borg-Warner Corp. He was formerly vice president and director of engineering of the Semiconductor Division of Hoffman Electronics Corp. Prior to that he was assistant professor and director of the Solid State Physics Laboratory at the Illinois Institute of Technology and associate physicist at the Armour Research Foundation.

—when and where—

DECEMBER

23rd Wright Brothers Lecture: High Temperatures in Hypersonic Flow—Physical Principles and Experimental Techniques, Natural History Bldg., Smithsonian Institution, Washington, Dec. 17.

American Chemical Society, Industrial and Engineering Chemistry Division, 1959 Christmas Symposium: Mechanisms of Interfacial Reaction, Shriver Hall, Johns Hopkins University, Baltimore, Dec. 28-29.

JANUARY

Gas Dynamics Colloquium on Electrostatic Propulsion, University of Michigan, Ann Arbor, Jan. 7.

Sixth National Symposium on Reliability and Quality Control in Electronics, IRE, EIA, AIEE, ASQC, Statler-Hilton Hotel, Washington, D.C., Jan. 11-13.

First International Space Science Symposium, and COSPAR Plenary Session, sponsored by COSPAR. Nice, France, Jan. 11-16.

Society of Plastics Engineers, 16th Annual Technical Conference, Conrad-Hilton Hotel, Chicago, Jan. 12-16.

Gas Dynamics Colloquium, Shock Tube Research, University of Michigan, Ann Arbor, Jan. 14.

American Astronautical Society, Sixth Annual Meeting, Statler-Hilton Hotel, New York City, Jan. 18-21.

Gas Dynamics Colloquium, Structure of Strong Normal Shockwaves, Northwestern University, Evanston, Ill., Jan. 21.

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

Gas Dynamics Colloquium, Research in Rarified Gas Dynamics, Northwestern University, Evanston, Jan 28.

Seventh Annual Western Spectroscopy Conference, Asilomar, Pacific Grove, Calif., Jan. 28-29.

American Rocket Society, Solid Propellants Conference, Princeton University, Princeton, N.J., Jan. 28-29.

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 & Exhibits, Rice Hotel and Sam Houston Coliseum, Houston, Feb. 1-4.

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We Can Catch Russians in Space

The real exploration of space will begin when this country or some other establishes a rendezvous capability in the solar system. Whether this capability is a space platform, which is most likely to come first, or a base on the moon is not too important. But all of the probes and studies now being carried on lead inevitably to this one focal point—the rendezvous in space where men and material can be assembled outside the atmosphere. This will be the base camp, the assembly point, the launching platform for the conquest of space.

The U.S. space program, if judged without an invidious comparison with the Soviet accomplishments, has not been trivial. From an almost standing start in 1956, the nation has achieved many significant successes—the *Discoverer* series, the paddlewheel satellite and the recent recovery of Monkey Sam are instances. Our failures have come dismally in the big prestige events—and in the lack of a national step-by-step program aimed at a realistic and significant goal.

Where should we be going? Warranted or unwarranted, there is an almost universal feeling among scientists, industry and the military that the nation's space program is at present on dead center; that the present Administration fails to recognize its importance; that we have no real space plan; that no significant action will be taken until we have a new head of government.

In discussions with military, industrial and other civilian space authorities, we have found no real doubts that America has the national courage, skills and basic techniques to overtake and pass Russia in the space race—*if we start now*. The starting means adequate funding, enthusiastic support and a real desire to win.

The plan—or schedule—encompasses nothing we have not already started, nothing we could not accomplish. Its five basic phases are:

1. *Saturn,* the 1.5-million-pound-thrust clustered booster.
2. The Rendezvous Capability.
3. The improved hydrogen engine for upper stages.
4. The nuclear engine.
5. *Nova,* the clustering of 1.5-million-pound-thrust single engines to produce 6 to 8 million pounds thrust.

The status of those five projects at the moment is:

Saturn—the project has slipped badly from lack of funds. It will be static-tested in the summer of 1960, fired with two or three stages in 1963, and probably not launched at full strength (with all four stages) until 1964. A total of eight or ten vehicles probably will be built. The funding for Fiscal 1960-61 may reach $150 million. Few outside the Administration believe this is enough.

Rendezvous capability—This is fundamental to establishing a space platform (or moon colony) for a space laboratory, exploration collection and launch-point, or for military purposes. Projects *Mercury* and/or *Dyna-Soar* could place men at a meeting place in space. Project *Centaur,* whose first use will be for moon and Venus probes, will have the capability probably in 1962 of sending up a 900-plus-pound space platform. There are, however, no plans for a space platform and no program to train men to handle it. The development of such a platform and the training of personnel are at least two-year programs which should be under way now.

The hydrogen engine is essential to provide higher energy and performance in second stages. Such an engine could, for instance, double the payload of *Saturn*. The status of the hydrogen engine is that Pratt & Whitney will deliver the first XLR-115 this year under an Air Force contract that has had both ARPA and NASA funding. The engine will have a thrust of 15,000 to 20,000 pounds. A larger, improved engine to produce 10 times that thrust—up to 200,000 pounds—could be coming off the production line in about two and a half years—with proper funding.

The nuclear engine is fundamental to any real space exploration, either as second stage or for final energy. It has been the undernourished stepchild of the Administration and its future depends largely on funding. A Model-T version may be ready in the 1962-63 time period. The need: money and emphasis.

Nova is the project of clustering probably four of the F-1 Rocketdyne 1.5-million-pound-thrust engines as a super booster. The F-1 could be available only a few months after the *Saturn* in 1964. It should be more reliable and much cheaper. Clustering it might take another 18 months, although this could be speeded up if a parallel program could be established during its final development.

With such a program or a variation of it, our nation would have a reasonable chance of catching up with the Russians and even eventually passing their achievements which at the moment have left the U.S. far behind.

But to do this the program must begin now. There is a minimum of 15 months' time lag from the time any space project is ordered and the time it can be accomplished. We cannot afford to wait until our space lag becomes an election issue, until a new administration recognizes the dangers inherent in losing the space race. We are losing or have lost our world technical prestige. Lagging behind so far that we may be denied access to space will mean losing our world.

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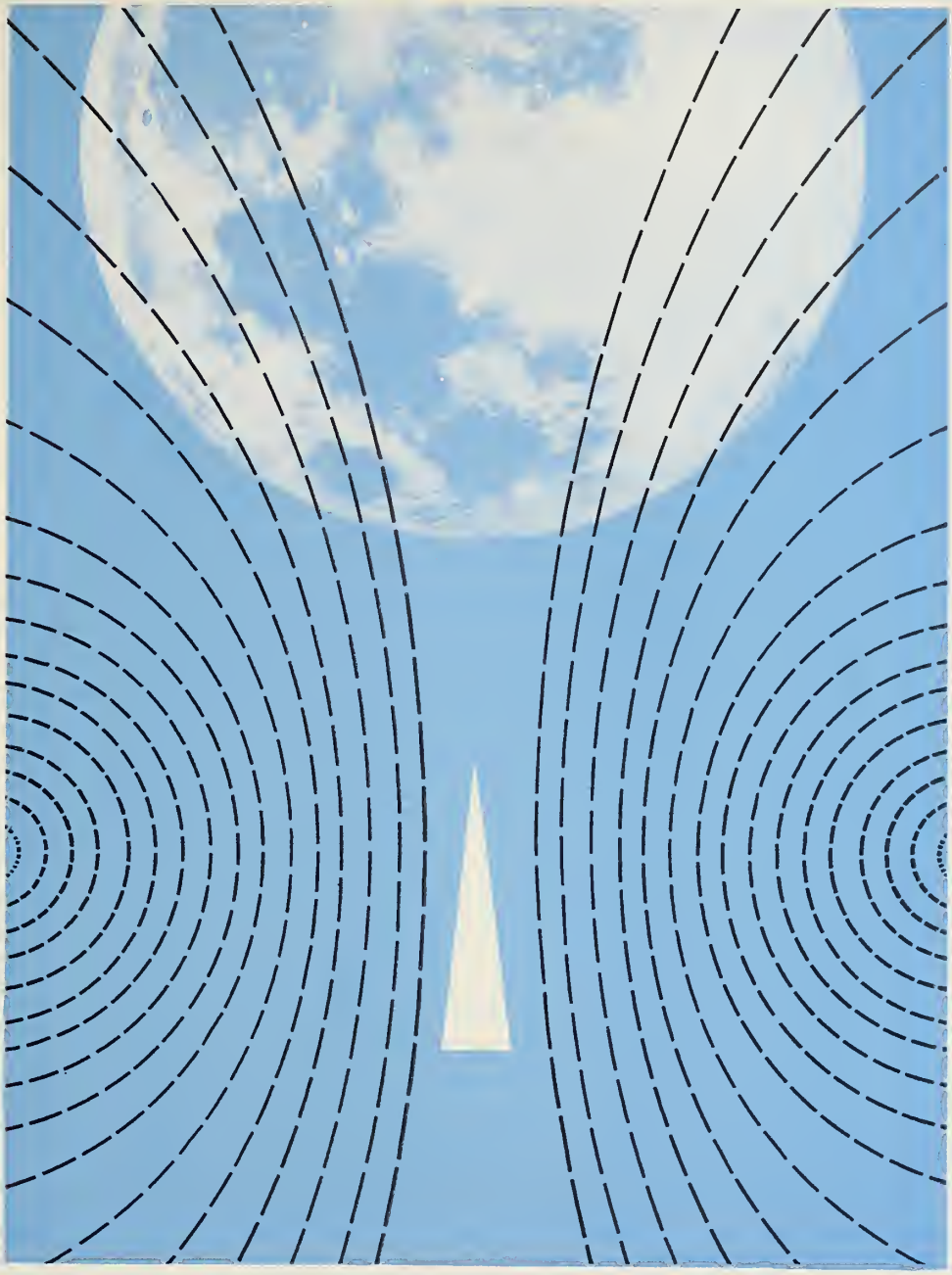

Avco's magnetic spaceflight—

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"Hound dog" makes a B-52's shadow broader than the state of Texas

Those sharp-nosed missiles slung close to the fuselage beneath the wings of a SAC B-52 intercontinental bomber are GAM-77 HOUND DOGS with a range of several hundred miles apiece. Thus equipped, the B-52 can reach out to blast enemy resistance points over a huge area along the route to its central target.

In actual combat the inertial guidance systems in the missiles would be fed their target locations, then the missiles would be released to find their way to target at supersonic speed. Locked on target from the time of leaving the "mother ship," the missiles could be neither jammed nor decoyed.

Hound Dogs are now rolling off the production lines into flight test. Alternate missiles are being assigned to a crew, half of which consists of USAF men. This is part of the Air Force's "Blue Suit Integration Program."

The Missile Division of North American Aviation is the weapon system contractor for the GAM-77.

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