NOVEMBER 9, 1959

INFANTRYMAN AND LACROSSE

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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ABC AUDITED PAID CIRCULATION · NBP · READERSHIP Continuous RESEARCH · ABP BUSINESS PAPER LEADERSHIP

COVER: Martin *Lacrosse* is replacing conventional Army artillery. Three more *Lacrosse* battalions will be activated early next year, making a total of seven operational units.

AERIAL View of Sunnyvale, Calif., plant of Lockheed's Missiles and Space Division. LMSD is the biggest employer in the San Francisco Bay's missile effort, surveyed on p. 16.

LINDE makes this liquid N_2 feed-vacuum insulated line in cooling infrared detection cells. This and other developments are rapidly solving IR's cooling problems. See p. 20.

HELIUM is produced in liquid form by the National Bureau of Standards laboratory at Boulder, Colo. Helium supply is now enough for essential needs, but this may well be temporary. See p. 30.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

30,550 copies of this issue printed

NOVEMBER 9 HEADLINES

ASTRIONICS

SPECIAL SECTION

ASTRONAUTICS ENGINEERING

U.S. Reg. Pdg.

NEW MISSILE PRODUCTS

THE MISSILE WEEK

U.S. Reg. Pdg.

DEPARTMENTS

Washington Countdown

IN THE PENTAGON

Long-delayed Project *Dyna-Soar* . . .

may well soar out of the Air Force and land in NASA's lap along with the huge three-stage *Saturn* rocket. NASA is looking at proposals to use *Saturn* for launching winged space vehicles. That would produce a *Dyna-Soar* in mufti . . . and give the budget-minded Administration an opening to scratch the proposed military program and substitute a stretched-out civilian one.

• • •

Missile-minded wits . . .

have already come up with a possible civilian name for a civilian *Dyna-Soar* project. They've dubbed it the *Von Braunto-Soar*.

• • •

The next *Transit* launching . . .

is scheduled for February. The ARPA-Navy navigational satellite is still expected to become the nation's first military satellite system despite the failure of the first launching in September.

• • •

An advanced *Hawk* . . .

is understood to be under development by the Army. The improved **Raytheon** surface-to-air missile would have more speed and range than the 20-mile range models being deployed with field units.

• • •

No speedup . . .

in construction of *Polaris*-launching submarines will be included in the tight new FY 1961 budget. The Navy will have to settle for three more of the missile-launching nuclear subs, bringing to 12 the number authorized. The Navy is expected to ask for a total of about $900 million for the *Polaris* program —$300 million more than it has under the FY 1960 budget.

• • •

Air-launched tactical satellites . . .

are still under study by the Navy despite the chill reception repeatedly given the idea by ARPA. However, reports that the Navy actually has launched a small satellite from a jet are greatly exaggerated. At best, Navy researchers scored a slim "maybe."

The first *Pershing* . . .

launchings from Cape Canaveral are expected within about a month. The launching facilities for the 700-mile range **Martin** missile will be completed in a few weeks. The solid missile will replace the Army's liquid *Redstone*.

ON CAPITOL HILL

A broadside of investigations . . .

into the nation's space programs are expected to be launched from committee hearing rooms as soon as Congress convenes in January. At least four are expected in the House . . . possibly two in the Senate.

• • •

Some early spade work . . .

will be done by an eight-member delegation from the House Space Committee. They plan during the next few weeks to inspect missile plants and military installations from White Sands Proving Ground, N.M., to Vandenberg AFB, Calif.

AT NASA

Seventeen space docs . . .

are being enlisted by NASA for assignment around the world at telemetry stations. They will monitor the results of biomedical space experiments and Project *Mercury*.

• • •

The *Vega-Centaur* schedules . . .

so far are reported unaffected by the steel strike. However, the strike continues to slow construction of the *Vega* launching stand at Cape Canaveral.

• • •

Pass the *Luna* . . .

is a new game being played at NASA. *Luna* is described as a space ship the size of the Empire State Building. A space agency engineer says NASA is developing one; NASA says it isn't. But the engineer's statement is reported to have been passed on by his superiors before he made it.

AN ENTIRELY NEW CONCEPT IN PRESSURIZATION AND COOLING . . . A *Nose cone cooling*, B *Cabin pressurization and cooling*, C *Suit pressurization and cooling*, D *System control*, E *Heat exchangers*, F *Electronic bay (cooling and inerting)*. G *Supply valve*, H *Nitrogen relief valve*, I *Liquid nitrogen storage tank*, J *Liquid nitrogen vent valve*, K *Liquid nitrogen filler valve*, L *Helium vent and buildup valve*, M *2-stage helium regulator, 4400-65 psi*, N *High pressure helium storage*, O *High pressure helium filler valve*, P *Helium relief valve.*

• *The AiResearch Pressurization And Air Conditioning System* in North American's X-15 is a radical departure from normal pressurization and cooling techniques, also pioneered by AiResearch, which up to now have utilized outside air surrounding the aircraft. When the X-15 manned spacecraft climbs into space beyond the earth's atmosphere, it will carry its own atmosphere in the form of liquid nitrogen dispensed through a self-sufficient AiResearch pressurization and air conditioning system for the pilot and vital equipment.

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From the B-29 to the modern jet airliner and now the X-15, AiResearch pressurization and cooling of these history-making aircraft exemplify the company's continued world leadership in the pioneering and advanced development of pressurization and refrigeration systems for high altitude, high speed flight. Your inquiries are invited.

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Industry Countdown

MANUFACTURING

Expect railroad launch . . .
production contract for **Boeing's** *Minuteman* to run around $50 million—just for the special missile car. Current planning calls for something like 100 missile trains, each with five missile cars and each of the cars costing about $100,000. Approximately 10 company teams in the competition are expected to submit cost proposals this month.

• • •

Before the year is out . . .
the Army probably will put its *Sergeant* artillery-type 75-mile successor to *Corporal* on the operational list. The **Sperry Rand**-manufactured missile is now in full production and in the final test stage with production-type launcher-erectors.

• • •

NASA will fire . . .
four NERV (nuclear emulsion recovery vehicles) payloads from PMR next summer. **General Electric's Missile and Space Vehicle Department** in Philadelphia has the $560,000 contract to produce NERV, which is designed for more extensive study of the earth's radiation belts.

• • •

Cost of hard ICBM bases . . .
is holding on even keel. In the $267 million released by AF recently for construction of facilities, *Titan* bases are being funded for about $43 million apiece. The four latest receiving money are at Beale AFB, Calif.; Mountain Home AFB, Ida.; Ellsworth AFB, S.D.; and Larson AFB, Wash. Funds also were released for *Atlas* bases at Lincoln AFB, Neb.; Shilling AFB, Kan.; and Warren AFB, Wyo. Each of them gets about $30 million.

• • •

Researchers are complaining . . .
there is still an urgent need for more cataloguing of the boundlessly increasing volume of technical literature. Much time and funds are being wasted in duplication of R&D. The situation is so bad, says one East Coast technician, that sometimes it is easier to get required data from Russian translations—rather than search our own sources.

PROPULSION

Future of AF high-energy . . .
fuel plant run by **Olin-Mathieson** at Modeltown, N.Y., is in doubt. The $35-million facility has been put on the idle list for screening and possible sale by the General Services Administration.

• • •

New heat treating . . .
facilities designed for processing large diameter solid rocket motor cases are being built by **Lindberg Steel Treating Co.,** Melrose Park, Ill. Project has received OCDM fast tax write-off certification on 60% of the $750,000 total cost.

• • •

Industry is still waiting . . .
and not too hopefully for a go-ahead on a two-year-old AF project called *Nomad* designed to land 1100 to 1200 pounds of payload on the moon. The two-stage vehicle would employ *Atlas* as a booster and utilize a hydrazine/-fluorine engine in the second stage.

ASTRIONICS

Silk screen printing . . .
of electrical circuits has been developed by **Bell Telephone Laboratories.** The process, which doesn't require adhesive, prints a paste of partially fused glass and copper oxide—then reduces the oxide to leave pure copper.

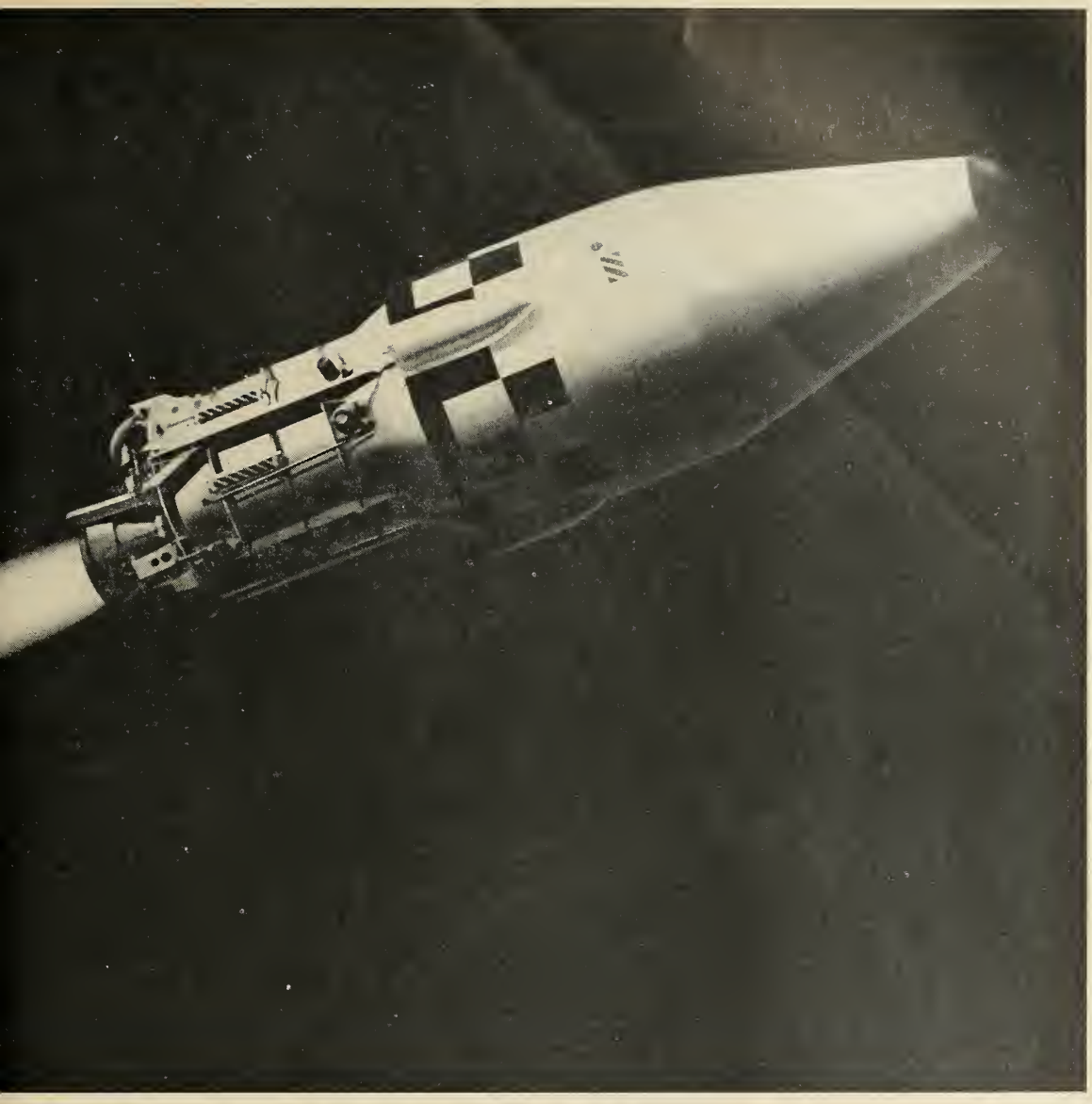
• • •

Search for better . . .
gravitational constant is under way at National Bureau of Standards. The latest approach abandons the conventional Aetvos pendulum method (which has produced inconsistent results) and uses acceleration during free fall in a vacuum.

WE HEAR THAT—

The Martin Co. is interested . . .
in obtaining control of **General Precision Equipment** . . . Rumors are cropping up that **Boeing** would like to buy **Bell** . . . Joining the undersea warfare ranks: **Cleveland Pneumatic Industries,** with a solid-propellant underwater propulsion system . . . a recent study by **Opinion Research Corp.** of 622 technical personnel and 105 persons in management of six companies showed nearly 75% of the scientists and engineers thought their abilities were misdirected; 90% thought they were underpaid . . . Thrust of the **Rocketdyne** F-1 engine in current tests is in milleseconds. The big NASA booster, fully developed, will have one million pounds thrust . . .

More About the Missile Week on Page 44.



The Agena is the largest and heaviest true satellite the U.S. has ever put on orbit. It is the only satellite that can be put on a precise, predicted orbit...that can be controlled while on orbit...that can eject a recovery capsule. It can carry a wide variety of very heavy and specialized payloads. The Agena satellite is now used exclusively in the Discoverer Program, directed by the Advanced Research Projects Agency and managed by the Ballistic Missile Division of the U.S. Air Force.

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Two-year fight ended . . .

NASA Emerges as U.S. Space Force

Space Agency has the resources and vehicles to catch Russia if the Administration and Congress provide the money.

Five little . . . four little . . .
three little Indians
And then there was one . . .

by C. Paul Means

WASHINGTON—The National Aeronautics and Space Administration, after two years of infighting which saw as many as five cooks in the space kitchen —each with its own recipe—has now emerged as the one agency responsible for U.S. space prowess.

The big question remaining about the now streamlined space program is how fast and how far will the Administration and Congress allow it to proceed.

• **Space setup**—A series of transfers during the past year culminating with the ABMA and Project *Saturn* transfer this month, has given the nation the following space setup:

—The Army and Navy space facilities, along with their scientists and technicians, have been transferred to NASA. If either service feels they need a necessary tool or weapon in space, they will have to get DOD's R&E Director Dr. Herbert F. York to okay the project, the Air Force to launch it, and NASA to provide any vehicle bigger than *Atlas* or *Titan*.

—ARPA's space booster and vehicle programs have been transferred to NASA.

—The Air Force now has the military booster mission in space (set at 600 miles).

—With few exceptions, NASA is now charged with the development of future space boosters, upper stages, vehicles, the projects which will explore near space, and all of space more than 600 miles away.

And with the Russian space lead calculated as being anywhere from two to five years, NASA will not have an easy job, and will need the cooperation of the Administration and Congress (principally in the form of dollars) to perform it.

How all this came about is not clear, and subject to many interpretations. As late as this fall responsible experts of space research and government were saying that the bulk of the space programs would fall to a military organization rather than NASA because it is easier for a military organization to get money out of Congress. Principal reason for the consolidation under NASA is that Russian successes demanded that the space program's responsibility be given to one agency. NASA was judged to have the greatest resources and capability for directing such a program.

• **NASA resources**—In existence a little over a year, the NASA table of organization is now firm. The tools which it can use include the research and development laboratories inherited from the old NACA. These are:

—The **Langley Research Center** at Langley Field, Va. The oldest NACA facility, its areas of research are aerodynamic heating, hydrodynamics, and structure loads.

—The **Lewis Research Center** at Cleveland, O. Lewis's staff is developing the chemical, nuclear, and electric rocket propulsion systems of the future.

—**High-Speed Flight Station** at Edwards Air Force Base, Calif. Now engaged in research of the rocket-plane *X-15*.

—**Ames Research Center** at Moffett Field, Calif. Micrometeoritic impact and aerodynamic heating of space materials are among the principal research efforts.

From the Army, NASA got the **Jet Propulsion Laboratories,** and will get the Development Operations Division of the Army's Ballistic Missile Agency. Long known for the work on propulsion, tracking and guidance, JPL was a major partner in the Army's *Jupiter-C* and *Juno II* experiments.

ABMA, the latest and most glittering of jewels in NASA's crown, consists of over 4000 rocket personnel led by a nucleus of German scientists who developed the *V-I's* and *V-II's*, and the *Jupiter-C's* and *Juno II's* which launched the free world's first earth satellite and only sun satellite into orbit.

If Congress confirms the President's action next year, ABMA will join NASA's group of space flight laboratories. NASA will appoint a director over Wernher von Braun because the German scientist does not want the administrative post.

From the Navy, NASA got the *Vanguard* team, including valuable space electronics personnel from the **Naval Research Laboratories.**

New agencies formed by NASA include the **Goddard Space Flight Center** and the **Plum Brook Research Reactor**

PAST . . .

JUNO II—this workhorse still serves until newer vehicles arrive.

facilities at Sandusky, Ohio. Goddard will move into its new headquarters near Washington next year. Personnel include the 200 personnel transferred from the Navy's *Vanguard* program and the Project *Mercury* team. This group will do overall research into space flight, and control the manned space program. The Plum Brook facility, to be ready next year, includes rocket test research facilities, and a $10,735,000 reactor under construction since 1956.

NASA can also call on the Air Force's **Space Technology Laboratories** as it has done in the *Thor-Able* and *Atlas-Able* shots. The quality of work done by this organization is demonstrated by the "paddlewheel" payload of *Explorer VI*.

Behind these agencies lie the many private industries who helped the individual services develop their missile and space programs. As the space budget grows, these industries should be able to get substantial space work to offset the decline of government contracts in other fields such as military aircraft.

• **Have program, need money**—The NASA space program will have the engines and vehicles to do the job—if the Administration and Congress give them money to develop them when needed in the quantity needed.

These vehicles include:

—*Scout.* A cheap, reliable solid-propellant vehicle which can launch a 300-lb. payload into a 200-mile orbit, *Scout* under prime contractor **Chance Vought** is expected to cost only $500,000 per vehicle and should be ready by this summer. This vehicle will be the workhorse of low-altitude satellite orbit research. The Air Force will use this NASA vehicle under the name S609.

—*Thor Delta.* Capable of putting 65 pounds of useful payload in orbit around the moon and of rough landing 50 pounds on the moon, *Thor Delta* under management of STL is expected to be ready early next year.

—*Vega.* Under the direction of JPL and **Convair,** *Vega* is an advanced vehicle capable of circular earth orbits, orbiting a 1,000 lbs. around the moon, and 260 pounds around Mars or Venus. First flight of this vehicle is expected next fall.

—*Centaur.* Similar to *Vega* except with a high energy liquid hydrogen-LOX second stage (**Pratt Whitney**), *Centaur* almost doubles *Vega's* payload capabilities and could orbit 275 pounds around the moon and then return the payload to earth.

—*Saturn.* The first space vehicle in the U.S. arsenal capable of operational manned space flight. With a booster consisting of a 1½ million pound thrust cluster of eight **Rocketdyne** engines, *Saturn* can lift heavy manned stations into low orbits. It would allow the U.S. to put up a space communication center, a meteorological observation center, and a scientific research center. Under the direction of ABMA, *Saturn* can also launch large unmanned payloads into deep space and to the planets. With funding, it could be ready in two years.

—*Nova.* A cluster of 1-million-pound engines being developed by Rocketdyne, *Nova* could make a manned landing and a return from the moon of 2,100 payload, orbit Venus with a 15,000 lb. payload, or land on Venus and return with a 4500 payload. Estimated operational date for this vehicle is 1965.

Until these newer vehicles come along, NASA will rely on the old standby *Juno-II,* and on the makeshift missiles *Thor-Able* and *Atlas-Able.* Though neither of the *Able* vehicles have the attractive design characteristics of space vehicles because their upper stages are not properly mated to their missile boosters, both have the capability of performing significant missions. The *Atlas-Able* will attempt a payload around the moon in the near future, and the *Thor-Able* will attempt to orbit a payload around the sun with a transmitter powerful enough to be heard further than 50 million miles.

• **How much money?**—Now that the U.S. has centralized and streamlined the command of its scientific space program, how much money will be needed to put it on a competitive basis with Russia's?

Figures given vary, but the consensus is that a program designed to obtain the vehicles now under development as quickly as possible, and to continue an adequate program to develop the next generation space engines operating on electrical and nuclear propulsion will cost over $1 billion in fiscal '61, and substantially more each year after that.

Estimates are that Project *Saturn* will cost $600 million more. If NASA is to meet the feasible two year completion date for this vehicle, $250 million will have to be spent in Fiscal '61, and $350 million in Fiscal '62.

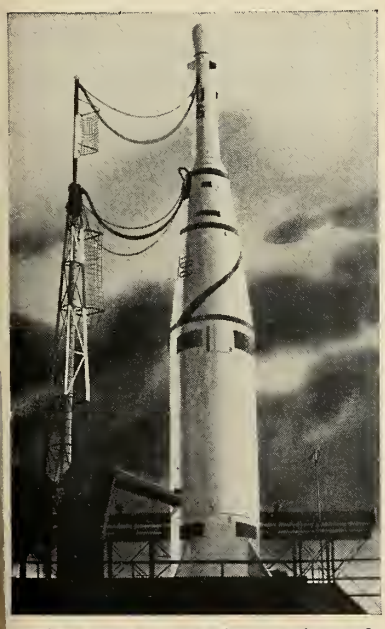
Vega and *Centaur* will need according to NASA figures, an extra $48.5 million during the next two fiscal years, and *Scout* will need at least an extra $15 million as it goes into production.

Estimated cost of *Nova,* if newer types of space engines do not make it obsolete and curtail its development, will be over a billion dollars during the next five years. Present NASA scheduling calls for $60 million for the project during the next two years.

Project *Mercury,* which is costing NASA more than was estimated, should be funded for close to $100 million in the Fiscal '61 budget.

Within the next decade when nuclear and electric engines come into use, and space missions become manned, larger, more complex, costs can be expected to spacerocket.

PRESENT . . .



THOR DELTA—goes into service early next year.

FUTURE . . .

SATURN—Over two years off, makes significant manned payloads possible.

Irvine Says Single Service Is Vital

WICHITA, KAN.—Blunt-spoken Clarence S. (Bill) Irvine took an incisively critical look at the nation's military and civilian leadership last week and found it woefully lacking in direction and purpose.

In his first sweeping defense appraisal since becoming an **Avco** vice president earlier this year, the former AF Deputy Chief of Staff for Materiel declared that the United States must have a single military service, better education and a streamlining of our space and defense posture to keep from being overwhelmed by Russia.

"It now becomes crystal clear," the retired lieutenant general told the Institute of Aeronautical Sciences, "that a simple and positive, civilian and military command structure is essential to survival."

Below NASA and "at the top" of DOD, he said, "we must get quickly to a modern streamlined organization, greatly reduced in numbers of divisions and numbers of people. A simple, understandable and operable military type line and staff organization."

He said taxpayers are footing the bill for an "unreasonably expensive and unwieldy" air operation comprised of five air forces—Army, Navy, Marines, Air Force and commercial airlines. And many millions of dollars are being frittered away, he contended, in duplicate production and research programs as the nation moves into operations in space.

Irvine advanced this plan for reorganizing the military:

- Create a single service with functional divisions for land, sea and aerospace with a single uniform and under a single commander—who would correspond to the present chairman of the joint chiefs of staff.
- Creation of single worldwide commands for the strategic air function and for air defense.
- Appropriate commands for control of surface naval operations and undersea warfare and another for all troop operations on land. Each command would be headed by a vice commander under the senior military commander.

For each of three functional areas of land, sea and aerospace, specialized engineering, procurement, production and support operations would be set up. "Halfway measures are not enough," said Irvine. "We must do the whole job if we want results—in time."

The only way that unification will be achieved is through "hardhitting" free press informing and educating Americans "in the actions necessary for survival." Failure to pursue an aggressive course in this direction, Irvine warned, will mean "we shall continue to look at the tail lights on the Russian caboose—always just rounding the corner ahead of us—and one day we will be teaching Russian and Chinese as the major lingual requirements in our universities."

While refusing to take any direct cracks at current policies of the Eisenhower Administration, Irvine made it clear that he believes them to be highly unsatisfactory. He said the Nation "must throw off the shackles of the past in our approach to the future."

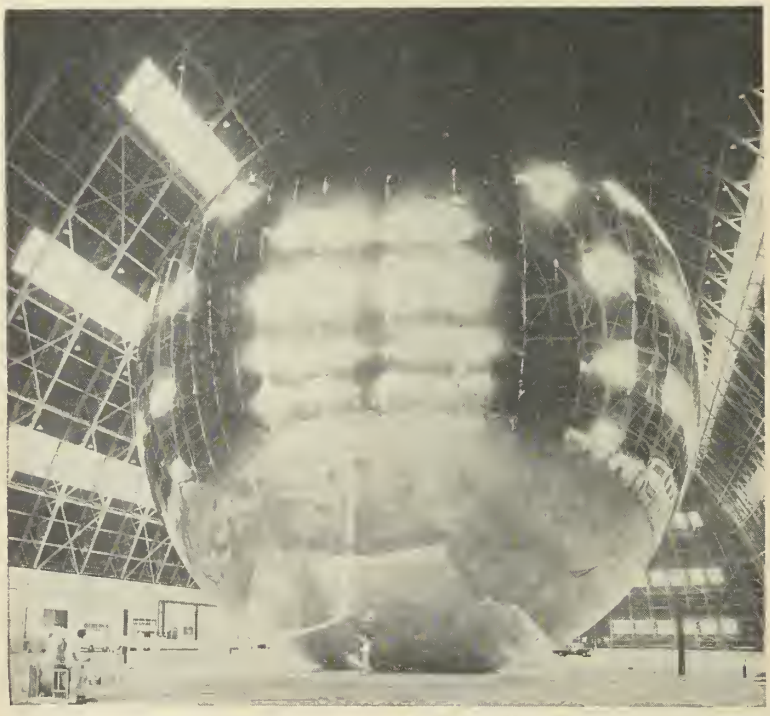
"We need productive creativeness, real solid results, rather than complacency."

He called for "bold, clear thinking unfettered by politics, geographical pressures, by individual corporation limitations, or sheltered university curricula." The major areas sorely in need of this approach:

- **Space propulsion**—The development of materials for nuclear ion, plasma and solar power plants are all "essential programs which must be properly supported and financed."
- **Air and ground transportation**—It is imperative that all air traffic communications and flight control systems—civilian and military—be aligned under single civilian control.
- **Education**—Women are a tremendous, untapped reserve of brainpower available for training in the sciences. Moreover, well-educated women will set higher educational standards for their children—thereby elevating the general standard of education.

Irvine sharply criticised "discriminatory" practices of government agencies—including NASA—in tying up previously-developed proprietary rights of companies under defense contracts. And he said there is an "absolute necessity" for the proper and appropriate utilization of "trained active and retired military men of all services."

NASA Sphere Gets Ejection Test



A 100-FOOT-diameter sphere like the one above was launched by a sounding rocket to 250 miles over Wallops Island recently. Designed to test satellite drag at high orbital altitudes, the balloon payload's ejection mechanism functioned perfectly, allowing the balloon to be seen over much of the East Coast.

7000 to Attend ARS Convention

Five Russians due at Nov. 16-19 sessions; McCone, Von Braun among featured speakers

by Jay Holmes

WASHINGTON—More than 7000 rocketmakers, industry representatives and government officials are expected to attend the fourteenth and biggest annual meeting of the American Rocket Society here Nov. 16-19.

The delegates will include five Russians, headed by Prof. Leonid Sedov, president of the International Astronautical Federation. They will be the first Russians ever to attend an American technical meeting devoted to space flight.

John A. McCone, chairman of the Atomic Energy Commission, will be the featured speaker at the Wednesday night Honors Dinner. Luncheon speakers will be: Monday, Wernher von Braun; Tuesday, Air Force Brig. Gen. Homer A. Boushey; Wednesday, Dr. William H. Pickering of the **Cal Tech Jet Propulsion Laboratory;** Thursday, George P. Sutton, of the Advanced Research Projects Agency. Gen. Boushey replaces Maj. Gen. Bernard A. Schriever.

• **Rocket report**—A Monday evening session on "Latest Events in Space Flight" will present late reports on data obtained from satellites and information of firings made as a part of International Rocket Week. Dr. Abe Silverstein of the National Aeronautics and Space Administration will be chairman.

On Tuesday evening, the ARS National Capital Section will present a panel discussion of "Planning the Nation's Space Program" by representatives of the three services, Department of Defense, NASA and ARPA.

Samuel K. Hoffman, vice president of **North American Aviation Inc.** and general manager of **Rocketdyne,** will receive the Robert H. Goddard Memorial Award at the Wednesday night dinner. Other top awards: C. N. Hickman Award, Dr. Ernest Roberts, **Aerojet-General,** Azusa, Calif.; G. Edward Pendray Award, Ali Bulent Cambel, Northwestern University; ARS Astronautics Award, Dr. Walter Dornberger, **Bell Aircraft;** James H. Wyld Memorial Award, Karel J. Bossart, **Convair.**

In addition, 21 persons will be awarded Fellow memberships in the ARS. They are:

Kurt R. Stehling, NASA, Washington; Raemer E. Schreiber, Los Alamos Scientific Laboratory; Milton Rosen, NASA, Washington; Eberhard F. M. Rees, Army Ballistic Missile Agency, Huntsville, Ala.; Walter T. Olson, NASA, Cleveland; Lester Lees, **Guggenheim Aeronautical Laboratory, Cal Tech;** Kurt H. Debus, ABMA; John I. Shafer, JPL; William Avery **Applied Physics Laboratory,** Johns Hopkins University; Maj. Gen. Leighton I. Davis, Air Force, Washington.

Also, Thomas F. Morrow, **Chrysler Corp.;** Homer J. Stewart, NASA, Washington; James Van Allen, State University of Iowa; William G. Purdy, **Martin Co.,** Denver; T. Keith Glennan, NASA, Washington; Richard D. Geckler, Aerojet-General, Sacramento; Adolph L. Antonio, Aerojet-General, Azusa; David A. Young, Aerojet-General, Monterey; Kurt Berman, **General Electric Co.,** Ballston Spa, N. Y.; Robert M. Lawrence, **Thiokol Chemical Co.,** Bristol, Pa.; James J. Harford, ARS, New York.

More than 100 technical papers will be given at 24 unclassified and five classified sessions. Here are the times and subjects of the unclassified sections:

• **Monday, 9 a. m.**—Guidance, Physics of the Atmosphere and Space, Wave Phenomena.

• **Monday, 10 a. m.**—Section Delegates Conference.

• **Monday, 2:30 p. m.**—Ion Propulsion, Bio-Instrumentation in Space Research Vehicles, Propellants and Combustion.

• **Monday, 4 p. m.**—Annual ARS business meeting.

• **Monday, 8 p. m.**—Man in Space—Design Work to Date.

• **Tuesday, 9 a. m.**—Safety and Reliability of Liquid Rockets, Astrodynamics, Far Space Communications Techniques, Space Law & Sociology.

• **Tuesday, 2:30 p. m.**—Solid Rocket Technology, Space Communications Equipment, Philosophy of Education—the Scientist and Engineer and Their Environment.

• **Tuesday, 3:30 p. m.**—Marketing Symposium.

• **Wednesday, 9 a. m.**—Structures and Materials in Near Space Current Problems of Space Travel, Test Facilities and Ground Support Equipment, Advances in Miniaturization, Louis B. Forman, Chrysler Corp.

• **Wednesday, 2:30 p. m.**—Plasma Propulsion, Recoverable Booster, Payload Instrumentation.

• **Thursday, 9 a. m.**—Space Law & Sociology, Power Systems.

• **Thursday, 2:30 p. m.**—Power Systems.

These classified sessions are scheduled: Tuesday, 2:30 p. m., Ramjets (confidential); Wednesday, 9:30 a.m., Survey of Storable Propellants and Combustion Oscillations (confidential); Wednesday, 2:30 p. m., Liquid Rockets (confidential); Thursday, 9:30 a. m. and 2:30 p. m., Recent Advances in Nuclear Propulsion (secret — restricted data).

IRE Group Told of High Reliability of M-I-S

BALTIMORE—A manned space system would be about four times more reliable per pound of weight than an unmanned system, according to **Martin Co.** engineers.

Speaking here before the sixth annual IRE Aeronautical and Navigational Electronics Conference, R. D. Sorkin and M. A. Grodsky, Martin-Baltimore, said that, for a reliability of .999+, a manned system would require about 32% additional weight while a comparable unmanned single back-up system would need 200% additional weight, and a double back-up 360%.

Other conference papers applicable to missiles and space travel covered satellite tracking, electronic space suit instrumentation, and electronic maintenance in space. Classified sessions were devoted to advanced radar techniques and equipment.

'Made by the Bay for the U.S.A.'

Southern California has more large firms in missile industry, but San Francisco area grows in popularity as site for all phases of Space Age manufacture

by Frank G. McGuire

SAN FRANCISCO—The San Francisco Bay area doesn't match Southern California in sheer multitude of large manufacturing firms (see M/R Sept. 7 & 28). But it encompasses a tremendous missile/space effort by industrial, research and electronics companies, as well as universities.

Giants in the area—**Lockheed, Westinghouse, Stanford Research Institute** and others—are supplemented by many small, specialized firms. The dominant field is electronics, represented by **Hewlett-Packard, Eitel-McCullough, Varian Associates, Sylvania, Sierra Electronics, Ampex Corp., Dalmotor, Beckman & Whitley**, and dozens of smaller manufacturers. The gamut runs from raw materials suppliers like **Coast Manufacturing and Supply Co.**, to final installation specialists like **Ets-Hokin & Galvan.**

The many-faceted **Food Machinery & Chemical Corp.** has its Ordnance Division in San Jose, turning out missile frames, propulsion systems and various support and handling equipment. Prominent among valve manufacturers is the **Grove Valve & Regulator Co.**

• **Top dog**—Lockheed's Missiles and Space Division participates in more than a dozen major projects and a number of minor ones; it probably is the area's largest employer, with 13,800 on its payroll, and $50 million invested there—not counting a $10-million Navy building housing the *Polaris* program, and a $1-million Air Force building housing its satellite programs.

About 11,870 LMSD's employes are based at the Sunnyvale facility, and 1100 at Palo Alto, with most of the remainder scattered throughout a number of leased offices. The Santa Cruz test site, a 4000-acre facility, utilizes 484 persons and two test stands for ground testing various systems and components.

Some idea of the scope of LMSD may be gleaned from the fact that its 1958 sales—$302,178,000—constituted 31% of Lockheed's total, while 1959 sales are expected to approximate $375 million. The weekly payroll in the Bay area alone is about $1.5 million.

A 346,000-square foot building to house all of the division's three ad-

SPRAWLING OVER 645 acres, Lockheed Missiles and Space Division's Sunnyvale site includes recently activated headquarters for *Discoverer, Midas* and *Samos* projects.

TEST OF *Polaris* launcher, made by Westinghouse's Sunnyvale Division.

vanced satellite projects (*Discoverer, Midas* and *Samos*) was completed at Sunnyvale and occupied in September. The $8-million structure is used by 2500 scientists, engineers, technicians and support personnel in the three programs.

The division's Space Communications Laboratory was doubled in size in August, with completion of an 8000-square foot addition. The lab is studying satellite communication, radio astronomy and other systems through use of advanced techniques including MASERS.

In addition to current work on *Polaris, Discoverer, Midas* and *Samos*, the division's Bay area facilities have carried out work on the *X-7* and *Kingfisher* projects, as well as continuing research on nuclear physics and other basic fields.

• *Polaris* **launchers**—Westinghouse Electric Corporation has some 3500 employees in the Bay area, most of them at its Sunnyvale Manufacturing Division, which makes the launchers and handling equipment for *Polaris*-packing submarines like the USS Theodore Roosevelt recently shown for the first time at the Navy's Mare Island Shipyard.

("Made by the Bay for the U.S.A." was considered as a label for the launching of the Roosevelt and its full-scale model *Polaris*, since the shipyard built the sub, Lockheed-Sunnyvale was prime for the missile, Aerojet-Sacramento [not far from the Bay] supplies *Polaris'* propellant, and Westinghouse makes the submarine nuclear reactor.)

It's impossible to estimate the sales volume of Westinghouse's Sunnyvale Manufacturing Division, since the parent corporation does not break down its sales reports by division.

• **Research reservoir**—Stanford Research Institute, an almost-bottomless source of research in a great number of fields, has also acted as mother-hen to several commercial enterprises founded by its "alumni."

Founded in 1946 to provide a fountain of applied research for the Western states, SRI has since made its mark in many fields, including electronics, solid and liquid rocket propellants, economics, transportation, explosives, medicine, and almost any other field you care to mention.

Employing over 800 full-time professional scientists at Menlo Park, the institute has four research divisions: Engineering, Physical Sciences, Economics, and Poulter Laboratories. The first of these, Engineering, has made considerable gains in microwave, data processing, control systems, and other fields. The Economics Division has concentrated its efforts in four areas: area development programs, concerned with studies of specific geographical areas; industrial economics, concerning long-range planning & marketing; defense research, including civil defense, logistics, etc.; and management sciences, including industrial operations research and computer-applications studies.

TWO TEST stands tower over LMSD's Santa Cruz site, with the Pacific Ocean in the background. The site covers 4000 acres and has a payroll of some 484 persons.

Physical Sciences Division is self-explanatory, delving into chemistry, physics, chemical physics, metallurgy and biology. Areas researched are numerous and cover ion exchange, fluid flow, heat transfer, solar-energy utilization, cermets, among others.

One of the latest additions to the Poulter Laboratories Division is the Propulsion Laboratory. The Poulter Lab is primarily concerned with work on explosives and detonation processes. Studies are also carried on in combustion research and high-pressure phenomena. The new Propulsion Laboratory will deal with high-energy propellants for large rocket engines. Its lab and test facility covering 16,000 square feet and using the most modern equipment, is at the Calaveras test site near San Jose.

An indication of the reputation enjoyed by SRI is seen in the extent to which major companies turn vital projects over to the institute with complete confidence.

Sylvania Electric Products Company, early in the 1950's, was searching for a western plant location. Sylvania chose a site in Mountain View from among a number of sites suggested by SRI. The SRI Engineering Division then assisted in developing a new product for the new plant. It then developed a pilot production line for the new product, hired the nucleus of a production staff in Sylvania's name, and provided training for the staff which was transferred to the new plant to manufacture the new product.

Varian Associates, located in Palo Alto, has doubled its master plan for construction in the Stanford Industrial Park from 500,000 to 1,000,000 square feet. The site is a 65-acre plot in the industrial park, and it is estimated that by the end of 1960, Varian's Palo Alto facilities will total 500,000 square feet.

Included in the master plan are an addition to the instrument building, a new unit added to the tube research and development facility, a radiation division building, and administration building, and support buildings.

Originally organized as a research company, Varian branched out into manufacturing, and became a dominating force in the production of klystrons and other microwave tubes, electron linear accelerators, spectroscopy instruments and vacuum products. Employees now number 2700 and company assets total about $24 million. Sales backlog for Varian and its associated companies totals $20, with an expected 1959 sales volume of $38 million. A 50% increase in earnings over 1958 is also anticipated.

Pyromet Company, specialists in brazing and heat treating, have begun construction of a $250,000 production facility in San Carlos. The site is ex-

pected to be ready for occupancy early in 1960. The nine-year-old firm is building the plant as part of an overall program to take advantage of expanded business volume.

Special production equipment housed in the new plant will be a bell furnace with six-foot-diameter working area for dry hydrogen brazing, along with a company-developed high-vacuum furnace. An expanded R & D capability will be housed in a metallurgical laboratory included in the plant.

Huggins Laboratories, Inc., manufacturers of travelling wave tubes for microwave applications, is one of those small companies whose staff and business volume practically double each year. Located in Sunnyvale Development Center in a plant designed to house 400 employes in its 30,000 square feet, the firm began in 1952 with one employe, and the number has doubled each year since.

Ultek Corporation, a recently-formed organization for the development and production of electronic vacuum pumps and related equipment, has as its president a former research engineer from Varian, Lewis D. Hall.

Eitel-McCullough, producers of over 100 vacuum tube types, has two of its three plants in the Bay area, the other one being in Salt Lake City. The most modern of the three, in San Carlos, was completed in 1958, and gives the firm 150,000 square feet of working space. Eimac's third plant is in San Bruno. Much of the company's production utilizes the Eimac-developed ceramic-metal design in tube construction.

Sierra Electronic Corp., a division of **Philco Corporation,** has facilities at Menlo Park for the production of electronic test instruments and systems and related equipment. Included in Sierra's line are signal generators, calorimeters, transistor testers and oscilloscopes.

Hewlett-Packard, the world's largest manufacturer of measuring instruments, employs over 2000 persons in the Bay area, and has an annual payroll of about $13 million. Sales have moved from the 1950 figure of $2.3 million, to the present level of $40 million annually.

The firm's production facilities consist of two plants in the bay area, one in Palo Alto and the other in Palo Alto's Stanford Industrial Park. Two new buildings are being added to the industrial park site. Upon completion of these, the company will have a total of 570,000 square feet of factory area. HP is also commencing operation of a small plant near Stuttgart, Germany, and has recently established a subsidiary marketing organization in Geneva, Switzerland.

HP has recently acquired **Palo Alto Engineering Company** and **Dymec, Inc.,** of Palo Alto, as well as **Boonton Radio Corp.** of Boonton, New Jersey. The latter, with annual sales of $2.5 million, will be operated as a separate company.

Caswell Electronics Corp., a San Jose firm, has work underway in microwave research, and in production of waveguide, ferrite and coaxial components. The company has recently suggested a new method for scanning microwave antennas, involving an electronic system which applies a longitudinal magnetic field to a waveguide slot partially loaded with ferrite. This scans the transmitting and receiving beam patterns radiated by the aperture.

American Ordnance Technician Services, Inc. has recently been formed to extend and broaden the services of **Western Ordnance Repair Co.** The firm specializes in servicing ordnance systems for prime contractors who need technical assistance on short notice. AOTS handles installation, test, acceptance checkout, maintenance, repair and overhaul. The 95-man company specializes in handling complex weapon-systems ranging from the German *V-2* to the *Sidewinder, Sparrow,* vintage, and other weapons now in development.

HEWLETT-PACKARD is representative of electronics activity in the Bay area, employs 2000. Here new voltmeters are assembled for testing at HP's Stanford plant.

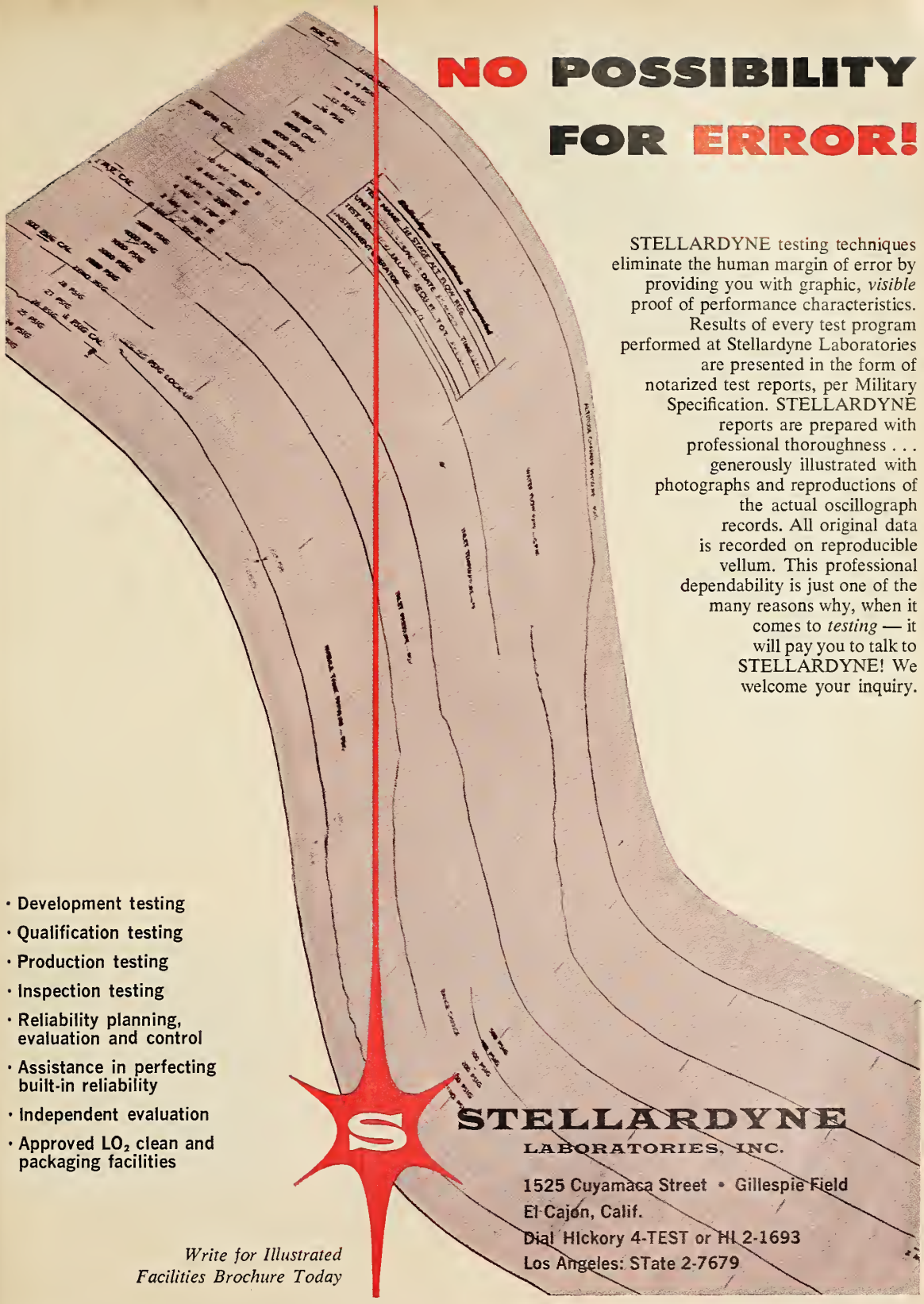
Latest Univac Computer Is 200 Times Faster

NEW YORK—A new computer, designed with the help of another computer, can operate at speeds 200 times faster than any similar equipment in use today.

The new system, just announced as available, is the Univac Larc Solid-State Computer, a large-scale digital computing system originally designed and constructed by **Remington Rand's Univac Division** for the Atomic Energy Commission for use at Livermore, Calif.

The Larc is geared to handle a range of variables extending from missile tracking to preparation of company payrolls. It can perform 250,000 additions or subtractions of 12-digit decimal numbers per second.

Data processing and scientific problems can be performed concurrently by the $6-million machine.



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Reliable Cooling: A Major Problem Is Being Solved by the Infrared Industry

IR-detector cells are behind state-of-the-art of cells, but current R&D efforts are closing the gap with better hardware, advanced methods

by Charles D. LaFond

WASHINGTON—Among the many technical problems facing the infrared industry today, one stands out on each list of trouble areas—the cooling of IR detector cells. Almost every company involved either is researching on its own to develop better coolers or has subcontracted the job to a company specializing in this type of component refrigeration.

To obtain the very best possible operating characteristics from long wavelength IR detectors, they must be cooled. Some require cooling down to liquid nitrogen temperatures (–196°C), but others operate best at temperatures well below this point.

In the laboratory, the problem is a relatively small one; by the use of liquid neon, hydrogen, or helium, temperatures as low as –268.9°C can be reached. But such gases are not readily available—and they are very expensive. The real problem must be faced when we attempt to put such systems in missiles, satellites, and aircraft detection systems.

Briefly, there are five principal problem areas: reliability, weight and volume, contamination of gases, power requirements and hardware costs. Industry is vigorously investigating all of these areas. There are some associated problems which will have to be solved when the major troubles are conquered. Accessibility is certainly an obstacle: the detector assembly may be completely within the particular infrared system, and this in turn may be inside the vehicle. Cooling time is another roadblock; it may vary from a few minutes to several days without allowing the recharging of the refrigerant.

Furthermore the environment and attitude of the vehicle must be considered. Any cooling system used in a missile/space vehicle must be capable of high performance at any altitude, temperature or position that the craft may assume. Finally, the detector assembly may be in gimbals which must not be unduly encumbered.

The views of **HRB-Singer, Inc.,** probably best indicate a typical customer attitude toward future cooling system needs. This firm believes that the great need is for a reliable closed-loop cooling system, with the stress on the word reliable. It feels that the big problem in this area is one of keeping the gas contaminant-free. Foreign matter introduced at the pumping stage is not always filtered out, systems foul up, and many man hours are lost as a result. Present-day cooling systems are far behind the state-of-the-art of detector cells.

The company is now using liquid-nitrogen systems because they are reasonably reliable. When used beyond the atmosphere, however, liquid nitrogen will no longer be adequate. Thus the need for a closed-loop system for use in a missile or space vehicle becomes doubly important.

The company has found that liquid nitrogen is hard to handle, and remains effective for a limited time. In summary, then, the company wants a lightweight, reliable, trouble-free, closed-loop system that will go lower than liquid nitrogen, and be free of the troubles associated with liquid nitrogen.

• **Types of systems**—There are many different systems, but they fall essentially into four principal groups: expansion, cryostat, direct liquid transport, and thermoelectric systems.

The cryostats use nitrogen, and there are three general types. One uses stored, compressed gas; another employs a liquid nitrogen converter; a third uses a compressor in a closed loop.

The expansion engines employ liquid helium and there is another system employing a gas liquifier with helium. There also have been developed cryostats for use at somewhat higher temperatures, employing carbon dioxide or Freon 13.

The Peltier-thermoelectric coolers currently are arousing a great deal of industry enthusiasm. This is for one principal reason—they have excellent reliability, and they are lightweight. The principal problem is to increase the temperature-differential. At present, most of the single-stage Peltier coolers have a temperature-difference range of from 40° to 50°C from an ambient of 25°C. Power requirements for the Peltier-type coolers are very low—approximately 2½ watts.

The miniature cryostats were the first major approach to cooling long-wavelength detectors. Essentially they consist of a short length of thin metal tubing of small size wound about a mandrel. This unit is installed in a close-fitting tube comprising the inner portion of a small vacuum flask.

Pressurized nitrogen gas is directed through the tubing toward the back of

AN INFRARED detector-cell cooling unit with a finned heat sink developed by the Philco Corporation. The company is pushing a search for better materials.

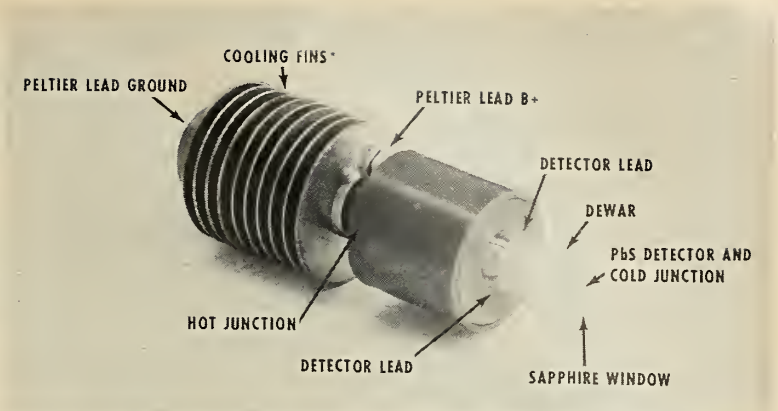
the detector. As the gas emerges, it is cooled by Joule-Thomson expansion. The gas, following expansion, is directed back over the coil of the tubing, producing regenerative cooling. Eventually, the gas is cooled enough to liquify at a temperature close to −196°C.

In the liquid nitrogen converter system, gas is stored in liquid form in a pressure vessel. By means of forced evaporation, high-pressure gas of very high purity is produced because the contaminants are frozen out in the liquid-nitrogen state.

Another method of operating a cryostat is by means of a closed-loop unit employing a non-contaminating compressor. So far, piston-type compressors have been generally unsuccessful, but bellows and diaphragm type compressors are well along in development by several companies.

The direct liquid nitrogen transfer system was mentioned earlier. In this technique an insulated flask stores the liquid nitrogen and maintains a small pressure, usually less than 15 psig. Liquid nitrogen is forced by the pressure through a tube which transports the liquid to the area of the detector. At this point two methods of application may be used: the liquid nitrogen may be passed into a heat-exchanger at the detector and thus leave the system in an expanded gaseous state; or droplets of liquid nitrogen may be sprayed on the rear of the detector.

The expansion engine normally is used for the liquefaction of helium. Gas is compressed which causes it to lose energy in expansion by doing work and thus its temperature is reduced. Additional Joule-Thomson expansion causes liquefaction. The gas liquefier uses an expansion engine to cool an enclosed surface. When the gases come in contact with this surface they are cooled, condensed and then flow off as a liquid. The systems eventually will be recirculating and will operate on a single charge of coolant gas.



PELTIER-TYPE IR cell cooler draws 20 amperes at 0.1 volt to produce temperature differential of 50°C at room ambient. Peltier design is by Nortronics; package by Infrared Industries. Fins may be omitted if adequate heat sink is available.

• **Recent results**—Because of the large number of companies involved in cooling research for detector cells, we cannot hope to cover all of their recent advances. But we can cover what a few of the major companies have been doing in the past few months and describe some of their results.

The **Linde Co.,** a division of **Union Carbide,** has been working with four types of liquid nitrogen systems. It also has a research program in progress for liquid-helium-cooled dewars, but according to a company spokesman this is in the early stages of research and its studies are devoted primarily to the feasibility of systems of this type.

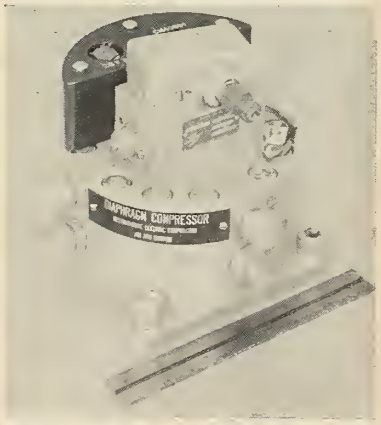
Liquid feed-vacuum insulated supply line with an insulated vessel is used by Linde for situations where the dewar must be located at some distance from the cell to be cooled. The system has an evaporation rate lower than the use rate, thus the same container might be capable of 24-hour standby and 8-hour operation, or 48-hour standby and 5-hour operation. An increase in standby time does not result in a corresponding decrease in operating time, as can occur in other basic systems.

Vacuum insulated lines have been furnished straight or coiled to reduce vibration effects. Linde currently is working on flexible vacuum insulator lines to accommodate scanning detectors. But this is still in development stage. The company feels that the liquid-vacuum insulated line systems are the most versatile of the four types of nitrogen cooling systems.

Linde also is working with bare liquid feed line systems, but here the line conducts more heat to the liquid

A RECENT development by the Linde Company is this 3 in. diameter X 4 in. integrally mounted cell and liquid N_2 cooler, having 8.5 hours holding time.

ANOTHER NEW Linde product is this liquid N_2 feed-vacuum insulated line. The unit has a 24-hour standby time and a six-hour operating time.



PROTOTYPE OF a Westinghouse diaphragm compressor for supplying high pressure nitrogen gas to a cryostat. Diaphragm is free floating.

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than the insulator type, resulting in a higher use rate of liquid. This higher use rate partly is compensated for by lower cost, sturdier construction of the feed line and easier maintenance.

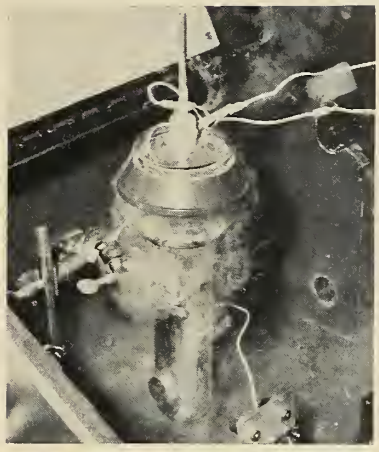
In the company's high pressure liquid-to-gas generators, the systems may or may not have insulated vessels. The insulated vessels provide much longer standby periods without the loss of gas. The company feels that this type of system is inferior to the liquid feed systems for cooling IR cells. To meet pressure requirements necessitates large containers. Another great disadvantage to this high pressure system is the susceptibility of cryostats to clogging due to ice formed from moisture and other impurities in the gas.

If the situation demands the use of a cryostat, the gas generator is then more desirable in the storage of high pressure nitrogen. One pound of liquid requires one/third the volume needed to store one pound of gas at 3500 psia.

The simplest system with which Linde has been working is the integrally-mounted cell. The detector cell is mounted on a conductor such as a sapphire rod or metal button which is in direct contact with the inner shell of the dewar. To fill, liquid is poured into the container and the cell is cooled during the fill. The use rate is the same during standby or operating condition because the cell is always cold. In general, systems with cells mounted in the vacuum space and close to the inner vessel shaped to give the minimum outside area for a given capacity will yield the highest holding times.

The **Santa Barbara Research Center,** a subsidiary of **Hughes Aircraft Co.,** has developed several systems for automatic operation in airborne environments. The two most satisfactory systems according to the company, are Joule-Thomson coolers operated on demand by a liquid level censor, and pressure-regulated liquid transfer systems using uninsulated transfer tubing. (See M/R Sept. 28.)

The Research Center also has found that detectivity is limited by ambient or room temperature radiation falling on the detector cells. The idea of course, is not new, but the company believes that it had not been demonstrated previously with lead selenide. By providing appropriate shielding in the detector package, improvements in detectivity of a factor of from 6 to 10 have been achieved. Shielding is designed to fit the optical system (improvement in detectivity is inversely proportional to the sine of



LAB MODEL of Santa Barbara Research Center's Joule-Thomson hydrogen expansion system. Dewar operates below liquid H_2 temperatures.

½ the angle subtended by the aperture of the detector.) The improvement is attained by an increase in the signal-to-noise level so that the shielded detectors are easier to use with conventional amplifiers.

Another technique employed by SBRC involves the restriction of the amount of ambient radiation by using spectral filtering. Selective filters on the detectors absorb light of wavelengths not contained in the signal radiation.

A typical liquid transfer unit developed by SBRC weighs 7.5 lbs. complete when filled with liquid nitrogen. The company said it can cool a complicated 8-detector package for more than 6 hours under in-flight conditions and after a standby time of 24 hours.

Westinghouse Electric Corporation, Air Arm Division, has done extensive work in closed-loop infrared detector cooling systems. The company has been working to improve the reliability factor for both short and long-term operating periods.

Westinghouse chose for its specific system development a diaphragm-type contaminant-free compressor supplying high-pressure nitrogen gas to a Joule-Thomson regenerative cryostat. The latter, the company believes, offers two basic advantages over an expansion-type cryostat. The first, is the lack of any moving parts in the cryostat at low temperature. The second is the absence of a temperature regulating device in the cryostat to compensate for heat-load variations.

The closed-system arrangement developed by Westinghouse has been tested for a period of over 500 hours at a cryostat tip temperature of −175°C. Only minor difficulties have been encountered to date. Heart of this system is the compressor. A series of O-rings within the compressor prevents contamination of the gas from the hydraulic system.

A critical component of the compressor was the diaphragm itself. Compressors of this type with metallic diaghragms have been used successfully for some time in gas purification systems. However, due to miniaturization required for missile and aircraft application, design of the cavity was extremely critical from a displacement point of view in order to meet the flow rate requirements of the closed system.

Two diaphragm materials were chosen for test purposes. One a stainless steel, the other a titanium alloy. Both materials proved to possess the proper combination of ductility and high endurance limit.

It may also be noted that in this particular design the diaphragms are free floating, not clamped around the edges. The design has proven entirely satisfactory under tests, according to the company, indicating that the life of the diaphragms will not be exceeded during the normal life of the compressor.

The company also has been working with an extension of this design concept to use a combination nitrogen-neon system. This may result in an airborne system capable of cooling detector cells to a temperature of −233° to −243°C.

The Garrett Corporation's Air Research Manufacturing Division has developed highly successful cryostats employing nitrogen gas and also employing liquid nitrogen for direct transfer (see M/R Feb. 16). Also the Min-Ircooler developed by **Arthur D. Little** has gained considerable publicity because of its very small size. The 8-ounce unit employs helium gas and can drop the temperature of an IR cell to 60°K. Total system weight eventually will be less than 10 pounds, according to the company (see M/R, May 25).

The Philco Corp. has for some time carried out a company-supported research program for cryogenic cooling of IR detector cells. Much of its current research dollar in this area is going toward advanced forms of thermoelectric cooling. The Philco infrared cell cooling unit employs a finned heatsink and using Peltier effect, has achieved a temperature differential of approximately 40°C. Current requirements are approx. 12 amps.

The company feels that material barriers have been pushed to their limit at the present time. Thus its researchers are extending their efforts to find materials with lower thermoconductivity, higher electrical conductivity and higher thermoelectric power.

Many, of course, believe that Peltier-type refrigerators may be the best solution to the detector cell cooling problem. It has one great advantage in that it can be constructed integrally with the detector itself. It has no moving parts, and can be highly reliable.

Infrared Industries, Inc., believes that it has developed the first Peltier cooler in a practical package. Working with **Nortronics Division** of **Northrop Corporation** for the past year, a highly successful device has been developed. It draws 20 amps at 0.1 volt and produces a temperature change of approximately 50°C at room temperature with a single-stage unit. It can achieve 50% more cooling with a 2-stage version of the same device. Besides the advantages of the Peltier cooler, already mentioned, Infrared Industries believes that it has several other very important attributes, particularly for missile and space environments: 1) A vacuum and most other environments have no direct effect on performance. 2) the efficiency improves as the reference junction temperatures goes up. This tends to compensate for any design error realized in maintaining temperature of the heat sink. 3) While a power supply for the cooler is required, it may be located at almost any remote location.

Working with the **Walter Kidde Co.,** Infrared Industries has also produced a very low cost carbon-dioxide cooler employing a simple 0.3 oz. "Sparklet" type cartridge. An IR cell can be cooled to approximately dry-ice temperatures, (–78°C) for approximately one hour. Cool down time is of the order of a minute or two, but this can be speeded up to a few seconds at the sacrifice of cooling duration. The depressed temperature can be maintained indefinitely by the replacement of the spent cartridge every hour or so. Also the same cryostat and filter can be used with the larger CO_2 bottle and a more complex valve for extending duration time to about 24 hours. Both of these CO_2 systems are considered ideal for lab use rather than for missile or aircraft applications.

According to a **Nortronics Laboratory** spokesman, its recently developed two-stage units, using improved materials, have yielded Peltier cooling of 79°C from room ambient. The company expects that still better materials will be available in the future providing correspondingly greater cooling for both single and double-stage units.

astrionics

Explorer VI May Solve Puzzle of Repetitious Radio Signals

MENLO PARK, CALIF.—The mystery of why radio signals sometimes repeat themselves seconds later may be solved by scientists experimenting with the help of *Explorer VI.*

A theory postulated by Dr. R. A. Helliwell, of Stanford University, is that while most low-frequency waves are reflected back by the ionosphere, some manage to penetrate this barrier and go on out into space. Here they are captured by magnetic field "ducts" which conduct them back to earth again, thousands of miles from the transmitter.

NASA's paddlewheel satellite carries an ultra-sensitive VLF receiver—the first in space—designed to pick up these signals as the ionized ducts are crossed. The signals are then relayed back to earth by telemetering equipment.

Special ground receivers located throughout the world receive, as a reference, the original radio transmissions by the usual paths. After evaluation, the compared data is expected to give clear evidence of the existence and location of the postulated ducts.

The experiment is also expected to shed light on other aspects of radio waves and ionization patterns in space. Detailed levels of the "fall-off" in signal strength from the rocket as it rose from earth through the ionosphere will provide valuable data on the makeup of this ionized layer.

In addition, the satellite receiver will register any VLF signals that may originate in outer space. So, not only will the experiment indicate how much low-frequency noise gets through the ionosphere from below, it will help show something about signals from above that can't penetrate to earth.

IRE Meeting Hears Reports on Myriad Electron Devices

WASHINGTON—More than 1300 electronic engineers and specialists jammed the 1959 IRE Electron Devices Meeting here last week.

Invited papers on three most widely discussed subjects in the electronics industry—tunnel diodes, low-noise amplifiers, and multifunctional devices—highlighted the opening. Dr. R. N. Hall, of **General Electric's** Research Laboratory, described the potentialities of the Esaki, or "tunnel," diode which shows great promise for ultrafast switching applications.

Professor H. Heffner, Stanford University, reported on competing device concepts for achieving low noise in solid-state and other electronic amplifiers. Such low-noise performance is vital in improving the range characteristics of communications systems such as radar and radio astronomy.

Dr. I. M. Ross, of **Bell Telephone Labs** presented the third invited paper, on the broad field of multifunctional solid-state devices. Among devices being investigated include micromodules, solid circuits, molecular electronics, and microminiaturization.

Frederick R. Lack, director of EIA and former vice president and director of **Western Electric,** summarized the past and present status of electron tube delevopment in an address at the opening-day luncheon. He warned against the pitfalls of moving too fast in adapting new electronic devices to expanding industries and military markets.

Nine technical sessions covered new designs and increased capabilities of traveling-wave and backward-wave devices, cathode-ray tubes, solid-state devices, and other electronic components.

Among the major advances described were a 220 mc negative resistance parametric amplifier for use in solid-state UHF receivers. The amplifier provides a low-noise figure and stable operation, with gain of 13 db despite pump power of only 0.1 mw. It registers noise figures between 1 and 2 db without a circulator or isolator.

Devices and techniques reported by foreign engineers included a silver-bonded diode for paramps, by engineers of **Nippon Telegraph and Telephone,** Tokyo; a series of pulsed high-perveance high-power klystrons for linear accelerators, by representatives of **Compagnie Génerale de Télégraphie Sans Fil,** Orsay, France; and characteristics of a beam power multiplier tube, by engineers from Cairo University.

ASTROLOG

A status report on U.S. missiles and rockets and all space vehicles presently in orbit

★ *Indicates change since Sept. 7 edition*

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SPACE VEHICLES			
★ATLAS-ABLE (NASA)	STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion	Orbit 200-lb. vehicle around moon or send into deep space	Moon orbit attempt scheduled for November
CENTAUR (NASA)	Convair, prime; Pratt & Whitney/JPL, propulsion	Soft-land 730-lb. on moon	First test flight in fall, 1961
★COURIER (ARPA-Army)	Army Signal Corps, prime	Delayed repeater communications satellite	R&D; satellite in advanced stage; first to be launched in spring
★DECREE (ARPA)	No contract announced	24-hour instantaneous repeater satellite	R&D
DISCOVERER (ARPA-AF)	Lockheed, prime	Thor-Agena launchings of early stabilized satellites	Of first 6 launched, 3 stabilized in orbit; ejected capsules not recovered
DYNA-SOAR I (Air Force)	Boeing and Martin/Bell, competing	Boost-glide orbital test vehicle	Late study stage
JUPITER-C (NASA)	ABMA/Chrysler, prime; Sperry, guidance; Rocketdyne, JPL, propulsion	Early satellite booster; small payload	Being phased out
★JUNO II (NASA)	ABMA/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, prop.	Early deep space booster; small payload	Five more shots planned
★MERCURY (NASA)	NASA, prime; McDonnell, capsule	First manned satellite	Capsule testing being conducted; manned capsule launching by REDSTONE down Atlantic
MIDAS (ARPA-Air Force)	Lockheed, prime	Early-warning satellite; detect ICBM launchings by infrared before birds leave pad	R&D
★MRS. V (ARPA)	No contract announced	Manueverable, recoverable space vehicle; also known as DYNA-SOAR II	Studies; future of project in doubt
NOVA (NASA)	Rocketdyne, prime; Rocketdyne, propulsion	Clustered 6 million lb. booster	Early R&D on 1.5 million lb. engines
ORION (ARPA-Air Force)	General Atomic	Space station launched by series of atomic explosions	Feasibility studies under way; tests may be attempted
★SAMOS (ARPA-Air Force)	Lockheed, prime	Reconnaissance satellite; formerly Sentry	R&D; stabilization already achieved in DISCOVERER series; first test launching scheduled in March
★SATURN (ARPA-Army)	Army Ordnance Missile Command, prime; Convair/Pratt & Whitney, propulsion; To be transferred to NASA if Congress approves	Clustered 1.5 million lb. thrust booster; liquid TITAN second stage; CENTAUR third stage; second stage may be changed by NASA	Timetable in doubt. Under current schedule, 3-stage SATURN would be first launched late 1963 earliest; under crash program, late 1962.
SCOUT (NASA)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Allegany/Thiokol, propulsion	Four-stage satellite launcher; 200-300 lb. payload in orbit	Operational next spring
★STEER (ARPA)	GE-Bendix, prime	Polar-orbiting instantaneous repeater satellite	R&D
★SUZANO (ARPA)	No contract announced	Space platform to be used as base for staging and other missions	Feasibility studies; no funding

This Astrolog May Be Detached from the Magazine for Constant Reference

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★THOR-ABLE (NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Early deep space booster	Sun orbit shot in late November
THOR-DELTA (NASA)	STL, prime; IT&T, guidance; Rocketdyne/Aerojet-General/Allegany,prop.	Put 65-lb. satellite in orbit around moon	R&D; first flight early 1960
★TIROS (NASA-Navy)	RCA-Army Signal Corps, prime	Meteorological satellite; TV pictures of cloud cover	R&D; first test launching 1960
★TRANSIT (ARPA-Navy)	Lockheed and Johns Hopkins Laboratory, prime	Navigational satellite	First shot almost complete failure because final stage didn't operate; next shot in late winter
TRIBE (ARPA)		Family of space launching vehicles	Planning
VANGUARD (NASA)	Martin, prime; Minneapolis-Honeywell, guidance; GE, Aerojet, ABL, Grand Central, Atlantic Research, Thiokol, propulsion	First planned satellite booster; small payloads	Program ended with successful launching of VANGUARD III September 18
VEGA (NASA)	JPL/Convair, prime; GE, guidance; Rocketdyne/JPL/GE, propulsion	Advanced space vehicle with ATLAS; second stage start-restart; can put 980 lbs. around moon	First flight in fall, 1960
★X-15 (NASA-AF-Navy)	North American prime; Thiokol, prop.	Rocket plane; 3600 mph; flight at edge of space	First powered flight successful
MISSILES & ROCKETS			
ABLE (Navy)	Avco, prime	ASW surface-to-underwater; 500 lb. solid; conventional	Deployed on destroyer escorts
★ASROC (Navy)	Minneapolis-Honeywell, prime	Surface-to-underwater; solid rocket torpedo; nuclear	R&D; operational Jan. 1961
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater; rocket torpedo; nuclear	R&D
★ATLAS (Air Force)	Convair, prime; GE/Burroughs, ARMA, guidance; Rocketdyne, propulsion	ICBM; more than 5500-mile range; liquid; nuclear	35 launchings of test vehicles all types: 19 successes, 8 partial; 8 failures; expected operational this month
★AUTOMET (Army)	No contract announced	New solid tactical missile	R&D; test vehicle stage
★ALBM (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion	Air launched ballistic missile; more than 1000-mile range; solid; nuclear	Design study
ARM	No contract announced	Anti-radar missile	R&D
★BOMARC-A (Air Force)	Boeing, prime; Westinghouse; guidance; Marquardt, propulsion	Air-breathing surface-to-air interceptor; liquid; 200 m. range; Mach 2.7; nuclear	A model operational at McGuire AFB, N.J.
★BOMARC-B (Air Force)	Boeing, prime; Westinghouse, guidance; Thiokol, propulsion	Air-breathing; surface-to-air; Mach 2.7; more than 500 m. range; nuclear	Late development
★BULLPUP (Navy)	Martin, prime; Republic, guidance; Thiokol, propulsion	Air-to-surface; 4-mile range; conventional 250-lb. bomb	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; Air Force buying modified version
★COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CORVUS (Navy)	Temco, prime; Texas Instrument, guidance; Reaction Motors, propulsion	Air-to-surface; pre-packaged liquid; radar homing; about 100-miles range	First successful test July 18, 1959
CLAYMORE (Army)	No contract announced	Anti-personnel missile	R&D
DAVY CROCKETT (Army)	In-House Project at Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead	R&D
EAGLE (Navy)	Bendix, prime; Sanders, guidance	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow aircraft	Early R&D
★FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional	GAR-1D & GAR-2A & GAR-3 operational; GAR-4 & GAR-9 under R&D; GAR-9 work slowed
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 20-mile range; solid; conventional; designed to hit low-flying planes	Operational; units training for early deployment
HONEST JOHN (Army)	Douglas, prime; Hercules, propulsion	Surface-to-surface; unguided; 16.5-miles range; nuclear	Operational; deployed in Europe
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Nearly operational; to be launched from B-52G intercontinental bombers
★JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	IRBM; liquid; nuclear	To be deployed with Italian troops in Italy and Turkish troops in Turkey; 23 launchings: 16 successes; 5 partials; 2 failures
★LACROSSE (Army)	Martin, prime; Federal Telecommunications Laboratories, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; 4 units being trained; 3 more planned for 1960
LITTLE JOHN (Army)	Emerson Electric, prime; ABL, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	Nearly operational; units training with it
LOBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm	Studies
LULU (Navy)	No contract announced	Surface-to-surface; nuclear	R&D
MACE (Air Force)	Martin, prime; AC Spark Plug, guidance; Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has 1000-m. range	Being deployed with U.S. troops in West Germany
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650-mile range	Being turned over to West Germans; also deployed in Far East
MAULER (Army)	No contract announced	Surface-to-air; IR guidance; field weapon	R&D
★MINUTEMAN (Air Force)	Boeing, prime; Autonetics, guidance; Thiokol, propulsion	2nd generation ICBM; solid; mobile; nuclear	R&D. Expected to be operational by late 1962 or early 1963; to be installed in hardened sites and made mobile on trains or trucks
MISSILE A (Army)	No contract announced	Surface-to-surface; 65-70 mile range; solid	Design studies
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Hercules Powder, propulsion	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion	Surface-to-air; 80-mile range; Mach 3+; nuclear	Rapidly replacing NIKE-AJAX
★NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Grand Central, propulsion	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D; major components being tested; first tests against ICBM's to be in PMR; first launched ZEUS fell apart in flight Aug. 26; second successful but short of programmed range, first and second stages ignited
PERSHING (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; solid; 700-mile range; nuclear	R&D; to replace REDSTONE; test launchings imminent at Cape Canaveral
★POLARIS (Navy)	Lockheed, prime; GE, guidance; Aerojet-General, propulsion	Underwater and surface-to-surface; solid; 1500-mile range; nuclear	41 launchings of test vehicle; 28 successes; 11 partial; 2 failures; launched from surface ship Aug. 27, 1959; expected operational late 1960; 900-m. range vehicles under test at Cape Canaveral
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
REDEYE (Army)	Convair, prime	Surface-to-air; 20-lb. bazooka-type; IR guidance; solid; conventional	R&D
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe
REGULUS (Navy)	Chance Vought, prime; Sperry, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines
SERGEANT (Army)	JPL/Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	Production. To replace CORPORAL
SHILLELAGH (Army)	Aeronutronics, prime	Surface-to-surface; lightweight; can be vehicle-mounted	R&D; expected to be operational mid-1960's
SIDEWINDER (Navy)	GE-Philco, prime; Avion, guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; 6-7-mile range; conventional	Deployment with Naval and Air Force units

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear-powered ramjet; nuclear	Study-R&D
SNARK (Air Force)	Norair, prime; Northrop, guidance; Aerojet-General, propulsion	Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear	Deployed at Presque Isle, Maine
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Air-to-air; 5-8-mile range; Mach 2.5-3; solid; conventional	Operational with carrier aircraft; earlier SPARROW I obsolete
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion	Underwater or surface-to-underwater; 25-50 mile range; solid; nuclear	R&D
★SUPER TALOS (Navy)	No contract announced	Seagoing anti-missile missile; possible AICBM	Early R&D
SS-10 (Army)	Nord Aviation, prime	Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa
SS-11 (Army)	Nord Aviation, prime	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional	Operational. Under evaluation by Army.
TALOS (Navy)	Bendix, prime; Farnsworth/Sperry, guidance; Bendix/McDonnell, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational this year aboard cruiser Galveston
TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Many test firings in Pacific; expected deployment 1960 as primary armament of guided missile destroyers; production
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional	Operational with fleet
★THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases being set up in England; 50 launchings: 33 successes; 10 partial; 7 failures
TITAN (Air Force)	Martin, prime; Bell, Remington Rand, guidance; Aerojet-General, propulsion	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear	5 launchings test vehicles: 4 successes; 1 failure; expected to be operational late 1960-early 1961; next launch scheduled in November
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime	Air-to-air, air-to-surface; solid; unguided rocket; 5-mile range; conventional	Operational

SATELLITES

SATELLITE	COUNTRY	STATUS
EXPLORER I (30.8 lbs.)	U.S.	Launched 1/31/58, est. life 3-5 years. Orbits earth, perigee: 224 m., apogee: 1573 m., period 114.8 min. (Discovered Van Allen Belt)
VANGUARD I (3.25 lbs.)	U.S.	Launched 3/17/58, est. life 200-1000 years. Orbits earth, perigee: 409 m., apogee: 2453 m.
SPUTNIK III (about 3.5 tons)	Russia	Launched 5/15/58, est. life, 15 mo. Orbits earth, perigee: 135 m., apogee: 1167, period: 106 min., inclination to equator: 65.3°. Speed, at perigee: 18,837, at apogee: 14,637 mph.
LUNIK I "MECHTA" (3245 lbs.)	Russia	Launched 1/2/59. Believed to be in orbit around sun on 15 mo. cycle.
VANGUARD II (20.7 lbs.)	U.S.	Launched 2/17/59, est. life 10 years +. Orbits earth but is "wobbling," perigee: 347 m., apogee: 2064, period: 125.85 min., inclination to equator: 32.88°.
PIONEER IV (13.40 lbs.)	U.S.	Launched 3/3/59. Orbits sun, and achieved primary mission, an Earth-Moon trajectory.
EXPLORER VI "PADDLE-WHEEL" (142 lbs.)	U.S.	Launched 8/7/59, est. life 1 year +. Orbits earth, perigee: 156 m., apogee: 26,357 m., period: 12½ hours, speed: at perigee 23,031, at apogee: 3126 mph., inclination to equator: 46.9°.
VANGUARD III (about 100 lbs.)	U.S.	Launched 9/18/59, est. life 30-40 years. Orbits earth, perigee: 319 m., apogee: 2329 m.
LUNIK III (about 614 lbs.)	Russia	Launched 10/4/59, orbits earth-moon; took first picture far side of moon; est. perigee: 30,000 m., apogee: 291,000 m.
EXPLORER VII (91.5 lbs.)	U.S.	Launched 10/13/59, est. life 20 years, orbits earth, perigee: 341, apogee: 679.

Who put the cart before the horsepower?

Autonetics did. Autonetics foresaw that the electronic systems inside a modern weapon would become as important as the frame that enclosed them... foresaw that the twin bugaboos would be time and talent: the time it would take a swarm of skilled technicians with meters and hand probes to make a thorough maintenance test—and the scarcity of such technicians. That's why Autonetics, together with the Department of Defense, set out to automate the whole procedure.

Result: carts that contain today's most versatile automatic checkout systems. These systems match the needs of the majority of manned and unmanned weapon systems. Adaptive equipment for testing special electronic systems can be packaged in similar carts and plugged into the basic cart. The system is thus complete and readily mobile.

Here's the payoff: as part of the Naval Avionics Support System, these new automatic checkout centrals will do the job 100 times as well—and with infinitely greater accuracy. All the operator needs to know is which button to push. This is the reliable way to find fault before you fly.

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Helium Supply Meets Current Needs

But unless steps are soon taken to prevent waste of 3 billion cubic feet annually, the limited supply will be inadequate to meet demands beyond 1980

by David Newman

WASHINGTON—For the first time in a year and a half, helium is being produced fast enough to satisfy the demand for it.

But the Government says that unless legislation now before Congress is enacted, this situation may last only a few years because of the stern laws of supply and demand. No important new sources of helium have been discovered since 1943, and the demand for the unique gas is jumping 20% every year.

Two weeks ago, the Interior Department lifted the informal helium allocation system and notified distributors that there was enough available for essential government and civilian uses. The allocation arrangement had been in effect since April, 1958, when supply and demand lost touch.

The move was made possible by full-speed production of helium at the Government's new Keyes, Okla., plant.

In a relatively short time, however, needs will probably outstrip production. This has been the case sporadically since 1954. In that year, the Interior Department's Bureau of Mines—sole producer of helium—shipped 185 million cubic feet of the gas. In Fiscal 1959, the figure had jumped to 360 million; the five plants now operating will be able to put out about 600 million cubic feet annually.

Even so, a little rough figuring shows that if demand continues to climb at its present rate supplies will run short again by 1962.

• **Long-range answer**—Faced with this potentially critical situation, the Department has taken steps to implement a long-range conservation program. Legislation to amend the Helium Act of 1937 is now before Congress. What the Department wants is authority to build 12 additional plants in the next few years to extract helium from natural gas before the gas is piped to market.

Natural gas is the primary, in fact the sole economical source of helium. (In the atmosphere, it appears in a 1:200,000 ratio.) Ninety-nine percent of the known helim-bearing natural gas resources in the United States is concentrated in four fields, all in the Southwest. These have been developed by private companies to supply natural gas to fuel markets; the helium is piped to the consumer right along with the natural gas—and passed through gas burners into the atmosphere.

Each year three billion cubic feet of helium go up the flue. This is what Interior wants to snare for future use.

A Department study conducted in 1958 indicated that 32 billion cubic feet of the gas could be conserved over the next 15 years, if prompt action is taken to construct the 12 new plants. It showed that these, together with the five plants now in operation, would recover about 43.5 billion cubic feet by 1975. This would be stored at the Government's Cliffside gas field near Amarillo, Tex. More than 32 million cubic feet of helium-bearing gas has been removed from this field since its discovery; consequently, it has the capacity to store an equal amount without exceeding the original field pressure.

Demand between now and 1975 is expected to be about 11.5 billion cubic feet, which would leave the 32 billion for future requirements.

If the bill, now in the House Committee on Interior and Insular Affairs, is eventually passed, Interior forecasts ample supplies well past the year 2000. Bureau of Mines officials predict present sources will be inadequate to meet needs beyond 1980 if the already limited supply is allowed to escape unchecked.

AIR TRANSPORTATION of liquid helium is still in the experimental stages, but the feasibility of air shipment is being proven by the National Bureau of Standards.

• **Paying the piper**—Cost of constructing each of the 12 plants would probably run between $15 and $20 million. The entire program could conceivably run in the neighborhood of $800 million over the period 1960-1975.

To amortize the program's cost within 25 years, the price of helium would have to be raised. Today it is produced and sold to government agencies for $15.50 per 1000 cubic feet at the plant site. For non-Federal users, the cost is $19 per 1000 ft. f.o.b. Based on present cost and expenses, Interior has come up with an initial figure of $44.50 per 1000 cubic feet to pay for the program, but this figure may be changed.

Should the legislation be passed, the Government would like to see private industry build and operate the plants. but if there are no takers, the Government will go it alone. Interior says, however, that there has been "a great deal of interest" lately on the part of commercial firms. Should they take over, provision has been included in the bill allowing government to buy the helium at a price insuring the company "a reasonable return" on their investment.

• **Nothing like it**—Helium is a unique gas. It diffuses more rapidly, flows through a hole faster, conducts heat better, and transmits sound at a higher velocity than any other gas except hydrogen.

Government is the major consumer of the gas, with a little over 50% of all production going to the Department of Defense. The Atomic Energy Commission is the next-largest user.

The major use of helium in rocketry is as an expellant for liquid fuels. It is also used for leak detection and opening and shutting valves, and it is sealed into instruments where inert gas is needed.

Transportation costs are a major factor in both the present use and future development of the gas. Today, cost of transportation usually equals or exceeds the cost of the helium itself. Most is shipped in heavy, high-pressure tank cars having a limited gas capacity. Each car weighs about 200,000 pounds when empty and about 2000 more when filled.

The National Bureau of Standards has studied the feasibility of transporting helium over long distances in liquid form. The Bureau learned that large-scale liquefaction plants and liquid distribution systems compare favorably with compressed gas systems as a means of transportation if the distances and quantities are sufficiently great.

• **Cutting leakage**—Liquefaction of helium is becoming a common cryogenic technique. Because its liquefaction point, —452°F, is second only to hydrogen's, it has been difficult to hold helium in a liquid state without a great deal of leakage.

Basically, the process of cooling helium to near absolute zero is similar to that used in producing ordinary refrigerator temperatures. Compression of purified helium gas to a pressure of 220 psi yields about 10% liquid when suitably pre-cooled and expanded.

The transfer of helium from liquefier to transportable containers is accomplished through pipelines insulated and shielded with liquid nitrogen or liquid air.

The liquefaction facility design adopted after recent studies resulted in a plant capable of condensing helium and delivering it to storage at a rate of 50 gallons per hour. The liquefied gas will then be transported by insulated rail tank car with a capacity of about 13,000 gallons.

Bureau of Standards says that the interest of large consumers, stimulated by the economic and technical feasibility of the accepted design, has extended the studies to the design of facilities with an hourly rate of 260 gallons.

Small quantities of liquid helium are now being shipped by air. The Bureau's Cryogenic Engineering Lab reports it has shipped 12.5 and 19 gal. containers about 2000 miles from the liquefaction source with losses in a typical shipment less than one quarter gallon.

LIQUID HELIUM being produced in the laboratory. This NBS Boulder Lab Engineering Research Tool is capable of putting out about 5 gal. of liquid helium per hour.

First Lithium-containing Alloy Developed by ALCOA

PITTSBURGH—A lithium-containing alloy developed by **ALCOA** is being tested for missile applications by the Aerospace Industries Association.

Designated X2020, the alloy is the first to employ lithium as a constituent.

X2020 has elastic and compressive moduli some 8% higher than similar alloys. The material has a tensile strength of about 78,000 psi and a strength-to-weight ratio of around 800,000 in.

The elevated temperature properties are excellent. X2020 is useful up to 400°F and, for short periods, almost 500°F.

In processing, the alloy has several distinct advantages—among them, low mechanical properties in the as-quenched condition and slow aging at room temperature. This may eliminate the "ice-box" procedure necessary with other aluminum alloys.

Thiokol Shows Integrated Engines Okayed by Navy

BRISTOL, PA.—Two prepackaged liquid propellant engines were shown for the first time at the opening of **Thiokol's** new manufacturing facilities here recently.

Slated for use in the Navy's *Sparrow III* and *Bullpup* missiles, the powerplants are the first such units to be qualified for operational use by the military.

moscow briefs

by Dr. Albert Parry

In "Rockets for Transport," a lengthy article in *Sovetskaya Aviatsia,* Professor G. Petrovsky promises that in the near future Soviet passenger and freight rockets will travel from the Soviet Union to Antarctica and back in just one hour or, at the most, one hour and a half. He takes issue with those Doubting Thomases who regard the use of rockets for transport as too expensive to be feasible. Admitting that rocket traffic would indeed be too costly for short hauls, Professor Petrovsky nevertheless insists that for flights "over distances longer than six or seven thousand kilometers" rockets will prove no more expensive than airplanes and "scores of times faster."

To minimize damage from cosmic radiation, man's future spaceships will depart preferably from launching sites situated "closer to the poles." This comes to us in an article in *Komsomolskaya Pravda* by Dr. Sergei N. Vernov, a Soviet astrophysicist specializing in radiation. He writes: "Who knows, perhaps in the future such names as Spitsbergen, Taimyr, and Yukon will designate not only an island, a peninsula, and a river, but also our planet's largest spaceship ports."

Russia's largest astrophysical observatory is now being built in the mountains near Shemakha in the Soviet Azerbaijan (western shores of the Caspian Sea). The weather there is said to be sunny on an average of 200 days a year. Three tall domes over the main building of the observatory will house modern equipment 1450 meters above sea level, and additional instruments will be placed at a nearby point almost 2000 meters above sea level.

In an article on "Aerial Reconnaissance" in *Krasnaya Zvezda,* Major General M. Smirnov (Soviet air force, retired) and Colonel G. Yeletskikh discuss our *Pied Piper* reconnoitering satellite of the future. "The vulnerability of this system," the two Russians writers comment, "is in the possibility that television signals relayed from this satellite can be interfered with, also in a situation where anti-rocket missiles sent to the satellite's orbit will succeed in intercepting the *Pied Piper.*"

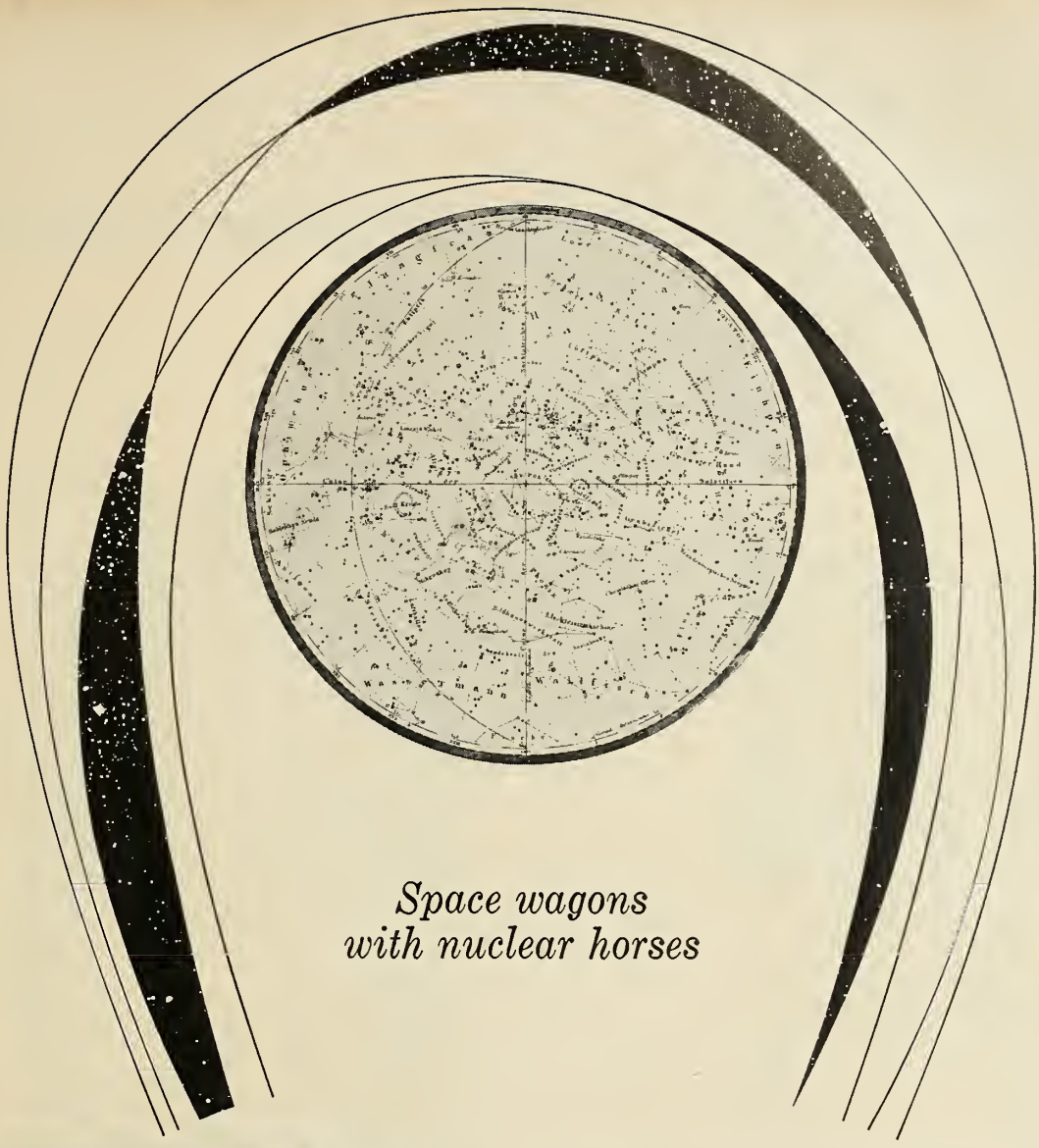
The missile armament of U.S. submarines is the subject of a special article in *Krasnaya Zvezda* by V. Marinin, a Soviet naval officer holding the rank of engineer-captain. The *Polaris* is the main item of his discussion. To illustrate its importance in American planning, the author cites the large 1959 appropriation for *Polaris*—"1,300,000 dollars, or more than the sums appropriated for the *Atlas,* the *Titan,* and the *Minuteman* all put together." After a detailed description of *Polaris* and its intended uses by American submarines, Marinin notes that, despite the large U.S. expenditures, testing of *Polaris* "has not been going too smoothly."

He writes skeptically that, while the first firing from a surface ship is scheduled for 1960, "the degree of success of the use of the *Polaris* on submarines will be shown on a yet more distant day." The Soviet commentator concludes his article by this statement: "No matter how complex the problems of creating guided missiles for submarines, the military groups in the capitalistic countries do not abandon the idea of incorporating such missiles into the armaments of their navies."

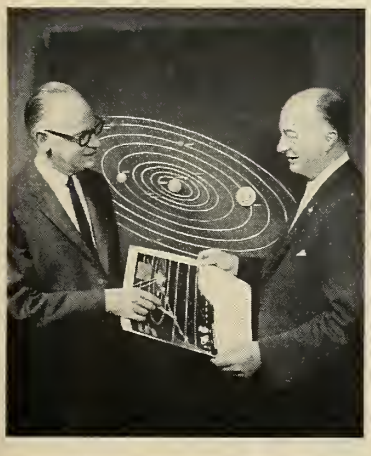
Use of the Maksutov Astrograph (Meniscus) is described at some detail in the article "How We Track *Sputniks*" by V. S. Matiagin and A. V. Kharitonov of the staff of the Astrophysical Institute of the Academy of Sciences of the Soviet Kazakhstan in Central Asia. The article, appearing in a recent issue of the Moscow *Nauka i Zhizn,* also deals with other instruments and methods employed in the Institute's mountain observatory headed by the famous Soviet astronomer, Academician Vasily G. Fesenkov. "The pure mountain air and the large annual number of clear nights help our fruitful astronomical observations," the two authors write. Among the *Sputnik* photographs achieved by this tracking point, they claim "one of the Soviet Union's first pictures of the rocket-carrier of *Sputnik I.*"

So tight is Soviet security on the Russian counterpart of our Project *Mercury* that even the fancy and detailed drawing (in several colors) of an astronaut in a recent Moscow article on "Life in Space" was admittedly based "on non-Soviet sources," most likely U.S. publications. The article, by B. Danilin, a candidate of the technical sciences, with illustrations by I Kaledin, appeared in *Tekhnika—Molodezhi.* Apart from data on Laika and other animals of Soviet experiments, it echoes Western sources.

"Radioelectronics and Cosmic Flight" is the title of a brief description of the launching of *Lunik I* in January, 1959, contained in the Moscow *Radio,* the monthly journal of the Soviet Ministry of Communication published for Russian "hams."



Space wagons with nuclear horses



Space exploration will really come of age when manned rockets can leave earth, accomplish their missions and return without disposing of parts of themselves en route. This breakthrough depends on the rapid development of both nuclear rocket engines and space vehicles capable of using them. Douglas is putting forth a major research effort in the area of manned nuclear space ships. Every environmental, propulsion, guidance and structural problem is being thoroughly explored. Results are so promising that even if the nuclear engine breakthrough comes within the next five years, Douglas will be ready to produce the vehicles to utilize this tremendous new source of space power! Douglas is seeking qualified scientists and engineers for this and other vital programs. Some of our immediate needs are listed in the column on the facing page.

Elmer Wheaton, Engineering Vice President, Missiles and Space Systems, goes over new space objectives that will be made possible by nuclear propulsion 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

British Ready To Press Space Program

by G. V. E. Thompson

LONDON—The result of the recent General Election means that the British Spaceflight Program will at last get under way. The new Conservative government will differ in composition from that before the election, but will continue the same policies.

Approval had already been given to construction of scientific satellite instrumentation to be placed in orbit by U.S. *Scout* vehicles, under terms of an agreement between the two governments. The possibility of building and launching all-British satellite vehicles has been under consideration for many months.

The apparent reluctance to reach a decision on this question was partly influenced by the forthcoming election. Apart from the undesirability of authorising such a program when there was a possibility that another party might take office and cancel or modify it, there was the reaction of the public to consider.

While there has been no sign that the ordinary man or woman disapproves of spaceflight (if anything, the contrary is true), a more critical watch is kept on expenditure at election times. Fortunately, the cost of space research did not become a political issue.

Now that they have been returned to power with an overwhelming majority, it will be possible for the Conservative government to allocate the large sums necessary to build orbital vehicles knowing that it will be several years before they have to account for their actions to the voters. By then the program should be successful.

This is not to imply that the opposition party (Labour) would have refused to participate in space research; they had not reached any definite decision. But Labour was committed to very heavy expenditure in other fields, and might have found it difficult to spare money for astronautics, particularly as some sections of their supporters are strongly opposed to rocket weapons.

British missile firms will now campaign strongly for an early start on the design and construction of British satellite vehicles. They are encouraged by the fact that when Mr. Aubrey Jones (Minister of Supply) opened the Tenth IAF Congress in London he declared himself in favour of the project. He concluded his address by saying that scientifically there was surely no doubt at all but that every State which claimed to bear the banner of civilization should do everything it could to encourage advances in the knowledge of the physics, chemistry, and even the biology of space.

• **Inertial navigation system factory**—A new factory for the manufacture of inertial navigation systems for missiles and other vehicles has been opened by **Ferranti, Ltd.** at Crew Toll, Edinburgh. This is not a completely new venture for the company (which also makes the semi-active homing guidance for the **Bristol** *Bloodhound*), for production of gyroscopes and accelerometers for inertial systems has been going on for the past 18 months.

The new plant has been specially constructed to ensure that the production area is dust-free. Workers arriving have to cross a long mat to remove as much mud and dust from their shoes as possible. Outdoor clothing is left in a cloakroom, then shoes and socks are removed in a changing room divided by a low bench. After swinging round to the other side of this, the workers put on special socks and lint-free carpet slippers. They then proceed to undress and put on special clothing, including a Nylon hat, Nylon overalls and Nylon boots fitting over the slippers; only the face and hands are left exposed. While undressing and dressing, the operatives are subjected to periodic blasts of filtered air to remove loose matter.

The assembly and test areas and the store rooms are temperature, humidity and dust controlled. Components leaving the machine shop have to pass through a system of double air locks to enter this clean area and are first freed from dust by use of ultrasonic cleaners. There is another air lock between the general clean area and the air-conditioned store room.

The air-conditioning equipment is designed to minimize vibration transmitted to the plant. It maintains the air in the plant at a dry bulb temperature of 72°± 1°F. and a relative humidity of 45%. The initial filtration is through glass fibre, but this is followed by large banks of high-efficiency filters, in duplicate to facilitate changing. These remove all particles greater than about 0.5 micron in size and tests have shown that only 0.2% of particles with diameters between 0.1 and 0.5 microns pass the filters.

Sixteen changes of air per hour are provided for the working areas and enter through perforated ceiling domes. Extraction is through floor-level grilles.

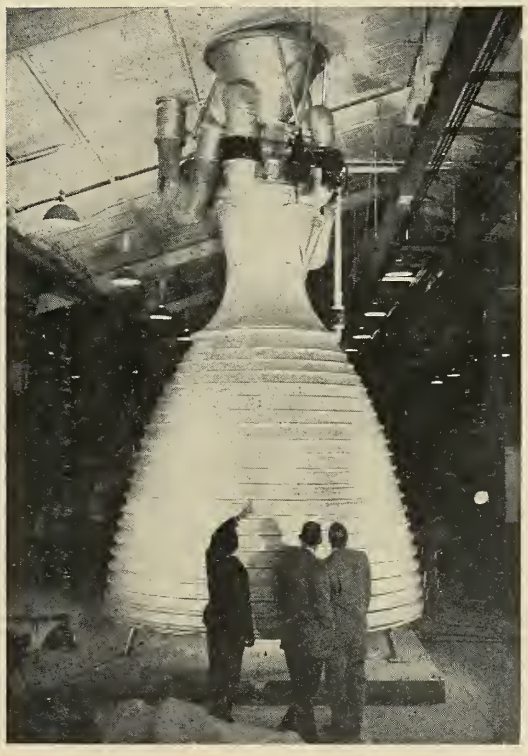
The test area is constructed in such a way that the instruments are isolated from ground-transmitted vibrations. Underneath the floor is a large pit containing one 60-ton and two 40-ton blocks of reinforced concrete. One of the small blocks is mounted on 16 helicoil springs and carries a single test pillar. The other two blocks are each mounted on four rubber pads, with rubber side buffers to reduce vibration in the vertical and horizontal planes. The tops of the blocks come to within about one foot of the underside of the suspended flooring over the pit, and carry several aluminum pillars filled with concrete, each weighing about one ton. On these are mounted the test instruments.

Between each pillar and the floor is a flexible dust seal, designed not to transmit vibration from the floor. Dashpots filled with silicone oil are used for damping.

Few details have yet been released about the instruments being manufactured, but they include a Ferranti-designed pendulous integrating gyro accelerometer, and a single-axis floated rate-integrating gyro. The latter is manufactured under license from the U.S., but will be further developed by Ferranti.

Other British firms working in this field include: **English Electric,** who are going to produce the **Minneapolis-Honeywell** miniature stable platform; **Sperry Gyroscope Co. Ltd.,** who are working on the guidance for *Blue Streak;* and **Elliott Brothers** (London) **Ltd.,** responsible for the inertial guidance of **Avro's** *Blue Steel* stand-off bomb.

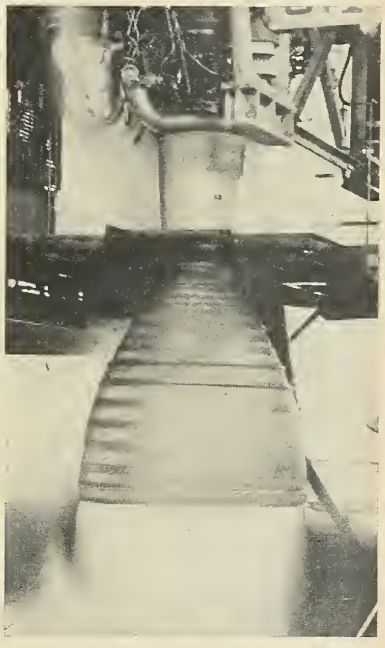
Missile News in Recent Pictures

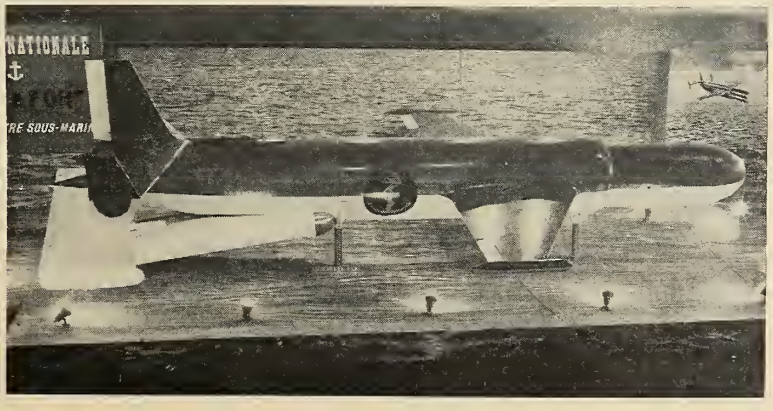


TOP RIGHT—Sweden's Saab J35 Draken fighters carry GE-Philco *Sidewinders* and also are equipped with new, semi-automatic air surveillance gear, part of Swedes' "STRIL 60" air defense system.

LEFT—Full-scale mock-up of Aerojet-General's concept of future space engine. An engine of this type would generate between one and two million lb. of thrust.

RIGHT—First released photo of Rocketdyne's 400,000-lb. thrust class R&D rocket engine being test fired in the Santa Susana Mountains under an Air Force contract.





FRANCE'S ship-to-submarine missile designated *Malafon* was designed and developed by the French Navy. It somewhat resembles U.S. Navy's Convair *Terrier* and French have said they plan to install it on a 5000-ton pocket cruiser still to be constructed.

—reviews—

IMPACT AND SHOCK RESISTANCE OF PLASTICS: Final report. N.C. State College for BUSHIPS. Order PB 151729 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 35pp. $1.25.

Placing plastics under a tensile impact load can yield valuable information about their impact resistance, this study revealed.

A pendulum-type impact machine—the Raleigh-Edwards-Tensile-Impact-Machine-Pendulum, or RETIMP—was developed to deliver energy at a high enough level to fracture notch-free specimens of relatively large diameter. The outstanding advantage of the tester is said to be its stability.

Energy delivered from arm to specimen is consistent for any energy and velocity level. RETIMP can be used at numerous energy and velocity levels, facilitating investigation of impact resistance as a function of these two variables.

Specimens of various sizes can be tested to determine relationships between specimen size and impact resistance.

COMBUSTION OF MONOPROPELLANT DROPLETS: THEORETICAL RESULTS, E. Sanchez Tarifa and P. Perez del Notario. Order PB 140776 from Library of Congress Photoduplication Service, Publications Board Project, Washington 25, D.C. Microfilm, $3.60, photocopy, $9.30.

The problems studied include; 1) extension of the integration method for overall reactions of n^{th} order and Lewis-Semenov numbers different from one; 2) comparison of the results for second order chemical kinetics with those obtained by means of numerical integration of the equations; 3) results of the investigation for first and second order chemical kinetics; 4) numerical application for hydrazine, taking the decomposition reaction model proposed by Adams and Stock.

UNCONVENTIONAL ELECTRICAL POWER SOURCES, P. A. McCollum, Oklahoma Institute of Technology for WADC. Order PB 151726 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 104 p. $2.50.

This study is concerned with the production of electrical power generated by means other than rotating machinery and conventional batteries.

Surveyed are the conversion of five sources of energy: mechanical, thermal, chemical, solar, and nuclear.

Specifically, data and theory are presented on the oscillating generator utilizing permanent magnet excitation, the variable reluctance oscillating generator, metal thermopiles, semiconductor thermopiles, thin film thermopiles, fuel cells, p-n junction silicon solar cells, and nuclear converters.

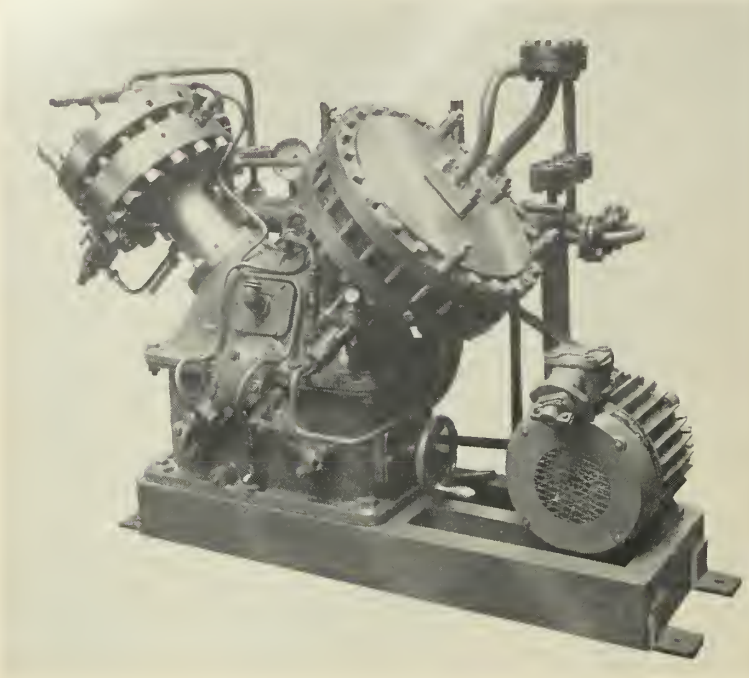
The information was collected through literature surveys, theoretical studies, and experimental work. Aims included the determination of efficiency of energy conversion, weight and size per unit power output, range of voltage and current, life, and reliability.

SALT WATER SHELL GAME

Find the sub. It is somewhere in the ocean basins that cover 70 per cent of the earth's surface. Listen for its motors. Find the hum that is lost in the din of marine life. Keep the sub at a safe distance. With one of its nuclear missiles, it can destroy any U. S. city. Don't be decoyed by a single prowler . . . an estimated 450 more subs need watching, too. So go the steps in one of history's toughest defense problems. So runs the routine aboard Navy ships and planes. Round-the-clock work reinforced by the efforts of American industry and ingenuity to provide the equipment needed to cut the Free World's biggest menace down to size.

AERONAUTICS | ASTRONAUTICS | ELECTRONICS | GENESYS CORP | RANGE SYSTEMS | RESEARCH

CHANCE VOUGHT
DALLAS, TEXAS



Compressor Leaves Gas Uncontaminated

A French Corblin diaphragm type of compressor which does not contaminate gas under compression is now being marketed in this country by the **American Instrument Co.**

The compressor is said to be completely leak-proof and can pressurize gas up to 30,000 psi in three stages. It has been used to handle such highly toxic and corrosive gases as radioactive hydrogen, oxygen and argon, fluorine, hydrogen fluoride, and hydrogen chloride.

The Corblin compressor's dead space is only about 1 percent of volumetric capacity per stroke. Because of the geometry of the head construction, it can operate efficiently in very high compression ratio, allowing a smaller machine to do a given job.

All parts coming into contact with corrosive gas may be made of such resistant materials as stainless steel, monel, nickel, and Hastelloy alloys.

The compressor functions because of the elasticity of a thin metal diaphragm which alternately flexes in two directions, providing for the suction and discharge of gas. The diaphragm is clamped on its outer edges between two metal plates having concave inner surfaces.

The lower plate has holes through which oil flows from a chamber beneath into the concavity between the diaphragm and the plate. The upper plate contains the suction and discharge valves.

A piston provides the pressurization of the oil in the chamber beneath the lower plate. At the top of its stroke, the piston causes the oil to move forward through the lower plate's holes, which produces the upper motion of the diaphragm.

The piston is driven by a connecting rod from the compressor crankshaft, and is obturated by ordinary piston rings. Leakage of oil is corrected by a piston type compensating pump, keeping the oil chamber full at all times. The pump is pulsed by an eccentric bearing connected at the end of the crankshaft, which injects the oil into the pump chamber in quantities greater than is lost.

Each stroke of the piston forces the diaphragm hydraulically against the inner concave surface of the upper head plate. Because the volumetric capacity of the compression chamber between the plates is greater than the displacement per stroke of the piston, the diaphragm never comes into contact with the lower perforated plate.

The excess oil is returned to the crankcase at the end of each stroke by a pressure valve controlled by spring tension. This tension can be adjusted to permit less and less oil to flow past the valve as the piston rings wear, and more oil is needed to make up for leakage.

The pressure control has a handle with two positions: one allowing spring tension to control the valve, and one for priming the unit to insure the complete filling of the oil chamber.

Gas can be pressurized from atmospheric to a maximum of 220 to 250 psi with one stage of compression. A second stage can bring the pressure to 3600 psi, and a third stage can pressurize the gas to 30,000 psi.

A single stage compressor is normally used when suction is taken directly at the varying pressure within the gas source. Because of the high compression ratios possible with Corblin compressors, the gas may be pumped down from its initial source pressure to pressures approaching atmospheric, and can be discharged into the storage vessel at pressures above that initially used in the gas source.

Liquefied gases are handled by connecting the suction to the empty storage vessel. The compressor sucks residual vapors from the vessel and pumps them into the source, thereby raising the pressure. The gas flows under the applied pressure from the source into the storage vessel.

When all of the gas has been transferred, the valves are reversed and the vapor is sucked from the source and is pumped into the vessel, thereby salvaging all of the gas in both the gaseous and liquid phases.

The compressor also can be used to salvage helium and rare gases from cylinders already considered spent by sucking the residual gases out and pumping them into other vessels which are pressurized to full pressure by taking residual gas from a number of sources.

American Instrument Co.
830 Georgia Ave.
Silver Spring, Md.

'Dacron' Uniforms Solve Lint Problem

Lint, a major problem in industries producing delicate mechanical and electronic components, has been found to be virtually eliminated from manufacturing areas when workers wear new uniforms woven of continuous fil-

ament yarns of 100% "Dacron" polyester fiber.

This contribution by the textile industry has been especially valuable in the electronics field, as quality tolerances for precision instruments have been continually tightened over the past few years. The presence of lint can critically affect the manufacture and operation of these delicate parts.

A pioneer in using the new uniforms is **Sylvania Electric Products, Inc.,** one of the nation's top producers of electron tubes. The tubes made by Sylvania, a subsidiary of **General Telephone and Electronics Corporation,** are used in data processing equipment, guided missiles, and warning systems. To keep the quality of these sensitive instruments high, it is imperative that the manufacturing area be kept lint-free.

To qualify for use in this plant, the uniform fabric must pass a minute examination under a 10-power magnifier, and show up as a completely smooth, lint-free weave. This can be achieved only with continuous filament yarns, as fabrics made with some of the natural fibers, or with synthetics in the staple form, have a "fuzziness" that generates lint, even though this fuzzy quality may not be detectable by the naked eye. This results from the abrasion of wear, which causes the staple ends to break.

The Du Pont Company, manufacturer of the continuous filament "Dacron" polyester fiber that goes into the new uniforms, is greatly interested in this lint-free aspect which is of such importance to many major manufacturing concerns. The company's Textile Fibers Department accordingly has set up a consulting service on industrial uniforms, to aid firms interested in discussing their lint problems.

Through a personal survey of the local requirements, recommendations are made as to the best types of uniforms and fabrics for the specific needs of the company involved.

Industrial Uniform Consulting Service
Attention: Peter E. Babiy
Textile Fibers Department
E. I. du Pont de Nemours & Co.
Wilmington 98, Del.

'Snap In' Connectors Feature Crimping Design

A new 8-indent crimping design for "snap-in" contact miniature connectors has been announced by **The Deutsch Company,** Electronic Components Division.

The crimp is formed of two rows of 4 indents each, each row having the indents spaced at 90° intervals around the contact barrel. The front row, nearest the mating end of the contact, is slightly deeper than the back row. This forms the wire strands into a ball-or key—between the two rows of indents, thus affording maximum crimp strength with minimum distortion of the wire. On wire sizes accepted by the Deutsch #20 contact, the crimp is greater than the strength of the wire: an inspection hole is provided to assure that the wire is inserted in the contact to the proper depth.

This 8-indent crimp is used with DS miniature environmental connectors. For application with Deutsch DRS miniature rectangular rack-and-panel connectors, a third row of 4 indents is provided as an insulation crimp.

To make this crimp possible, Deutsch has designed and is manufacturing a simple, fool-proof crimping tool—either hand or bench-operated—which makes the quality control of the crimp a function of the tool itself, rather than the operator.

The Deutsch Co.
Electronics Components Div.
Municipal Airport
Benning, Calif.

Insulation Breakdown Tester Is Automatic

High voltage breakdown tests of insulation in controls, cables, motors, servos, bushings, and other components as well as assembled electronic systems are said to be simplified and made more dependable by the automatic control offered in the Model 8514 Automatic HYPOT High Voltage Tester, produced by **Associated Research, Inc.**

The new Model 8514 HYPOT allows accurate and dependable voltage breakdown tests to be made with operating personnel that would not be considered sufficiently skilled for less automated equipment.

Sensing and control circuits may be provided in the Model 8514 for fully automated production testing of components, such as motors, controls, capacitors, and transformers.

Some of these automatic control features are: 1. Automatic rate of rise on high voltage d-c test potential. 2. Adjustable automatic shut-off of voltage and leakage current meter. 3. Timer to automatically shunt the leakage current microammeter for 0-5 minutes while capacitance loads are drawing up to a 10 Wa for rapid charging. 4. Timer to apply high voltage control with high speed return to zero.

Associated Research, Inc.
3777 W. Belmont Avenue
Chicago 18, Ill.

Re-entry Attitude Plotted by Dynametrics Instrument

The Dynametrics Corporation announces a new instrument for field evaluation of ballistic missile components.

The nose cone of an ICBM will disintegrate from the violent shock and temperature that builds up as it plunges back into the earth's atmosphere, unless re-entry can be made at the optimum attitude. The Dynametrics Weight and Center of Gravity Locator enables re-entry attitudes to be determined to a high degree of accuracy by providing readout of weight and center of gravity along the roll, pitch and yaw axes.

This instrument measures the mass and center of gravity for the three axes of the nose cone. Based on null-balanced mass and lever principles, the Locator will repeat measurements at all latitudes and altitudes, since it measures essentially mass and mass moments rather than weight. Designed for pre-flight evaluation of ballistic missile components, the W & CG Locator uses precision wind tunnel balance principles to achieve the accuracies required by aerospace vehicles.

The Locator, which can resolve 0.001 inches from maximum weight down to as little as 45 lbs., has an overall accuracy of 0.010 inches over its specified operating range of 1800 to 4500 lbs.

The Locator can handle a complete re-entry vehicle without damaging its critical surface. A special ring is provided for mounting the nose cone to be measured. Measurements are made with reference to the face and axis of this ring as it is rotated by a motor in the weighing yoke. Direct reading of the weight and center of gravity of the missile component are automatically obtained by a flip of a switch for two axes of the cone; then by rotating the cone 90° by the motor, similar measurements are made along the third axis. Polar coordinated measurement may be made by rolling the component to the pisition of maximum radial center of gravity indication and observing the roll angle.

Dynametrics Corporation
Northwest Industrial Park
Burlington, Mass.

RAMJET LEADERSHIP—Ken Hisey (left), Superintendent, Propulsion Shops, discusses some of the finer points of one of the many Marquardt engines with Frank McGuire of the editorial staff of Missiles and Rockets magazine. The pioneering of higher performance ramjet engines by Marquardt has vastly increased the defense area of the advanced Bomarc missile.

WHO READS MISSILES AND

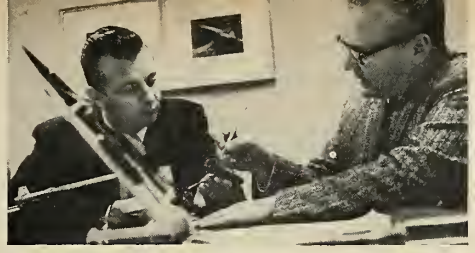
Well, for instance . . . TOP ENGINEERS AT MARQUARDT

Accelerated developments in air-space research . . . advanced power systems . . . manufacturing . . . space-age training . . . and research rocketry have made The Marquardt Corporation one of the foremost leaders in the field of astronautics.

The Marquardt ramjet engines, for example, have been actually flight tested at speeds well over Mach 4 at an altitude of 80,000 feet. Continuous ground cell endurance tests have been successfully conducted to simulate even greater altitudes and higher speeds. In addition to the development and production of propulsion systems that will operate at supersonic speeds, Marquardt has also been a leader in the development and application of high temperature metals and reinforced refractory ceramic coatings for future missiles.

Precision controls and rotating accessories for space vehicles are still another facet of The Marquardt Corporation. A few of these are . . . precision controls for ramjet engines . . . rotating accessories for pneumatic servo actuators . . . and air inlet controls for North American Aviation's "Hound Dog" air-to-surface missile. New and superior production line techniques have been installed at Marquardt's Ogden Division to more than double the production capacity of Bomarc ramjet engines—yet with 100% reliability.

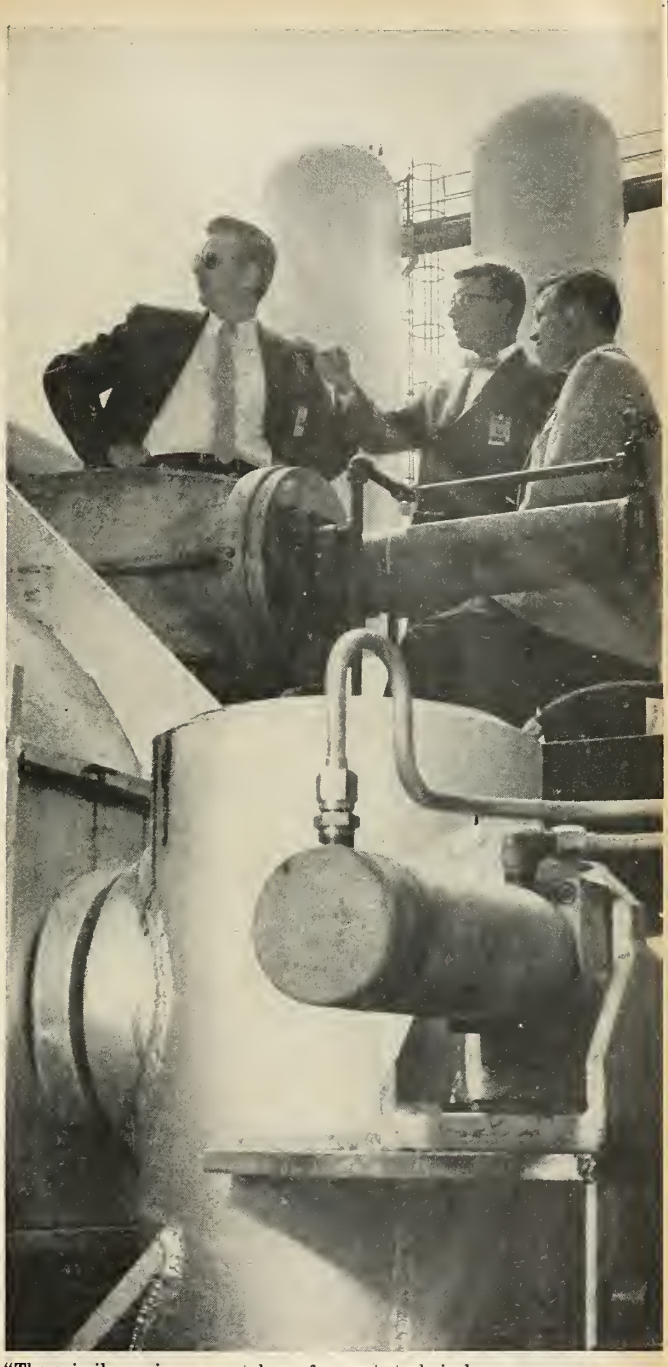
Marquardt is also taking a giant step into tomorrow with ASTRO—Air-Space Travel Research Organization. ASTRO has its own aerodynamic test facilities that are capable of approaching the speed of Mach 12 and temperature tests at approximately Mach 7 (3700° Fahrenheit). Also included in Marquardt's



"Development of products in today's space age is a complex business requiring vast engineering and scientific technology. Additionally, information concerning latest developments in our industry is essential. Missiles and Rockets helps us keep pace in this rapidly expanding market." Don L. Walter, Marquardt Vice President, Power Systems Group.

"Today's missile engineers are comparative youngsters with an unending thirst for knowledge of the entire astronautics market. Missiles and Rockets gives us a total, uncluttered picture of what's going on in this field from week to week!" John Widell (left), Project Engineer, Propulsion Engineering.

"If you want pears, you don't order fruit salad. The same holds true in astronautics. We prefer Missiles and Rockets magazine because it deals with astronautics and astronautics *exclusively*." Dick DeSantis (right), Supervisor of Numerical Analysis Section.



"The missile engineer must have frequent, technical news concerning the industry. That's why the *weekly* issues of Missiles and Rockets are so important to us. Month old news is of little value when yesterday's developments could easily be obsolete tomorrow." Leigh Dunn (right), Director, Test Section.

ROCKETS?

diversified activities is the manufacture of ground support and handling equipment for missiles . . . systems engineering and equipment for data display . . . development and production of rocket systems . . . specialized solid rocket motors and components for space and missile systems. Marquardt recently established a Nuclear Systems Division in the Power Systems Group. Project Pluto is one of their major programs — aimed at the development of a nuclear ramjet engine.

TELL YOUR PROOUCT OR CAPABILITY STORY TO 29,000 MISSILE TECHNICIANS. . .PAID SUBSCRIBERS . . . THROUGH THE PAGES OF MISSILES AND ROCKETS—TECHNICAL/NEWS WEEKLY OF THE MISSILE/SPACE MARKET.

missiles and rockets

AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

Dr. Herbert R. J. Grosch, formerly manager of Space Programs-Advanced Programming for IBM's Military Products Division, has joined C-E-I-R, Inc. as director of Corporate Programs and Planning.

Dr. Grosch, a national authority on scientific and commercial applications of high-speed computers, has been in charge of organizing and opening eight major computing and data-processing centers since 1945. In addition to being in charge of the *Vanguard* Computing Center in Washington, D.C., he has directed computing for the Watson Scientific Computing Laboratory and the Washington Technical Computing Bureau of IBM.

GROSCH

Hans W. Weickardt has been named section chief of stress analysis in the research and development engineering division at Solar Aircraft Co.

He comes to Solar from Huntsville, Ala., where he was chief of stress analysis with the Brown Engineering Corp., contractor with ABMA at Redstone Arsenal. Prior to joining the Brown corporation, he was a senior design engineer at Lockheed Aircraft Corp.

W. Hubert Beal has been elected president and chief executive officer of The W. L. Maxson Corp. to fill the vacancy occasioned by the retirement of **Hugo A. Leander,** who was elected chairman of the Board of Directors. **William L. Maxson, Jr.,** son of the founder, its secretary and a director since 1947, was made vice president.

Vitro Laboratories has elected **Clifford E. Suer** project manager of the Mark 37 Mod 1 torpedo weapon system program, succeeding **E. M. Troup,** resigned.

SUER

Suer was formerly head of Vitro's torpedo engineering group and played a key role in developing the Navy's wire-guided torpedo Mark 39. He joined the company in 1956 after two year's service with the General Tire and Rubber Co.

Virgil N. Comsa has joined the newly formed space defense systems group of Electro-Optical Systems, Inc., where he will be engaged in research and development of satellite and space defense mechanisms.

Prior to joining EOS, Comsa was associated with Douglas Aircraft Co. as part of the structures research group assigned to the preparation of reports and data on factors affecting structural design of high-speed vehicles.

Frank K. MacMahon has been appointed manager of military programs for Vertol Aircraft Corp., responsible for overall administration of policies and practices in the firm's defense work.

MacMahon, who joined the company in 1951 as an administrator in the military liaison department, previously served as acting manager of the department he now heads.

Sam L. Ackerman, senior project engineer on the *Atlas* program, has been named to the new post of program director of electronic products for Convair-Astronautics division of General Dynamics Corp.

Ackerman was an Air Force electronics officer during the war, and afterward became assistant manager of Rangertone, Inc. He was a member of the RCA staff at AFMTC from 1954 until he joined Convair in 1956.

Alexander N. Beichek has been appointed assistant director of W. L. Maxson Corp.'s Research Laboratory. He was formerly with the Army Signal Research & Development Laboratories directing design and development of equipment and systems. Prior to that he directed research in tropospheric, ionospheric and outer-space propagation for the Signal Group's Wave Propagation Section.

BEICHEK

In his new position, Beichek will direct research in the field of instrumentation, advanced inertial techniques and other projects.

Nortronics division of Northrop Corp., has announced the appointment of **Ross F. Miller** as project manager for the *GAM-87A* guidance system.

Miller will direct an integrated line project team of research scientist and engineers in the development of an automatic navigation system for the advanced air-to-surface missile. He was formerly chief engineer for the electronic systems and equipment department. **Frank Lynch** has been named to succeed Miller.

Robert E. Whalin, formerly with RCA, has joined Packard Bell Electronics as a liaison engineer for the technical products division and **John M. Evans** has been named manager of special products manufacturing.

Minnesota Mining and Manufacturing Co. has announced promotion of **Dr. R. W. Fritts** to the newly created position of manager, thermoelectric project. Fritts joined the company in 1957 as head of a research team pioneering the development of new semiconductor materials and device technology involving both thermoelectric generation and heat pumping.

Other personnel changes in the thermoelectric program are: **Dr. J. D. Richards,** supervisor for materials research; **William V. Huck,** supervisor for applications research; **William Krawczak** as product development supervisor; **Walter H. O'Neal** as product control supervisor; **Russell Fredrick** as research metallurgist, and **A. D. Steele** as product sales manager.

David Edwin Cordier has been elected technical director of Mesa Plastics Co.

CORDIER

Mr. Cordier, formerly director of research of Plaskon and technical director of Carwin Polymer Products, is a chemical engineering graduate of Purdue University, holds over 20 patents, and is a specialist in resins, polymers and plastics.

William H. Thomas has been elected Washington representative of Air Products, Inc. He will represent all phases of the company's defense and commercial activities in the Capital. **Wesley E. Timmcke** has been appointed East-Central district representative and **Roy H. Price,** Southeast district representative.

John P. Schafer has been named vice president of Hexcel Products Inc. He will continue as a member of the board and will retain his post as secretary.

Howard F. Farmer has been appointed manager of quality control for the Richmond plant of Avco Corp.'s Crosley Division. He succeeds **Richard T. Branch,** who was recently promoted to divisional director of quality and reliability assurance.

Brooks & Perkins, Inc. has announced the promotion of **Earle V. Schirmer** from chief design engineer to chief engineer.

C. E. Huddleston, recently appointed chief engineer, has been named executive vice-president of The Cleveland Punch & Shear Works Co.

James Stacy has been promoted to manager of contract administration of Cooper Development Corp. His previous position as the company's chief estimator has been filled by **Melville Birney.**

Second Test of the *Mercury* Escape System Is Successful

WALLOPS ISLAND, VA.—The second *Little Joe* test, launched last Wednesday to try the escape system in the project *Mercury* capsule, was a complete success, the National Aeronautics and Space Administration reported.

The capsule was lifted to an altitude of 35,000 feet and a distance of five miles before falling into the Atlantic. The escape rockets, located 16 feet above the capsule in a tower, were activated 30 seconds after launch, carrying the capsule several thousand feet from the *Little Joe* booster.

The escape rockets burned for one second and, after a 20-second coasting period, were ejected. About 10 seconds later, the capsule's drogue chute began to break the vehicle's fall, and three minutes after launch—at an altitude of 10,000 feet—the main chute was deployed, easing the capsule into the ocean at 30 feet per second.

A Navy salvage ship recovered the capsule 45 minutes after it was launched.

Two of the four big Pollux engines in the first stage of *Little Joe* were dummies in last week's test, since a short trajectory was desired.

Earnings Reported Higher

A spate of quarterly reports shows earnings of missile manufacturers generally higher than 1958. Items:

For the first nine months of the year, **The Martin Co.** reports net income of $9.4 million, or $3.22 a share, on sales of $377.7 million compared to a net of $7.3 million, or $2.50 a share, on sales of $355.5 million for the corresponding period of last year. Third quarter earnings were $3.2 million on sales of $129.4 million.

Temco Aircraft Corp. reports nine months earnings of $864,000, or 51 cents a share on sales of $77.7 million against earnings of $1.8 million, or $1.07 a share, on sales of $89.7 million for the like 1958 period.

Rohr Aircraft Corp. reports a $2.6 million net, equal to $1.40 a share, on record sales of $191 million for the fiscal year which ended July 31. This compares to earnings of $2.18 a share and a net of $4 million on sales of $147.5 million for the previous year.

Litton Industries reports a net profit of $5.9 million, equal to $3.24 a share, on sales of $125.5 million for the fiscal year which ended July 31. In the previous fiscal year, profits were $3.7 million or $2.13 a share on sales of $83 million, and including a special $1 million income credit.

Minnesota Mining & Mfg. Co. reports nine month sales of $323 million and earnings of $42.5 million or $2.50 a share, compared to sales of $271 million and earnings of $29.5 million, equal to $1.75 a share, for the like period of last year. Third quarter sales were $95 million and earnings $11.9 million.

Borg-Warner Corp. reports $484 million sales and net earnings of $25.6 million for the first nine months of the year. This compares to $396 million sales and a $13 million net income for the like period last year.

Avnet Electronic Corp. earnings for the fiscal year which ended June 30 were $767,000 compared to $235,000 for the previous year . . . Earnings of **Daystrom Inc.** jumped to $802,000 for the first six months of the year—more than double the $369,000 profits for the comparable 1958 period . . . and the nine months net of **Air Reduction Co.** was $11.4 million against $9.7 million for the same 1958 period.

AF Calls Briefing On New Solid Rocket

EDWARDS AFB, CALIF.—The Air Force will hold a contractor briefing here Nov. 10 on a requirement for a solid-propellant rocket with twice the thrust of *Minuteman*. Thrust of the 55-foot **Boeing** *Minuteman*, which is designed to hurl a one-megaton warhead more than 8000 miles, is classified.

The announcement gave rise to speculation that the AF may be seeking a second-generation *Minuteman*-type ICBM that can carry a larger nuclear payload. Higher thrust solid motors also would have space applications.

GM Wins AF Contract For Satellite Powerplant

The Air Force awarded a contract to **General Motors** for design, fabrication and testing of an earth satellite powerplant. The powerplant is being developed by the GM's Research Division and Allision Division.

Lockheed Corp. has built a test facility at Cape Canaveral for the *Midas* early-warning satellite system. More than 200 scientists, technicians and administrative personnel are expected to take part in the ARPA Air Force program at the Cape.

The Air Force scratched one of its five **Douglas** *Thor* squadrons. Previously it planned to hold the 15-missile squadron in reserve. The four others are being stationed in England and manned by British troops.

Engineer Gets Prize For Design of Pads & Fences

WASHINGTON—The Department of Defense has awarded $750 to Curtis A. Anderson of Mariemont, Ohio, for designing launch pads at Cape Canaveral and jet blast deflection fences at Startegic Air Command bases.

Anderson is chief of the instrumentation and special studies branch of the Ohio River Division Laboratories, Army Corps of Engineers.

He conceived of the bowl-like blast deflectors that distribute and disperse discharged gases evenly around launch pads and static test sites. Previously, launch pads were often destroyed when missiles were fired.

His blast deflection fences applied the principle of the venetian blind to channel and dissipate blasts from jet aircraft during maintenance and warm-up operations.

The cash prize was given in connection with a special DOD distinguished Civilian Service Award.

Rare-earth Metals Made Available in Fine Powders

NEWARK, N.J.—Rare-earth metals are now available in finely divided powder form.

Cerium Metals and Alloys Division of **Ronson Metals Corp.** announced recently that it has powders of any desired size down to 325 mesh in cerium, lanthanum, didymium, mischmetal and other rare earths and alloys. The company also produces the metals, in purities from 99.5% to 99.9% in ingots, rods, pellets and turnings.

• **Pittsburgh**—Deputy Defense Secretary Thomas S. Gates said the steel strike was crippling the *Atlas, Titan* and *Polaris* missile programs. As of mid-October, he said, delivery dates of **Convair** *Atlases* were being extended one day for every day of the strike. He said two to three months delay in construction of four *Atlas* and *Titan* bases is already anticipated. And he said production of at least one essential *Polaris* component had been halted and curtailment of others was expected shortly.

• **Washington**—President Eisenhower ruled out military exploration of the moon. He told a weekly news conference projects directed at the moon were strictly scientific, and therefore should be handled by a civilian agency—NASA—in line with long-standing national policy of assigning to the military only those missions which fall within its province. He said he could see no reason for using—or misusing—military talent to explore the moon.

• **Washington**—Members of the House Space Committee set out on a tour of West Coast and Southwest missile production facilities for an "informative-type" study of high-thrust engine programs.

• **Ordill, Ill.**—During a solid rocket fuel mixing and casting operation, an explosion destroyed a small research building in the **Olin Mathieson** plant, killing one employee. The exact amount and type of propellant involved were not disclosed. But, the mixture was said to be part of a 2000-pound grain.

• **Philadelphia**—GE Satellite Engineer Robert P. Haviland predicted that within 10 years missile-boosted space vehicles will be able to ride in on a radio beam and land at a predetermined point. He said such a space vehicle could deliver within minutes thousands of pounds of emergency medical supplies to a disaster area.

• **Cape Canaveral**—A **Douglas** *Thor* roared 1700 miles down the Atlantic Missile Range on a "routine test flight." The shot brought the *Thor* launching score to 51—34 successes, 10 partial successes and 7 failures.

• **Washington**—Charles Critchfield, **Convair** director of scientific research, has been named successor to ARPA Chief Roy Johnson. Johnson is expected to leave the post within about a month.

• **Washington**—An attempt will be made to sell about 50 Air Force-owned aircraft plants to the companies now occupying them . . . The Air Materiel Command is establishing an electronic systems center at Hanscom Field, Mass., near Boston.

• **Washington**—Impact of strategic missiles being phased into the Air Force is causing a sharp drop in pilot training—2500 this year compared to 3600 in 1958 and 5800 in 1955. Rated pilots on flying status have decreased from 57,000 in 1957 to 54,000 and aircraft in inventory has dropped from a 1956 peak of 24,536 to 19,416.

• **St. Louis**—A polysonic $5.3-million airflow laboratory which includes a 4000 mph wind tunnel is now in operation at **McDonnel Aircraft Corp.** It is the last element of a four-year, company-financed $34-million expansion program.

• **Washington**—The Labor Department is holding a meeting with industry Nov. 19 preparatory to issuing a questionnaire which will survey minimum wages in the aircraft industry. The survey will bear on the question of whether the aircraft industry should be expanded to include at least some phases of missile production. The electronics industry is not included.

Mergers & Expansions

Switching the usual merger roles, **Microdot Inc.**, small South Pasadena, Calif., miniature cable maker, has purchased the **Westinghouse Corp's** specialty transformer division at Los Angeles . . . **Electronic Research Associates,** Cedar Grove, N.J., has acquired **Advanced Acoustics Corp.** . . . Two large steel fabricators, **Pittsburgh-Des Moines Steel Co.** and **Hammond Iron Works,** Warren, Pa., have merged . . . A substantial interest has been acquired by **Copper Range Co.** in **The Alloyd Corp.**, Watertown, Mass. . . . At Niles, Ill., **American Machine & Foundry's** Mechanics Research Division is taking over a new 30,000 square-foot laboratory . . . **Industrial Electronic Engineers Inc.** has moved into a larger plant at North Hollywood, Calif. . . . The European subsidiary of the **Burndy Corp.**—**Burndy Electra**—is building a new plant at Malines, Belgium . . . **Bytrex Corp.,** Newton, Mass., and **Kulite Semiconductor Products,** Ridgefield, N.J., have formed a jointly-owned subsidiary—**Kulite-Bytrex Corp.**—to manufacture semiconductor strain gages . . . Newly opened West Coast plants: **Weston Hydraulics Ltd.,** a subsidiary of **Borg-Warner Corp.,** is now in a 100,000 sq. ft. facility at Van Nuys, Calif., and at Sunnyvale, Calif., **Avnet Electronics Corp.** of Northern California has an 11,000 sq. ft. factory . . . The **Autonetics Division** of **North American Aviation** has established separate product divisions for armament and flight controls, computer and data systems, inertial navigation and industrial products . . . Plant expansions are underway at **Networks Electronic Corp.,** Van Nuys, Calif., and **Heinemann Electric Co.,** Trenton, N.J. . . . **Clevite Transistor Products Division** of **Clevite Corp.,** is putting up a multi-million plant at Waltham, Mass., which will employ 1500 persons . . . **Waltham Precision Instrument** has acquired more manufacturing space at Brookfield, Conn. . . . and at Detroit, **General Motors Corp.** has formed a new, non-manufacturing Defense Systems Division . . .

GE To Start Building $14-million R&D Center

PHILADELPHIA—The **General Electric Company** will soon begin construction of a $14 million center to provide space for expansion of its missile and space vehicle R&D work.

The new center will be part of GE's Missile and Space Vehicle Department and will be located on a 130-acre site 17 miles west of here at the junction of the Pennsylvania Turnpike and the Schuylkill Expressway, near historic Valley Forge.

H. W. Paige, general manager of the MSVD, said ground-breaking and other pre-construction work will begin before the year is over, and part of the center will be occupied in late 1960.

propulsion engineering . . .

By JAY HOLMES

Public interest in the booster program . . .
has grown suddenly as a result of Russia's spectacular success with the *Luniks*. Major rocketmakers are seizing the opportunity to press some of their more elaborate ideas for space propulsion. They figure there is no better time than the present to let the man in the street know how he can contribute to catching up with Russia in the race for space—that is, if we are in a race.

The latest such plan is Aerojet's Project Cosmos . . .
which the company calls a new approach to building big, liquid-fueled boosters, ranging from 6 million to 14 million pounds thrust and more, which could enable the U.S. to put a man on the moon in four years.

Project *Cosmos* is a plan for simplifying the engineering of a big booster rocket. In the trade-off between performance on the one hand and cost and development time on the other, some performance would be given away to accelerate development and reduce cost. A side advantage would be increased reliability, **Aerojet** says. For example, a *Cosmos*-concept rocket would be more rugged structurally, although it would be heavier than necessary under present lines of development.

Aerojet declines to reveal further . . .
details about the *Cosmos* proposal. A spokesman says anything additional would endanger the company's proprietary rights. The concept is not a new propellant combination. It can be used with any of the existing combinations—LOX, storables or high-energy.

Although no cost figures were mentioned, Aerojet spokesmen said the concept could be tested in a relatively inexpensive initial-year experimental feasibility-development study. Aerojet said it has spent $400,000 of its own money and 40,000 man-hours of staff time examining the concept.

The plan is not married . . .
to any specific size of engine. Aerojet says one major outlay will be needed to prove that the concept is workable—then a minimum additional expense to vary thrust over a considerable range. Also, it can be varied to provide for recoverability of the booster.

Project *Cosmos* was presented to officials of the Defense Department and NASA. Spokesmen for both government bodies declined comment pending study. However, a NASA official pointed out that use of the name *Cosmos* was selected by Aerojet and has no official sanction.

Cosmos is in competition . . .
with the **Thiokol** plan for a 10-million-pound, 60-second solid-fuel booster, announced last month by Dr. Harold Ritchey. Another entry in this sweepstakes is a more modest million-pound-thrust solid booster proposed by D. F. Sprenger of Aerojet.

Ritchey and other solids men argue that less time and cost are involved. Further, they say, solids are more reliable. Liquid-engine advocates challenge each point, of course.

Rocketdyne, of course, has plans, too . . .
The **North American** division has the E-1 already developed, the F-1 under development and the L-1 on file if anyone wants something even bigger. E-1 has 400,000 pounds of thrust. The F-1, a single-chamber engine with 1,500,000 pounds of thrust, is in the first year of a four-to-six-year NASA development timetable. L-1 is a blueprint for the next generation after F-1—a single chamber-burning LOX-RP end generating 12 million pounds of thrust. It would pump 24 million pound of propellant a minute.

What kind of mission for L-1? A Rocketdyne spokesman said he couldn't remember just what was proposed but it was something like putting the City of Chicago into orbit.

NASA

$73,000—**Republic Aviation Corp.**, for an investigation of lunar and interplanetary space probe trajectories.

NAVY

$3,250,000—**Vitro Laboratories**, Silver Spring, Md., for systems engineering work on the *Polaris* missile.

$1,000,000—**Electronics Div. of Webcor, Inc.**, Chicago, for airborne electronics equipment used to detect the presence of enemy submarines and other classified equipment.

$600,000—**Hallamore Electronics Div., The Siegler Corp.**, for design, manufacture and installation of electric instrumentation and systems control equipment in connection with the *Polaris* missile.

$280,870—**Northeastern Engineering, Inc.**, Manchester, N.H., for switch-boards, electrical, for missile power.

$259,200—**New Hampshire Ball Bearings, Inc.**, Peterborough, N.H., for 65,400 advanced-design ball bearings to be used in the *Sidewinder* air-to-air missile. Subcontract from **Farmers Tool & Supply Co.**, Denver.

$200,000—**Electronic Systems Development Corp.**, subsidiary of **Solar Aircraft Co.**, for development, manufacture and installation of a precision radar synchronization system linking all the tracking and surveillance radar facilities to the Pacific Missile Range.

$95,000—**Chance Vought Aircraft, Inc.**, Dallas, for engineering services and materials necessary to conduct the *Regulus I* weapon system support program.

$30,820—**Southern Research Institute**, Birmingham, Ala., for an investigative program to assess the significance for design purposes of experimental techniques for evaluating the resistance of high-strength structural alloys to catastrophic failure by brittle fracture.

AIR FORCE

The Sheffield Corp., Dayton, Ohio, Subsidiary of **Bendix Aviation Corp.**, for research and development to evaluate the application of high-frequency vibrations to grinding operations. Amount not disclosed.

$2,820,000—**Hughes Aircraft Co.**, Culver City, Calif., for *Falcon* missile composite flight test program.

$2,394,829—**Eastman Kodak Co.**, for various types of aerial film.

$1,000,000—**Ford Instrument Co.**, Div. of **Sperry Rand Corp.**, for building and testing an experimental model of a radically new airborne inertial navigation system, designated the AJN-7.

$550,800—**Melpar, Inc.**, Falls Church, Va., for study and development of a speech compression system.

$488,051—**Aerojet-General Corp.**, Azusa, Calif., for rockets.

$400,000—**Hallamore Electronics Div., The Siegler Corp.**, for further development and installation of closed circuit television, ground instrumentation and other data acquisition equipment for the *Titan*. Subcontract from **The Martin Co.-Denver.**

$270,000—**Budd Lewyt Electronics, Inc.**, N.Y., for research and development of transistorized equipment for a classified mission.

$129,980—**Sylvania Electric Products, Inc.**, N.Y., for electron tubes.

$124,890—**Raytheon Co., Microwave & Power Tube Div.**, for electron tubes.

$100,000—**Massachusetts Institute of Technology**, for investigation of the interaction of high powered R.F. energies and high density plasmas.

$84,150—**North American Philips Co., Inc.**, for electron tubes.

$51,625—**General Electric Co.**, Scranton, Pa., for electron tubes.

$49,500—**Penta Laboratories, Inc.**, Santa Barbara, Calif., for electron tubes.

$40,000—**American Meteorological Society**, Boston, for research directed toward abstracting and bibliographic services in the field of meteorology.

$30,392—**Sperry Rand Corp., Electronic Tube Div.**, for electron tubes.

ARMY

Kearfott Co., Inc., subsidiary of **General Precision Equipment Corp.**, for conducting a design study program for an automatic resolver tester. Amount not disclosed.

$3,400,000—**International Telephone & Telegraph Corp., Federal Division**, Clifton, N.Y., for production of *Lacrosse* missile guidance units. Subcontract from **The Martin Co.-Orlando.**

$2,176,040—**Bendix Aviation Corp., Frieze Instrument Div.**, for meteorological equipment.

$236,550—**Electronic Associates, Inc.**, Long Branch, N.J., for three transformation computers.

$179,880—**Electro-Optical Systems, Inc.**, Pasadena, Calif., for investigation of ionized gases.

$167,140—**Raytheon Co.**, Andover, Mass., for concurrent repair parts for the *Hawk* missile.

$128,600—**Western Electric Co.**, N.Y., for *Nike* spare parts and components.

$112,000—**Cardinal Building & Constructors, Inc.**, Plattsburgh, N.Y., for construction of missile run-up shop.

$96,977—**Transitron Electronic Corp.**, Wakefield, Mass., for research and development leading to development of high-efficiency silicon solar cells.

$83,036—**Dynametrics Corp.**, Burlington, Mass., for the design and fabrication of a data recording system.

$75,000—**The Dow Chemical Co.**, Tulsa, Okla., for developing and applying a practical procedure for cleaning *Saturn* missile parts and components.

$66,459—**Aeronutronic Systems, Inc.**, Glendale, Calif., for conducting research in the guided missile and range instrumentation field in the telemetry area technical reports.

$35,150—**Minneapolis Honeywell Regulator Co.**, Aeronautical Div., for components for laboratory evaluation tests in connection with *Sergeant* missile system.

$33,355—**United Engineers, Inc.**, Springfield, Mass., for design and fabrication services.

MISCELLANEOUS

Electronic Communications, Inc.'s Advanced Technology Corp., for ICBM guidance study. Subcontract from **Lockheed Aircraft Corp.** Amount not disclosed.

$400,000—**Radiation, Inc.**, Melbourne, Fla., for a highly advanced PCM flight test acquisition and data processing system for use in the N-156F program. Subcontract from **Northrop Corp., Norair Division.**

$340,000—**Polarad Electronics Corp.**, N.Y., for a completely automatic signal generator for use in a classified project. Subcontract from **Boeing Airplane Co.**

$217,625—**Servomechanisms, Inc.**, Hawthorne, Calif., for magnetic amplifiers and transformers for the MA-1 and MG-13 Aircraft Weapons Control Systems. Subcontract from **Hughes Aircraft Co.**

$106,000—**Yardney Electric Corp.**, N.Y., for manufacture of silver-zinc batteries for missile application. Subcontract from **Boeing Airplane Co.**

* * * * * * * *

NASA announced that it awarded the following contracts during September. (Most of them have been reported in M/R previously):

$2,000,000—**Bendix Radio Div., Bendix Aviation Corp.**, for operation of minitrack stations for 1960.

$140,000—**Minneapolis-Honeywell Regulator Co.**, for fabrication of a guidance and control system for *Scout*.

$110,000—**Instituto Geofisico de Hyancayo**, for operation of tracking and receiving station at Lima, Peru.

$110,000—**Geophysical Corp. of America**, for instrumentation to measure electron density in the ionosphere.

$100,000—**Pratt & Whitney Division, United Aircraft Corp.**, for investigation of heat transfer potentialities of a number of materials in a near-vacuum under extremely high temperatures that would be encountered in a nuclear-electric generating system.

$90,000—**University of Michigan**, for basic research on the plumbing erosion that occurs under high temperatures in certain rocket engines.

$73,000—**Republic Aviation Corp.**, for study of lunar and interplanetary space probe trajectories.

$50,000—**Society of Photographic Scientists and Engineers**, for operational expenses for volunteer photo and radio tracking of earth satellites.

$50,000—**Thiokol Chemical Corp.**, for spherical rocket motors for re-entry research.

$50,000—**Avion Division, ACF Industries, Inc.**, for radar tracking beacons for *Scout*.

—reviews—

THE EXPLOSIVE PRESS AS A RESEARCH TOOL IN MATERIAL BEHAVIOR AND FORMING, E. W. LaRocca and J. Pearson, U.S. Naval Ordnance Test Station, China Lake, Calif. Order PB 151844 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. $.50.

Expendable explosive presses were devised for research in explosive forming of powdered metals and non-metals, as well as expensive materials.

Unlike most metal explosive systems, the presses permit recovery of the test specimens. Presses are single and double action. The double action press, which is of sandwich-type construction, uses two explosive charges fired simultaneously to drive two opposed pistons together into a central steel cylinder in which the specimen material has been placed. Pressures of several million pounds per square inch can be obtained.

By modifying the working faces of the piston, materials can be formed into various shapes. Text and line-drawings in this report describe the action of the presses and their application to several materials.

STATUS REPORT ON FUEL CELLS, B. R. Stein, Army Research Officer. Order PB 151804 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 119p. $1.25.

A recently appointed Army Fuel Cell Steering Committee has gathered data on advancements in the field and published its first report of the current status of fuel cell development.

All fuel cell activities currently pursued or planned by the Army are described, as well as some of the work of other agencies.

The report reviews military requirements and interest and contains a general description of the fuel cell operation, descriptions of a variety of fuel cell systems, a general discussion, a review of the Dept. of Defense supported program, a summary, and references.

ADVANCED PROPULSION SYSTEMS, H. F. Calcote, AeroChem Research Laboratories, Inc. for ONR. Order PB 151796 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 105p. $2.50.

A critical look at the mid-1958 state of the art of advanced propulsion systems and prospects for their future development is taken in this report of a study for the Office of Naval Research.

Conclusions reached included: Possibilities of very high specific impulses from free radicals are limited by their low densities and other problems such as storage. Excited chemical species and noble gases, also high specific pulse possibilities, need more basic research. So does the oxygen-atom recombination ramjet.

In electrostatic propulsion ion-rockets, major problems exist in the separation of electric charges. Magnetogasdynamic propulsion, with no problems of charge separation, appear more promising.

missile business . . .

By WILLIAM E. HOWARD

For 35 cents missile contractors can now avail themselves of the latest Defense Department edict on cost principles (Revision No. 50, Armed Services Procurement Regulation) published by the Government Printing Office. This new regulation, says DOD, is the product of years of study. And while it establishes some new rules on allowable costs generally, its principal affect is to liberalize chargeable costs incurred by R&D contractors.

The new cost principles do not cover either . . .

negotiated contracts or profits. Rather they are designed to "serve as the contractual basis for the payment of costs under cost-reimbursement type contracts." And in all other contracting or contract settlement situations, says DOD, "they will serve as a guide in the negotiation of prices or settlements, to the extent that the evaluation of costs is necessary for the setting of fair and reasonable prices."

To the R&D contractor the new ruling provides that his independent research and development costs will be allowed as indirect costs —if the development work is related to product lines for which the Government has contracts, and if the costs are reasonable.

These costs will include a share of indirect . . .

and administrative costs. But R&D costs which were incurred in accounting periods prior to the award of the specific contract generally are not permitted.

What are "reasonable" expenditures? In arriving at this often seemingly nebulous quantity, DOD contract officers are instructed to take into account such factors as previous contractor R&D activity, cost of past programs, and changes in science and technology. Such expenditures by the contractor must follow "a broad planned program, which is reasonable in scope and well-managed."

Some other cost principles which are revised . . .

include: advertising costs—allowable in limited areas only (ads pushing a particular weapon system or lobbying are out); profit-sharing plans for executives—allowable to the extent that an individual's total compensation is considered reasonable; contingency costs—allowable in settlement of contract terminations and in connection with estimates of future costs in certain areas; interest—not allowable; materials—allowances are expanded to include sales and transfers between plants; plant reconversion costs—restoration after the removal of government property is allowable.

Severance pay after contract termination would be allowable only in individual contract agreements. State and local taxes are allowable if they have been imposed upon work in progress or inventories—and if the instructions of the contracting officer are followed in cases where the taxes are thought to be illegal.

The rules also establish for the first time the principle that cost factors may be used as "guidelines" in the negotiation and administration of fixed-price type contracts.

Procurement officials deny that contractors . . .

will be forced into adopting new cost accounting systems. They also claim that the principles will not lead to formula pricing.

What do they all add up to in the way of plus or minus money for DOD? Says a spokesman:

"In the fixed price area, we expect that the new principles will ultimately result in more efficient procurement and, hence, savings will accrue in the long run. It is not possible to put a dollar sign on any such savings at this time."

—when and where—

NOVEMBER

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

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

National Academy of Sciences, Autumn Meeting, Indiana University Memorial Union, Bloomington, Nov. 16-18.

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

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

American Society of Mechanical Engineers, Fifth International Automation Exposition and Congress, New York City, Nov. 16-20.

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

National Aviation Trades Association, 20th Annual Convention, Hotel Montelone, New Orleans, Nov. 16-20.

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

Institute of the Aeronautical Sciences, National Turbine-Powered Air Transportation Meeting, Fairmont Hotel, San Francisco, Nov. 17-18.

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

Ninth Aircraft Hydraulics Conference, sponsored by Vickers, Inc., Div. Sperry Rand Corp., Park Shelton Hotel, Detroit, Nov. 18-20.

DECEMBER

AFOSR/Physics Division, Physical Sciences Directorate and NAS/NRC, Conference on Problems Related to Interplanetary Matter, Northwestern University, Evanston, Ill. (Dates still not firm).

Rocket and Missile Symposium, USAF Arnold Engineering Development Center and ARO, Inc., Arnold Air Force Station, Tullahoma, Tenn., Dec. 1-2.

Eastern Joint Computer Conference, Statler Hilton Hotel, Boston, Dec. 1-3.

National Conference on Application of Electrical Insulation, Sheraton-Park and Shoreham Hotels, Washington, D.C., Dec. 6-8.

American Institute of Chemical Engineers, 52nd Annual Meeting, Sheraton-Palace Hotel, San Francisco, Dec. 6-9.

American Management Association, Briefing Session on the Defense Market, Ambassador Hotel, Los Angeles, Dec. 7-9.

First Aerospace Finishing Symposium, sponsored by Southwest Society of Aircraft Materials and Process Engineers, and Dallas-Ft. Worth Branch of American Electroplater's Society, Hotel Texas, Fort Worth, Dec. 8-9.

Institute of Environmental Sciences, New York Metropolitan Chapter, Technical Symposium and Product Exhibition, Henry Hudson Hotel, New York, Dec. 10-11.

1960

Sixth National Symposium on Reliability and Quality Control, Statler-Hilton Hotel, Washington, D.C., Jan. 11-13.

American Astronautical Society, Sixth Annual Meeting, New York City, Jan. 14-20.

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

Univac Users Association, Semi-Annual Meeting, Greenbrier Hotel, White Sulphur Springs, West Virginia, Feb. 25-26.

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

American Welding Society, 41st Annual Meeting and Welding Exposition, Los Angeles, April 25-29.

CLASSIFIED

ADVERTISER'S INDEX

Keep the Military in Space Race

The awarding of a development contract for the last remaining military space system, *Dyna-Soar,* has been held up for many months now. The competition for this boost-glide, manned and winged space vehicle is between teams headed by the Boeing and Martin companies.

In September, General Bernard Schriever, boss of the Air Research and Development Command, said it was being dclayed for another look at the propulsion and guidance systems.

Just a few days ago, following the announcement from the White House that the Army Ballistic Missile Agency at Huntsville was being turned over to the National Aeronautics and Space Administration, Wernher von Braun, head of the old Army space team, made a rather significant statement.

The payload for *Saturn,* he remarked, might be a winged vehicle. *Saturn,* the cluster of eight Rocketdyne engines designed to produce 1.5 million pounds of thrust in one bundle, is the chief project of the ABMA.

A "winged vehicle" presumably would be *Dyna-Soar* or a similar vehicle, winged and manned for control and re-entry.

Actually, the nation has no booster at the moment capable of lifting a *Dyna-Soar* type spacecraft. The F-1, Rocketdyne's 1.5-million-pound-thrust single engine, was projected with *Dyna-Soar* in mind. Martin's bid for the contract is thought to involve clustering several Aerojet-General *Titan* engines. The F-1 was taken from the Air Force and given to NASA, where it progresses slowly for lack of funds. The Martin approach is in a design study stage.

Saturn might be the answer, if Von Braun and his team can get the money they are clamoring for to bring the project to operational status before it sprouts moss—and if *Dyna-Soar* is finally approved.

But this brings up a major and most important point. Will *Dyna-Soar,* under any name, remain a military project or will it too be transferred to the civilian space agency?

At the moment all space projects except *Dyna-Soar* have been taken from the military. The services have no space mission according to the Administration viewpoint, and there are even recurring reports that an unwritten order limits their operations to 600 miles above the earth.

We have sincere doubts that this is wise and we believe it is one of the things the House Space Committee will want to look into when it conducts the full committee investigation of our national space program, now announced as first order of business when Congress reconvenes in January.

For we believe the services do have a mission in space and that the nation can use the talents and the experience of the military; that the sense of urgency inherent in the military usually does not exist among civilian scientists; that—above all—the military has the sworn task of defending this country and that the battle for space—with the knowledge, experience, prestige and strategic advantage it can bring us—*is a war which we dare not lose.*

Dyna-Soar is a man-in-space program, but more than that it is the first program promulgated by the U.S. which puts a man into space for a reason other than to see if he can survive.

The Project *Mercury* Astronauts will be fired aloft in capsules, observe and report. The *Dyna-Soar* pilot would command his own flight, to a great degree, control his course, effect his own re-entry. He would be the fore-runner of many space and interplanetary pilots. Like the Astronauts, he would probably be a military man—as most of the great explorers throughout history have been. For the nation needs his skill and his dedication—as it needs the skill and dedication of his leaders.

Clarke Newlon

New from Clary!

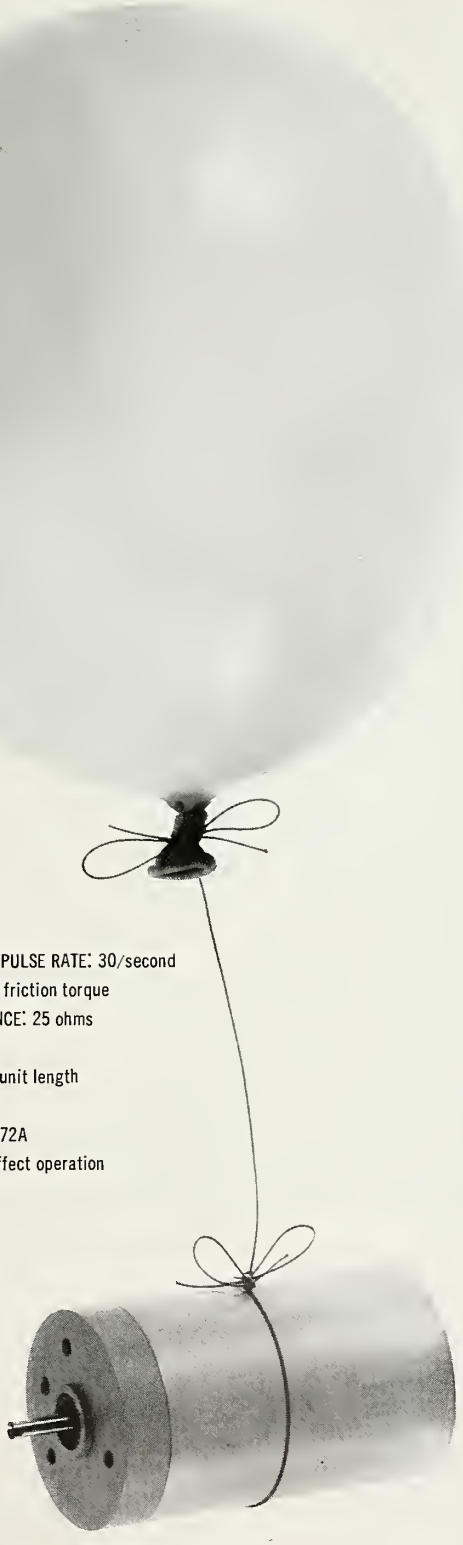
AN 8-OZ. STEPPER MOTOR!

New unit is small... surprisingly low in cost... extremely accurate!

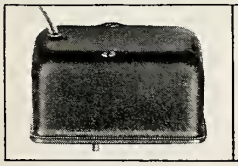
Now from Clary comes a small, lightweight incremental motor with extremely high repetitive accuracy. The unit will accept consecutive command pulses from either of two independent sources in any order, and resulting successive shaft "steps" may be continuously clockwise or counter-clockwise, or any random combination of the two directions.

This high-quality motor is a standard shelf item at Clary – the company whose long experience, outstanding staff, and complete facilities for extreme environmental conditions testing have made it one of the nation's leading manufacturers of automatic controls.

For detailed information on this exceptional motor, write Clary direct.



SPECIFICATIONS: Clary CD-700 Incremental Motor · WEIGHT: 8 oz. · MAXIMUM COMMAND-PULSE RATE: 30/second
LOAD: will drive a load possessing 0 to 25 gm cm² moment of inertia and/or 0 to 2 oz. in friction torque
INPUT VOLTAGE: 28 v dc · POWER: 15 watts average power at 50% duty cycle. · RESISTANCE: 25 ohms
DIRECTION: clockwise–red and black leads...counter-clockwise–white and black leads
ANGULAR TRAVEL: 36° per pulse, standard. Other values available with slight increase in unit length
DESIGN LIFE: 10^6 cycles each direction · TEMPERATURE: −65°F. to +160°F.
VIBRATION: 5 cps to 600 cps at 10 g or .020" double amplitude · HUMIDITY: per MIL-E-5272A
SALT SPRAY: per MIL-E-5272A · SAND AND DUST: per MIL-E-5272A · ALTITUDE: does not affect operation
MOUNTING: standard AN servo mounting available



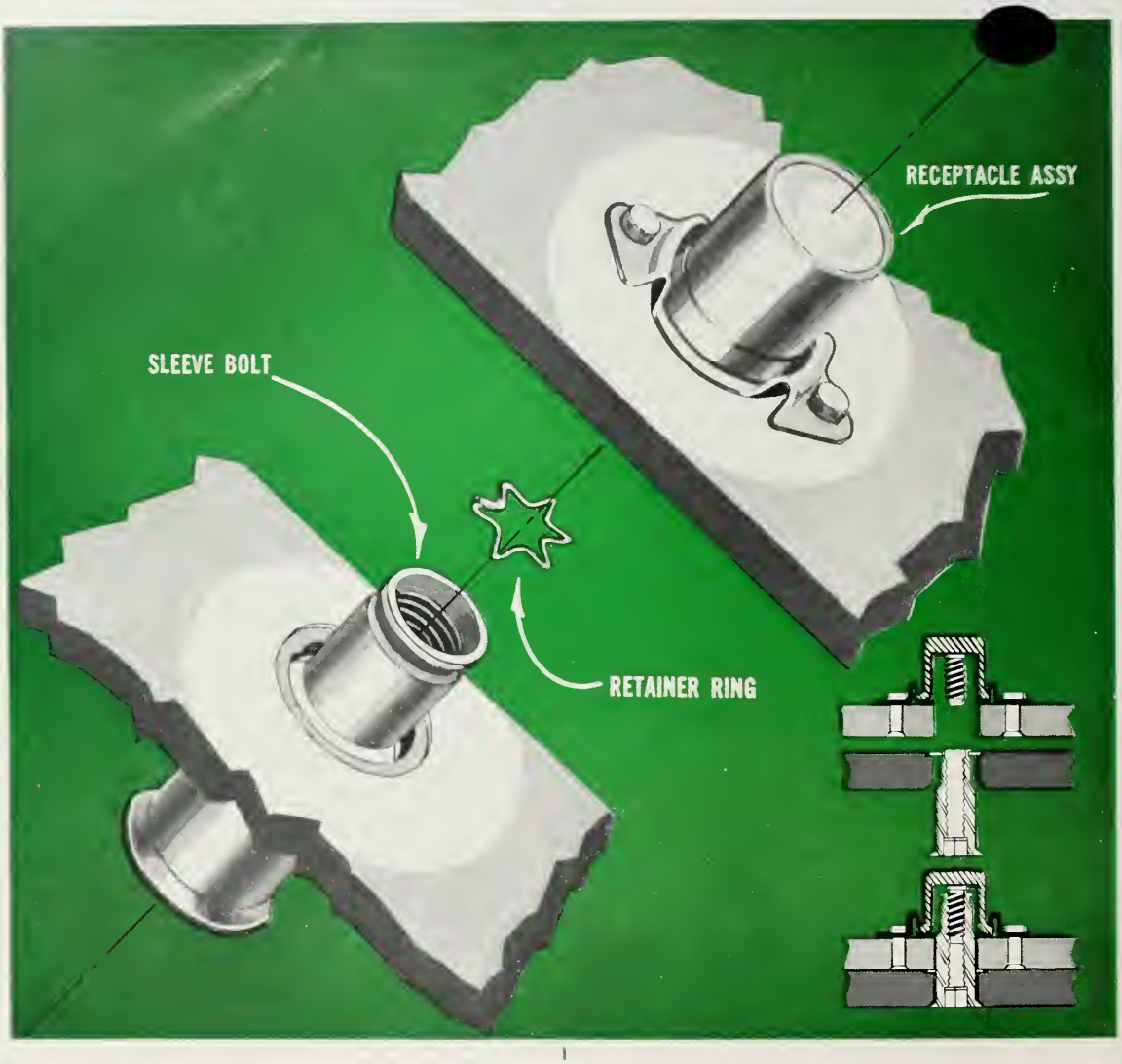
Also available for commercial use:
an even smaller, more compact and more economical version of the CD-700.

Clary

Clary Dynamics
Dept. RM-119 San Gabriel, California
Manufacturer of business machines, electronic data-handling equipment, aircraft and missile components.

EVER INSTALL AN ACCESS PANEL WITH HOLES MISALIGNED as much as .040 in. ?

Nutt-Shel's structural panel fastener closes gaps between panel and structure up to .125 in. *even when holes are misaligned as much as .040 in.*



In just a few turns the self locking, self jacking sleeve bolt is installed or removed. No special tools or instructions required. Construction is foolproof. Only four parts; nothing to adjust.

This high strength fastener, 4500 lbs. tensile and 13,000 lbs. double shear, has a deep hex recess for faster power driving and high preload. The fail-safe shear groove in sleeve bolt prevents over torquing.

Only one common hole size for panel and substructure Sleeve bolt is retained near flush, for easy removal of highly curved panels. Receptacle and sleeve bolt are readily replaceable. Self draining receptacle prevents moisture accumulation.

STYLES

Standard and self sealing types. Two-lug and corner-floating receptacle styles. Made in alloy steel for temperatures to 550° F. and in corrosion resistant steel for 700° F. service.

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