July 11, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

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loids May Cut Time of Mars Trip.....

Atlas—New Target for Zeus

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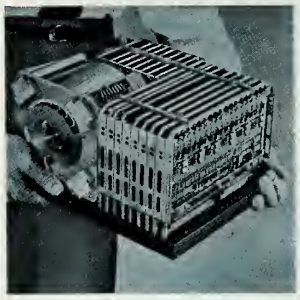

computers that pace man's expanding mind

LI 0-1

Circle No. 1 on Subscriber Service Card.

New Kinetics switch transfers battery power automatically in space craft

Part of the electronic circuitry that senses battery voltage and operates the switch to transfer the load to another power source when voltage drops to pre-set level.

For satellites, deep space probes or extended space flights, it is frequently necessary to switch from an exhausted battery to a fresh one or to solar power. Now Kinetics Corporation has combined an ultra reliable switch with a voltage-sensing element to meet this critical requirement. The new Kinetics switch is motor driven. It is more rugged and reliable than other designs and is impervious to shock and vibration.

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An ultra-sensitive electronic circuit measures battery voltage. When the sensed voltage falls to a pre-set level, the circuitry passes current to the switch motor, causing power transfer. It may be applied in systems where a missile is switched to internal battery power after check out on ground power. After launch, when the missile is in flight and the first battery is discharged, the same switch can transfer the load to a fresh battery or to solar cell power. For systems employing more than two batteries, additional switches can be utilized for programed or automatic power change overs.

For any switch application where absolute dependability under tough environmental conditions is essential, write or phone Kinetics Corporation, Dept. K-27, 410 S. Cedros Avenue, Solana Beach, Calif. SKyline 5-1181.

KINETICS CORPORATION

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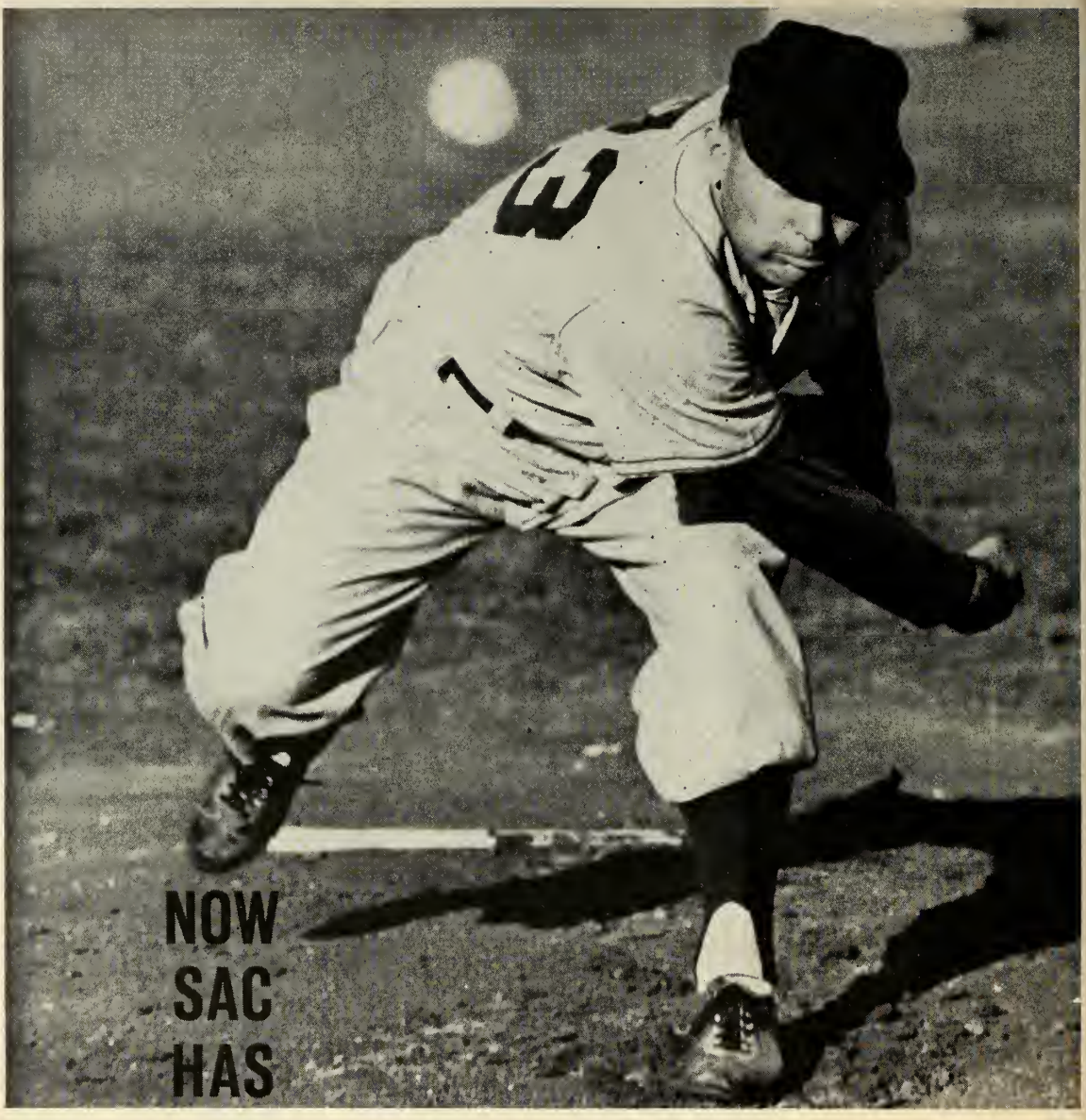

TWO STRIKES ON THE OPPOSITION

When SAC's B-52 crew steps up to the mound it can throw two deceptive curve balls before winding up to deliver the third strike. Two GAM-77 HOUND DOG air-to-surface missiles slung beneath the wings of the B-52 intercontinental bomber can quash enemy defense centers and clear a path to the main target.

Blazing into action at supersonic speeds, these GAM-77's can be used either on resistance points or on the main objective itself. Inertially guided, they can fox enemy radar by making passes at pseudo-targets before heading for the actual one. To further confuse the opposition, the jet-powered missiles can fly high or low on the way to the strike zone.

The GAM-77 HOUND DOG was designed and is in production for SAC by the Missile Division of North American Aviation.

THE MISSILE DIVISION OF
NORTH AMERICAN AVIATION, INC.
Downey, California

THE MISSILE / SPACE WEEKLY

missiles and rockets

July 11, 1960 Volume 7, No. 2

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THE COVER

Launch of an Air Force Convair Atlas down the Atlantic range into the Indian Ocean. The ICBM will be used, in place of Jupiter, as a target for Nike-Zeus. *(See p. 14)*

JULY 11 HEADLINES

PROPULSION ENGINEERING

ELECTRONICS

TEST EQUIPMENT

ASW ENGINEERING

ADVANCED MATERIALS

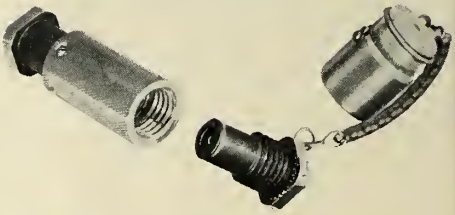
INTERNATIONAL

DEPARTMENTS

30,562 copies this issue

Rita Roylyn Says:

"Roylyn AstroCon high-pressure valves...* help men breathe in outer space"



*STERILAB decontaminated

Sterilab decontaminated **AstroCon** oxygen valves such as these are supplied to AiResearch Manufacturing Company, a division of the Garrett Corporation, who are designers of environmental systems for men in space.

High-pressure valves are a specialty of Airaterra, designers of the popular line of Roylyn products for the aircraft and missile industry. They are engineered for pneumatic, gaseous or liquid applications, and are available in standard as well as custom sizes.

These valves as well as many other Roylyn products are decontaminated, assembled and packaged in the ***Sterilab.*** Design features of these Roylyn high-pressure valves include the ability to be coupled under pressure to 10,000 psi, yet maintain zero leakage stored. Utilizing metal-to-metal valving, these components have an operating temperature range of from −65°F to over 225°F. Light in weight, they exhibit extreme vibration resistance, meeting 160 Db white noise.

Airaterra engineering and design makes possible the adaptation of these and other Roylyn couplings to meet your special requirements.

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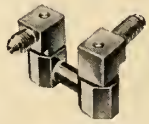
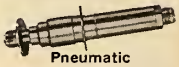


Twin-Mounted Swivel Connector



Pneumatic Rise-Off Disconnect

when and where

JULY

Metallurgical Society of American Institute of Engineers, Conference on the Response of Materials to High Velocity Deformation, Estes Park, Colo., July 11-12.

American Rocket Society, Propellants Combustion and Liquid Rockets Conference, Ohio State University, Columbus, July 18-19.

Third International Conference on Medical Electronics, sponsored by Institution of Electrical Engineers, Olympia, London, July 21-27.

Management Development Seminar, Pennsylvania State University, University Park, Pa., July 24-29.

Denver Research Institute, Seventh Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

AUGUST

Fourth Global Communications Symposium, co-sponsored by IRE, Professional Group on Communications Systems, and USA Signal Corps, (100th Anniversary) Statler Hilton Hotel, Washington, D.C., Aug. 1-3.

MIT Special Summer Program on Modulation Theory and Systems, Cambridge, Aug. 1-12.

University of Connecticut, Institute for Practical Research on Operations, Storrs, Aug. 7-13.

University of Connecticut, Third Annual Institute on Missile Technology, Storrs, Aug. 7-19, 1960.

American Astronautical Society, Western National Meeting, Olympic Hotel, Seattle, Aug. 8-11.

American Institute of Electrical Engineers, 1960 Pacific General Meeting, El Cortez Hotel, San Diego, Aug. 9-12.

ASME-AICHE Heat Transfer Conference and Exhibit, Statler Hilton, Buffalo, N.Y., Aug. 15-17.

XIth International Astronautical Congress, International Astronautical Federation, Stockholm, Aug. 15-20.

Cryogenic Engineering Conference, University of Colorado and NBS, Boulder, Aug. 23-25.

Western Electronics Show and Convention, Los Angeles Memorial Sports Arena, Los Angeles, Aug. 23-26.

International Union of Pure and Applied Physics, International Conference on High Energy Nuclear Physics, University of Rochester, Rochester, N.Y., Aug. 25-Sept. 3.

The German Rocket Society, Annual Meeting, Hanover, Aug. 26-28.

University of Connecticut, Eleventh Annual Basic Statistical Quality Control, Institute, Storrs, Aug. 28-Sept. 9.

SEPTEMBER

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

Society of British Aircraft Constructors Show and Flying Display, Farnborough, England, Sept. 6-11.

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The Countdown

WASHINGTON

Polaris Ready Now?

Though it won't prove out its full underwater launch capability until this month with a *Polaris* shot from the Atlantic south of Cape Canaveral, the Fleet Ballistic Missile submarine George Washington is considered an operating unit now. It has been on an emergency standby status since April.

Pershing Success

Army officials are boasting about *Pershing*. They are pointing out the planned mid-air "zig-zag" shot June 30 marked the "first time in the history of the Atlantic Missile Range that a new R&D missile achieved five successes in its first five flights."

Prime for Scout

Once development of *Scout* is completed, NASA expects to move closer to a prime contractor arrangement. At present, Chance Vought assembles the vehicle under supervision of NASA personnel. When the solid-fueled bird is operational, a prime contractor (to be chosen) will assemble, install instrumentation and launch with a minimum of government supervision, if the plan goes through.

Base Delay Investigated

The Air Force—at Defense Secretary Gates' request—is now preparing a report on the six-month slippage in readying the first *Atlas* squadron at Cheyenne, Wyo. (M/R June 20; p. 11.) The delay—also said to be spreading to *Atlas* pads at Offutt AFB—appears to stem from managerial troubles. (See editorial p. 50.)

An Exact Amount

Despite all the in-fighting, or maybe because of it, NASA wound up with a FY 1961 appropriation from Congress of $915 million—just what the Administration had requested. The space agency also received money for a new office building in Washington.

It's an ALM

The Navy has let a study contract for a secret new missile named *Semper*. Wags around the Pentagon have dubbed *Semper* an ALM—standing for "air-launched marine."

INDUSTRY

Full Study

Latest word on the Army's battlefield mobile anti-missile project is that as many as six companies may be given full $250,000 feasibility study contracts. Final evaluation of industry proposals for these studies is expected to be completed by ARGMA by Oct. 1. The Army is entertaining proposals for advanced concepts as well as hardware-type anti-missile missiles.

Strike's Effect

The Machinists' strike at Lockheed has cut into *Polaris* production schedules. So far the effects of the walkout have not been too serious, but DOD officials are pressing for a quick settlement.

Mauler's Prospects High

Award of a follow-on $8-million contract to Convair-Pomona for continued development of *Mauler* is being interpreted as an indication the anti-missile/aircraft system will achieve operational status in early 1961. *Mauler* is solid-fueled, radar-guided and deployed aboard tracked vehicles.

Along Mahogany Row

Harvey Gaylord is staying on at the helm of Bell Aerospace Corp., the new division of Textron which purchased the defense divisions of Bell Aircraft. Gaylord had been president of Bell . . . Payroll at Cape Canaveral of Pan American and its major subs topped $54 million for the FY just ended. It's expected to go up another $2 million this year . . . Now that STL is separated in part from the Air Force, Thompson Ramo Wooldridge expects a substantial increase in STL $60 million volume.

INTERNATIONAL

British Push Blue Water

Following up disclosure that France's SEPR has concluded an agreement with Rocketdyne and Thiokol on a medium-range ballistic missile (COUNTDOWN, July 4) the British and the West Germans have entered into an agreement on another missile. It's the short-range *Blue Water*, made by English Electric. Both birds are competitors in the NATO market.

Japan Angling for Mighty Mouse

Persistent reports from overseas have the Japanese attempting to make a deal for a stockpile of 24,000 *Mighty Mouse* air-to-air missiles.

Caribbean Storm Warning

The Dominican Republic is now reported to be importing foreign rocket talent, apparently to counter expected Russo-Cuban missile deals. Castro has rocket fuel-refining facilities. He also hates the Dominican Republic as well as the U.S.

Peru Exhibits Model IRBM

The Peruvian Air Ministry is apparently getting ready to move into the missile to move into the missile field. It is displaying a model of an IRBM called *Manco Capac*.

Committee hits delays . . .

Group Wants Man on Moon by '70

A Congressional committee demanded last week that the United States raise its sights and set as a goal the landing of a manned expedition on the moon before 1970.

The Democratic-controlled House Space Committee lashed out at the Republican Administration's meandering space program as Congress broke up for a month's recess.

It called on the National Aeronautics and Space Administration to adopt a high-priority program to put men on the moon within 10 years. The current NASA schedule has set this goal for a vague "after 1970"—apparently about 1972.

"A firm plan with this goal should be drawn up and submitted to the Congress by NASA," the report said. "Such a plan, however, should be completely integrated with other goals to minimize total costs. . . . Particular attention should be paid immediately to long leadtime phases of such a program."

• **Conflicts recalled**—The committee recalled that Brig. Gen. Irving L. Branch, chief of the Aircraft Nuclear Propulsion Office of the Atomic Energy Commission, had testified this spring that AEC could develop propulsion for a manned moon expedition in less than 10 years if given such a requirement.

However, Deputy NASA Administrator Hugh L. Dryden testified that a manned moon expedition would be impossible in this decade regardless of progress in propulsion. Dryden said solving the problems of re-entry from a lunar distance will take longer than 10 years.

The NASA timetable, put forth by administrator T. Keith Glennan in February, is about four years behind a schedule that some of the nation's top scientists, engineers and government officials thought possible a scant 18 months ago.

In a report issued Jan. 2, 1959, the original Select House Space Committee quoted 20 experts as saying the United States could put a man on the moon by 1968—if willing to pay the price.

The experts included Dr. Herbert F. York, now Defense Department director of research and engineering; Lt. Gen. Bernard A. Schriever, commander of Air Research & Development Command; Dr. Louis G. Dunn, president of Space Technology Laboratories; and Gen. James H. Doolittle, then chairman of the National Aeronautics and Space Council.

The committee made these other points:

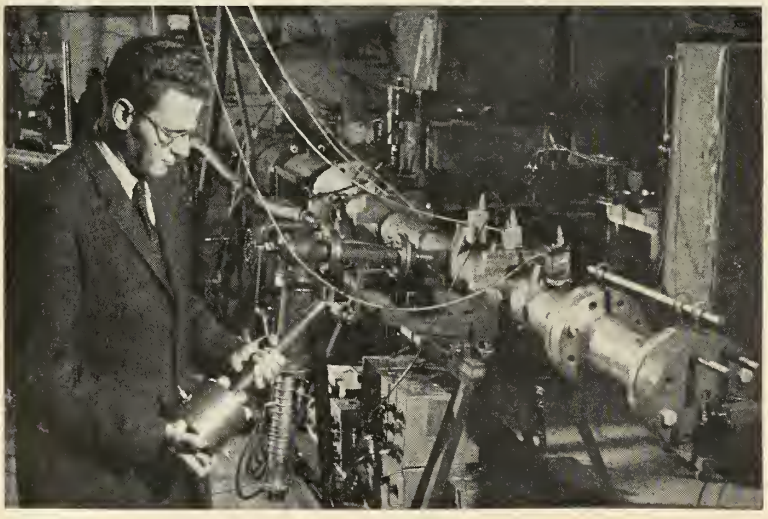
• The F-1 1 and ½-million-lb.-thrust single-chamber engine should be speeded and granted a "DX," the nation's highest priority.

• NASA should consider whether a nuclear engine "either by itself or in combination with the more conventional engines now in use or contemplated, does not offer a faster and more economical method of achieving a breakthrough. . . ." The decision should be made before large sums are committed to *Nova*, the committee said.

• Administration action in withholding $137 million voted by Congress for preproduction items for *Nike-Zeus* was unwarranted.

The Department of Defense has wasted a unique organization by failing to utilize Army in-house research and development facilities, worth $1 billion.

Gun Aids Study of ICBM Wakes



A 24-inch long hypervelocity gun developed by Avco-Everett Research Laboratory accelerates projectiles up to 18,000 feet per second. The gun was designed for the Army as a low-cost device to aid in the study of wakes left by projectiles traveling at ICBM speeds.

The device—held by Steven Georgiev, Avco scientist, in the accompanying photo—consists of a driver section, diaphragm, and barrel. Hydrogen gas in the driver section is exploded by a 20,000-volt capacitor discharge, the diaphragm ruptures, and a .22 cal. nylon pellet is fired down the long instrumented tube shown in the photo. At the far end of the tube is a window through which Schlieren photos of wakes up to five feet long have been made.

Soviets Open New Series Of Shots into South Pacific

The first in a series of long-range rocket tests being conducted by the Russians in the Pacific this month landed in its designated target area after travelling a reported 8078 miles.

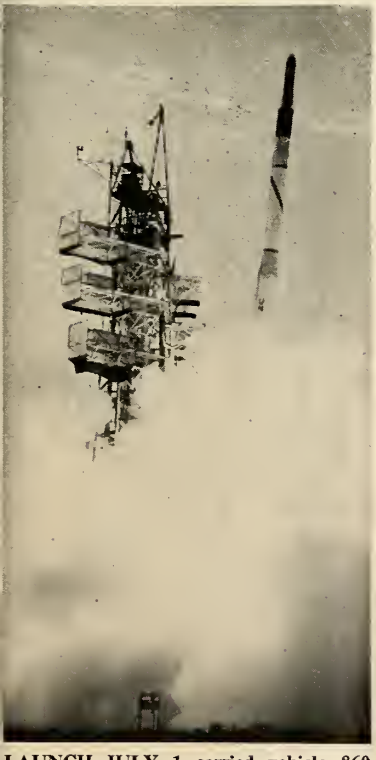
Two U.S. Navy patrol planes watched the rocket plunge into the atmosphere July 5, creating a long vapor trail. The pilots were not able to say whether the payload impacted in the ocean or disintegrated during re-entry.

Pentagon estimates were that the Red rocket had travelled 7700 miles. An *Atlas* travelled 9000 miles May 20.

In January, the Russians launched a multistaged rocket into the Pacific that travelled 7150 miles into a target area 150 miles northwest of the present area. This rocket was supposed to have been fired from the launching base near the Aral Sea.

The difference in range and target area indicates that the present series are being fired from the Kapustin Iar base on the Volga.

SCOUT STANDS at launch tower, ready for launching at 85° angle of elevation.



LAUNCH JULY 1 carried vehicle 860 miles up, 1500 miles downrange.

Three Scout Stages Ignite: Fourth Blocked by Command

by Jay Holmes

The launching of the first four-stage *Scout* vehicle was a propulsion success and an apparent guidance failure.

The first three stages of the all-solid satellite launcher ignited as planned July 1. But the vehicle appeared on the radar track to have veered off course and fourth-stage ignition was prevented by command from the Wallops Island, Va., station of the National Aeronautics and Space Administration.

The burning of second and third stages was visible over a wide area of the mid-Atlantic states. *Scout* rose to an altitude of 860 statute miles and traveled 1500 miles down the Atlantic. With all four stages burning, the trajectory would have carried it to an altitude of about 2300 miles and about 4700 miles downrange. Launching was at 8:04 p. m. (EDT).

The launching had been postponed several times since it was first scheduled June 16. The first delay was caused when an umbilical failed to detach less than a minute from firing. On subsequent days, difficulties arose with the guidance. Then the shot had to wait four days because Navy vessels were active in the range area. However, it was only four minutes behind schedule on the actual firing date.

NASA propulsion specialists were jubilant about the successful firing of the rockets—particularly the third-stage *Antares*. It was the first time *Antares* had been fired in flight.

The flight of the 72-foot *Scout* was a test of performance, structural integrity and environmental conditions of the vehicle and guidance-controls system. It carried 193 lbs. of payload.

Scout, which weighs 36,100 lbs. overall, is being developed as a small, reliable and flexible vehicle designed for a variety of tasks. It will carry more than 150 lbs. into orbit or will loft a 50-lb. package to an altitude of about 10,000 miles. With a ballistic trajectory, it will be possible to obtain two hours of zero-gravity environment with a 100-lb. payload.

Because of its solid propulsion, *Scout* will be a relatively cheap means of launching satellites. The latest estimate of vehicle cost, by Maj Gen. Don R. Ostrander, NASA director of launch vehicle programs, is $750,000 a copy.

The four-stage *Scout* frame and motor transition section are manufactured by Vought Astronautics Division, Chance Vought Aircraft, which also fabricates and installs the launch tower. Stages are as follows:

• **Algol**—a-30-ft.-long Aerojet-General rocket also called *Senior*. The 40-in.-diameter polyurethane composite motor develops 105,000 lbs. thrust for about 40 seconds. It is a modification of an early *Polaris* test vehicle. NASA said this fin-stabilized first stage is the largest solid rocket flown in this country.

• **Castor**—a-20-ft.-long Thiokol motor modified from the Army *Sergeant*. A 30-in.-diameter polysulfide composite motor, *Castor* develops 55,000 lbs. thrust for about 25 seconds. On the *Scout*, *Castor* is stabilized and controlled by hydrogen peroxide jets.

• **Antares**—a-10-ft.-long rocket specially developed for the *Scout* by Allegany Ballistics Laboratory, a Navy installation operated by Hercules Powder Co. A 30-in.-diameter double-base motor, *Antares* develops 15,000 lbs. thrust at altitude for 38 seconds. *Antares* also uses hydrogen peroxide jets for stabilization and control.

• **Altair**—a-6-ft.-long final-stage rocket used extensively in satellite and space research applications. An 18-in.-diameter motor, *Altair* develops 3100 lbs. thrust at altitude for 35.6 seconds. *Antares* is a scaled-up version of *Altair*. Both use fiber glass and plastic rocket cases.

Guidance and controls were manufactured by Aeronautical Division, Minneapolis-Honeywell. The 193-lb. payload—protected by a fairing jettisoned at third-stage ignition—included:

• A 23-lb. package of flares for observing the fourth-stage flight path, attached to the skirt of the *Altair* and fired at intervals after burnout. *Altair* was attached to the payload throughout the flight.

• A 23-lb. unit consisting of four blade antennas, a horn antenna and a cylindrical collar, 20 in. in diameter and 15 in. long.

• A 110-lb. electronic package, in-

cluding 190 liquid zinc silver batteries and mountings and four radio transmitters—two for data transmission, one radio tracking beacon and one radar beacon.

• A 37-lb. item made up of a plastic dome and measuring devices.

One data transmitter broadcast five channels including external temperatures, vehicle position and attitude. The other sent eight channels including compartment temperature, motor pressures, four accelerometer readings, magnetic field, radiation penetration of the payload and aspect information from a horizon scanner and a sun seeker.

The guidance compartment is between the third and fourth stages. It is based on a system of three gyros attached rigidly to the vehicle frame—in contrast to a true inertial system based on a free-floating gyro.

Azimuth and roll orientation are maintained essentially at the initial attitude established at launch; guidance is confined to pitch. The main component in addition to the three miniature integrated gyros—one for each reference axis—is the pitch axis programer.

The programer consists of two components, a timer and a DC power supply, which sends signals to the pitch axis gyro through six potentiometers.

The first three stages are controlled; the fourth stage is spin-stabilized. First-stage control is provided by a conventional hydraulic position servo, which actuates jet vanes in the motor exhaust and movable aerodynamic tip controls in each of the four fins.

Two pitch and two yaw hydrogen peroxide reaction jets provide control in the second stage. Their nominal thrust is 450 lbs., but they yield about 600 lbs. during the first five seconds of second-stage flight. Four 20-lb. pressure jets provide roll control.

Control in the third stage is also provided by H_2O_2 jets. To allow for coasting periods of up to 10 minutes after burnout, the Antares has two sets of controls. Four 44-lb. reaction jets provide pitch and yaw control and four 2-lb. jets provide roll control during powered flight. In the coasting period, two additional 2-lb. jets provide pitch control.

The fourth stage is stabilized by spinning it up to 160 rpm by three small rockets mounted tangentially. Spinning is begun near the end of the third-stage coast.

In a related development, NASA pinpointed the cause of the ignition failure of the third-stage *Antares* in the component test last April 18. The heat shield covering the third stage became displaced, NASA said, causing a structural failure in the vehicle before third-stage ignition.

special M/R survey shows . . .

Next President Will Pre

NIXON

KENNEDY

JOHNSON

Where will the next Administration stand on the important questions of defense and space exploration?

An M/R survey on the eve of the two political conventions indicates that regardless of which of six potentional candidates win their party's nomination, the next President will take a more forceful approach to these problems than did the last.

The Summit Conference blow-up and other recent U.S. reversals have done much to throw the missile and space issues into the political arena. For better or for worse, they will be debated in a heated, partisan manner this fall.

As was expected, the survey revealed a remarkable similarity in the positions of five possible candidates (Sen. John F. Kennedy, Gov. Nelson Rockefeller, Sen. Lyndon B. Johnson, Sen. Stuart Symington and Adlai E. Stevenson), and a sharp divergence between their views and those held by Vice President Richard M. Nixon.

The Democratic Party contingent and Gov. Rockefeller uniformly assert that Administration military and space spending has been inadequate, while Mr. Nixon has consistently defended the Administration's position.

Sen. Symington wanted to increase next year's military budget by $3.5 billion, Gov. Rockefeller by $3 billion, and Sens. Kennedy and Johnson supported the Senate attempt to increase defense spending by $1.3 billion. Gov. Stevenson has endorsed the Democratic National Advisory Committee's recommendations for increased military spending.

Mr. Nixon's recent statements, however, indicate he will present a stronger approach to defense and space problems once he is no longer an Eisenhower team member and becomes his party's candidate.

This was indicated during his recent press conference in Camden, N.J., where in defending the Administration's defense budget, the Vice President was careful also to approve the "slight modifications by the very able and experienced Appropriations Committees of the House and Senate."

As noted above, the "slight modification" made by the Democratic-controlled Senate Appropriations Committee was to add $1.3 billion to the Administration's request!

According to reliable sources, the Vice President will offer a complete reorganization of the military and other "cold war" organizations, and will add additional funds to the military budget as studies indicate a need.

The only other area in which all candidates agree, with the possible exception of Sen. Symington is that the United States is today stronger than the Soviet Union.

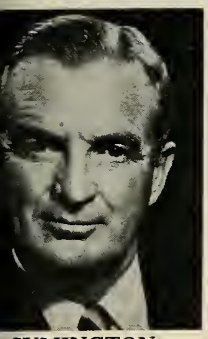
The central issue upon which the candidates disagree is whether past and present budgets will give the United States military superiority in the future, or at least an effective deterrent power.

On this issue, the candidate's views are:

Nixon: "As far as deterrent power is concerned, there is no gap today, and there will be no gap under the program (FY '61) that the President has submitted . . . I believe that militarily . . . we maintain and have a position of strength unparalleled in the history of this country."

Kennedy: "This year (1960), our 'mix of forces' is undoubtedly 'far superior.' But . . . we are today de-

.S. Missile/Space Effort



SYMINGTON

ROCKEFELLER

STEVENSON

ficient in several areas . . . in one of those areas, ballistic missiles, our deficiency is likely to take on critical dimensions in the near future."

Johnson: Criticized the military budgets of FY '60 and '61 as inadequate, and last December described the U.S. space lag as "unilateral disarmament."

Symington: "I do not think this budget (FY '61) is adequate from the standpoint of the security of our country."

Rockefeller: ". . . our position in the world is dramatically weaker today than 15 years ago . . . I believe our national defense needs great strengthening to meet the physical danger in which America lives."

Stevenson: Has consistently advocated increased military spending. Warned last December that the Russians cannot be confronted safely in negotiations with "inferior military deterrent capability."

In what areas do the six candidates criticizing present Administration defense policies believe that increased spending is necessary?

Kennedy: In supporting the Senate's attempt to increase the Administration's defense budget by $1.3 billion, Kennedy advocated funds for "an airborne alert keeping 25% of our nuclear striking force in the air at all times . . . to step up our *Polaris, Minuteman* and air-to-ground missile program . . . to step up production of *Atlas* missiles to cover the current (ICBM) gap as best we can . . . to provide funds to augment, modernize and provide increased mobility and versatility for the conventional forces and weapons of the Army and Marine Corps."

Johnson: Lead the Senate forces attempting to increase the defense budget by $1.3 billion, and has consistently advocated modernization of ground forces and giving them greater mobility, acceleration of the ICBM, military space, anti-missile defense, and B-70 programs as well as acceleration of the ballistic missile early warning system.

Symington: Believed that an extra $3.5 billion should have been spent in FY '61 to increase our "airborne alert capability, modernization of our ground forces, continuation of manned aircraft development through the B-70 program; antisubmarine warfare capability; accelerated space development—*Midas, Samos,* and *Discoverer; Minuteman, Hound Dog,* and *Sky Bolt.*"

Rockefeller: Advocated "an additional $3 billion for immediate defense needs, including additional and improved bombers, airborne alert, more missiles, more *Polaris* submarines, and modernized equipment for our ground forces."

Stevenson: Endorsed the Democratic National Advisory Committee's recommendations for increased military spending.

The Vice President, in replying to charges that present military spending is inadequate, has said that "Administration critics in Congress take only a part of the picture when it should be viewed as a whole," and that as a whole, the Administration's budget provides for "no gap in overall deterrent strength . . . and is adequate to maintain that position in the future.

Mr. Nixon seldom gets specific. But in one rare example, he did defend the decision to retard the B-70 program: "I think the President's decision that we would continue it (B-70) on a research basis, making up planes in the future and then putting them into production only if we found that they would be an effective instrument in our arsenal, is a proper one. Because the choice is between the B-70 and between the missiles."

But the Vice President has also made it clear that he is not committed to the Eisenhower program in the future, and has intimated that he would make changes once he were President. "Because we're living in an age of rapid technological advantages and advances in military science, we must submit our national security program to a searching month-to-month re-examination in the light of any new technological development and of our best current estimates of military capabilities by any potential aggressor."

It is also apparent from the candidates' statements that some reorganization of the Department of Defense and NASA may come about under a new President.

Mr. Nixon's reorganization ideas are referred to above, and Sen. Symington's ideas about reorganizing DOD and setting up a unified space organization are well-known. While not as specific, the other candidates have proposed that studies be made and that the necessary reorganization indicated be effected.

Should the national defense posture be a campaign issue?

The Democrats and Mr. Rockefeller think so. Mr. Nixon does not.

Nixon: In October the Vice President said it would be "most unfortunate if Senator Symington or others should make defense a political issue . . . Debate on national defense "can be constructive, but criticism can be destructive when emphases on alleged weakness overlooks acknowledged strengths and has the effect of making the U.S. appear to be a 'sitting duck' for an aggressor."

Kennedy: In February, Kennedy said that the nation's ability to defend itself will be the "basic issue" in November's battle for the White House.

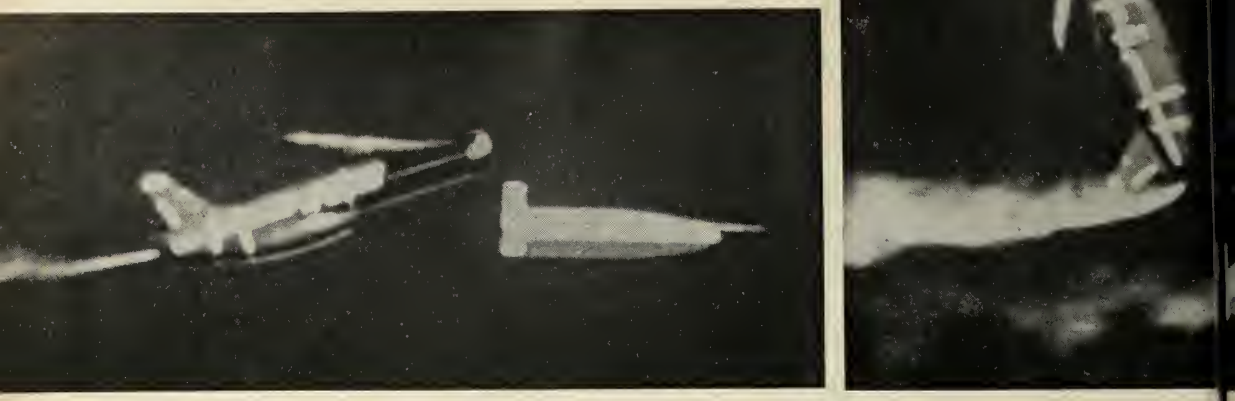
Johnson: Thinks the issue should be debated "fully, frankly, at length, and, I am sure, heatedly" . . . but with "all the maturity and the objectivity we can muster."

Symington: Has devoted a large portion of his campaign to the defense issue, and believes that it is one of the most important problems to be debated.

Rockefeller: Wanted the defense issue (as well as others) debated within the Republican party prior to the convention.

Stevenson: Made defense an issue in 1956, and since his views differ with the present Administration's on this subject, could be expected to do so again.

Snark Tosses Its Warhead . . .



FIRST PHOTOS of the SM-62 *Snark* releasing its nose cone toward a target. Frame of the 600 mph, 5000-mile missile turns upward after separation and is torn apart by air pressure to create confusing pattern on enemy radar. Now operational in the only planned squadron at Presque Isle, Me., *Snark* reportedly can carry up to 20 megatons. Warhead is released several miles from target and travels on ballistic trajectory. These photos were enlarged from motion picture film as the Northrop bird performed a test drop of a dummy warhead in the AMR near Cape Canaveral. Fifteen to 22 *Snarks* are now in combat status.

The Missile Week

Atlas To Be Zeus Target

Atlas has replaced *Jupiter* as the clay pigeon for the Army's *Nike-Zeus* anti-missile system. *Atlases* will be used during tests to be conducted in the South Pacific in late 1961 or early '62. The 18 *Atlases* DOD intends to purchase as *Zeus* target birds will be fired from Vandenberg AFB, affording Air Force training crews experience in firing the large ICBM.

The *Zeuses* attempting to intercept *Atlases* will be fired from Kwajalein Island—about 4800 statute miles from Vandenberg. Original planning called for Army-fired *Jupiter* missiles as targets—to be launched from Johnson Island in the Pacific. Approximately $7.5 million had been obligated for the *Jupiter* target birds.

The decision to replace *Jupiter* with *Atlas* raised the eyebrows of long-time Pentagon observers who remember the fierce fight the Army put up for its own missile program. The decision was made by Dr. Herbert York, DOD director of research and engineering. His reason was that the *Atlas* would provide the most "thorough test of the *Zeus* system, including such factors as re-entry velocity and associated factors such as payload capacity."

Minuteman Train Tested

The mobile *Minuteman* ICBM test train is out on a 7-to-14-day road test along the tracks of six different railroads in six states. The train's first run, concluded June 27, lasted a week. The trials are to test communications and the ability of the rails to support the trains.

Titan Blows Up

Titan billed as the first operational model to be flight-tested blew up in the attempt at Cape Canaveral July 1. The official Air Force statement said that the ICBM—which is to join *Atlas* in the operational ranks later this year—malfunctioned and was blown up by the range safety officer. This was to have been the first test of the modified *Titans* to be sent to Vandenberg AFB for use in underground launching silos.

Another Pershing Success

Pershing, the Army's solid-fueled successor to *Redstone,* was fired successfully from mobile equipment last week. The 400-mile-range missile's guidance system was set on an erratic zig-zag course to simulate the buffeting the weapon might get from severe upper-air winds during combat firing.

This was the sixth straight successful firing for the Martin Co. missile. The Army is campaigning to get *Pershing* adopted by NATO as the standard medium-range missile. Its competitor is the Navy's Lockheed *Polaris,* which was selected originally because it was the only missile available that met NATO Commander Gen. Lauris Norstad's specifications.

More Red Animals Recovered

The Russians are becoming adept at the trick of pulling rabbits and dogs out of missile nose cones which have just completed re-entry tests. Last year, the Russians announced that two dogs named Snowflake and Daring, and an unnamed rabbit, had been sent to "great height" by an IRBM and recovered with no ill effects. (See M/R, June 13, 1959, p. 45.) This year, preceding Soviet long-distance ICBM tests in the Pacific, the Russians announced that two dogs (one named Courageous) and another unidentified rabbit successfully completed a rocket ride to 130 miles.

Last year, the payload carrying the animals and their instruments was purported to weigh 4400 pounds, the largest object to have been thrown spaceward at that time. This year the payload was said to have weighed 4629 pounds.

Tiros I Winds Up Operating Life After Big Contributions to Science

Tiros I, the highly successful weather-eye satellite launched April 1, has reached the end of its operating lifetime after transmitting 22,952 pictures. More than 60% of these are good-quality cloud cover photographs useful to meteorological research.

The National Aeronautics and Space Administration said the data produced by *Tiros* has already made major contributions to the science of meteorology. One of the most important was the information on spiral bands and vortices in the atmosphere up to 1000 miles in diameter. Weathermen had no idea before *Tiros* of the frequency and extent of highly organized cloud systems associated with these vortices.

The weather satellite has also taken many pictures of jet streams, regions of moist and dry air, thunderstorms, fronts, and other meteorological phenomena. The U.S. Weather Bureau says *Tiros* data resulted in increased accuracy of reports on weather conditions, particularly over ocean areas.

Tiros—which was expected to have a life of about three months—actually operated for 78 days. On June 17, the wide-angle camera failed to turn off on command, apparently because a relay malfunctioned. As a result, batteries serving the camera and related equipment ran down.

After giving the satellite equipment a rest in hopes that the batteries might recharge, scientists made new attempts at interrogation on June 28 and 29, but without success.

The narrow-angle camera and the 108 mc tracking beacon remain operational. However, it is considered impractical to attempt to identify narrow-angle pictures without the use of wide-angle pictures for reference. These often include some easily recognizable geographic features which aid in orienting narrow-angle cloud cover photos.

Of the total photographs transmitted by the satellite, the station at Ft. Monmouth, N.J., received 17,449—4698 from the narrow-angle and 12,751 from the wide-angle camera. Kaena Point, Hawaii, received 5503 frames—1117 narrow-angle and 4386 wide-angle photos.

NASA plans to launch a second *Tiros* in the final three months of 1960. *Nimbus,* an advanced weather satellite, is scheduled to be launched in the last quarter of 1961.

Britain Plans Limited Effort in Space Race

Indications are that Britain will soon decide to join Russia and the United States in the space race, but with strictly limited objectives.

The initial emphasis will probably be on communications and weather-forecasting satellites.

Although *Blue Streak* has been abandoned as Britain's nuclear deterrent, work has been completed on the missile's No. 1 launching pad at the Woomera range. This is taken to mean that at least some of the completed vehicles will be fired. Plans under consideration involve expenditure of about $250 million over several years and conversion of *Blue Streaks* into two- and three-stage satellite launchers.

A team of British scientists, Aviation Ministry experts and Treasury officials is in Australia to discuss the future of the Woomera range. Until a decision has been reached on the space research programme, work on two other *Blue Streak* launchers has been suspended.

Computers for Mauler To be Built by Burroughs

An electronic computer system for *Mauler,* Army's mobile battlefield air defense system, will be developed by Burroughs Corp. under an Army Rocket and Guided Missile Agency contract just awarded. The computers will be designed to be transported by aircraft and dropped by parachute into battle areas.

The *Mauler* missile system is a compact, mobile weapon which will use solid-fuel radar-guided missiles to destroy short-range tactical missiles and low-altitude aircraft. Each *Mauler* unit will be entirely contained in a single vehicle designed to deliver accurate fire while moving over rough terrain.

NATO Supply Center Now Supports Nike, Honest John

The NATO Supply Center at Chateauroux, France, is providing support for the *Nike* and *Honest John* missiles now in use in the European NATO countries. This was disclosed at the same time that it was announced that first shipments of some $9 million worth of aircraft spare parts to Germany, France and Italy were made at the beginning of June.

The newly established Supply Center was formed by the NATO countries as a cooperative international logistics enterprise intended to improve the efficiency of support operations and to achieve economies. In addition to providing support for *Nike* and *Honest John,* the NATO Supply Center supplies and maintains NATO planes.

First Polaris Sub Tender Is Unique

by Charles D. LaFond

CHARLESTON, S.C.—The Navy's first *Polaris* submarine tender, USS Proteus (AS-19), was commissioned last week after a 19-month shipyard conversion of unprecedented magnitude and complexity.

The seagoing maintenance facility, capable of any repair or replacement—short of complete overhaul—for the nuclear sub fleet-to-be, will join the fleet operationally in early 1961. Meanwhile, she will undergo extensive shakedown cruises, starting next month, and equipment installation and checkout will continue throughout the rest of '60.

Although similar to conventional sub tenders in many respects, the oversized vessel has many unique facilities. These include a massive bridge crane to handle *Polaris* IRBM's, a 4-deck storage area for 20 missiles, a 120-ton container to store nuclear waste (spent elements), and a $5-million navigation system repair center.

Proteus and her successors (the AS-31 is now under construction at Portsmouth Naval Shipyard) will be an integral link in maintaining a large number of nuclear missile-packing submarines on station at sea.

• **Stern outdistances bow**—The lengthening of Proteus by 44 feet represents a fantastic achievement by the Charleston Naval Base shipyard workers. It also introduced a believe-it-or-not oddity in the reconstruction sequence: Proteus is probably the only ship in the world whose stern has travelled farther than its bow.

The vessel, in drydock, was cut in half. The stern section was then sealed and the dock flooded. While the bow section remained sunk, serving as a benchmark, the stern was floated down ways 44 feet.

The water was then pumped out of the drydock and the stern settled to the bottom within its massive chocks. Alignment of the two sections was well within tolerance—reportedly the stern was only 1/32 in. out of alignment.

Just floating the after end of the vessel was a difficult task, for its stability had to be determined without the aid of the ship's weight curve. Nevertheless, weight, size and unsymmetrical mass distribution were successfully surmounted. By June 8, 1959, the precedent-making relocation was accomplished—all within two days following application of the first cutting torch.

• **Expansion problem formidable**—In normal ship construction, variations in hull expansion and contraction is dissipated in each smaller piece as it is joined to the hull. But to join two massive hull sections in the middle introduces conflicting natural forces of movement.

The 30° daily temperature change was licked by combined tactics. Exposed hull and deck areas were painted white to increase heat reflection. Water was piped over these areas to further minimize heat effects.

Finally, one tenth of the welding job was performed at night in four hours to provide sufficient strength to withstand the expansion forces.

• **Shakedown in August**—First builder's sea trials were performed in April of this year and reoutfitting has continued ever since. The first shakedown cruise will begin August 1; sea tests will be carried out between Charleston and Cuba during the next few months.

The vessel when completely outfitted will carry an unusually large provisioning of electronic spares. Much of these will be for support of the complete navigation repair shop. Designed by Sperry Gyroscope Company, over $5 million in highly precise equipment for the repair and adjustment of SINS (Ship Inertial Navigation System) is housed in a 34 x 20 ft. room.

Duplicating everything carried aboard submarines plus simulation gear, Proteus' binnacle-mounted SINS—both types, Sperry Gyroscope and Autonetics Div. of North American Aviation—will serve as "standards" against which operational systems may be compared.

• **Proteus employment record**—The third U.S. Navy vessel to bear the name Proteus, the ship was formerly an AS-11 class tender. She was originally commissioned in June, 1944.

Mothballed in 1947, she had a 12-year rest at New London, Conn. In January, 1959, rehabilitation began.

Indicative of the stature of the "new" vessel is the recent assignment of Captain Richard B. Laning as skipper. He was the first commanding officer of the nuclear sub Sea Wolf.

POLARIS Submarine Tender Proteus (AS-19): Vital Statistics

Time Table

Navy Yard (Charleston) sea trial—*April 29, 1960.* **Inspection and Survey**—*July 6, 1960.* **Recommissioning**—*July 8, 1960.* **Basic facilities completed**—*July 24, 1960.* **1st Shakedown Cruise** *August 1, 1960 (Continual shakedown thereafter between Charleston and Guantanamo Bay, Cuba).*

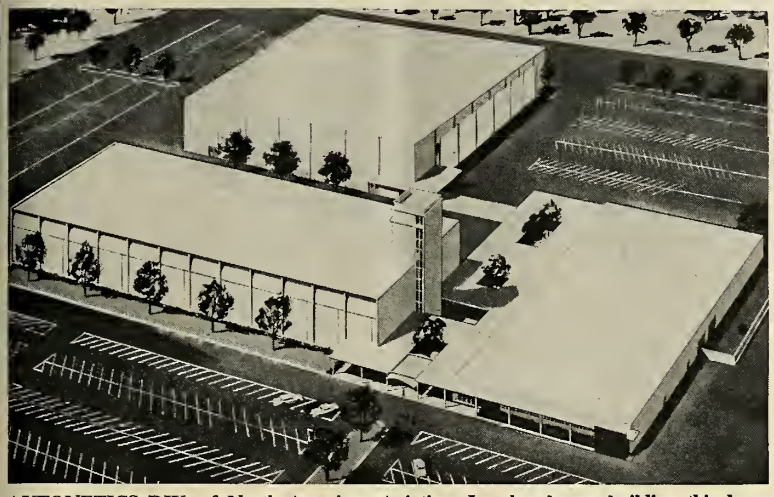
Dimensions

Length: *573 ft., 10 in. (was 530 ft.)* **Beam:** *73 ft., 4 in. (was 63 ft.)* **Displacement** *(full load): 18,500 tons (was 17,200 tons).*

Ship's Complement

Officers—*45.* **Enlisted**—*850.* **Total Normal Complement**—*895. (Repair and Engineering Dept.—roughly 500 personnel).* **Total Reinforced Complement**—*1297.*

SUBMARINE REPAIR tender Proteus undergoes completion at Charleston Naval Base. The massive bridge crane above deck amidships will be used to handle 28,000-lb. *Polaris* IRBM's and a 120-ton nuclear waste container.



AUTONETICS DIV. of North American Aviation, Inc. has begun building this large electronics complex near Anaheim, Calif. The division's Armament and Flight Control Operations will be housed in three buildings totaling 400,000 sq. ft.

WESTINGHOUSE is expanding its West Coast facilities with a new Astro-electronics Laboratory, scheduled to start operations this month. The lab—part of the Defense Products Division—will be located in the Rancho Conejo light manufacturing and research center 40 miles northwest of Los Angeles. It will concentrate on developments in semiconductors, molecular electronics, thermoelectric devices, and sensing tubes for missile/space applications. Manager will be J. E. Darr, formerly electronic warfare projects manager at Westinghouse Air Arm.

TENNEY ENGINEERING, INC. has organized an Aerospace division to coordinate advanced R&D and initiate new programs. Tenney President Monroe Seligman also said that the new division would be available for contract assignments. PAM, an affiliate of the environmental test chambers manufacturer, has moved to larger quarters in Baltimore. PAM specializes in noise control and acoustic and vibration equipment.

CALLERY CHEMICAL COMPANY will establish a new R&D laboratory in Encino, Calif. The lab will conduct basic research on new energy source concepts, and other related propulsion and non-propulsive aspects of space technology.

M-H's BROWN INSTRUMENTS DIV. has created a planning and procurement department with William B. Shellenberger as manager. Shellenberger will continue to serve as consultant to the six-division Industrial Products Group on production planning and procurement.

INTERNATIONAL RECTIFIER CORP. has acquired Dallons Laboratories of Los Angeles through an exchange of stock. Dallons produces aerospace medical instrumentation for Project *Mercury*.

BENDIX CORP. and Telefunken GmbH of Germany have jointly formed Teldix, in Heidelberg, Germany. The new firm will handle R&D, manufacture, sale and service of aircraft systems and equipment, flight control equipment and navigation instruments, including airborne computers.

FANSTEEL METALLURGICAL CORP. has opened another semiconductor building to be devoted exclusively to the production of silicon rectifiers.

SOLAR SYSTEMS, INC. has been formed in Skokie, Ill., to manufacture silicon solar cells, silicon readout assemblies and silicon photocells. Jerome Kalman, General Manager, and Chief Engineer Walter A. Hasbach both were formerly with Hoffman Semi-conductor.

LAMART CORP. of Clifton, N.J., has moved to larger quarters in the same city.

LITTON INDUSTRIES INC. has purchased a majority interest in Fritz Hellige & Co., Gmbh, electronics equipment manufacturer in West Germany. Hellige will continue its present line of goods as well as produce Litton products for Germany.

AMPEX CORP. is considering merger plans with Telemetering Magnetics Inc., through an exchange of stock. Ampex would be the surviving company, giving one share for two shares of TMI stock.

AVIEN, INC. is finalizing negotiations to acquire Electrol, Inc., manufacturers of precision hydraulic components and systems for private, corporate and military aircraft markets.

JEFFERSON ELECTRONIC PRODUCTS, manufacturer of custom cables, harnesses and related devices for the missile industry has opened a jacketing site in Goleta, Calif.

EXPERIMENT INC., a Texaco subsidiary engaging in propellant research and development, has changed its name to Texaco Experiment Inc., and will be known as TEI.

RAYCHEM CORP. of Redwood City has purchased the Bentley-Harris Manufacturing Co., producer of sleevings and tubings for electrical insulation for 50,000 shares of Raychem stock.

LORAL ELECTRONICS CORP. has acquired Hillburn Electronics Products Co. of New York. Chief executive Bernard Gilman will remain with the company, which will be operated as a subsidiary of Loral.

FXR, INC. has planned considerable expansion of its Woodside, N.J., quarters. The firm recently moved its executive offices and some manufacturing operations to a 25,000-sq.-ft. new building adjoining its original plant, and this summer will finish a 100,000-sq.-ft. building across the street.

PACIFIC AUTOMATION PRODUCTS, INC. has expanded its Reliability Laboratory at Glendale, Calif. . . . Epoxylite Corp., moves to larger quarters in South El Monte, Calif., . . . Airborne Accessories Corp. has located its West Coast branch in a new office in Los Angeles . . . Sterling Transformer Corp. has moved to a new 18,000-sq.-ft. plant in Brooklyn, tripling its facilities . . . Tracerlab's Western Europe office located in Holland has been expanded.

Expert Advice on Diversification: Better Not Do It Unless You Have To

Lockheed's diversification chief calls it a last-resort strategy to be adopted only if nothing else works

Editor's note: The technological revolution in the aircraft industry in changing from manned aircraft to missiles has seen many airframe companies diversifying to meet the problems which have arisen. New firms have entered the field. Others on both sides of the fence still are considering diversification into or out of the industry.

Dr. H. Igor Ansoff has headed Lockheed Aircraft Corp.'s diversification task force for the past three years and has just been elected vice president for plans and programs of Lockheed Electronics Corp. In this article, condensed from a recent speech before the Los Angeles Chamber of Commerce, he gives his views on diversification and warns of some of the pitfalls.

by Dr. H. Igor Ansoff

The so-called airframe industry is having serious problems. It is going through a technological revolution, a change from air-breathing vehicles to rockets, which has made obsolete many of its skills. To meet this rapid obsolescence, firms in our industry need to diversify as a matter of simple survival.

Does this necessarily mean that diversification is the solution to all growth problems, that a firm should diversify regardless of its particular industry, or its position in that industry?

There is considerable evidence to suggest a strongly negative answer, that indiscriminate and unplanned diversification can do more harm than good. I'm reminded of a very successful firm, one of the 100 largest in the U.S. economy, which some 15 years ago decided to diversify in a major way into the defense industry. Over a short period of time, through a combination of acquisitions and reorganizations, this firm set up a very impressive complex of activities: an electronics division, a propulsion division, and a ground support division.

But something was wrong, some lack of a careful plan or a realization of its purpose, for in the past three years we have seen this firm gradually dispose of these activities to a point where now it is exactly where it started 15 years ago.

Here, as in all other phases of business, one man's meat can be another man's poison.

• **Most radical approach**—Diversification is one of four basic growth strategies which a firm can pursue.

One growth strategy available to a firm is to increase its share of its current markets. Another strategy is to develop new markets for the firm's present products. A third is to develop new products for the present markets.

Springs for Polaris

"HOT DOG" air springs will cushion the Lockheed *Polaris* missile during transportation and storage. The rubberized-fabric cushions—manufactured by Air Cruisers Division of Garrett Corp.—are installed in the bottom and overhead curvatures of *Polaris* transportation containers. They are inflated by simple inlet valves. Lockheed and Beech Aircraft have ordered nearly 100 pairs.

The fourth, and most radical, growth strategy is to diversify; to develop new products and to sell these to markets to which the firm has not sold before.

In market penetration, market development, or product development, a firm has a basic strength to carry over to the new endeavor. For example, in product development it has a knowledge of the customer, his requirements and his idiosyncrasies; in market development, it knows and understands the capabilities and limitations of its product.

• **A last resort**—In diversification, on the other hand, a firm is attempting to do something it has never done before. To be sure, diversification, when properly conceived, still involves a carryover of basic skills to the new endeavor, but this carryover is much weaker, less tangible than it is in the other growth strategies.

A basic operating rule, which I firmly believe to be the keystone to success in diversification, is:

"Don't unless you have to."

Do not undertake diversification until you have convinced yourself that the objectives of your firm cannot be met through the other growth strategies. Even then, diversification should be viewed as supplementary to the other strategies, a method for solving your firm's problems and not for running away from them.

• **Reading the handwriting**—Suppose that, after a careful analysis, you conclude that your industry is going to hell, or at least it doesn't have the characteristics needed to satisfy your growth ambitions. What do you do then? Under these circumstances, you find yourself faced with diversification outside the confines of your industry.

Or suppose that the firm's industry has passed into the maturity stage. It still appears to be doing well, in fact, trade periodicals predict a good growth rate for the next year and the year after. If the management of the firm is astute it will note however, that, while this growth rate is still high, it has

slowed down from the growth of the past; it will note disturbing signs of saturation of demand, needs for additional emphasis on product promotion, and appearance of substitute products.

This is the time for serious soul-searching on the subject of diversification. Many people in the top management, particularly those concerned with manufacturing and sales, will probably feel that the firm should not divert its resources away from a good market, that it should not spend money on product diversification or acquisitions while this money can still be spent profitably on present product improvement and merchandising.

It will take a great deal of foresight and fortitude to embark at this time on the expensive and risky course of diversification. As a matter of fact, this decision is so difficult that many very good firms refuse to see the writing on the wall until it is too late.

Some of you will recognize in this description several local important firms in the defense industry which had refused to see the writing which was there for all of us to see as far back as five years ago. These firms had some wonderful programs and they were busy, too busy to concern themselves with diversification. Now they have a very difficult problem of having to come up from behind.

And make no mistake about the difficulty. If you allow your firm to face a decline in sales before facing up to diversification, your management will probably be beset by self-doubt, you are likely to have financial problems, and you're not going to appear very attractive to a potential diversification partner. In short, you'll have to pay higher than the going price for any diversification move.

• **Impact of breakthroughs**—So far we have talked about reasons for diversification which can be inferred from economic growth data which is available in the form of industry, trade, and economic statistics. I would next like to touch upon a reason which is less tangible but no less potent. It is commonly known as a "breakthrough": a sudden and dramatic change in economy or technology which upsets the growth cycle of an industry and sends it into early maturity.

The last fifty years have witnessed many dramatic examples of such "breakthroughs": the impact of trucking and airline industries on railroads, of synthetic fibres on the textile industry, of television on the movie industry, to name just a few.

To a firm contemplating diversification, this means that even if it finds no concrete economic impetus to diversify, it may need to do so in order to reduce its vulnerability to potential breakthroughs. Whether the firm has this need depends on the breadth of its technological and marketing base. If it is a one product-one customer firm, it certainly needs to diversify; if, on the other hand, it has already prudently spread its product and market base to different product technologies and economic demand patterns, it can feel reasonably secure that no single breakthrough can seriously jeopardize its growth prospects.

• **Proceeding with care**—How does a firm maximize its chances of success in diversification?

First and foremost the firm must be very clear about its basic strategy, and it must relate this strategy to its needs. I know from my own experience that once you embark on a program, you become virtually besieged by well-wishing people who have just the right diversification opportunity for you.

You must know your requirements, you must know where you are going, and you must resist extraneous temptations. This is not to say that you have to be hide-bound by a set of rules, but you must avoid creating a hodgepodge of unrelated interests, rather than a well-rounded diversified company.

The choice is basically between what we at Lockheed have described as a *concentric* and a *conglomerate* strategy. In a concentric approach, a firm seeks opportunities with some measure of common thread, some business characteristics which will permit a *joint* utilization of resources between the old and the new business such as common research skills, or manufacturing techniques, or basic management practices. Concentric diversification thus holds a potential of what is commonly known as 2 plus 2 equals 5 effect—a combined business performance which is better than a simple sum of the two performances.

At the other extreme, the conglomerate approach places no requirements on the common thread and selects new business areas according to rules based on the economic characteristics of the new industry.

Whether a concentric or a conglomerate strategy is appropriate for a particular firm is a very difficult choice which is influenced by many factors: its reasons for diversification, urgency, capabilities of the diversifying firm, and management preferences. The investment community generally tends to favor companies which have taken the concentric approach. However, there are examples of firms which have made a very good thing of a clever conglomerate strategy.

• **Picking your spots**—Let me pass to the second requirement for success. It is essential to make sure that the economic climate of the new industry offers a potential for solving the firm's diversification problem.

If the firm is diversifying because of cyclical nature of its industry, it must make sure that the new industry is more stable; if it is seeking growth, it needs to be sure that the new growth perspectives are high enough to give it a desired average growth rate. Thus, if growth is its objective, it would make little sense for a locomotive manufacturer to merge with a manufacturer of railroad signaling equipment.

It has been a puzzle and a surprise to me to count the number of times Lockheed had been offered, in glowing terms, opportunities to enter either a declining or a dying industry.

• **Capability confusions**—The third and the most essential requirement for success is to be sure that you lead from strength. This requirement is particularly imperative when you seek to diversify through new product development, but it applies almost as strongly in many acquisition programs.

It can be fatal to confuse capabilities which a diversifying firm has in abundance with the capabilities which are required for success in the new field. A vivid example of such confusion is provided by the efforts at diversification by many airframe manufacturers at the end of World War II. You may recall that several of them tried to diversify by offering a variety of aluminum products to consumer industries. You may also recall that none of them succeeded.

In looking back on that experience, it seems apparent that the failure was due to a confusion between skills which these companies had in abundance and skills which were needed to make a success of their venture. To be sure, nobody can bend aluminum like we can bend aluminum in our industry, but advanced manufacturing skills have very little to do with success in consumer industries. Success depends on merchandising: distribution channels, competitive pricing, and aggressive product promotion. And the firms which were trying to sell aluminum skis, coffins, canoes, and wheelbarrows had none of these skills.

We have not discussed the choice between product development and acquisition, the techniques by which one selects a particular new industry, the problems of proper organization for diversification, nor several other relevant topics. I do hope, however, that I have been successful in sketching out for you the principal dimensions of the problem.

(Copies of the full speech by Dr. Ansoff may be obtained from the Lockheed Aircraft Corp., Public Relations Office, Burbank, Calif.)

Bendix cermets (ceramic-metallic materials) beat the inferno-like heat af racket launching and re-entry. Sub-scale and full-scale motor tests, using the latest types of aluminized propellants, cansistently shaw zero erasian in the throat areas.

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NOSE CONES

JET VANES

ROCKET NOZZLE THROATS

ELECTRONICS

Computer Development to Leap-frog

IBM's next-generation computer should startle the entire industry. Expected to be ready in about two years, the new system promises to outperform today's best in solid-state high-capacity equipment. Size will be about 75% smaller than the highly touted 7090. The advancement will result from IBM's work in thin-film techniques.

Radar for Satellites

Radar for space reconnaissance is feasible, according to some researchers. They say a 200-lb. system with 300-ft. resolution at satellite altitudes could be built. Needed now is a program to put radar on space vehicles for experimentation.

Tracking by "Roberts Rumble"

A phenomenon known as "Roberts Rumble" may provide a method of tracking passive satellites. It was first noticed during early orbits of *Discoverer I;* scientists connected certain radio disturbances with passage of satellites through earth's ionosphere. General Electric is working on an AF contract to study the possibilities of using the effect to track and time non-transmitting satellites.

Tunnel Diodes for Computer Storage

Tunnel diodes may be the answer to problem of computer storage in the 2000-3000 bit range. Storage range is particularly troublesome because it is too large for standard shift registers and too small to be economically and physically feasible for drum storage.

New A-D Conversion Techniques

A unique hybrid computer converts analog to digital by multiplying the two together. Advantages are increased speed and accuracy.

Solar Mystery Investigated

A recent extremely severe radio blackout—without the usual coincident solar flare—has set Bureau of Standards solar researchers on a critical appraisal of current observation techniques. Further adding to the mystery is the fact that no major geomagnetic or ionospheric storms followed the radio disturbance.

Infrared

Infrared for USW?

Infrared continues to be mentioned as a practical method for airborne detection of underwater objects. While many seem to feel it has absolutely no application in USW, others refuse to discount its feasibility. It's a fairly safe bet that some top-level thinking is being centered on the possibility.

IR Sensitivity Multiplied

An infrared sensor tube 100 times more sensitive than any presently in use is reported to be in development. The advance is based on new materials processing techniques.

Sensor Has No Moving Parts

A new IR horizon sensor that contains no choppers or other moving parts is being researched by General Electric. An extension of its "Cat" family (Tom-, Bob-, and Wild-), the new sensor uses camera scanning to eliminate conventional moving components.

More Sensitive IR for Sidewinder

Newest infrared detector for *Sidewinder* is reportedly able to track on the skin temperature of a target. The more complex and sophisticated system would thus make the airborne missile effective for frontal attack, overcoming what has been its most serious limitation.

MATERIALS

Little Money, High Vacuum

A novel vacuum pump for environmental test chambers that can be built for less than $10 was disclosed recently by General Atomic scientists. Its theory of operation is not fully known, but the rugged device can draw a pressure down to 2×10^{-5} mm Hg. (See story, p. 28)

Money for Materials Research

Contracts totaling almost $14 million recently went out to three universities to set up laboratories for advanced research on materials needed for military purposes. The Pentagon awarded Cornell $6.1 million, U. of Pennsylvania $4.4 million, and Northwestern $3.4 million.

Distilled Refractory Metals

A distillation process is being adapted to refractory metals at the General Chemical Division of Allied Chemical. The process is part of the company's uranium hexafluoride production facility at Metropolis, Ill., a raw-material source for the AEC.

Radiation-sensitive Glasses

Lenses which turn opaque almost instantaneously after exposure to the flash of a nuclear blast are being researched at Bausch & Lomb. The "solid-state viewing device" would protect wearers' eyes from flash blindness and thermal burn from unexpected blasts.

PROPULSION

Variable-thrust Rocket Sled

Calibration of a missile guidance system at constant acceleration will be possible with a rocket sled designed by Aerojet around its variable-thrust (50,000-150,000 lbs.) engine. The sled will accelerate a 3000-lb. payload to more than Mach 2 and at a negative rate up to 20 g. Hypergolic propellants are N_2O_4 and UDMH. Area ratio: about 6:1.

Advanced Solids Research Contract Extended

Research on high-energy oxidizers for solid propellants has been extended at Allied Chemical. Redstone Arsenal granted the 12-month extension which bring the total funding for the two-year effort to $1.4 million. The nature of the work is classified, but it is known to include fluorine-containing materials.

breaking the language barrier . . .

Auto-Translation Effort Lacks Focus

House Space Committee report scores failure to coordinate mechanical translation projects, predicts workable models by 1961

"And the Lord said, 'Behold, they are one people, and they all have one language; and this is only the beginning of what they will do; and nothing they propose will be impossible.'

. . . Therefore its name was called Babel, because there the Lord confused the language of all the earth; and from there the Lord scattered them abroad over the face of the earth."—Genesis XI

by Paul Means

The U.S. effort to overcome the language barrier in this post-Babel space era by developing an automatic mechanical translator is held back by lack of coordination.

This conclusion is reached in the House Space Committee's report, "Research on Mechanical Translation," and is also apparent from testimony taken by the committee.

Now is the time, according to the Report, to combine the good features of the various programs carried on by six government agencies, and to come up with the best workable program.

Under present scheduling, a machine rendering crude translations with some degree of accuracy will be available in 1961. An improved model should be ready by 1963.

A machine accurate enough and efficient enough to replace human translators, could be ready during the next five years.

To accelerate the program, the Committee has recommended:

- That more information be disseminated among the various governmental agencies and academic institutions conducting research in this area;
- That the National Science Foundation make a greater effort to establish a coordinated program;
- That the Department of Defense centralize the present efforts of the Army, Navy and Air Force in one service, "with the requirements of the other services being met by the responsible agency."
- And that serious consideration be given to the proposal made by Georgetown University mechanical translation experts to form a National Academy of Language Sciences, responsible for all of the mechanical translation programs.

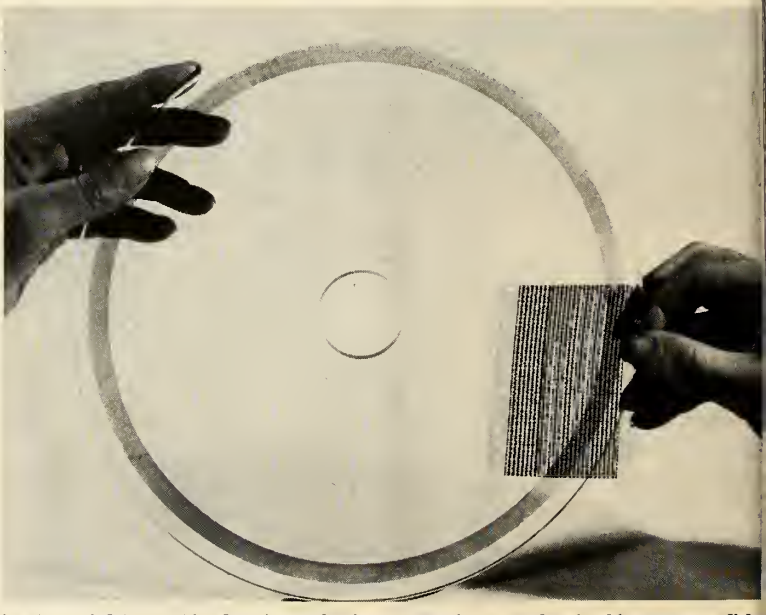
• **Big Russian lead**—The need for an efficient, accurate mechanical translator can be shown by comparing the annual available output of Russian scientific and technological literature (780 million words) with the amount that is presently translated into English (53 million words). In some areas, there is a five-to-eight-month lag between receipt of the Russian text and its translation and dissemination.

The Soviet Union maintains an information bureau manned by nearly 50,000 scientists, engineers, translators and librarians, 14,000 of whom are employed on a full-time basis. Th Soviet information center receive publications from 95 countries writte in 65 languages, and each day scan translates, catalogues and distribute 2500 to 3000 technical articles.

And the Russian effort takes o greater proportions when it is realize that a majority of Russian scientist and engineers can read English, bu only about 7% of American scientist read Russian.

• **Race for translator**—How fa along is the Russian program to buil a mechanical translator?

A CIA witness stated that "th Soviets have a program which con siderably exceeds our own in scop and size, and . . . they are doing ver good theoretical work, though restric tions on the availability of compute time has limited (their) opportunitie



HEART OF THE Air Force's mechanical translation complex is this memory disk.

o apply theory to practice."

Present U.S. efforts are being conucted by the National Science Foundation, the Central Intelligence Agency, he National Bureau of Standards, the rmy, Navy and Air Force.

Under provisions of the National Defense Education Act of 1958, the National Science Foundation was given he responsibility for coordinating hese activities.

According to the Committee's Report, the program being undertaken y the Air Force should produce the nost immediate practical results, and he program conducted by the Army n conjunction with the National Bureau of Standards has the most longange promise.

• **Difficulties**—One of the basic roblems in attempting to devise a ystem that will translate a foreign anguage into English and vice-versa s that the meaning of a single word an be confusing even to a human ranslator depending on its form and ts position in a sentence.

For example, the English word b-o-r-e," can be (1) a noun describng a feature of a gun; (2) a noun haracterizing a certain type of human eing; or perhaps (3) the past tense f the verb "to bear," which in itself as various meanings.

There is the added difficulty of devising a system which can transfer he foreign language text to the transator, and then receive its output of English text.

The three basic elements of any nechanical translating system are: inut, logical processing, and output.

The bulk of present research is centered on the logical processing phase of the system, according to the report "as the input and output problems are mainly of a technological nature."

Almost all of the present programs use high-speed computers to store the information, though many different systems have been devised as to what information should be stored.

Input to the computer presently is handled by punching the foreign text onto cards, but future systems will use optical print readers in order to increase speed.

There are many commercial products capable of providing a high-speed output for printed text. The task is to combine the high-speed output with the original equations, charts, graphs, and pictures, so as to maintain the format of the original text.

A review of the current programs, and the various approaches taken follows:

• **The National Science Foundation**—While not conducting "in-house research," the National Science Foundation is sponsoring a research program through grants to various academic institutions.

1. Massachusetts Institute of Technology—Begun in 1954, the MIT program has made advances in the areas of generative grammar and the theory of grammatical transformations, making possible more precise descriptions of language, and shedding light on the relationship of syntax to some aspects of meaning.

An early effort at MIT showed the necessity for sentence-for-sentence rather than word-for-word translation.

The MIT group has prepared detailed grammars of English, German and French, and has devised techniques for the translating (computing) machine to aid in their research.

2. Georgetown University—One of the pioneers in the mechanical translating field, Georgetown in conjunction with International Business Machines has carried three experimental procedures for translating Russian texts on organic chemistry to the point of testing them on computers.

One of these methods dealt primarily with the analysis of Russian syntax; the other two were aimed at actual translation. These methods were able to produce a crude output in English words, which, though subject to error, could be generally understood.

Presently, a corpus of 268,000 running words has been used in preparing a dictionary of 10,800 entries. Some 115,000 words of Russian text have been processed by the computer.

A code-matching technique recently devised by Georgetown is being continued by the Corporation for Economic and Industrial Research, and the experimental procedure for analyzing Russian syntax is being continued by Thompson Ramo Wooldridge.

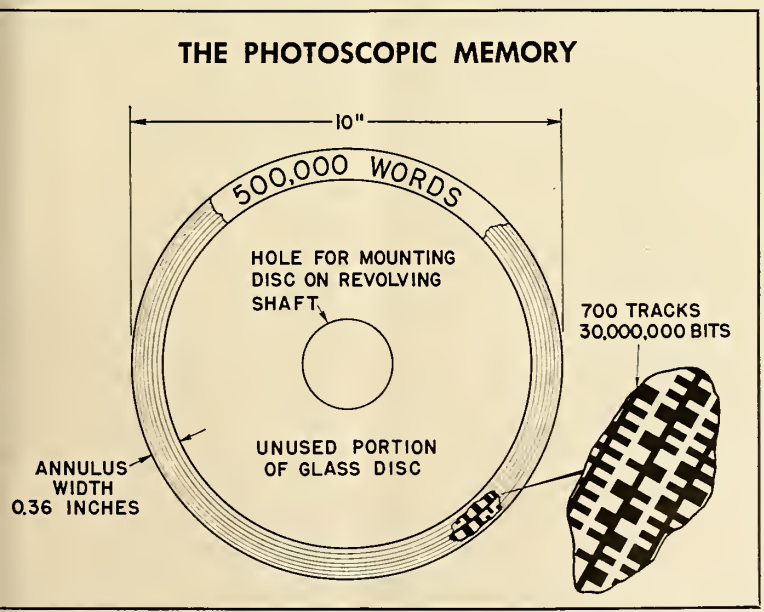
3. The Cambridge Language Research Unit—Principal study has been devoted to the ways that words are semantically related to each other, and transforming these relationships into a specialized mathematical system.

4. Harvard University—During the first two years of research, programs for the computer were written to permit the operation of an automatic dictionary containing about 15,000 words.

The programs make it possible to recognize any of these words in any one of their forms, enabling the processing of more than 150,000 distinct Russian word forms.

This automatic library has been used to produce word-for-word translations of scientific Russian texts, which are not true translations since they fail to take account of the grammar, but which have proved useful for some purposes in lieu of actual translations.

5. University of California, Berkeley—Concentrating on the field of biochemistry, a system has been devised which includes (1) a segmentation system for splitting Russian words into component parts; (2) a coding system for Russian grammar; (3) a Russian-to-English dictionary with a vocabulary coverage of over 300,000 words; (4) an automatic dictionary which can look up and segment at a rate of 7500 words per minute when used on an IBM 704 computer; (5) a system for analyzing Russian text; (6) a linguistic data-gath-



THE UNIT can store 550,000 words on concentric tracts of binary code (see insets).

The Mechanical Translator Budget

	All Prior Years	Present Year	Next Year
ARMY	$ 109,000	$ 170,000	$ 225,000
NAVY	50,000	50,000	70,000
AIR FORCE	3,400,000	1,400,000	1,500,000
CIA	315,000	177,000	922,000
NSF	1,063,300	325,000	490,000
TOTAL	4,937,300	2,122,000	3,207,000

ing program for obtaining information from analyzed text by means of an IBM 704; (7) a system for coding Russian scientific text for input; and (8) a method for automatic parsing of Russian text.

Central Intelligence Agency—First government agency in the mechanical translating program (1952), the CIA has supported the efforts of Prof. Leon E. Dostert at Georgetown Univ. (See preceding).

Of particular interest is the Georgetown experimental system developed for French-to-English translation which has been brought to the point where French nuclear physics texts can be converted into English words which in many cases convey the thought of the original.

• **Army**—Two projects are presently being supported by the Army, the first of which, according to the Committee's report, has the most long-range promise:

1. National Bureau of Standards —Under the direction of Mrs. Ida Rhodes, this Army-financed project is making a program for machine translation of Russian to English by a method called predictive analysis. An operating model should be ready by 1963.

According to a description in the report, "Russian words have many 'handles'—prefixes, affixes, grammatical endings and especially word agreements. A machine can be programed to identify these 'handles' and make predictions of what else must be in the same phrase, clause, or sentence. If it doesn't find them, it stores the predictions and goes on with an eye cocked. If there are multiple choices, the machine makes a choice but stores the other choices to try if the first proves wrong.

"Some predictions must be fulfilled such as having a subject and a verb, expressed or implied. Others may be fulfilled or may not. When the machine reaches the end of a sentence, it examines its hindsight pool where unfulfilled predictions are stored. If it finds any that are labeled 'must be fulfilled,' then it knows that the translation is probably faulty."

At the present time, according to Dr. Edward W. Cannon of NBS, this system is "able to cope with the syntactical aspects of the mechanical translation problem" though "we wish we could say as much for the semantic or multiple meaning aspect."

The final translation, according to Dr. Cannon, will be "quite inelegant, . . . even in pidgin English," but "we do feel that the crude translation yielded by our method will give the reader a correct image of the meaning in the foreign text."

2. University of Texas—Under the direction of Prof. W. P. Lehman, the Texas project is a long-term research effort based on computer analysis of parallel German and English texts.

Described as a tedious, systematic, objective approach, this system examines the parallel text in German and English and derives rules for translation by means of the computer.

The advantage of the system is that it is equally applicable in either direction for a pair of languages.

• **Navy**—Research in machine translation of a general critical nature at Hebrew University in Israel and at Wayne State University is being supported by the Navy.

The Wayne State group is attempting to program the translation of mathematical literature from Russian to English.

• **Air Force**—The Air Force is conducting a large program in mechanical translation at ARDC's Rome Air Development Center which is equipment oriented, with the objective of attaining a complete automatic language translation complex.

This program includes development of input, processing, and output machines, and integration of these units should be accomplished by the fall of 1961.

Principal contractors in the Air Force program are Indiana University, Thompson Ramo Wooldridge Inc., University of Washington, Syracuse University, IBM, Baird-Atomic, Inc., University of Milan, Italy, Intelligent Machines Research Corp.

The greatest effort is with IBM, and has resulted in an experimental model of a "fully automatic dictionary look-up technique," which "accepts Russian word input, searches for the English equivalent, and produces these English equivalents at the rate of a proximately 30 words per second."

Key to this system is a glass dis storage device invented by Dr. Gilbe King of IBM. (See picture.)

Input into the Air Force unit, th fastest yet devised, is accomplished b an optical print reader developed b Baird-Atomic Inc. This unit is capab of recognizing and distinguishing large number of different type fonts i various alphabets, including Englis Cyrillic, and Greek characters.

The reader has recognition capabi ity independent of the spacing betwee lines, the position of the text on th printed page, and the occurrence c randomly interspersed graphic materia

The present design objective is t provide an instantaneous reading rat of about 1000 characters per second and is accomplished by an optical sys tem permitting comparison of an un known character, printed letter or num ber simultaneously with each of a larg set of reference characters.

The text is fed into the reader o film, and is fed out into the compute on magnetic wire.

Any words which cannot be found in the lens disc dictionary are converted from Cyrillic to Arabic alphabet and bypassed to the output, which prints it in red. Thus the output copy shows all transliterated words in red and the translation in black.

• **Unification**—As the descriptions of the various programs would indicate, there are areas in which the independent research overlaps.

Many of the technical witnesses from the various projects working on the problem of mechanical translation either did not know the details of the competing projects or had misinformation about them.

This slowed up the entire effort, the Report states, because of duplication and research into problems which have been solved elsewhere.

The Report points out, for example, that the equipment-oriented Air Force program "provides a unique tool for the checking out of the complex fully automated system of input, logical processing, and output. This program provides for the inclusion of modification derived from other research as the results are made known to the overall mechanical translation family."

"With so many government agencies conducting research in this field," the report warns, "it will eventually make coordination of the total effort more complicated . . ."

"It is now time for the mechanical translation research community to start combining the good features of the several programs and come up with the best workable program for the first application," the report concludes.

Colloids May Cut Space Travel Time

Little-discussed acceleration of particles provides thrust superior even to ion propulsion for a trip to Mars

by Milton Farber and Stanley Singer*

PASADENA, CALIF.—A relatively unexplored concept, the electrical acceleration of colloidal particles, gives promise of bridging the gap between the chemical and other varities of electrical propulsion.

Colloid propulsion provides higher thrusts than other electrical methods with equivalent consumption of power. And like all electrical systems, its specific impulse is much greater than liquid or solid chemical systems or nuclear propulsion with a chemical working fluid.

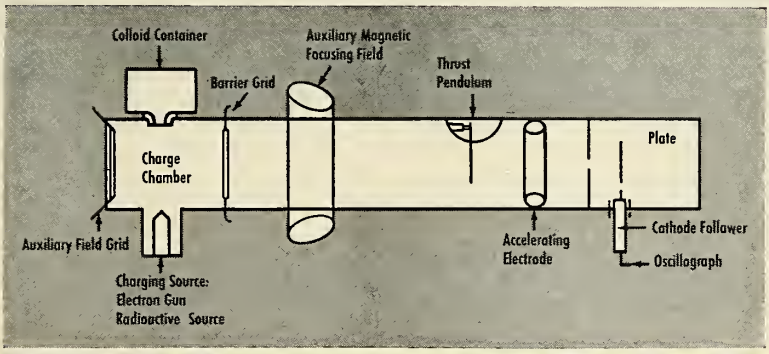
The specific impulse of colloids, although greater than for chemical or nuclear systems and approximately equivalent to the arc jet and magnetohydrodynamic methods, is not as great as that obtained with ion devices.

For example, here are the relative propellant requirements for a 5-lb.-thrust device, which would give an acceleration of 10^{-4} g to a 50,000-lb. vehicle:

Method	Specific Impulse (seconds)	Mass Flow rate (lbs./sec.)
Ion	10,000	5×10^{-4}
Plasma Jet	2000	2.5×10^{-3}
Colloid	1500	3.3×10^{-3}

An advantage often cited for electrical systems such as ion propulsion is weight economy on a long space flight—for example, a trip to Mars. Because of the high specific impulse of the ion system, less propellant is consumed than if chemical propellant is used in a high-thrust burst of power at the beginning of the journey.

• **Shorter journey**—The advantage of high thrust, of course, is that it shortens the journey somewhat—an important consideration both from the standpoint of any passengers aboard and the operating lifetime of the equipment.



SCHEMATIC OF an experimental colloid apparatus designed by Rocket Power/Talco, to allow determination of charge-to-mass ratio and available thrust.

Our calculations show that a shorter trip time to Mars is possible with colloid propulsion than with an ion system, since the thrust is higher. If we assume complete consumption of the colloid propellant on the trip to Mars, a comparable ion vehicle with exactly the same mass of propellant would continue to accelerate as far as Jupiter.

The difference between any two electrical propulsion systems in the results shown in the following table is partially obscured by the fact that both begin from an orbital velocity that is generated by another means. However, given comparable conditions, the colloid rocket will enable a vehicle to reach Mars sooner but the ion rocket will require less time for a trip to Jupiter. Here, for example, are flight times for missions to Mars and Jupiter for a 100,000-lb. vehicle powered by a system drawing 100 kilowatts with just enough propellant aboard to keep the colloid rocket accelerating all the way to Mars:

System	Thrust (lbs.)	Days to Mars	Days to Jupiter
Colloid	2.5	44	344
Ion	0.6	53	300

The advantage in specific impulse that all electrical systems have over chemical propulsion is due, of course to the high exhaust velocity of the ejected particles. This results in turn partly from the small size of the particles. Colloidal propulsion, however, is based on particles much larger than individual ions. Charged colloids are electrically charged smokes or fogs produced from particles with diameters varying from 10^{-7} to 10^{-4} in. Thus their velocities in a given electrical field are much smaller than those of ions and individual molecules.

Here is a table that indicates the position of colloids with respect to present and future propellants:

Rocket	Specific Impulse
V-2	225
Advanced Chemical	300-350
Nuclear with Chemical Working Fluid	300-800
Colloid	500-2500
Plasma	1500-5000
Ion	5000-10,000
Photon	1,000,000

All the electrical methods of propulsion—use of neutral plasmas, ions and charged colloidal particles—have been considered theoretically and, to a limited extent, experimentally. However, the electrical propulsion rocket is

* *The authors are with Rocket Power/Talco Research Labs. Pasadena, Calif.*

of necessity bulky when constructed with components fabricated according to current technology.

Charged colloids present a means of effective application within the limitations now faced. They appear to present the most readily developed electrical propulsion method available at present to bridge the gap between advanced chemical propellants and the ion motors under study.

• **Powerplant limitation**—The use of electrical propulsion methods introduces characteristic problems in addition to the usual one of propellant selection. Some of these result from the use of a power source independent from the working fluid. The high weight of powerplants presents a marked limitation; the total flow and beam density of a current of charged ionic particles is limited; and the generation of plasmas or ions involves problems of high temperature, power utilization and ionization.

Power sources available at present or in the near future supply a relatively low quantity of power per unit mass (specific power). Existing units supply somewhat less than 0.1 horsepower per pound (ca 0.1 watt per gram).

Since the ion current which provides thrust is a function of the power available, ions exhausted with limited power have low velocity. In similar terms, inadequate thrust is provided for a vehicle of large mass resulting in great part from the mass of the power source. This appears to be the most significant limitation for electrical propulsion at present.

This is particularly true of the plasma jet, a method of electrical propulsion in which a neutral fluid is generated by heating a metallic or gaseous propellant to a high temperature. Consequently, the working fluid includes significant concentrations of electrically charged ions and electrons. This plasma of neutral gas and electrically-charged particles permits magnetohydrodynamic control with which additional performance is obtained. Although a high specific impulse is obtained by this method, a large amount of power is necessary to produce the plasma.

In ionic propulsion the magnitude of the ion current which can be obtained is determined by the accelerating voltage and the current density. The current density, ie., the cross-section of the ion-beam, is limited by the total electrical charge produced in the beam.

This "space charge" limitation, although directly related to parameters determined by the powerplant, does not appear as serious as the lack of suitable power plants. The ion currents available with the low power obtained from present or foreseeable power sources can be readily utilized within space charge limits.

• **Charge-to-mass ratio effects**—The performance limitations for ionic propulsion can be mitigated by use of appropriate propellants. Since the power available is low and the density of charged particles of like sign in the ion beam is limited, reasonable thrusts must be obtained by using particles which provide a high mass flow in a relatively low current.

This goal is achieved by use of particles with a low charge-to-mass ratio. Monatomic hydrogen and cesium ions present readily available examples of the wide variation in this parameter. Both elements provide monopositive ions, the first with an atomic mass of approximately 1, the second with a mass of 133. To obtain high thrust with limited current it is apparent that the higher ionic mass is desirable.

An extreme variation in the charge-to-mass ratio can be obtained by using particles ranging from electrons to large colloids. Protons (2.9×10^{14} esu/gram) can be generated efficiently in a suitable ion source, and simple atomic ions such as cesium 2.2×10^{12} esu/gram) can be obtained readily in pure form from application of the work function for ionization on metallic surfaces. Colloidal particles have been obtained with charges on the order of 10^5—10^7 esu/gram. Therefore, the size of the charged colloid particle is on the order of a million times greater than the cesium ion.

Ionization of atomic and molecular propellants is achieved by two general methods. In thermal ionization, a metal, usually an alkali metal such as cesium, is converted to its ion by contact with a hot metal surface, such as tungsten. This method is most effective with readily ionized metals as propellants. Specific ionizing surfaces are necessary even at temperatures of 1500°K.

Ions can also be prepared by placing propellant material in an electric arc. Accurate placement and stabilization of the arc, which is essential to most promising acceleration systems (and ion optics) is difficult, requiring auxiliary magnetic or electrical fields. However, the arc is very effective at causing ionization. Voltages considerably higher than the minimum ionization potential of the ionizing material are required to establish the arc. The power requirements of both contact and arc ionizing sources in practical form for rocket propulsion would be high, especially for start-up.

• **Application of Colloids**—The advantages of colloidal propellants may be compared briefly with other electrical and "thermal" working fluids. On the basis of preliminary consideration of available materials, potential power sources, accelerating devices, etc., it seems clear that such propellants are the most readily developed working fluids for electrical means of reaching reasonable velocities for certain interplanetary flights.

Colloidal propulsion appears most likely to permit attainment of both sufficient thrust level and high exhaust velocity to allow flight in moderate gravitational fields and reasonable flight times for interplanetary trips. The colloid rocket gives many variables adjustable to a specific rocket mission. Since any substance can theoretically be dispersed as a colloid, many materials are potential propellants.

Obtaining low charge-to-mass ratios with ionic colloids apparently presents no difficulty. Charge-to-mass ratios which are excessively low may actually be obtained, resulting in low exhaust velocities. It should be noted that a range of ratios is provided by control in charging a single colloidal material, as compared to charging atomic or molecular ions with which only a given ratio can be obtained. Ability to vary the charge-to-mass ratio in flight may prove desirable for certain trajectories. An additional advantage of charged colloids for electrical propulsion lies in their exit from the rocket at low current density so that the problem of neutralization of the particle in space is minimized.

The colloidal material can be prepared for use by several methods. Chemical reactions (including photochemical) frequently provide colloidal products dispersed in a gas phase. Condensation of vaporized metals, liquids, or sublimed solids are also suitable. Fine dispersions may be prepared by spray atomization of liquids and by applying an electrical potential to either liquids or solids.

• **Gold as propellant?**—For rocket propulsion, a powder of colloidal dimensions may be carried in the vehicle. It is desirable to have small particles in order to obtain high velocities. Colloids have been reported with radii ranging from 10^{-4} cm to 10^{-7} cm. The unusually uniform polystyrene spheres useful as dimensional standards in electron miscroscopy are approximately 10^{-5} cm in radius, and gold particles with radii somewhat less than 10^{-7} cm have been prepared.

Force Field Shows Propulsion Promise

San Diego—A promising research approach to force field propulsion is reported by the Electronics Div., Ryan Aeronautical Co., San Diego, Calif.

The system is being studied for possible application in a series of manned watch satellites for detection and intercept of hostile ICBM's.

Martin N. Kaplan, a senior research engineer at Ryan Electronics, does not think present-day chemically fueled rockets have the duration required for an orbital mission. More exotic propulsion methods—nuclear, ion or plasma-type systems—can be ruled out because of weight or very low initial velocities, he says.

The need, according to Kaplan, is for a new approach to propulsion which would furnish very high speeds along with high initial velocities and long duration.

Ryan research in force fields is running along two paths that "look promising." One is termed "unified field theory," the other a "quantum mechanical theory of free space." The latter approach, derived from a quantized model, has led to successful experiments, Kaplan says. Additional experiments are being set up.

A more comprehensive research program is planned which, if successful, will produce either "restricted" or "general" results. Either would be a revolution in propulsion.

Restricted results might be dubbed antigravitation. This would permit an acceleration force which could be directed only toward, or away from, a second body. A general result would permit a reaction against free space.

The general result is anticipated. But this would still require one major breakthrough—development of a means of converting potential energy (perhaps nuclear) to kinetic energy in the form of a rectilinear momentum without expelling mass. Such a breakthrough seems possible, Kaplan believes, when there is a better understanding of the mechanism by which matter is converted to energy.

• **100-g acceleration**—In practice, the thrust produced by engines of this type would be directly proportional to their energy conversion rates. Neglecting energy losses, the vehicle's rate of change of momentum would be limited only by its peak energy conversion rate.

Kaplan believes these conversion rates could be safely employed to achieve space accelerations of 100 g or more. This is not so fantastic when compared to recent ultracentrifuge tests which have produced reactions against space of nearly 500,000 g. Once requirements for rectilinear reactions against space are discovered, 100-to-1000-g propulsion should be attainable.

A complete cycle of acceleration and deceleration at 100 g would take a vehicle from the earth's surface to a 1000-mile altitude in 80.8 sec., disregarding atmospheric drag. Although this extreme acceleration rate might be no problem for the vehicle structure, it would hardly create a friendly environment for its occupants or their instruments.

The same principle used for vehicle propulsion could be used to give the vehicle's occupants a g-controlled environment of a less disastrous character.

• **Putting it to work**—So where's the practical use if it all works? Kaplan proposes a system of six "stacked" counterorbiting fleets of 24 manned ICBM detection-pursuit vehicles per orbit and counterorbit. Vehicles in each orbit (12 in each direction) would be spaced about 2075 miles apart. Each fleet would patrol an area at least 2000 miles wide, extending completely around the world. Thus, 144 patrol vehicles would have to be in space at all times to give continuous early warning coverage of the entire earth's surface.

If, for some reason, orbiting vehicles could not be used, the vehicles might be placed in a hovering position, deployed to form a space blockade about a potentially hostile power.

The early warning system could double as repeater stations in closed communication links, separated by slightly over 2000 miles. Tandem vehicles of each orbit, or the vehicles of a hovering blockade, would be within line-of-sight of each other. Thus, they could relay information originating in any one station or from an earth station in contact with any one space point.

Method in Madness

BULGES AND BUCKLES with a purpose were built into this room at Republic Aviation's new Farmingdale, N.Y., Research and Development Center. Gibson-Girl build of walls makes almost completely echo-free environment for testing antennas.

Do It Yourself: A $10 Vacuum Pump

Phenomenon still not entirely understood has been harnessed by two researchers to provide a low-cost lab system

by William Beller

Two researchers have hit upon a cheap substitute for usually expensive laboratory diffusion pumps.

You have to build it yourself. The cost: less than $10.

Its an "ice-pumping" system. Its discoverers aren't quite certain why it works. But they report it can rapidly bring a chamber down to 2×10^{-5}mm Hg pressure.

The discovery is a by-product of some basic research for the Air Force Office of Scientific Research.

W. L. Fite and R. T. Brackmann of the General Atomic Division of General Dynamics were studying the effects of bouncing a beam of hydrogen molecules off very cold surfaces. The men noticed that when hydrogen particles and water vapor simultaneously hit a cold surface, the hydrogen was not reflected. Instead, the gas stuck to the surface.

This was true even though the surface's temperature was considerably higher than the boiling point of the hydrogen.

Seeing that the gas was being "pumped" out by a condensing water vapor, the experimenters asked whether nitrogen might behave the same way. If it did, then a new and exceedingly cheap way of getting a vacuum was at hand. The nitrogen experiment gave positive results.

• **Phenomenon not understood**—Later work showed that relatively crude equipment could replace diffusion pumping by the condensing water technique, "ice pumping." The pressure could be reduced to 2×10^{-5}mm Hg.

All the system needed for pumping air was an aspirator costing about $2.00, a nitrogen trap for $5.00. 10 cents worth of liquid air, and a clothespin if a hose clamp were not handy. Total cost: $7.10.

Why the system works is not fully understood. However, at least two phenomena are believed to be involved. The first is the brute force trapping of air molecules by the condensing water vapor. This is a very rapid pumping action.

The second action is a slower one. Here the air is pumped by a surface of stationary frost just sitting in the vacuum. This may involve an equilibrium condition. It was noticed that after the water vapor was taken out by freezing, the pressure slowly crept upward unless the ice were isolated from the rest of the system.

Diffusion pumps are normally used to push pressures below 1×10^{-2}mm Hg. These pumps spray either a mercury or an oil vapor to carry away a volume of gas particles that have drifted out of the chamber being evacuated. The vapor's action is similar to that of rain cleansing the atmosphere of dust.

In practice, the exhaust from the diffusion pump is led into the inlet of a mechanical back-up pump. This last pump is needed to provide the intermediate operating pressure the diffusion pump requires.

To get extremely low pressures, technicians hook two or more diffusion pumps in series. A cold trap between the chamber and the pumps is generally installed to thwart any migrating oil or mercury vapors.

• **Helium takes out H_2**—The ice pump can take pressures below 1×10^{-2} mm Hg without using diffusion pumps or associated equipment, according to the experimenters. It can get these pressures by using a few pieces of generally available laboratory equipment.

In the method disclosed in the patent application by Fite and Brackmann, a closed system is first partially evacuated to a few millimeters of mercury. Then the system is opened to a surface that has been cooled below the freezing point of water.

For best results, the surface's temperature should be brought down to roughly the boiling point, at atmospheric pressure, of the lowest boiling point gas that is to be removed from the system.

Water vapor is then ejected into the system, or it may be that enough water is already present. When the water freezes upon contact with the cold surface, the system's pressure will be materially reduced.

For example, suppose air is to be removed from a chamber. Then communicating with the chamber, perhaps by way of a glass hose, would be a relatively small cooled surface. Conveniently, the lower part of the surface, (the one not open to the chamber's atmosphere) would be soaking in a bath of liquid nitrogen.

If the system contained large quantities of hydrogen, the cooled surface would have to be in contact with liquid helium. This lower temperature would then be in the area of the boiling point of hydrogen.

If enough water vapor is present, the continuing condensation will bring the chamber's pressure down to the range of 2×10^{-5}mm Hg. This reduced pressure is of far greater magnitude than can be attributed to the removal of the water vapor alone.

• **Water is injected**—Explanation of the phenomenon does not lie in the cooling effect exerted by the surface on the chamber's atmosphere. This effect is limited to the gases in the immediate neighborhood of the surface, which leaves most of the contained gases very close to ambient temperature.

Except for water and carbon dioxide, the dew points of the gases at the reduced pressure in the chamber are still well below the temperature of the cold surface. Thus the pressure reduction can not be explained on the basis of condensing the residual gases.

The experimenters empirically discovered that to get a pressure in the range of 2×10^{-5}mm Hg, the system should contain about 50 molecules of water for every molecule of non-condensible gas present before the ice deposition begins. This calls for supplying water to the system. One way to do this is to inject water before the evacuation begins; another, to inject the liquid during evacuation.

In one method (see Figure 1), a chamber is first reduced to a pressure of about 5 to 1×10^{-2}mm Hg by a mechanical pump. Then a valve isolates the pump from the rest of the system.

A series connection runs from a water reservoir, past a cold surface, and into the chamber. The surface is

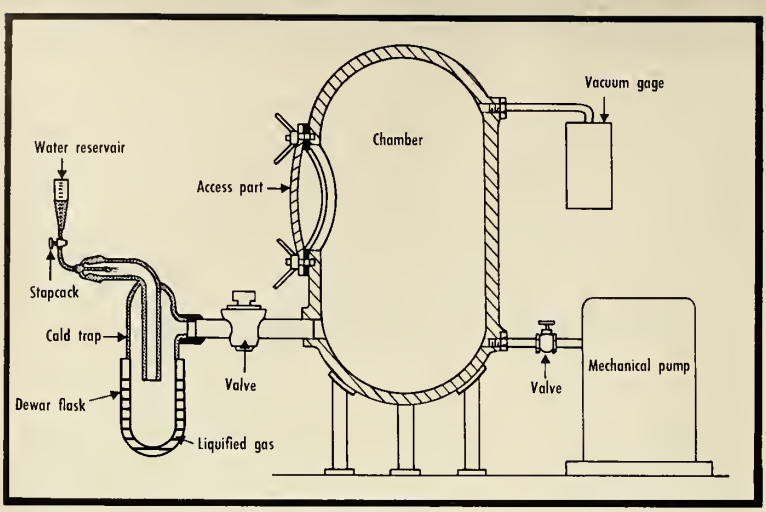


FIG. 1—Mechanical vacuum pump performs first-stage evacuation in one "ice-pumping" method. There is no upper limit on the size of the chamber.

kept cold by being inside a Dewar flask that is being cooled by a height of liquid air.

In operation, a stopcock is opened to admit a small amount of water into the partially evacuated system. Thus a vacuum is drawn by the water condensing on the cold surface. When the desired vacuum is reached, as shown by a connected gage, a valve isolates the chamber from the surface.

If the pressure within the chamber should begin rising, then the cycle can be restarted; and stopped, when the desired pressure is reached.

• **$10 vacuum pump**—The experimenters found that (1) when a chamber having a volume of about 400 liters is initially evacuated to about 0.5mm Hg pressure, and (2) liquid nitrogen is added to the Dewar flask so that about 500 square centimeters of cold surface is exposed to the atmosphere in the system, and (3) one milliliter of liquid water is put into the system—the system's pressure will be brought down to about 2×10^{-5}mm Hg.

The second method is the one that can be put into hardware for less than $10.00, provided some standard laboratory pieces are available. In the apparatus (see Figure 2), a series circuit connects the following elements in sequence: a water aspirator, stopcock, U-tube, hollow jacket used as a cold trap, another stopcock, and a forked path one leg leading to a bell jar and the other to a vacuum gage.

Operation begins by putting about one milliliter of water into the U-tube, all stopcocks being open. The system is then partially evacuated by means of the water aspirator, which is regulated by a water valve.

When the water stops bubbling in the U-tube, the aspirator has lowered the pressure as much as it can. The device is isolated by closing a stopcock.

Liquid air is now poured into one surface of the cold trap. At the same time, the water contained in the U-tube is supplying the vapor needed for the final evacuation. When the desired pressure is reached, a stopcock is turned to isolate the system from the bell jar.

• **Advantages of ice pumping**—There appears to be no theoretical upper limit to the size of the chamber that can be evacuated by the ice-pumping method. There perhaps is a lower limit, in the microscopic range. Thus, besides using the method as an inexpensive laboratory technique for getting a vacuum, technicians might also find applications to environmental chambers, and for generating low-pressure ambients for rocket engine work.

The economic advantage of the ice pump over the diffusion pump to reach pressures down to 2×10^{-5}mm Hg is apparent, Fite and Brackmann say. Further advantages are the absence of potential contaminants such as the mercury or oil found in a diffusion pump; the relatively simple operating technique of the ice pump; and its adaptability to compactness, and quick and varied applications.

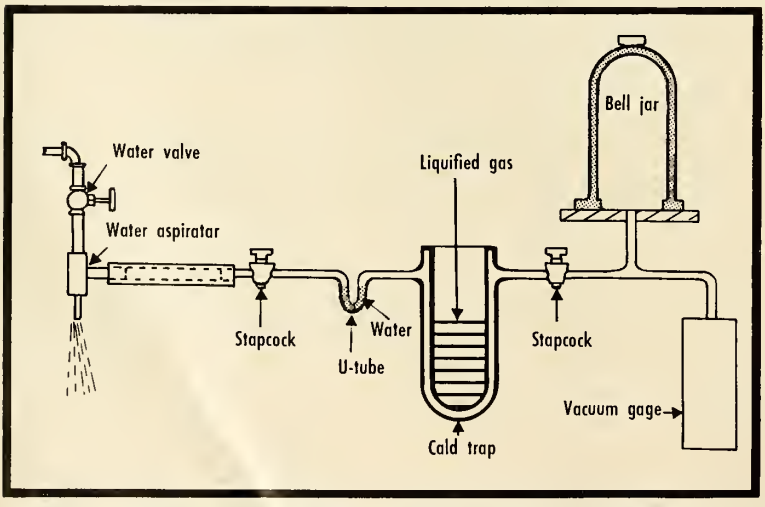


FIG. 2—A Water aspirator replaces the mechanical pump in this "ice-pumping" method. This is a highly economical type of installation.

Spacelabs at Work on Two AF Biomedical Contracts

LOS ANGELES—Spacelabs, Inc., has received Air Force contracts for developing a vest for the AF School of Aviation Medicine to monitor human physiological conditions via radio and providing the AF Ballistic Missile Division with instrumented animals for space research.

The vest being designed for AFSAM is intended for use in checking the condition of astronauts; it will include an electrocardiogram, respiration data, temperature and other physiological parameters.

Designated "Biotel," the unit is worn in a lightweight vest-type garment containing a tiny radio transmitter and rechargable battery power supply. Sensors are held in place by the skin-tight elastic garment.

Another contract, the result of a joint proposal submitted to AFBMD by North American Aviation, Wiley Laboratories, and Spacelabs, calls for instrumenting two American rhesus monkeys supplied by the Air Force. The Biotel unit will be surgically implanted in the monkeys in a manner similar to techniques proven in past programs. No dollar amounts of the contracts were given.

TV Camera Photographs At Night

Television equipment sensitive enough to take nighttime pictures and said to be rugged enough to be used in a surveillance drone is now in advanced development.

The manufacturer also sees ASW uses for its equipment, particularly as an aid to vessels on mapping and mine detection missions. Looking further ahead, the company believes that low light-level television will have high scientific value for spacecraft seeking astronomical data, or for such craft using the stars for navigational purposes.

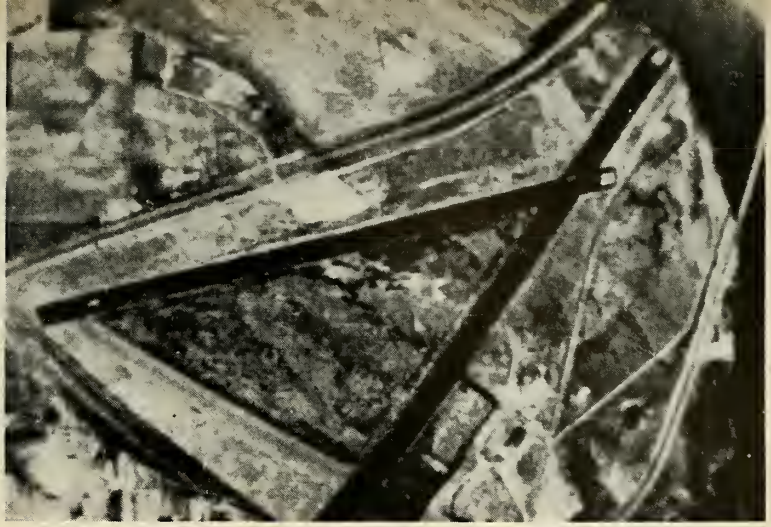
Made by Allen B. Du Mont Laboratories, Clifton, N.J., the TV camera is 8.5 inches in diameter, 17 inches long. Its weight, less optics but including sync generator, pre-amp, video processing circuitry, high-voltage supply and deflection circuitry, is only 30 pounds.

• **Pictures in the dark**—The three photos on this page showing the camera's work were taken at a simulated altitude of 10,000 feet. The target was a floor-mounted, giant map of a 36-million sq. ft. section of Burley, Idaho, which displayed an airport, railroad, highway, two bridges and a river.

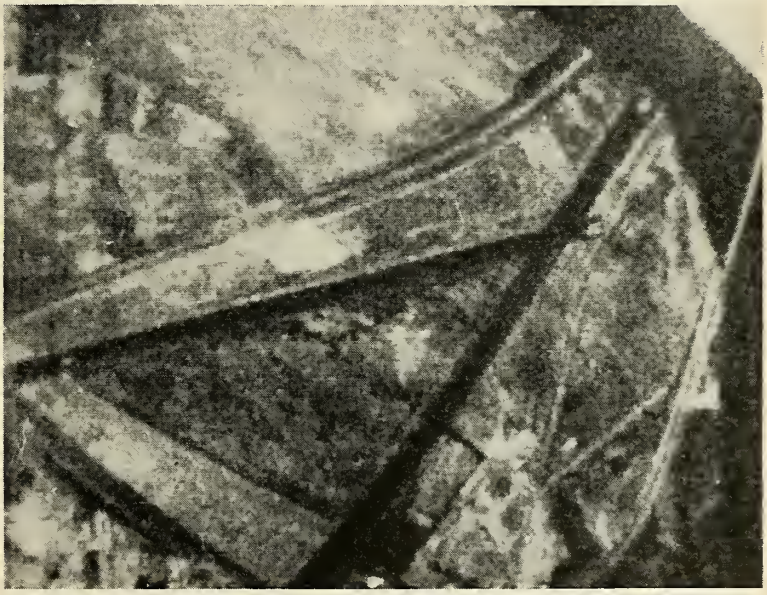
Three illumination levels were used, $8x10^{-3}$, $8x10^{-4}$, and $8x10^{-5}$ foot-candles on the ground. These levels respectively correspond to the light given out by a moon at 50 degrees elevation five days before it is full, ten days, and finally when the night is moonless and cloudy. The exposure time of the photographic camera making the pictures was 1/10 sec.

Du Mont work in the low-light television field started in 1957 under an Army Signal Corps study contract. The company was asked to set up a detailed specification for a television reconnaissance system for Radioplane's *RP-71* surveillance drone.

Prior to this time, most attempts to put television sensors in aircraft simply involved modifying commercial equipment, which was heavy and had technical weaknesses. At the time of this study, even though the potential

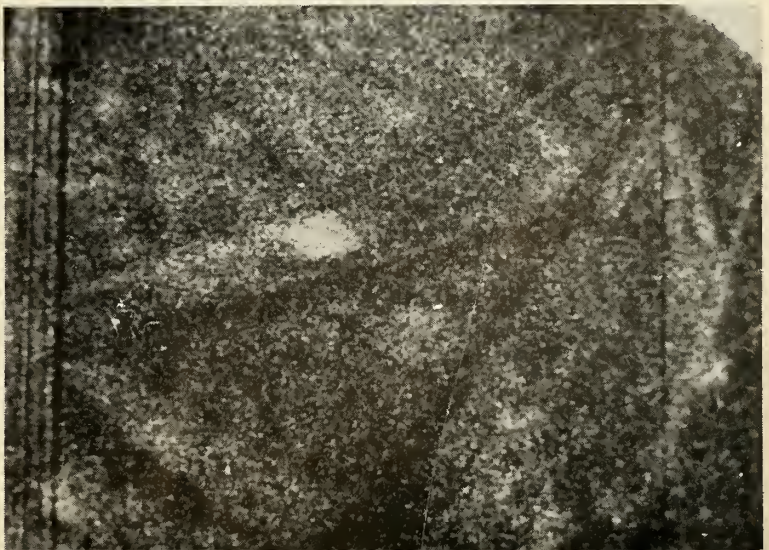


RUNWAYS CLEARLY spotted by TV shooting a scene lit by $8x10^{-3}$ foot-candles.



SAME SCENE, simulated by a giant map, as light falls to $8x10^{-4}$ foot-candles.

GROSS FEATURES still seen as light sinks to level of cloudy moonless night.



of television as a passive reconnaissance system was recognized, the state-of-the-art still lagged the desires of the engineers.

In rapid succession came improved sensitivity and ruggedness of image orthicon tubes coupled with compact transistorized circuitry having low power consumption. Special circuitry, image enhancement, image motion compensation, and similar techniques helped further the progress already obtained from the orthicon tubes themselves.

As television capabilities improved technically, the continued need for a useful night sensor persisted. Engineering development is now bringing about low light-level television as a practical, not just a laboratory, system.

The television used by Du Mont operates at 625 lines, 50 fields and 2:1 interlace. The camera is transistorized and uses a highly sensitive G.E. Z5358 image orthicon tube and an appropriate objective lens.

Low light-level electro-visual systems offer advantages of being passive and operating on a real-time basis. Sensor systems of this type will undoubtedly play important roles in spacecraft as well as aircraft surveillance missions. This is particularly true as the television systems now in the laboratory and under evaluation move into production and operational use.

Instant Motion

Scorsby Machine Used To Test SINS Gear

DOWNEY, CALIF.—Pre-delivery testing of *Polaris* submarine autonavigators at the Autonetics Division of North American Aviation, Inc., includes use of a machine to simulate shipboard motion.

Known as the Scorsby Machine, the equipment employs electric motors geared to shafts that are mechanized to accomplish motion about three axes—pitch, roll and heading (or azimuth). The Scorsby test objective is to demonstrate that the autonavigator—known as "Ship's Inertial Navigation System (SINS)—will provide position information within the precisely specified limits.

"Autonetics Scorsby equipment simultaneously introduces shipboard motions in such degrees as are required for the acceptance test of the *Polaris* submarine autonavigator," according to Senior Test Engineer Jack A. Crain. However, he notes that the Scorsby "runs" are only the last in an extensive series of pre-delivery tests of the system employed to fix a fleet ballistic missile submarine's underwater launching position for accurate delivery of the *Polaris* missile.

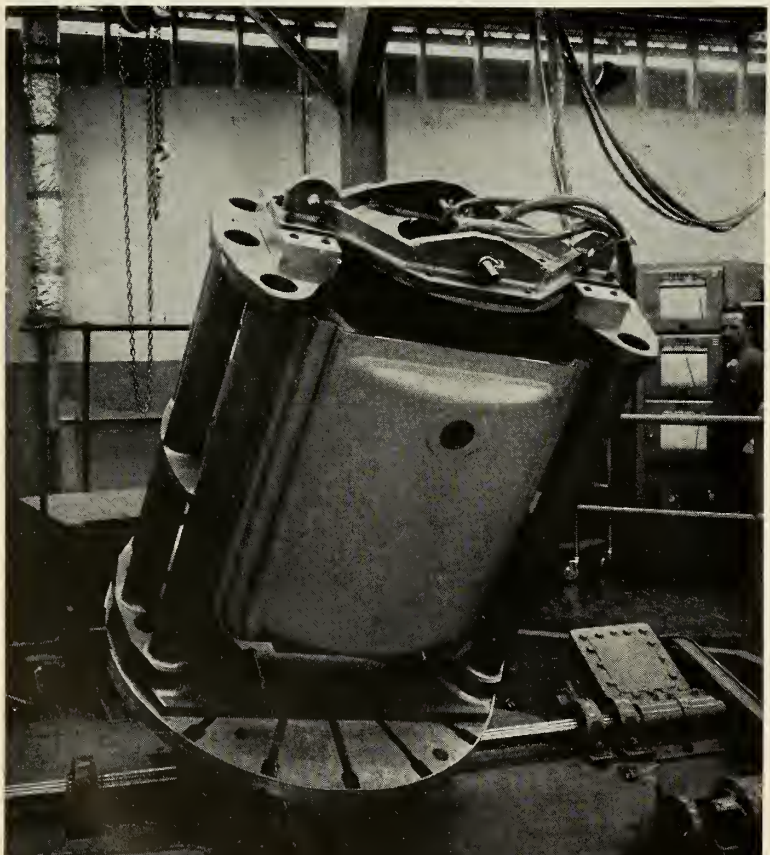
Preceding the Scorsby tests are stationary checkouts of individual SINS components, functional tests of power supplies, circuits, servo loops and compatibility tests of assembled components.

Next comes a series of runs of the entire SINS. One stationary run determines if the inertial components,—gyros and velocity meters—operate within specifications. Another simulates ship's heading, wherein outside heading is successively changed to the four cardinal directional points.

Finally comes running of SINS on the shipboard-motion-simulating Scorsby machine along various headings with motion introduced about the roll, pitch and heading axes. The gyro-stabilized platform is tilted in various ways during these runs to determine if it retains its initially-fixed orientation.

Basically, the Scorsby machine is a controlled-motion platform, believed to have been originally based on a familiar 6-in. naval gun turret installation. In its configuration at Autonetics' Downey facility, the equipment is firmly secured in a concrete, below-ground-level pit.

The SINS' binnacle—stabilized platform and frame—is attached to the Scorsby's platform in an Autonetics-designed holding and mounting frame, familiarly called the "bird cage".



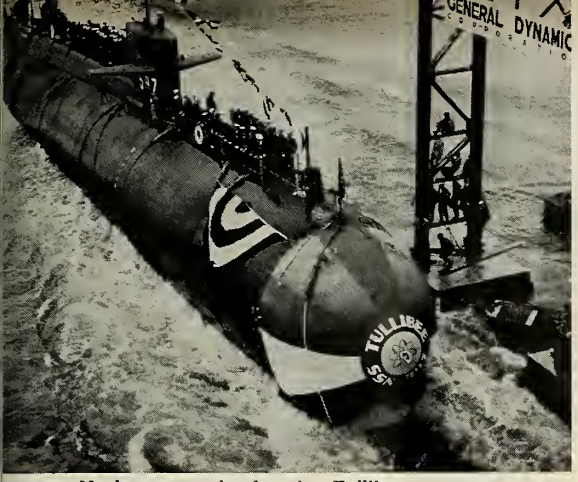
SCORSBY MACHINE in its below-ground-level pit at Autonetics' Downey, Calif., plant, where it is employed to simulate sea motion for testing *Polaris* SINS.

Houston Firm Enters High-altitude Rocket Field

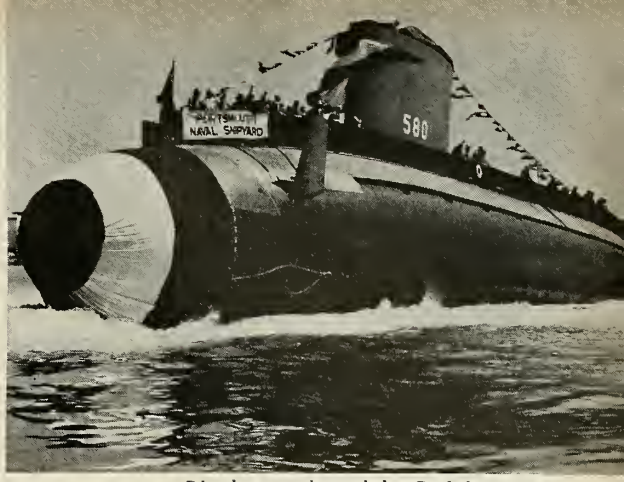
Anderson, Greenwood & Co. of Houston, which made its start after World War II building two-place pusher-type aircraft, has entered the high-altitude rocket research field.

The company is building 24 sounding rockets under fixed price for the U.S. Army's signal missile agency at White Sands. The two-stage solid fuel-ramjet motors are capable of sending payloads of 1 to 1.5 lbs. to 250,000-300,000 ft. Ten have been test-fired.

Anderson believes the 2.76-in.-diameter folding fin rockets can be furnished for $200 or less per copy.



Nuclear-powered submarine Tullibee.



Diesel-powered snorkeler Barbel.

ASW engineering

'Killer Sub' Fleet Strongly Backed

Advocates claim concept is today's best and least expensive solution to the threat—and may be final answer

A number of industrial officials are pushing an ASW "dark horse."

It is a proposal for a massive fleet of "killer" submarines.

These experts contend that the killer sub is the interim answer—possibly the final answer—to the Soviet submarine menace.

• **What's the plan?**—Killer boat proponents want no less than 100 submarines within five years, the dual objective: to counter-attack Russia's submarines—a force of at least 500—and to replace our World War II submarines, all of which will soon be obsolescent.

• **Cost:** Depending on how it's done, the bill should be less than $5 billion for a mixed killer force—both conventional and nuclear-powered. More for an all nuclear-force made up of ships such as the $43-million-a-copy Tullibee class.

The proposal for a large killer boat force came to public view only last month. The subcommittee on Produceability of the National Security Industrial Association said there should be 60 conventional diesel-powered pursuit-type subs and 40 atomic-powered versions, plus 36 missile-launching subs.

The subcommittee says it should be possible to cut these boats' costs 40% below those of the prototype.

Admiral Arleigh Burke, Chief of Naval Operations, repeatedly has voiced concern over the problem of individual excellence of a few ships at a high unit-cost vs. many ships at a low unit-cost.

He believes this relationship should always be carefully considered, lest we spend too much money on too few units to do the job. He recently cited before NSIA the case of a destroyer 10 times as effective as previous types, but costing three times as much. At first, this appeared to be a very good buy. However, it became obvious that should there be three tasks, the superior unit could cover but one—and two would remain unguarded. Burke emphasized that three lesser units could cover all spots.

• **The only answer?**—This has been ammunition for some shipbuilders who want a mix: diesel- and nuclear-powered killer submarines.

These builders concede the nuclear sub's greater speed, its independence of the surface and inexhaustible endurance. But for the foreseeable future, they say the absolute quiet of the hovering diesel-power submarine will give it great advantage where sonar search against submarines is paramount.

The ability of submarine sonar to detect and classify enemy submarines under a greater variety of conditions has been emphasized repeatedly by scientists of sound in the sea. The Woods Hole Oceanographic Institution has advocated the need for a substantial force of killer submarines. Service evaluations at New London have demonstrated operationally that the killer boat is perhaps the only means of detecting the deep-diving submarine which is evading air and surface ASW detection.

This has created a new school of thought in the Navy and in industry. Some insist that the problem of establishing surveillance of the ocean depths can *never* be solved from the air, from the surface or the sea or from shore stations.

They contend that this will be true even if there is a revolutionary breakthrough in detection and attack. They say that history shows that every mobile anti-submarine weapon is soon adapted to the submarine, where it becomes a more effective weapon against surface ships than it was against the submarine.

The group almost universally

agrees that in the immediate and foreseeable future, the only sure method of finding, identifing and destroying enemy missile-firing submarines in the ocean depths is by sending fighting men to the scene of action on killer boats.

They say there is not a single case on record where a surface ship sonar screen ever found a submarine that didn't want to be found.

Some believe that ASW surveillance under the Arctic ice is entirely a problem for the SSK. They agree that some form of passive surveillance of the Arctic Ocean could be achieved from ice stations—vulnerable to air or missile attack—but that no means of attack can be provided with air and surface ASW completely thwarted by submarine under-ice navigation (which is as well-known to the Russians as to ourselves).

Nuclear power is preferred for under-ice SSK's, although the possibility of using diesel submarines which can break through ice long enough to charge batteries, is not being discounted.

• **Nuclears vs. diesels**—What's the case for conventional subs? On patrol modern diesel submarines need to snorkel no more than two hours per day. When they operate in pairs for mutual protection, they are virtually undetectable because one is always on the alert.

In no case are they noisy more than four hours out of each 24 as they recharge batteries at snorkel. Noise on nuclear subs is still a problem, but it's minimal. Many say nuclears are only interim submarines until the fuel-cell submarine comes into being. Operating costs of conventional boats are about 1/7 those of nuclear.

Advocates of diesel killer boats say the 18-19 knot Barbel snorkeling class, which utilizes the streamlined Skipjack hull design and carries a crew of 55-60, would be ideal. Why?

Because the basic need is just for a substantial number of ultra-quiet boats with the ability to hover silently for at least 20 minutes, giving a sonar listening capability—with present fleet sonar—up to 120 miles range.

They contend that if this design were settled upon, one private shipbuilding yard could turn out one a month at a cost of approximately $12 million per boat, maybe even less. The stipulation would be that already proven sonar, batteries and other components and subsystems be used. The emphasis would have to be on *no* new research and development gear being mandatory under government-furnished equipment. As one builder puts it:

"We get into the craziest situations when we sign a contract which guarantees that we will operate and make successful anything that the government chooses to buy and furnish for installation."

• **The coming bind**—The next five years are the crucial ones, the shipbuilding industry feels. In 1965 all of the World War II submarines will be in block obsolescence, with general loss of hull thickness and drastic depth restrictions. "Then can we say our 20- or 30-knot-faster nuclear submarines will be equal even to the present Russian strength of about 500?" many observers ask.

The solution, shipbuilders say, is mass production in commercial shipyards, with boats being delivered on time and at a stated price—not cost-plus. But they also realize that the Navy has the problem of ships versus progress; volume is sacrificed because the latest, most modern ship is desired.

The Navy now has 110 submarines in commission. Only 30 have been built since World War II, although another 24 started during the war have been completed.

But, on the other side of the coin, builders point out that we would not have much time in another war to design and build ships.

Progress in ship design has been limited. The shipbuilding industry likes to cite the Nautilus and Seawolf. Even after three years of operation of these radically differing designs, one top

To Eavesdrop Underseas

TWO OF THESE Martin company-designed sonar units have been delivered to Naval Research Laboratory for evaluation under a no cost contract. Unit consists of a pressure sphere with electronics control equipment at the base and sonar transducer above the sphere. In background is a hydrophone receiving array which is suspended beneath the sonar unit. Array contains 20 hydrophone listening devices for detecting and measuring underwater sounds at depths to 18,000 feet. Basic aim is to get an acoustic path that is reliable under a good many oceanic conditions. A transistorized preamplifier circuit board in the hydrophone is imbedded in a one-inch cylinder. Rubber shells are put on to prevent short-circuiting when transducer is immersed in water.

Navy admiral remarked he couldn't see the particular benefit of one versus the other, excluding the power plant.

In fact, some builders contend that many of the changes in various classes of submarines are not actually improvements at all. They say the cost goes up because more funds are spent in production of one-or-two-of-a-class—just for design and making it operable. They say money can be saved by repetition of classes and cutting down on government-furnished equipment.

• **Where the trouble lies**—Proponents of SSK's acknowledge that the Navy has partially recognized the value of the killer sub. Some 27 nuclear attack submarines have been authorized; 12, including the Tullibee have been launched, and seven are in commission. However, the Tullibee is the only one which can be said is strictly in the hunter-killer class with the best available sonar. Even it has the SS(N), rather than SSK designation which the Navy has abolished.

The big trouble, according to some killer boat proponents, is that the Navy tends to limit the number of such ships, and to insist that they be "along with other—sea, air—approaches" in the ASW contest.

However, more than one expert voices the same conclusion: "If forces in power in the Navy today can keep the cost of submarines up, fewer submarines will be built. Control of the Navy comes with numbers."

The killer boat proponents consider ASW warfare to be the sea-going epitome of General Sherman's epigram—"War is hell." They say there can be no such thing as a "clean" ASW war—one in which the attacker stays beyond the range of submarine counter-attack. Many are violently opposed to spending billions of dollars on research and developmnet and purchase of weapons to give surface ships and aircraft this capability. As one ex-Naval officer comments:

"While we are researching for a final solution, we'll find the barbarian with knife in hand at our ivory tower's door."

They feel that the stand-off concept in recent years has actually lost ground in terms of its effectiveness against the enemy submarine. When nuclear power is further applied, they say, the disparity will favor the enemy even more. They insist that it remains to be proven that the Navy's air or surface arms can do the job, particularly if the enemy fights back.

The enemy, they argue, is taking a lesson from the Nazi Navy's Doenitz, who—until the last days of the war—didn't have his submarines fighting back. American submarines have always fought back (recall the many torpedoed Japanese destroyers) and the Russians may be expected to do likewise.

While knowledge of the Russian submarine fleet is scanty, many point to the evidence that the Soviets have weapons that out-range our surface stand-off weapons to a constantly widening degree. Their tactic will be that of the wolf who reasons that if he kills the dog he can get all the sheep he wants.

With naval history showing that battles are most often won by sheer force of numbers, the massive SSK proposal is gaining attention—particularly when a cost ratio of 6 for 1 could enable the Navy to build, operate and maintain three pairs of conventional ASW submarines for each nuclear sub at sea.

Ships are built for a life expectancy of 15-20 years; not many in the Navy see a future for a diesel-powered submarine 20 years from now. Nonetheless, if it's decided we need more forces in being, the tide could turn to the conventional sub.

Singer 'Sniffers' Help Navy Planes Locate Submarines

The Navy has added a new nose for its hunter-killer aircraft to "sniff out" enemy submarines. The system, which involves an unusual technique, shows a lot of promise.

Singer Manufacturing Co. has a contract to produce 800 ASR-2 "sniffer" units for installation in the Grumman S2F-2, the Lockheed P2V and the new S2F-3.

Origin of the system undoubtedly is traceable to smog-ridden Southern California, which years ago had to come up with an atmosphere sampler to determine chemical content. General Electric's Light Military Electronics Department conceived the idea that such a device could be used for detecting the snorkeling submarine.

Now, six years later, the fleet is getting the ASR-2. Some six aircraft of Carrier Group Four have it installed; pilots say it's working fine. While security prevents mention of specific capabilities, this much can be said:

Exhaust through the vent line of the snorkel contains small particles of carbon monoxide generated by the diesels.

S2F-2's take about five samples per second at an altitude of about 1500 ft., where surface winds usually level off. Particles are scooped in and moisturized, and hydrocarbons are detected by a cloud-chamber photoelectric cell. The system, however, depends on strength of wind and amount of exhaust emitted. The British have a similar system called Autolocus.

Ceramic Provides Its Own Heat Shield

Oxidation-resistant coating forms at 2200°F; compound ideal for changing temperatures of re-entry

An experimental self-sealing ceramic compound which develops its own protective coating in the face of two of the primary environmental enemies of hypersonic flight—heat and oxidation—has been developed at the Aerospace division of Boeing Airplane Co.

Ceramic engineer John DiLazzaro, who developed the new graphite-based material, says the ceramic is capable of instantaneously mending cracks in its protective layer from its own base material.

Boeing Magazine says that tests made thus far, while not considered sufficient for design data, have shown interesting results.

The material is composed of graphite and ceramic powders encompassing a range of compositions. The magazine points out that investigation of the mechanism involved in forming the protective layer can be important to a number of high-temperature materials now in the process of development.

• **Plumbago**—"Graphite materials have a good strength-to-weight ratio at very high temperatures," the publication says. "Graphite doesn't melt; at around 6500°F, it sublimes, changing from solid to gas."

One of the main limitations to use of graphite in hot-structure materials and coatings has been its tendency to oxidize. To overcome this, coating must be used. A self-sealing graphite ceramic would provide its own coating, the Boeing report notes.

Typical of the composite graphite bodies developed by DiLazzaro is one consisting by weight of 50% graphite, 24% molybdenum disilicide and 25% titanium boride, plus a small percentage of minor ingredients to promote bonding.

This composition contains over 70% of graphite by volume and retains many of graphite's desirable properties, the ceramics engineer reports. A powder is produced by milling the components together that will pass through screen mesh openings of about .003 inch.

HEAT-and oxidation-resistant coating is visible on the lower test disc. Upper disc has not been exposed to high temperatures.

After cold-pressing to shape, the ceramic is fired to nearly 3300°F for about one hour in an inert atmosphere. DiLazzaro reports that the material shrinks very little during firing and resembles graphite in appearance when it comes from the furnace.

The protective layer develops after heating in air for three hours at 2200°F.

"In one composition, the layer appears as a smooth, adherent, nonporous, yellowish-brown film about a thousandth of an inch thick," the Boeing publication says. "After several hours at 2600°F, the color changes to brown. After 23 hrs. at this temperature, the layer has thickened to between 0.01 and 0.015 in."

• **Lasting protection**—Ultimate thickness of the layer is said to depend upon the combination of time, temperature and oxidation. Even when suddenly plunged into a heat furnace, the layer forms spontaneously, although it is thinner than when heated slowly from a cold-furnace state.

"This could make the ceramic useful in space-flight applications where re-entry and other conditions often involve rapid and extreme changes in temperature," Boeing points out.

In a typical test, a small rectangular bar was clamped between water-cooled graphite electrodes and resistively heated to 3000° in less than one minute. After three minutes the temperature was 3300° and remained approximately constant for 15 min.

"The protective surface appeared as a viscous, glass layer agitated by a slow, continual 'boil off' of gaseous material," the Boeing publication says. "The glassy material remained on the surface and continued to provide a measure of protection to the material beneath, even after becoming liquid."

How the material will behave in temperature ranges above present test limits is not yet known; current Boeing research is devoted to making the composite graphite bodies usable for long periods of time at temperatures of more than 3000°.

Dry Lubricant Efficiency Upped 30% by Radiation

Solid film lubricants capable of operation while exposed to nuclear radiation have been developed by Electrofilm Inc., North Hollywood, Calif.

Exposures on the order of 1 x 10^7 Roentgens up to 1 x 10^9 Roentgens at temperatures up to 550°F. did not deteriorate the films. Wear life was actually increased by 30%.

The dry lubricants operate effectively from –65° to 1800°F. and the friction and wear characteristics meet Mil Spec 25504.

Wyman-Gordon Moves Precision Forging Plant

Wyman-Gordon Co. is transfering its Prex facilities at Franklin Park, Ill., to its eastern locations.

Prex Corp., which became part of the Wyman-Gordon corporate struc-

ture in 1956, specializes in close-tolerance, small, precision forgings. Most of its machinery will now be located at North Grafton, Mass. and the rest at Worcester, Mass. The move will take several months.

No interruption in Prex's regular production schedule is anticipated.

In addition, Wyman-Gordon is carrying out a threefold expansion of its beryllium machining processing and inspection facilities at North Grafton. Special rooms installed earlier this year to handle beryllium powder will be increased in size to facilitate the larger quantities of the element required in production.

With the expansion of the physical plant, Government security restrictions are also increasing—but at a much faster pace. The North Grafton plant is owned by the Air Force and operated by Wyman-Gordon.

Shock Tunnel Will Use Pressures To 100,000 psi

A Mach 20 shock tunnel will be in operation in September at Republic Aviation Corp., Farmingdale, N.Y.

The tunnel, utilizing pressures to 100,000 psi, consists essentially of a driver tube, driven tube and vacuum tank. The high pressures are a product of the combustion of a mixture of hydrogen, oxygen and helium gasses in the driver tube.

The driver tube will be charged with the mixture at 15,000 psi. Ignition and combustion will raise the pressure to the maximum which bursts a metal diaphragm, driving the gas into a small zone ahead of the nozzle.

The compressed and heated gas ruptures a secondary diaphragm, causing the flow through the nozzle into the vacuum tank at about Mach 20.

The specimen is mounted in the vacuum tank at a working pressure of one micron of mercury. Observation windows in the tank permit high-speed photography of the tests.

Republic intends to use the tunnel in studies relating to aerodynamic and heat transfer problems associated with high-speed flight and re-entry.

The facility is being installed by the designer, FluiDyne Engineering Corp.

Shadowgraph Photographs Hypervelocity Projectiles

A hypervelocity shadowgraph system capable of "freezing" projectiles with velocities of more than 14,000 feet per second has been installed at the Eglin Air Force Base Air Proving Ground Center, Fla.

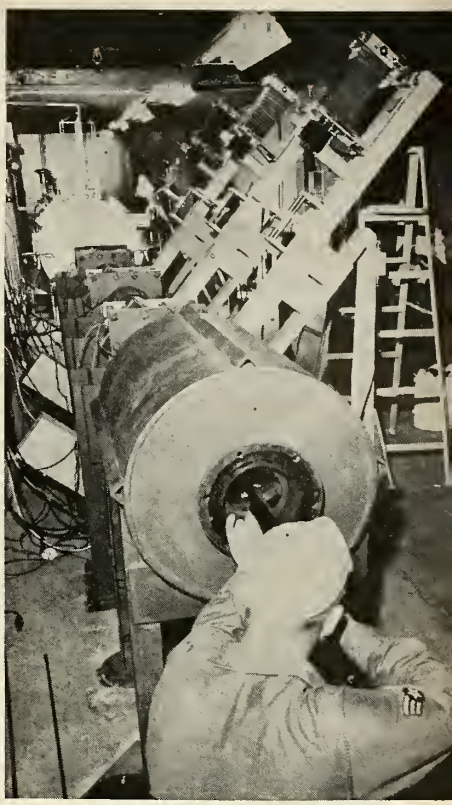
Designed and built by Avco Corp., the multiple-path photoelectric projectile detector and shadowgraph system will be used in a terminal ballistics study under simulated high-altitude conditions.

Each station in the commercial system consists of a 0.25 microsecond spark-gap light source, collimating lens, light screen, objective lens, 0.050 microsecond Kerr Cell shutter, camera, pulse generator and optical bench.

A special light screen and optical port assembly was developed to meet the requirement of a simulated 100,000 ft. altitude. The light screen is based on catadioptric techniques of reflection and refraction of light that produce a field of uniform sensitivity.

When a hypervelocity projectile interrupts the screen, it causes a current change that as a result triggers the synchronized shutter-light source.

A similar screen has been tested at Avco for projectile sizes as small as a 0.22 caliber bullet. The bullet crosses the 2.5 in. camera field in 15 microseconds. The system freezes the projectile within a half-inch of the center of the field.



SHADOWGRAPH system undergoes pre-operational checks at Ballistics Range 22, Eglin AFB, Fla.

)VERALL LENGTH of the FluiDyne shock tunnel is 120 ft. The driver tube is nounted on a steel track to facilitate primary diaphragm replacement. The model sup-ort in the vacuum tank allows 12 inches of streamwise adjustment.

Simple Separation Slated For Re-entry Balloon Test

In-flight stage and cannister separations in the Goodyear re-entry balloon deceleration tests this summer will be effected by a system from Hunter-Bristol Division of Thiokol Chemical Corp.

The system consists of a circular arrangement of shaped-charge explosives which cut outward through the *Cree* test missile's skin. The method eliminates the usual flanges, brackets, accurate joints and bolt patterns associated with conventional separation systems.

The Goodyear balloon deceleration system (M/R, July 4, p. 26) will be tested in a series of Cook Electric *Cree* test missiles this summer.

attempted diagnosis . . .

Lost Discoverer Heavily Instrumented

The recovery capsule of the ill-fated *Discoverer XII*—launched June 29—was loaded with nearly four times the instrumentation for capsule investigation carried in previous launches. The "diagnostic" attempt was futile, however, since the 300-lb. vehicle failed to go into orbit.

The capsule was equipped with four telemetering channels and instrumentation to monitor all phases of satellite re-entry and recovery procedure.

In previous *Discoverer* launches, six stabilized in orbit as programed. At least two re-entered, but none were recovered. Lockheed and the Air Force had hoped the latest attempt would tell what went wrong in other shots.

IAS meeting is told . . .

Venus' Radiation Worse Than Mars'

Other speakers discuss need for lifting vehicles in manned re-entry, a proposed space glide vehicle, pilot's role in moon landing

LOS ANGELES—Radiation may not be a significant hazard in a landing on Mars, but it could be during entry to Venus.

Observations of the two planets indicate that Mars probably has a magnetic field so weak that nothing akin to the Van Allen belts surrounds it. Venus, on the other hand, has a more intense magnetic field—indicating that radiation belts may exist.

Zdenek Kopal, a University of Manchester astronomer who presented these observations to the Institute of Aeronautical Sciences last month, also suggests that the moderately dense Martian atmosphere might offer a safe-entry corridor for purely ballistic vehicles.

Lifting vehicles, he believes, probably will be needed for manned entry to Venus or the Jovian planets to avoid excessive deceleration and heating.

Manned re-entry to earth's atmosphere at super-satellite speeds also calls for lifting vehicles, Robert B. Hildebrand, Chief of Advanced Systems Research for Boeing Airplane Co.'s Aerospace Division, told the meeting.

"Rocket decelerated entry and multiple pass entry each have problems peculiar to their operation which may make them less desirable than the single pass re-entry," Hildebrand said. He noted that one important new consideration is that in a multiple pass entry the vehicle might pass in and out of the Van Allen radiation belts.

"A lifting vehicle with moderate lift-to-drag ratio could be utilized for re-entry with super-satellite velocities and could be protected with ablation materials to overcome the high heating rates associated with the initial entry."

The Boeing researcher said that the speed decreases to below satellite speed, where radiation cooling appears attractive, the vehicle could use its lateral maneuverability to provide an extremely flexible system.

• **Glider transport**—L. W. Warzecha of General Electric's Missile and Space Vehicle Dept. also proposed a maneuverable semi-ballistic glide vehicle—for transporting men or material between earth and a satellite.

He said such a piloted space craft can be built light enough so that it can be launched by an advanced *Atlas* or *Titan* missile.

Warzecha described such a vehicle as having a recoverable glide vehicle section controlled by the pilot; a parachute landing system; and a detachable rocket propulsion and guidance section for space maneuvers. He said launch weight would be about 5700 lbs.

The vehicle would have a 550 mi. cross-range maneuverability so that it could come down out of a north-south orbit and head east or west 550 mi. to a safe landing area.

Without a cross-range capability, he pointed out, a space pilot might have to wait for days until the earth's rotation placed his orbit over a favorable area. The 550-mi. range would make possible a daytime landing at any pre-selected point on any day of the month from an orbit of 500 mi. altitude, he said.

• **No job for pilot**—Discussing a lunar landing at a pre-selected site, research engineers Arnold Peske and George Swanlund of Minneapolis-Honeywell Regulator Co. said their studies indicated little justification for having a man in the control loop since he would be serving as little more than an amplifier in an error-tracking task.

"The major conclusion here is that the operator is not making the best use of his capabilities; his function in the control of the vehicle should be to monitor the automatic system and then to take over in event of a failure," they said.

It was suggested that a better task for the pilot might be in recognizing and tracking the landing site since automatic techniques such as map-matching require heavy and complex equipment.

In some of the other papers:

• Cornell Aeronautical Laboratory's Roger C. Weatherston and William E. Smith proposed a new type of thermal radiator for space vehicles with a long, thin, continuously rotating belt to replace heavy conventional radiators.

• Solar Aircraft Co.'s C. W. Haynes and P. J. Valdez reported on an extensive pressure vessel test program to evaluate rocket motor case material, carried out under contract for Thiokol Chemical Corp. They said the program has led to improvements in manufacturing techniques.

• North American Aviation's Tajashi Mitsutomi of the Autonetics Division asserted that electronic microminiaturization will have a tremendous effect on electromechanical control systems in regard to increased reliability and reduction of size, weight and power. He said one of the most difficult problems of electronic microminiaturization is electrical interconnection. Welding offers high reliability for this but has yet to be fully evaluated, he said.

• Thiokol Chemical Corp.'s R. W. Seaman and D. S. Smith reported on successful completion of preliminary flight rating tests of the Reaction Motors Div. XLR99-RM-1 rocket engine being installed in the North American *X-15*.

• North American Aviation's V. L. Beals and S. R. Hurley of the Columbus Division said miniature rocket motors not much bigger than shotgun shells but with nearly 10 times the recoil have been used for impulsive excitation in flight vibration testing of the A3J Vigilante, Navy's Mach 2 attack bomber.

• Chance Vought Aircraft's Russel O. Bowman and Fred W. Thomae reported on an algae life support system in which a mouse survived for 28 days supported by four liters of algae. Highest CO_2 content found was 0.5%.

• Lockheed Aircraft Corp.'s R. O. Lowrey discussed space flight simulators under development at the Georgia Division and ARO, Inc.'s B. H. Goethert presented an extensive analysis of base flow characteristics of missiles with cluster-rocket exhausts.

Britain to Buy 500 Malkaras But Aussies Reject Missile

A few days after it was announced that Britain would buy 500 *Malkara* anti-tank missiles from Australia, an Army spokesman in Melbourne said Australia had turned down the weapon because in its present form it did not meet their requirements for use in a tropical country.

Development of *Malkara* began in 1951 at the Australian Government Aircraft Factory near Melbourne, and trials started at Woomera over four years ago. Development costs amount to $14 million and production figures for the 500 missiles, to be bought by Britain for use by the Royal Armoured Corps, will be over $4 million.

Immediately after the Army's rejection of the weapon, production officials of the Australian Defence Ministry expressed surprise at the announcement. One said "The British seem to be very enthusiastic about the *Malkara*. We think it could play a very useful part in an emergency in Asia."

It appears now that Britain is the only country interested in the weapon. NATO countries and America have chosen the French anti-tank missiles *SS10* and *SS11*, produced by Nord Aviation. These are believed to cost only one-tenth as much as *Malkara*.

The British Labour Party has seized on this as another "Government missile muddle" and "rocket flop." They claim that British Army experts advised that the weapon was too cumbersome and already out of date, and that the decision to buy *Malkara* was political—to keep the Australian factories going and as a gesture for the cooperation received at Woomera. The Australian designers have been asked to develop a smaller version of the weapon.

Indian Research Rocket Nears Testing Stage

The Indian Astronautical Society is spearheading a successful rocket development program in India which far surpasses any other program in the East. The IAS expects to supervise the launching this month of a solid-fuel rocket capable of reaching over 120 miles.

Twelve receiving stations are deployed throughout southern India to receive the signals transmitted by the instrumented second stage. The instrumented payload weighs nine lbs. Solar cells will provide the power for transmission.

The two-stage high-altitude rocket will follow several one-stage test shots expected to reach over 100 miles each. The two-stage rocket will measure the accuracy of programed ballistic flights through the shaped-charge technique developed with a solid, slow-burning (1.8cms./sec.) plastic propellant.

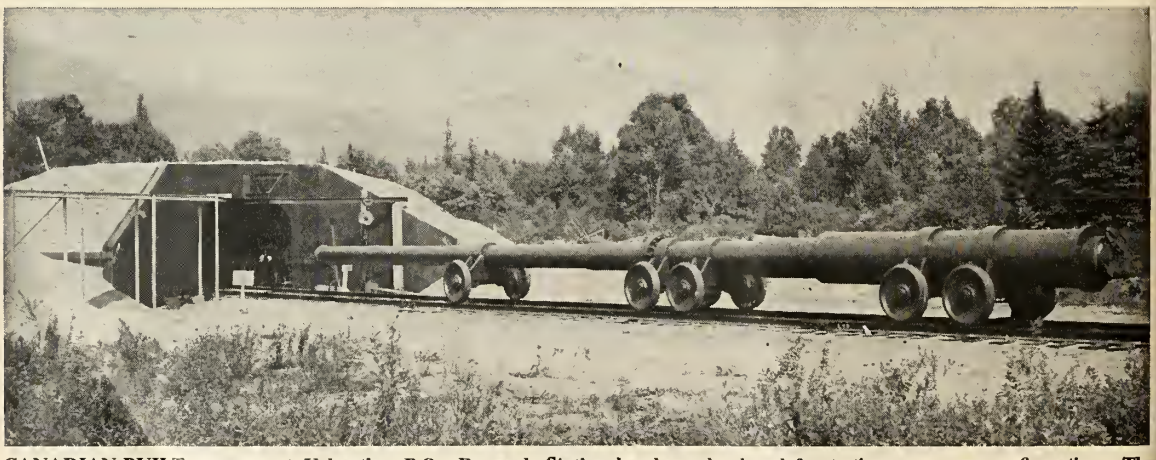
Indian officials claim that the new alloy used in the rocket's construction is "one of the lightest known" but have declined to identify it. It is understood, however, that the same metal is being used in a rocket engine being developed by the Indian Defense Department.

Sweden Adds Helicopters To Bolster ASW Strength

The Royal Swedish Naval Administration last week moved to strengthen its Antisubmarine warfare and minesweeping capability. It signed an option agreement for 20 Vertol 107 Model II transport helicopters.

Under terms of the option, deliveries of the new twin turbine powered helicopters can begin in the fall of 1961. The aircraft would be operated by both the Royal Swedish Navy and the Royal Swedish Army. Tandem-rotored Vertol 44 helicopters, powered by a single piston engine, have been in service with the Royal Swedish Navy since 1958. They have been used extensively in minesweeping and ASW-type missions.

Cannon for Nose Cone Firings



CANADIAN-BUILT gas gun at Valcartier, P.Q., Research Station has been developed for testing nose cone configurations. The rail-mounted 14-in. gun can propel a 100-lb. nose cone at 12,000 ft./sec. into the evacuated tube. The tube has gas composition and pressure controls to simulate upper atmospheric conditions. Launcher recoils up inclined railway on firing.

soviet affairs

by Dr. Albert Parry

Many rocket and missile terms

are included in the latest foreign-language military dictionaries being issued by the Military Publishing House of the Ministry of Defense of the USSR. The new *English-Russian Military Dictionary*, to be published by the House in Moscow this summer, will contain nearly 55,000 words, phrases and abbreviations used in the armed forces of the United States, Great Britain, Canada, and other Western countries, also in the united forces of NATO. This will replace a dictionary issued by the Russians more than ten years ago, which is considered now quite obsolete. Rocketry and missilery make up a prominent category in the new work.

A separate missile glossary

is soon to be issued in Moscow under the title *English-Russian Dictionary of Jet-Age Weapons* (in Russian: *Anglo-Russky Slovar' po Reaktivnomu Oruzhiyu*). Many rocket and missile terms are also found in the *German-Russian Artillery Dictionary*, published by the same House in Moscow in early 1960. According to Maj. Gen. P. F. Kopylov, chief of the Ministry's Military Publishing House, it issued five other dictionaries from 1956 to 1960: *English-Russian Dictionary of Radioelectronics, English-Russian Artillery Dictionary, German-Russian Aviation Dictionary, English-Russian Dictionary of Rear Service and Logistics,* and *Japanese-Russian Military Dictionary*. All of these include many Space Age entries.

Practically ready and soon to be printed

by the same Moscow House are *French-Russian Military Dictionary* and *German-Russian Military and Naval Dictionary*. In preparation are military dictionaries in Chinese-Russian, Korean-Russian, Polish-Russian, and other languages. In early March 1960, some 25 different military dictionaries were in the works at the House, in various stages of compilation.

In the current supply

of Russian dictionaries available for sale in the United States, the electronics part of *International Electrotechnical Vocabulary (Group 07, Electronics)* should be cited as quite comprehensive. Its second edition, issued in Moscow in 1959 by the State Publishing House of Physical-Mathematical Literature, effectively uses two methods: terms and their definitions are given in Russian and English; terms alone (with no definitions) are listed in French, German, Spanish, Italian, Dutch, and Swedish. The dictionary, printed in various editions for different "groups," is gotten out under the auspices of the International Electrotechnical Commission, affiliated with the International Organization for Standardization in Geneva, Switzerland. Another solid dictionary in the same series is for *Group 10, Machines and Transformers,* published by the same house in Moscow in 1958, with the same arrangement by languages, except that Polish is substituted for Dutch.

American missile dictionaries

are most outstandingly represented by Alexander Rosenberg's *Russian-English Glossary of Guided Missile, Rocket, and Satellite Terms,* published by the Reference Department of the Library of Congress in 1958. In electronics, still useful is *English-Russian, Russian-English Electronics Dictionary,* issued as a Department of the Army Technical Manual in August, 1956. It is for sale by the Superintendent of Documents in the U.S. Government Printing Office. The *Russian-English Glossary of Aeronautical and Miscellaneous Technical Terms,* published a few years ago by the Air Technical Intelligence Center at the Wright-Patterson Air Force in Ohio, is not listed as a restricted item, but it is available only to U.S. Government personnel and government contractors.

Complete Optical Inspection Kit

Bausch & Lomb Inc. announces the availability of a complete set of industrial optical tools assembled in a single kit. Originally designed to be used cxclusively by B&L personnel, the kit is now being marketed for its wide application to the industrial and engineering fields. It brings together componets of fundamental measuring and examination tools and offers them in a single package.

The kit has value for quality control and inspection work, since the flexibility provided by its many component parts is a convenient way to meet changing job requirements. Within the kit are more than 20 optical units which can be assembled into a variety of optical viewers, surface comparators and microscopes. The case, with full compliment of parts, weighs only 16¾ pounds.

Magnifications vary from 7x, with the small optical viewer, to combinations of 10x, 20x, 40x and 80x, with the various microscopes. Also included is a selection of reticles and measuring scales ranging from divisions of 0.001 in. to 0.005 in. The instruments are suitable for mounting on machincry as well as for bench inspection.

Circle No. 225 on Subscriber Service Card.

High Voltage Varactors

A series of diffused junction varactor diodes with high voltage breakdown properties is available from Microwave Associates, Inc.

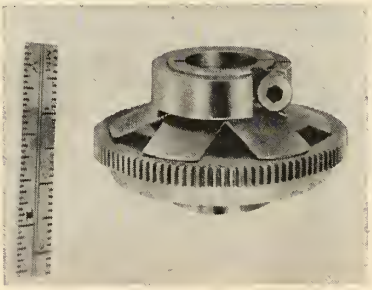
The complete series MA-4280 through MA-4292 (13 new diodes) range in junction capacitance values from 0.4 uuf measured at –6 volts, to 35 uuf maximum for the MA-4292. Junction capacitance at 0 volts is approximately twice the –6 volt value. At –30 volts, the junction capacitance is approximately one-half its value at –6 volts. The inverse breakdown voltage rating is –30 volts. Typical cut-off frequency of the new units is 30 kMc except for the large capacitance types which have about 2 ohms series resistance.

The units are mechanically interchangeable with 1N21, 1N23, 1N415, 1N416, 1N21WE, or 1N23WE point-contact diodes and the MA-450 and MA-460 varactor diodes.

Circle No. 226 on Subscriber Service Card.

Ball Bearing Slip Clutch

A slip clutch which eliminates galling and also maintains more uniform slipping torque is available from Dynamic Gear Co. Overall length of the unit is only 0.800 in.



The slip clutch has application as a safety device in expensive, complex gear trains. Installed in the train as a tensioning device, the unit will slip should output rotation be interrupted due to jamming or overloading. The Dynaco slip clutch can be set to a predetermined torque value and will maintain this value even after extended periods of slipping.

Circle No. 227 on Subscriber Service Card.

Low Noise Fan

The Cosmodyle Corp. is producing a Low-Noise Axial-Flow Fan, which operates with a noise level of less than 65 db. The fan, which was designed for ship-board and airborne applications, will deliver 140 CFM at a pressure rise of 2 in. H_2O. The motor is designed in conformance with the requirements of Specification MIL-M-1940. It operates on 400 cycle, 3-phase, 115 volts. The fan housing is 4.25 inches in diameter and is 4.5 in. long, and the unit is finished in accordance to MIL-C-6805.

Circle No. 228 on Subscriber Service Card.

Telemetry Band Unit

A completely solid state telemetry band unit incorporating electronic commutation and a single multi-input amplifier has been announced by Solidtronics Division of Electrosolids Corp. It is designed to handle any number of low level input transducer signals and is available in all of the IRIG bands.

The system consists of an electronic commutator, carrier amplifier, subcarrier oscillator and discriminator network. The electronic commutator is available in plug-in modules of five inputs each which can be added by simply plugging in to obtain as many inputs as desired. The physical unit is made up of the basic module containing a two input commutator, carrier amplifier, subcarrier oscillator and discriminator network and the additive five-input plug-in modules.

Circle No. 229 on Subscriber Service Card.

Reference Tunnel Diodes

The General Electric Co. is now manufacturing two new germanium tunnel diodes designed for use as circuit reference elements.

The devices' peak point current ratings of 2.2 ma and 4.7 ma conform to the preferred value standards set by industry associations for electronic components.

The 1N2969 has a typical peak point current of 2.2 ma and the 1N2941 has a typical peak current of 4.7 ma. This rating is held to a variation of no more than 10% in both tunnel diodes.

Both devices have typical peak to valley current ratios of 8 to 1. The 1N2941 has a total capacity of 30-mmfd while the 1N2969 is rated at a total capacity of 20-mmfd.

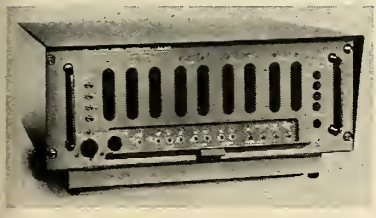
Both tunnel diodes have typical peak point voltages of 55-mv, typical valley point voltages of 350-mv, and typical forward peak point current voltages of 500-mv.

The new G-E current reference tunnel diodes are rated for operation over an ambient temperature range from −55°C to 100°C.

Circle No. 230 on Subscriber Service Card.

Correlation Device

Time correlation of data recorded by various instrumentation devices using the proposed IRIG code is now possible with the EECO Model ZA-810 Time Code Generator from Electronic Engineering Co.



The compact, single chassis solid state unit is suitable for laboratory or field use as the heart of an instrumentation timing system. The ZA-810 has the accuracy and stability (three parts in 10^8) equivalent to a secondary standard.

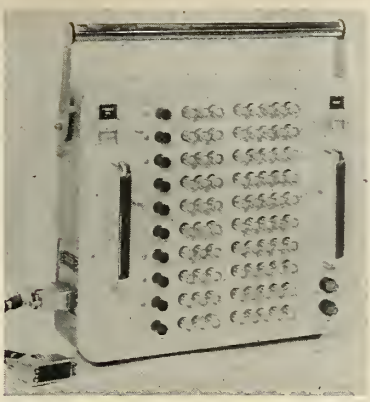
The two outputs of the unit are in DC level shift form and modulated 1000 cps. carrier. The 36-bit code indicates time-of-day and day-of-year and is read out once per second at a 100 pps rate. The unit employs a "leap year switch" to provide for the extra day every four years for long duration timing programs.

Circle No. 231 on Subscriber Service Card.

Tape Frame Simulator

A portable Tape Simulator for manual entry of data into punched tape systems is available from Hallamore Electronics, a division of the Siegler Corp.

The Tape Simulator, Model 0359, has a capacity of 80 bits of information, each entered by a push button on the instrument's panel. The 80 buttons are arranged in 10 lines and 8 channels to coincide with the common 8-channel punched tape code. As each push button is depressed it lights up to



facilitate easy reading of the program that has been punched. Each of the ten lines can be reset by its own reset button, and the entire panel can be cleared for a new entry by a master "clear" switch. A lamp test switch turns on all lamps to facilitate maintenance and checkout.

Circle No. 232 on Subscriber Service Card.

Refractory Thermocouple

A refractory metal thermocouple combination for reliable temperature measurement up to 2800°C (5072°F) is now available from Engelhard Industries, Inc. The new combination consists of tungsten vs. tungsten 26% rhenium and is suitable for use in vacuum, hydrogen or inert gases such as nitrogen, argon and helium.

Recommended for use at 2000 to 2800°C (3632 to 5072°F), its high output also makes it useful at lower ranges. The combination of high melting point with low vapor pressure makes it attractive for use in vacuums at both high and intermediate temperatures.

Circle No. 233 on Subscriber Service Card.

Sub-Subminiature Switch

A sub-subminiature environment-sealed switch—designed for missile, aircraft, and mobile applications—has been introduced by Micro Switch, a division of Minneapolis-Honeywell Regulator Co. The switch operates dependably in temperatures from −65 to 250°F, the company said.

The single-pole double-throw switching unit is housed in a sealed enclosure which has been evacuated and filled with inert gas to insure constant operating characteristics. An O-ring seal on the actuator shaft, glass-to-metal terminal seals and potted lead wire termination keeps dust, moisture or air out of the switching chamber. An ice-scraper ring removes ice or mud from the actuator shaft.

Circle No. 234 on Subscriber Service Card.

Weighs Liquid Propellants

A weighing system for liquid propellant storage tank installations is available from Gilmore Industries, Inc. The Model 176-A is designed to 1) weigh fuel stored in the tanks and 2) determine a weight versus "time flow" relationship for accurate calibration of flowmeter transducers.

A printout is provided every second by time correlation, to permit a sufficient number of points to accurately determine a curve of weight flow versus time. Checking this against flowmeter output results in a calibration curve for any particular flowmeter. The data is picked up instantaneously with the servo running, and the only error in this type of system is the lag of the servo behind true weight.

Calibration is provided by a M170 Digital Indicator Load Cell Calibrator.

Circle No. 235 on Subscriber Service Card.

Disk Storage Device

Laboratory For Electronics' Computer Products Division, announces a line of rotating magnetic disk storage devices, the BD-100 (Bernoulli Disk) Series, for commercial application.

The flexible rotating Disk of paper-thin magnetic mylar material maintains a small, controlled separation between the storage disk-medium and the read/write heads of the memory unit through utilization of basic fluid motion principles.

Due to the low mass of the revolving disk, the positive separation constantly maintained between disk and back plate, the air-tight sealing of the entire unit, and the simplification of machining required, the Bernoulli Disk-100 Series offers many advantages over conventional drum-type memory units.

Circle No. 236 on Subscriber Service Card.

Miniature Drill Head

A multiple drill head providing speeds high enough for very small drills on center distances as small as 3/8 in. has been announced by Metron Instrument Co. Especially designed for precision production of miniaturized parts, the Metron drill head features speed ranges of 0-8000 RPM, which makes possible the use of extremely small drills. All spindles are ball-bearing mounted; gears are case-hardened; hole center tolerances are ±.001 in. Maximum distance between centers is 3 in.; maximum drill size, #20. Case size is 2 in., 3 in., or 4 in. dia., depending upon particular requirements of individual user.

Circle No. 237 on Subscriber Service Card.

Swiftest Silicon Switch

The fastest silicon mesa switcher in industry is being supplied by Texas Instruments.

The guaranteed features of the 2N706A include: dc beta ranges of 20 to 60; lower T_s (charge storage time constant) of 25 nanoseconds maximum; guaranteed lower output capacity from 6pf to 5pf; turn-on time (T_{on}) of 40 nanoseconds maximum; turn-off time (T_{off}) of 75 nanoseconds maximum; minimum BV_{ceo} of 15 volts at a sustaining current of 10 mA; and maximum I_{cer} (RBE = 100K) of 10 uA at 20 volts V_{ce} (which gives a practical "Switch off" test).

Circle No. 238 on Subscriber Service Card.

Telemetering Commutators

A size and weight reduction of 67% is the principal feature of a new solid-state multi-coder developed by General Devices, Inc.

The unit, a completely self-contained telemetering commutation package, contains in one housing two high and two low level commutators, two power supplies, inverter, amplifier gate matrix, and probe. The entire package measures 7¾ in. x 3¼ in. x 2½ in. and weighs 5¼ lbs.

Designed to sample and sort high and low level signals in standard PAM/FM telemetry applications for missiles and aircraft, the unit will operate directly from 28 volt power source in peak accelerations up to 75 "g", and in temperatures up to +300°F. The multi-coder is designated as Model S-857-1B, and has been qualified for the *Titan* and *Minuteman* programs.

Circle No. 239 on Subscriber Service Card.

Subcarrier Oscillator

A high-input impedance, millivolt transistorized subcarrier oscillator is available from Hoover Electronics Co., with floating input and essentially infinite common mode rejection.

Model 10081 has an input impedance of 50,000 ohms, provides full frequency deviation output for only 20 millivolts input, maintains linearity within 1% of bandwidth and a frequency stability within 2.5% over the temperature range of 0° to 85°C.

The oscillator is available for channels 5 through 18 and A through E and is manufactured to IRIG standards.

Circle No. 240 on Subscriber Service Card.

Video Band Recorder

The Mincom Division of Minnesota Mining and Manufacturing Company is producing a CM-100 Video Band Recorder/Reproducer. This new system records both analog and pulse signals. At any one of its six speeds, the CM-100 is capable of twice the frequency response of similar equipment previously produced—1 mc at 120 ips, 500 kc at 60 ips, 250 kc at 30 ips, 125 kc at 15 ips. Overall bandwidth is 400 cycles to 1.0 megacycle per track. The 7-track system is packaged in a single, standard size rack and offers selection of six speeds ranging from 7½ ips to 120 ips with instantaneous speed control.

Circle No. 241 on Subscriber Service Card.

Heavy Duty Stopwatch

A new precision 12-hour stopwatch, specifically designed for panel-board and dash-board mounting, is available from Heuer Timer Corp. It incorporates shock-resistant heavy-duty features (Incabloc jewel mountings, solid man-size crown, Plexiglas crystal, and heavy dust-proof housing s p e c i a l l y which qualify it for aircraft, marine plated for brine and sweat resistance) and test-bench service. The large jumping hour-disc, the full-circle center-shaft minute register, the bold luminous

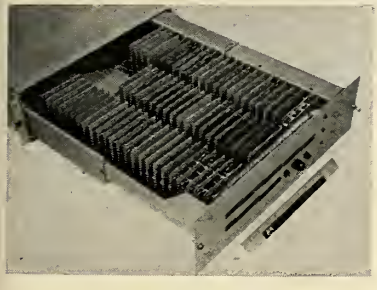
markings on a non-reflective black face, and the knurled turning bezel with its large set mark—all make for easy visibility and fast reading under the half-light of shop or cockpit.

For process and research instrumentation which requires decimal data, an alternate dial face with extra peripheral divisions in hundredths-of-a-minute is provided.

Circle No. 242 on Subscriber Service Card.

Core Memory Tester

A solid-state Magnetic Core Memory Tester from Packard Bell Computer verifies the operational status of a 19-bit, 4, 096 address core memory. Designed to fit a standard relay rack, the Memory Tester measures 5-¼" high x 19" wide x 20" deep. The power requirement is 105 to 125 VAC, 50/60 cps.



The core memory test may be made on selected addresses and bits or in sequence on all addresses with every combination of the 19-bits. During the test it is possible to start, stop, or restart from any address with any word pattern.

Circle No. 243 on Subscriber Service Card.

ECM Cooling Package

A miniaturized vane pump with integral relief valve and electric motor combination has been added to the Vickers line of packaged components and systems for aircraft and space vehicles. The 3.0 pound package is used as a coolant motorpump for electronic countermeasures equipment (ECM).

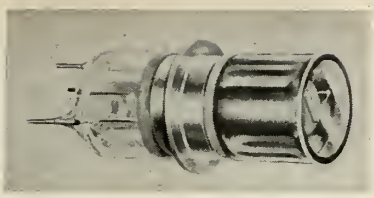
This package occupies approximately 28 cubic inches of space. The main feature is the replaceable vane pump cartridge that simplifies service.

The pump delivers 1.05 gpm at 90 psig pressure. It is nominally rated for 1000 hours continuous duty at operating temperatures ranging from −65°F to +160°F at 11,000 rpm speed.

Circle No. 244 on Subscriber Service Card.

Fast Infrared Detector

An infrared detector of extremely small area (0.1x0.1 mm^2) is being produced by Radiation Electronics Company, a division of Comptometer Corp.



Utilizing the photovoltaic effect in indium antimonide at liquid nitrogen, the Model J-02 detector exhibits typical NEP values of 2×10^{-12} watt at 5 microns and 7×10^{-12} watt for 500°K blackbody. The J-02 responds from the visible region to 5.7 microns with a time constant of less than one microsecond.

Circle No. 245 on Subscriber Service Card.

High Temp Cement

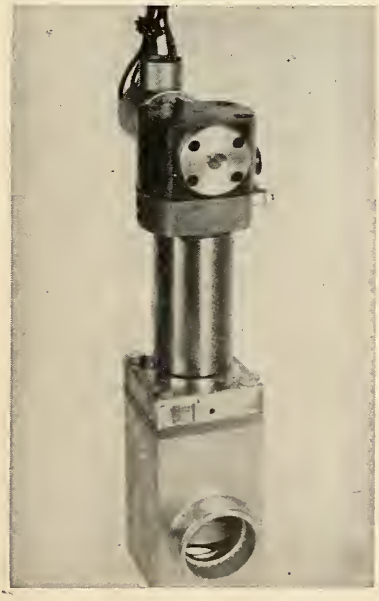
Instrumentation Associates has available a new high temperature cement product known as Astroceram Cement Type A and B. Astroceram A, a high temperature cement (over 4300°F) can be air dried. It exhibits particularly good adhesion to metals, suggesting possible use in coating, seals, and feedthroughs. Application is simple.

Astroceram Cement Type B is a high temperature (over 5000°F) cement which must be fired to develop a bond. This cement gives excellent bond strength with refractories. It has very low thermal expansion and exceptional resistance to heat shock.

Circle No. 246 on Subscriber Service Card.

Pneumatic Vacuum Valves

A complete line of compact pneumatically operated vacuum valves is being sold by Veeco Vacuum Corp.



Designated type "PV", these valves are bellow-sealed construction and are sold in 5/8, 1 and 1.5 in. port size. Each valve is individually tested on a Veeco mass spectrometer leak detector assuring no leak at a sensitivity of 1×10^{-10} std.cc's/sec.

Available for either right angle, or in-line application, the Veeco "PV" valve can be mounted either vertically or horizontally and can be obtained with either pipe thread or solder connections.

Circle No. 247 on Subscriber Service Card.

Tension Liquid Spring

A Tension Liquid Spring using liquid compressibility is available from Taylor Devices, Inc.

This Taylor T823 Tension Spring may be preloaded up to 300 lbs. with an end force of 800 lbs. As a shock absorber, this spring will absorb up to 1000 in. lbs. of energy.

With a ½ in. stroke, this 1 in. diameter by 3 in. long (plus mounting ends) the Spring equals 5 coil springs of the same dimensions. These Taylor Springs are complete with end attachments.

Circle No. 248 on Subscriber Service Card.

Finned Heat Sinks

Relco Products is currently producing six types of heat radiators which dissipate heat rapidly by means of machined integrally finned aluminum surfaces.

The heat radiators are machined from solid aluminum cylinders to permit great design flexibility. Radiating surfaces of 35 to 65 square inches are machined to rigid specifications to give low thermal resistance.

A hard anodized insulating surface provides the maximum in thermal radiation and meets military specifications for long life and durability.

Circle No. 249 on Subscriber Service Card.

Sub-Miniature Ceramics

Sub-miniature ceramics within extreme tolerances are available from American Lava Corp. The webs are held to ±0.001 in. and comparable tolerances are held on concentricity.

The parts are made in a high strength AlSiMag alumina ceramic. However, these parts can be made with comparable precision in any of several AlSiMag compositions.

Circle No. 250 on Subscriber Service Card.

Ganging Air Valves

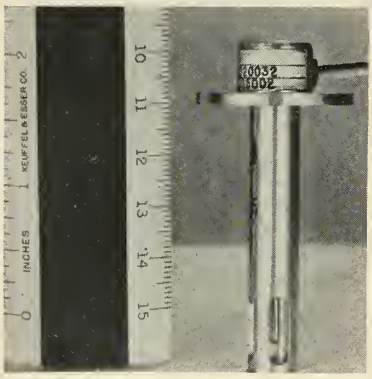
Solenoid operated air valves from Mechanical Air Controls, Inc. can be combined quickly and easily to provide a single, compact and inexpensive manifold to suit the exact requirements of any application. Two to ten (or

more) MAC "add-a-unit" manifold-base 4-way valves may be ganged together to form common inlet, common exhaust and common conduit channels. If more than one pressure is to be used, valves can be isolated and pressure fed from each end of the manifold.

Circle No. 251 on Subscriber Service Card.

Mercury Tube Thermostat

A tiny, reliable mercury tube thermostat, used to accurately control the temperature of the ground support equipment is available from Vap-Air Division of the Vapor Heating Corp.



The Merc is a single built, single setting (45°F) accurate to ±1°F with 1.5°F differential.

Circle No. 252 on Subscriber Service Card.

Tough Spaghetti Tubing

A line of Spaghetti Tubing and Monofilament is available from Pennsylvania Fluorocarbon Co., Inc. Extruded from a new, tough, clear, modified trifluorochloroethylene polymer, Penntube III has the unusual thermal and chemical stability of fluorocarbons and the advantages of lower cost, transparency and heat sealability. Available in monofilament down to .008" and spaghetti tubing in AMS 3648 sizes.

Circle No. 253 on Subscriber Service Card.

Size Eight Gearheads

Kearfott Division of General Precision Inc., has added Size 8 units to its extensive line of gearheads for servo motors and motor generators. Centered-shaft gearheads are available in 28 ratios, ranging from 7.62:1 to 1254:1, and eccentric-shaft gearheads can be provided in 25 ratios, ranging from 7.62:1 to 903:1. Shafts may be plain, pinion, or of special design. A specific gearhead may be mounted on any Kearfott motor or motor generator of the proper size and having the proper shaft configuration.

Circle No. 254 on Subscriber Service Card.

new literature

FILLER METAL CHART—Aluminum Company of America announced a filler metal selection chart for engineers, designers and shop men, that quickly specifies correct filler alloys for all recommended wrought alloy parent metal combinations. Filler alloy choices are based on parent metal combinations and common service requirements demanded of welded assemblies. In one table, parent metal combinations of wrought alloys currently recommended for welding, are indicated. Acceptable filler metal alloys are listed for each combinations, and given an A, B, C, or D rating for each of the following service requirements: ease of welding; strength of welded joint, corrosion resistance; service suitability at temperatures exceeding 150°F; color match after anodizing; and ductility.

Circle No. 200 on Subscriber Service Card.

DENSITY METERS—A 48-page general catalog (No. 604) has just been issued by Empire Devices Products Corp. It describes and illustrates the company's entire line of noise and field intensity meters, impulse generators, power density meters, modulation meters, coaxial attenuators and terminations, crystal mixers and microwave components. Fully indexed, each catalog section provides information on applications, features, characteristics and specifications, as well as a photograph and descriptive text, for every product in the Empire Devices line. Where necessary, line drawings and tabular data are also included.

Circle No. 201 on Subscriber Service Card.

POROUS METAL—A two-page, two-color, technical bulletin discussing Porostrand, a new type of porous metal made by wire winding techniques, is now available from Bendix Filter Division, Bendix Aviation Corp. This bulletin covers both filteration and non-filteration applications of Porostrand porous metal. Typical applications are listed together with outstanding features, which include an extremely wide size range of the finished Porostrand structures.

Circle No. 202 on Subscriber Service Card.

VIDEO BAND RECORDER—Extended capabilities of Mincom's new CM-100 Video Band Recorder-Reproducer are detailed in 12-page, 4-color brochure by Minnesota Mining and Mfg. Co. The new system records and reproduces both analog and pulse signals. Single, standard size rack contains 7-track system covering an overall bandwidth of 400 cycles to 1.0 megacycle on each track. Illustrated curves show greater bandwidths at lower speeds; for example, frequency response up to 1.0 megacycle at 120 ips, 500 kc at 60 ips. Instantaneous selection of six speeds ranging from 7½ ips to 120 ips on single ½-inch tape.

Circle No. 203 on Subscriber Service Card.

SUB-SUBMINIATURE SWITCH—Data Sheet 169 describes the new environment - free sub - subminiature switch, catalog listing 1XE1, developed by Micro Switch, a Division of Minneapolis-Honeywell Regulator Company. Data Sheet 169 includes full description, dimensions, electrical ratings, mechanical characteristics and other important information.

Circle No. 204 on Subscriber Service Card.

OSCILLOGRAPHS—The Heiland Division of Minneapolis-Honeywell Regulator Company has published a new 36-page manual that illustrates the applications of its direct-recording Visicorder oscillograph. Designed as a reference guide for engineers and scientists, the booklet contains 18 case history descriptions of how Visicorders have been used in widely different ways.

Circle No. 205 on Subscriber Service Card.

HIGH TEMPERATURE RESISTORS—A high temperature, non-inductive resistor is described in a new bulletin, CE-2.07, available from Corning Electronic Components. The bulletin states that Corning ST-type resistors were designed for power circuits requiring minimum component volume and maximum power dissipation. They are made by fusing a tin-oxide film to the surface of glass rod, then coating the assembly with ceramic cement.

Circle No. 206 on Subscriber Service Card.

TOROIDAL INDUCTORS—A comprehensive ready-reference wall chart on toroidal and variable inductors has been published for design engineers by Burnell & Co., Inc. The three-color chart measures 24" x 36" and has metal edging top and bottom to insure its hanging flat against a wall. Twenty graphs provide Q versus frequency curves for several ranges of voltage or inductance.

Circle No. 207 on Subscriber Service Card.

BORON—A 24-page booklet entitled "Borax and Other Boron Compounds" has just been published by Stauffer Chemical Company. Contents include data on the production, uses and chemistry of borax, borax glass and boric acid. Also outlined are properties, reactions and uses of boron oxide, boron trichloride and thirty other boron compounds now available in research quantities.

Circle No. 208 on Subscriber Service Card.

names in the news

WHITSON

PRITCHARD

JOHNSON

COHN

Dr. William L. Whitson: Elected vice president of The Martin Co. Prior to joining the firm he was Daystrom, Inc's vice president, engineering and previously acting chief scientist for the Advanced Research Projects Agency.

Dr. Edward M. Pritchard: Named director of engineering for the Military Systems-Stavid Division of Lockheed Electronics Co., directing Airborne Electronics, Electromagnetic Systems, Shipboard Electronics, Special Projects, Advanced Techniques and Advanced Systems.

Dr. Ralph P. Johnson: Appointed vice president, Electronics Divisions, Thompson Ramo Wooldridge Inc. responsible for TRW's Commercial Electronics Group, Electronic Components Group, Pacific Semiconductors, Inc., Ramo-Wooldridge Division and The Thompson Ramo Wooldridge Products Co.

Dr. Seymour Cohn: Former head of Stanford Research Institute's Electromagnctic Laboratory, joins the Rantec Corporation as vice president and technical director. He succeeds **Dr. Robert S. Elliott,** now a professor at UCLA, who will remain with the firm on a consultant basis.

Richard P. Thornton: Appointed general manager of the Packaged Electronics Division of Amphensol-Borg Electronics Corp.

Howard H. Hubbard: Former Space Technology Laboratories' South Point, Hawaii, manager, named director of a newly formed Commercial Microwave Systems Division of D. S. Kennedy & Co.

Guy J. Sanders: Director of engineering for the Industrial Acoustics Co., appointed chief engineer of the Sound Control Department, Metal Products Division, Koppers Co., Inc.

George Friedl, Jr.: Former Litton Industries vice president, joins Houston Fearless Corp. as director of operations in its Houston Fearless Division.

Laurence H. Cherry: Former chief of planning, research and development at Solar Aircraft Co., joins Grand Central Rocket Co., as associate director of marketing.

Peter P. Pruce: Former consulting engineer for research and development in the Airborne Systems Laboratory of Hughes Aircraft Co., joins Lynn-Western, Inc., as executive vice president and director of client services.

Harold A. Goldsmith: Appointed president of The Siegler Corp.'s Bogen-Presto Division. Was co-founder of Magnetic Amplifiers, Inc., recently merged with The Siegler Corp.

H. French Harris: Named manager of the *Discoverer* and *Samos* satellite projects at Philco Corp.'s Western Development Laboratories. Was formerly systems design and integration section manager.

W. C. King: Former sales manager for Commercial and Government products for The Hammerlund Manufacturing Co., elected district manager of Wilcox Electric Co., Inc.'s new marketing office in the New York City area.

B. F. Coffman, Jr.: Appointed manager of Aerojet-General Corp.'s Hybrid Rocket Engine Projects. Was formerly head of the Navy's rocket branch, Bureau of Aeronautics.

James R. "Bob" Bruce: Former technical program coordinator of the research projects lab at the Army Ballistic Missile Agency, named assistant manager of Northrop Corp.'s Huntsville, Ala., district office.

Dr. Donald A. M. Mackay: Appointed director of research at Evans Research and Development Corp.

John M. Britton: Elected manager of research and development contract sales for Hughes Aircraft Co.

William J. Tull: Vice president, GPL Division of General Precision, Inc., received The Thurlow Navigation Award, the highest honor conferred for advancing the science of navigation. He received the citation for his work as the pioneer of Doppler navigation.

Francis X. Buschman: Former vice president in charge of operations for Tensolite Insulated Wire Co. named director of research, development and engineering at Hitemp Wires, Inc.

Royce Johnston: Former senior research engineer with North American Aircraft's Rocketdyne Division, named western regional sales manager for Sealol, Inc.

Raul H. Frye: General manager of the Sparton Electronics Division, elected vice president of the Sparton Corporation. Prior to joining the firm he was assistant general manager and marketing manager of the Defense Products Division of Fairchild Camera and Instrument Corp.

Lawrence H. Stanley: Former executive vice president of Case-Stanley Marketing Consultants, Inc., elected to the newly created position of manager of marketing services for ACF Industries.

Dr. Tai Nien Feng: Former consulting engineer in the Avionics Division of John Oster Manufacturing Co., elected associate director of research for Control Data Corporation.

Dr. Arch C. Scurlock: Elected to the board of directors of C-E-I-R, Inc. Cofounder and president of Atlantic Research Corp., he is also a director and president of the Greater Washington Industrial Investments, Inc.

David F. Frost: Former specialist in the design and development of lumped constant delay lines at R. D. Brew Co., named project engineer in the wire wound delay line division of Andersen Laboratories, Inc.

Frank J. Delves: Appointed vice president-Foreign Marketing for General Precision, Inc., a subsidiary of General Precision Equipment Corp.

contracts

NAVY

$500,000—Summers Gyroscope Co., Santa Monica, Calif., for a quantity of free gyros for use with the *Terrier* and *Tartar* missiles. Subcontract from Convair.

$57,911—Chrysler Corp., Engineering Division, Detroit, for conducting a research program on semiconducting compounds for thermoelectric power generation at high temperatures.

AIR FORCE

The Hunter-Bristol Division, Thiokol Chemical Corp., for furnishing a shaped-charge system to effect in-flight stage and canister separation on the *Cree* missile. Amount not disclosed. Subcontract from Goodyear Aircraft Corp.

$26,000,000—Remington Rand Univac, for production and testing of electronic ground guidance computers for the *Titan* missile.

$12,894,376—Burroughs Corp., Detroit, for 36 coordinate data transmitting sets and 40 aircraft detector kits for use with *Sage*.

$7,577,988—Gilfillan Brothers, Inc., Los Angeles, for 165 modification kits for ground control approach equipment and 25 modification kits for mobile radar approach control equipment.

$7,000,000—Vitro Laboratories Division of Vitro Corp., for operation and maintenance of all test instrumentation at Eglin and four other locations which make up the Eglin Gulf Test Range.

$2,963,046—Motorola Inc., for 22 microwave systems for use in radar approach control centers.

$1,392,200—Bendix Corp., Radio Division, for phase-in of radio repairs and maintenance on U.S. and Pacific area facilities.

$1,993,000—International Business Machines Corp., New York City, for 72 situation display consoles for Sage semi-automatic ground environment computers.

MISCELLANEOUS

$87,651—Ortholog Division, Guiton Industries, Inc., Princeton, N.J., for a tape editor system to be used in studying the performance of missile re-entry vehicles or nose cones. Subcontract from General Electric Co.

ARMY

$13,387,382—Hughes Aircraft's Ground Systems Group, Fullerton, Calif., for 13 fire distribution systems for air defense batteries.

$8,825,623—The Martin Co., Orlando, for 15 sets of major components for the Missile Master System.

$8,176,000—General Dynamics Corp's Convair Division, Pomona, Calif., for continued development of the *Mauler* missile system.

$7,199,262—Convair, Pomona, Calif., for development of the *Mauler* system.

$7,000,000—Sperry Rand Corp., Salt Lake City, for the *Sergeant* missile system.

$6,800,000—The Martin Co., for test equipment and engineering services on the *Lacrosse* missile.

$6,757,290—Douglas Aircraft Co., Santa Monica, for *Nike-Hercules* ground support equipment.

$5,000,000—Belock Instrument Corp., College Point, N.Y., for electronic radar simulator systems.

$4,177,049—The Emerson Electric Manufacturing Co.'s Electronics and Avionics Division, for rocket motor metal parts for the XM-50 *Honest John*.

$4,097,513—Western Electric Co., New York City, for repair parts to support improved *Nike-Hercules* Hipar equipment.

$4,047,476—Minneapolis-Honeywell Regulator Co., Hopkins, Minn., for *Honest John* rocket warheads.

$3,623,367—Clark Equipment Co., Industrial Truck Division, for 195 special rough-terrain fork trucks with swing-type crane for handling missiles.

$3,600,000—Aerojet-General Corp.'s Aeronautical Division, Downey, Calif., for continued development of the SD-2 surveillance drone system.

$3,517,675—Raytheon Co., Waltham, Mass., for the *Hawk* missile system.

$3,394,051—General Electric Co., Burlington, Vt., for work on *Little John* and *Lacrosse* weapon systems. Two contracts.

$3,171,320—Raytheon Co., Waltham, Mass., for nine battery sets for the *Hawk* missile system.

$3,159,303—Sylvania Electric Products, Needham, Mass., for a large-scale mobile digital computor.

$3,150,974—Northrop Corp., Van Nuys, Calif., for RP 76-3 target missile.

$3,085,103—Belock Instrument Corp., for 25 *Hawk* missile system training devices.

$2,900,042—The Martin Co., for the *Lacrosse* weapon system.

$1,363,676—Douglas Aircraft Co., Santa Monica, for *Nike-Hercules* transporters.

$1,213,489—Douglas Aircraft Co., for *Honest John* components.

$1,200,000—Summers Gyroscope Co., Santa Monica, Calif., for a quantity of free gyroscopes for use with the *Lacrosse* missile. Subcontract from Martin-Orlando.

$1,131,299—Stromberg-Carlson Division, General Dynamics Corp., for two engineering test models of single sideband tactical transistorized radio sets.

$1,084,983—Minneapolis-Honeywell Regulator Co., Hopkins, Minn., for *Sergeant* missile warhead fuses.

$1,077,096—The Martin Co., Orlando, for the *Pershing* weapon system.

$993,447—Belock Instrument Corp., Long Island, N.Y., for industrial engineering services in connection with the *Hawk* missile training device 3-G-36.

$588,000—Whittaker Gyro Division, Telecomputing Corp., for gyroscopes used as part of the guidance system for the *Nike-Hercules*. Subcontract from Western Electric Co., Inc.

$333,813—Arde-Portland, Inc., Newark, N.J., for research and engineering study in connection with the development of high-strength rocket motor cases by cryogenic stretch-forming for the investigation of cool solid propellant rocket nozzles.

$310,274—The Wurlitzer Co., North Tonawanda, N.Y., for manufacture of two classified electronic devices.

$250,000—Piasecki Aircraft Corp., Mayfield Electronics Division, Mayfield, Pa., for electronic work.

$208,346—Braddock, Dunn and McDonald, Inc., Yonkers, N.Y., for program of scientific assistance to White Sands Missile Range covering missile systems assigned to Ordnance Mission for testing and evaluation.

$73,000—IBM, Federal Systems Div., Owego, N.Y., for fabrication, packaging and delivery to ABMA of one prototype digital computer.

$49,121—Curtiss-Wright, Wright Aeronautical Division, Wood-Ridge, N.J., for research and engineering study in connection with the development of high-strength rocket motor cases utilizing interlocked titanium wire.

$46,757—Bulova Research & Development Laboratories, Woodside, N.Y., for feasibility study directed toward "Optimization of Polecat Weapon System."

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CLASSIFIED

editorial . . .

Slippage and What's to Blame

Lost in the thunderous build-up to the presidential nominating conventions is a rather distressing piece of news. The Air Force has revealed that construction of the first combat *Atlas* ICBM pads at Warren AFB outside Cheyenne, Wyo., has slipped six months or more.

Remarkably, not very many people in Washington appear to be particularly concerned. The candidates have not yet picked it up as an issue—or even mentioned it. Yet here is a clear-cut instance where there will be further delay in closing the Missile Gap with Russia.

The pads at Cheyenne—six in the first squadron—were scheduled to be operational by April. In the middle of last month, Gen. Curtis LeMay looked over the installation and said it appeared the pads would not be ready until September.

The Air Force, when queried by M/R about the LeMay statement, said the slippage was confined solely to the first squadron at Cheyenne.

However, since then, reports have circulated that some slippage is to be anticipated in the finishing of some *Atlas* launchers at Offutt AFB near Omaha, Neb., this summer.

What is the reason for the delays?

The answer is at best rather nebulous. The newspaper at Cheyenne, the *Wyoming State Tribune,* notes that since construction started in 1958, about 24 months ago, there have been 21 labor disputes. Work stoppages, says the paper, have resulted more from inter-union jurisdictional disputes than from management-union issues.

But the unions say: "Not so."

They claim the stoppages have been short and scattered. They hold the Air Force responsible for any delays.

The Air Force, which for some not very clear reason (since *Atlas* is a crash program), says it has a "hands off" policy regarding labor disputes, and in a way, it indicates that it does not hold labor difficulties primarily responsible. For the Air Force has not requested any Executive Department intercession, nor does it intend—at the moment—to ask for any.

At the same time, the Air Force does not hold the contractor—Convair—responsible. It says simply that the task of readying the pads is an enormously complex job—a job being undertaken for the first time—that some delays are to be anticipated.

This seems a logical enough explanation. But it is rather interesting that the Air Force did succeed in putting a coffin-type pad—like the ones in the first Cheyenne squadron—in shape for a training shot last month from Vandenberg AFB.

True, the Vandenberg pad did not require all of the equipment going in at Cheyenne. But it is a reasonable facsimile. It shows most of the design and circuitry problems have been licked.

Then why the delay?

It is a curious characteristic of big government and big military programs that when something goes wrong it is very difficult to point the finger at who, or what, is to blame.

Indeed, the bigger a program gets the more difficult it is to single out a weakness and correct it—in time.

Bigness today is a challenge in itself. Just because something grows large does not mean it will move forward.

But bigness is not the only problem. The military and its contractors will set their own pace in the absence of strong direction and a persistent whip at their backs.

That whip really can be flicked only by the White House.

William E. Howard

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UNITED AIR LINES

Circle No. 5 on Subscriber Service Card.

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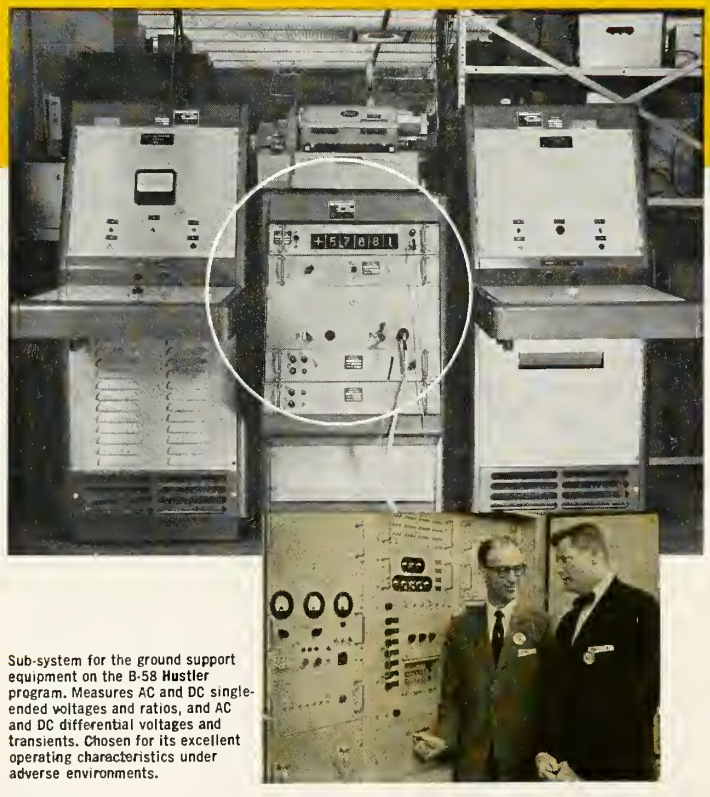
Systems shown here are typical of more than 200 designed and built by EI and now in use. They range in complexity from data logging systems for automatic scanning, measurement and recording of data from multiple transducers...to high speed, automatic checkout systems for missile and aircraft...to systems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

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

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

Multi-purpose digital system for measuring a variety of transistor parameters while the transistors are being subjected to environmental testing.



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

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

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

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

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