June 13, 1960

missiles and rockets

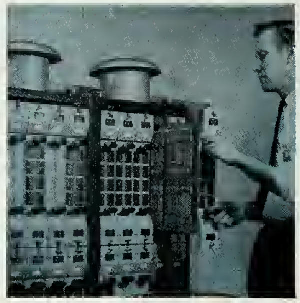
THE MISSILE/SPACE WEEKLY

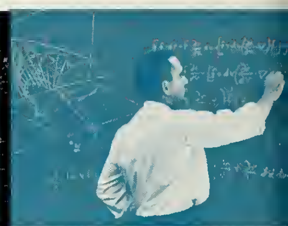
Periscope for Astronauts

AN AMERICAN AVIATION PUBLICATION

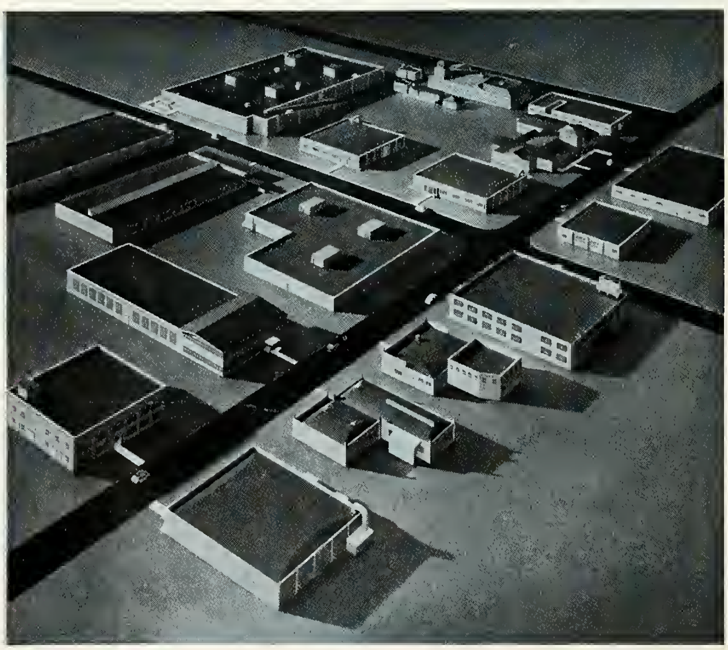
LIBRASCOPE COMPUTER FACILITIES

Shown below is a composite view of Librascope's facilities where a variety of computer systems are currently in different stages of design and production. Some are strategically involved with national defense...others deal with business and industrial process control. Each is uniquely designed to answer a particular need. The success of these systems illustrates the value of Librascope's engineering philosophy: A decentralized organization of specialized project teams responsible for assignments from concept to delivery...and backed up by excellent research, service, and production facilities. For your computer requirements, call on the company whose breadth of diversification in computer technology is unsurpassed. ■ Librascope Division, General Precision, Inc., 808 Western Avenue, Glendale, Calif. For career opportunities write to John Schmidt, Engineering Employment. ■





computers that pace man's expanding mind



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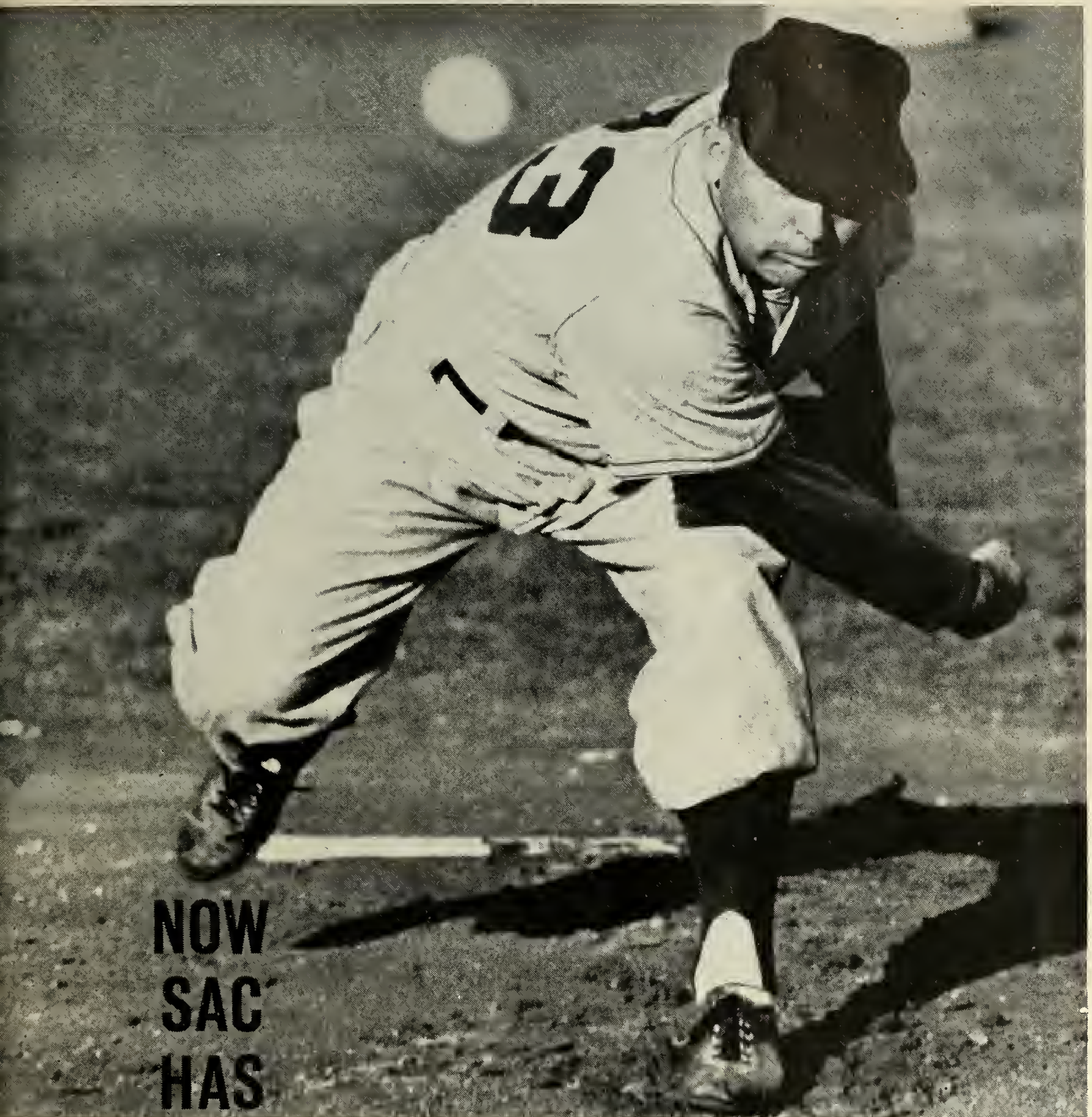

TWO STRIKES ON THE OPPOSITION

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

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Wayne W. Parrish
President

Leonard A. Eiserer
Exec. Vice President and General Manager

Fred S. Hunter
Vice Pres. and Editorial Director

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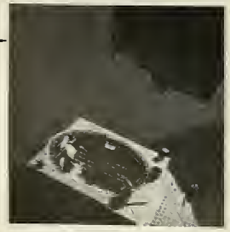
An American Aviation Publication

THE COVER



Mercury astronaut will get man's first view from space back to earth through this periscope developed by the Perkin-Elmer Corp. *See report on p. 12.*

JUNE 13 HEADLINES

ELECTRONICS

PROPULSION ENGINEERING

ASW ENGINEERING

HUMAN FACTORS

ADVANCED MATERIALS

DEPARTMENTS

31,052 copies this issue

THE ARDC MODEL ATMOSPHERE, 1959, R. A. Minzner, K. S. W. Champion, and H. L. Pond, USAF. Order PB 161305 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 151 pp., $2.75.

A revision of a 1956 book, this edition is based on new rocket and satellite data. A model of the earth's atmosphere up to 700 kilometers is described.

THE USE OF HIGH-ALTITUDE ROCKETS FOR SCIENTIFIC INVESTIGATIONS: AN ANNOTATED BIBLIOGRAPHY, M. Benton Technical Information Div., USNRL. Order PB 151805 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 132 pp., $2.75.

The growth and development of upper-atmosphere study by rockets is described in periodical articles and technical reports, referenced and annotated for the period from 1946 through mid-1959.

MISSILE AERODYNAMICS, Jack N. Nielson, McGraw-Hill, New York, 450 pp., $12.50.

The text's purpose is to give a "rational, unified account of the principal results of missile aerodynamics," which the author succeeds in doing through strong reliance on NACA and NASA reports and on his own experience at the former agency, where he was an aeronautical research scientist. The presentation is clear and standard, corresponding to the classical report methods set up at NACA.

The subject matter is mostly post-war material, covering bodies, wings, and tails and the interactions between them. Methods are given for determining the air flow around missiles including vortex generation. Chapters are devoted to stability derivatives for missiles, and aerodynamic controls.

PHYSICS AND MEDICINE OF THE ATMOSPHERE AND SPACE, edited by Maj. Gen. Otis O. Benson, Jr. and Dr. Hubertus Strughold, John Wiley, New York, 645 pp., $12.50.

In late 1958, the Second International Symposium on Physics and Medicine of the Atmosphere and Space was held at USAF's School of Aviation Medicine in San Antonio. Papers then given by prominent authorities in the field have been collected, edited and published in the present book.

The book seems well worth having as a succinct and technical record of the state of the art in space as related to physics and medicine. It gives most attention to the astronaut's environment in space. Radiation problems in space and laboratory simulation of ambient conditions in space are considered, together with such other topics as vehicles for space exploration, weightlessness, and escape and rescue in space.

AEROSPACE DICTIONARY, Frank Gaynor. Philosophical Library. 260 pp., $6.

Some sample definitions:

Space flight—flight in outer space.

Space propulsion—Propulsion of a space vehicle through space.

Deep space probe—A probe that penetrates deep into space.

Headward acceleration—Acceleration of the human body in the direction of the head.

Interstage section—A section of a missile that lies between stages.

THEORY OF INERTIAL GUIDANCE. Connie L. McClure. Prentice-Hall, Inc., Englewood Cliffs, N.J. 368 pp., $9.00.

Comprehensive and sound in theory, this book provides a solid approach to the fundamentals and theories of inertial guidance. It reviews the classical concepts of Newtonian dynamics and motion, and includes both past and current research on the subject to make it most timely. Classical gyro-dynamics and the preliminary theory of stabilized platforms are also covered. Six appendices and an extensive bibliography make the book a valuable reference for senior and graduate-level studies based on an undergraduate background in mathematics and elementary mechanics.

Like many of its kind, this book is afflicted with the tendency toward high-level "engineeringese" that makes it difficult reading even for its intended audience. Simplification of terms and avoidance of unnecessarily obtuse and complicated phraseology would do much to make it more readable and interesting.

THE DYNAMIC BEHAVIOR OF THERMOELECTRIC DEVICES. Paul E. Gray. Technology Press (MIT) and John Wiley & Sons, Inc., New York. 136 pp.

A Technology Press Research Monograph, this is the first published report that investigates the small-signal dynamic behavior of thermoelectric devices. Based on a study sponsored by the Air Force, it was the basis of a doctoral thesis submitted by the author.

The book considers the dynamic behavior of thermoelectric devices as a prerequisite to their control in useful applications. Since such devices are nonlinear distributed-parameter systems, it is difficult to analyze their behavior exactly. This study, therefore, is based on linear small-signal distributed-parameter models for which useful analytical results can be obtained.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOL. 2, BATTERIES, E. J. Hellund, Plasmadyne Corp. for USAF. Order PB 161262 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 97 pp., $2.25.

This volume is a survey of the performance characteristics, structure, power-weight ratios, and power-volume ratios of chemical and nuclear batteries. It also evaluates fuel cells.

Performance data on various battery types include watt hours per pound, watt hours per cubic inch and other data.

The report includes charts, graphs, illustrations and tables of comparative statistics on the performance of various cell types.

AUTOMATION AND PERSONNEL REQUIREMENTS FOR GUIDED MISSILE GROUND SUPPORT FUNCTIONS. W. B. Knowles. Order PB 151978 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 49 pp., $1.25.

The study was conducted to determine the relations between automation and personnel requirements for guided missile ground support functions.

Snark, *Bomarc*, and *Mace* systems were investigated regarding organization-level maintenance of electronic equipment. A maintenance system concept was developed to explain in more detail the respective roles of automatic equipment and manual operations and general outline of maintenance system factors.

CURRENT REVIEW OF THE SOVIET TECHNICAL PRESS, Order No. 60-21441 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. Published weekly. Subscription $7 for six months.

This weekly review covers Soviet articles in many fields of science and technology. Articles are not translated in their entirety, but a citation is given to the original Russian publication. OTS says the time lapse between appearance of an original article in a Russian publication and its review is no more than a few weeks and usually within a month.

BASIC ULTRASONICS, Cyrus Glickstein. John F. Rider Publisher, Inc. New York. 144 pp., $3.50 soft cover, $4.60 cloth cover.

The book is divided into three major sections covering the theory of ultrasonic waves, their generation, design of equipment, applications, biological and chemical effects, cameras and instrumentation.

Review questions are contained at the end of each section and a glossary of ultrasonic terminology is included.

The Countdown

WASHINGTON

Missileer Award Near

Look for the Navy to name a contractor by the end of the month for a slow-flying long-range "Missileer" aircraft to carry the *Eagle* missile. Insiders are betting Chance Vought will get the multimillion-dollar award.

In Solid Together—So Far

To anyone who cares to ask, NASA's new conical solid-propellant motor is being billed as "complementary" to the Air Force's Project 3059. United Technology Corp. has the $186,000 study contract on the conical motor and the AF plans to let a contract for the other in a few weeks. However, both Project 3059 and the NASA conical motor would involve eventual fabrication of huge solid boosters of more than one million pounds thrust. Which means—sooner or later—someone will have to decide which one will be pushed to completion, setting the stage for another interagency squabble.

Sky Bolt on Tankers

Long-range jet aircraft such as the KC-135 tanker is expected to be the principal carrier of the *Sky Bolt* air-launched ballistic missile. Britain will probably use the Vickers jet transport. Interceptors also may carry the weapon.

No Quick Solution

Navy plans to produce a cheap, shore-bombardment missile with a conventional warhead now appear to involve tougher problems than many thought. The specs call for a missile of very high accuracy, very high reliability and relatively low cost. Study contracts are in force with several firms.

More X-15 and Scout Tests

First flight of the *X-15* with a 50,000-lb.-thrust XLR99 liquid engine made by Thiokol may come any day. Initial powered flights will be in "low gear"—about half the engine's potential, but still more than twice the thrust of the present pair of engines . . . NASA is expected to make a second flight test of the *Scout* solid-propelled rocket shortly. The first shot on April 18 aborted.

Talent Pool

The dispute over duplication in space medicine seems to be solved with the Air Force assigning a top man in the field—Col. C. H. "Chuck" Roadman—to NASA's Office of Life Sciences. Roadman has been chief of human factors under the AF's deputy chief of staff for R&D.

INDUSTRY

Better Batteries for Space

Reliability of batteries for satellites is proving a nagging problem. Accordingly, a considerable R&D effort is about to get under way. The problem is particularly acute in low-altitude satellites where solar cell/battery units are subject to rapid charge-discharge cycles—once each hour or so—for long periods of time.

Big Space Chamber Wanted

The Air Force is getting ready to build an enormous space environmental chamber at the Arnold Engineering Development Center at Tullahoma, Tenn. It will be capable of testing space vehicles—booster and all. Estimated cost: more than $50 million. This chamber will be in addition to a smaller one for testing only payloads such as the *Dyna-Soar* glider and satellite vehicles, which will cost $10 million to $15 million.

Single DOD Electronic Manager

In an effort to eliminate duplicate purchasing, the Government Accounting Office is urging DOD to establish a single central agency to manage electronic supplies. GAO says such an agency should monitor the entry of all new equipment into the supply system as well as coordinate and consolidate procurement throughout the services.

14-year Safety Record

The Air Force Ballistic Missile Division reports that in 14 years of launching ballistic missiles during their development phase there have been no fatalities. And despite some industrial fatalities—the BMD doesn't say how many—"the total ballistic missile safety record is excellent."

Aerojet Wins Hybrid Rocket

Drawn-out competition for the Navy's hybrid liquid-solid-fueled rocket has ended with the award of a $580,000 contract to Aerojet-General Corp.

On Mahogany Row

Thiokol Chemical is setting up a separate nuclear space propulsion unit at Parsipanny-Troy Hills, N.J. . . . Martin Co. is now working in-house on a 10,000-15,000-lb.-thrust nuclear rocket sustainer . . . The nation's only commercial manufacturer of cyclotrons—Mevaa Corp., Santa Monica, Calif., is now a subsidiary of Hughes Aircraft . . . and High Voltage Engineering Corp. has acquired Applied Radiation Corp., Walnut Creek, Calif.

INTERNATIONAL

Government-Owned Missile Industry?

Shift to a government-owned and privately-managed guided missile industry is being recommended for Japan. The suggestion was made by a nine-man mission which inspected U.S. missile operations.

On the Way Up

Electronics production figures for 1959 show Japan taking a giant stride forward in detection and navigation equipment. In one year, the total has jumped from $7.9 million to $16 million. Output of radar alone has more than doubled.

Secret Deal Cooking?

Sources in Britain report Convair and deHavilland have concluded a missile deal. Details have been kept secret.

Pilâtre de Rozier and Marquis d'Arlandes (November 21, 1783), using a Montgolfier balloon, were the first to leave the earth to test man's physiologic reactions. This experiment was the forerunner of intensive Space Medicine studies of today.

SPACE MEDICINE

There is a relatively narrow zone above the surface of the earth in which man's physiologic mechanism can function. Hence the unrelenting search by Lockheed scientists into many aspects of Space Medicine.

Engineers already have equipped man with the vehicle for space travel. Medical researchers now are investigating many factors incident to the maintenance of space life—to make possible man's flight into the depths of space. Placing man in a wholly new environment requires knowledge far beyond our current grasp of human biology. Here are some of the problems under investigation: The determination of man's reactions; the necessity of operating in a completely closed system compatible with man's physiological requirements (oxygen and carbon dioxide content, food, barometric pressure, humidity and temperature control); explosive decompression; psycho-physiological difficulties of spatial disorientation as a result of weightlessness; toxicology of metabolites and propellants; effects of cosmic, solar and nuclear ionizing radiation and protective shielding and treatment; effects on man's circulatory system from accelerative and decelerative G forces; the establishment of a thermoneutral range for man to exist through preflight, flight and reentry; regeneration of water and food.

Exploration into unknown areas such as Space Medicine, provides endless stimulation to imaginative scientists and creative engineers. Research at Lockheed's Missiles and Space Division covers the entire spectrum—from pure basic research to development work, in support of current projects. Space Medicine is but one phase of Lockheed's complete systems capability in missiles and satellites. To maintain this position of leadership calls for an extensive research and development program—ranging from electrical propulsion research to advanced computer research, design and development. Typical current projects are: Man in space; oceanography; fuel cells; space station; space navigation; solid state electronics.

Engineers and Scientists: If you are experienced in work related to any of the above areas, you are invited to write: Research and Development Staff, Dept. F-29A, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / MISSILES AND SPACE DIVISION

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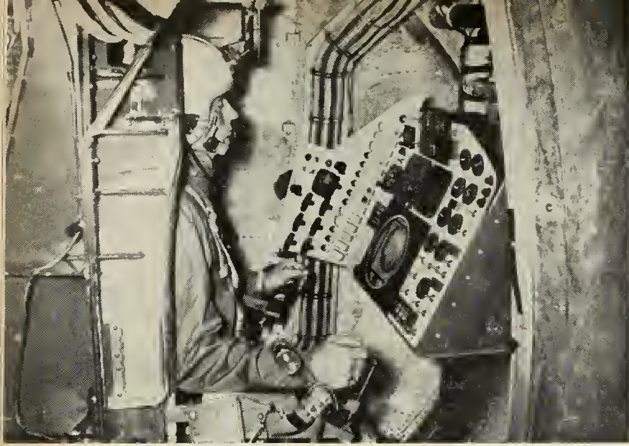


MERCURY ASTRONAUT undergoes flight simulation with instrument panel in the Navy's Human Centrifuge.

Mercury Instrumentation

Pilot's Fate Depen

Engineers try to design "fail-safe" system for the man-in-space capsule, with instruments able to compensate

by Paul Means

A few hundred pounds of instruments, seven miles of electrical wiring, mechanical linkage and several clock mechanisms hold the key to survival for the first astronaut who orbits earth within a *Mercury* capsule sometime in 1961.

Design and development of these components has been one of the greatest challenges yet posed to the practitioners of the new art of space instrumentation.

The problems have mostly been solved and the instrument configuration of the capsule is now fairly firm. The remaining answers will be found when the components are flight-tested. This work has been conducted by the McDonnell Aircraft Corp.—prime contractor for the capsule—and its subcontractors, by the laboratories of NASA's Space Task Group, and by other field centers of the space agency.

Design and development of the *Mercury* capsule's instrumentation has been under way since the old National Advisory Committee for Aeronautics began wind tunnel testing of capsule configurations over two years ago. The project began in earnest with the letting of the McDonnell contract.

The problems confronting *Mercury's* instrumenters began with the size and configuration of the capsule, which were frozen by the decision to use a ballistic re-entry vehicle and an existing ICBM booster.

This meant that space available and configuration were frozen by booster and aerodynamic requirements even before the instrumentation program got under way. An added consideration was that most of the instruments had to be mounted near the blunt end of the capsule to keep the center of gravity near the base.

Within these severe limitations, the instrumentation experts were required to come up with a completely reliable system that would provide the astronaut with the atmosphere and temperature necessary for survival, keep him and his instruments in constant contact with ground stations, and provide for a fail-safe operation of the capsule's flight and its abort from orbit.

• **Environmental control system**—The primary job of keeping the astronaut alive is the responsibility of the environmental control system being developed by McDonnell and its system subcontractor, the AiResearch Manufacturing Division of the Garrett Corporation.

There are two independent systems in the *Mercury* capsule that can keep the astronaut alive for a maximum of 28 hours: the cabin circuit and the suit circuit. Both operate simultaneously but either can operate in case of failure of the other. Both systems have redundant safety features which can maintain satisfactory operation after failure of certain components. The systems are operated automatically, and can be operated semi-automatically or manually by the astronaut.

Basic functions of the environment system are: to provide metabolic oxygen, pressurization (5psi) and ventilation to the suit and cabin; to maintain selectible cabin temperature between 50° and 80° in orbit and a maximum 200° during launch and re-entry; to remove carbon dioxide and water produced by the astronaut; and to provide comfortable humidity/temperature combinations within the pressure suit.

Common supplies to both systems are the oxygen containers and the coolant tank. Eight pounds of oxygen is supplied from two spherical 7500 psi containers—enough for 26 flight hours with a consumption of 500 cc/min. and a maximum cabin leakage of 300 cc/mm. Pressure transducers supply data on the supply pressures and pressure reducers lower the primary supply pressure to 100 psi and the emergency supply pressure to 80 psi. The emergency supply is automatically actuated upon depletion of the primary supply.

The coolant tank, fitted with an elastic membrane so that oxygen forces water from the tank, supplies water to the cabin and pressure suit control system heat exchangers. Valves on the astronaut's instrument panel meter the water flow.

Electrical power is supplied as 115-volt 400 cycle a.c. current to drive system blower motors. Twenty-eight volt d.c. current is supplied to operate the various solenoid valves and system instruments.

• **Pressure suit control system**—Prior to launch, the astronaut closes his helmet face-piece and breathes 100% oxygen. Though he will later open visor and use the cabin's environmental system, anytime he chooses to close the visor the suit provides him with a complete environmental system.

The suit, a modification of the Navy's Mark IV suit developed by the B. F. Goodrich Co., has a ventilation system which admits oxygen at the chest connection, then distributes the air over the entire body and vents at the helmet connection. The pneumatic visor seal is operated by a separate high-pressure oxygen source, and can be unsealed by pushing a red button on the side of the astronaut's helmet.

The oxygen circulation within the suit picks up carbon dioxide, water vapors and body odors. The odors are removed by an activated charcoal bed, the CO_2 with lithium hydroxide, and the air is cooled in the heat exchanger. Water condensed from the oxygen is caught with a vinyl sponge which is squeezed out periodically into a condensate container.

In the event of cabin decompression a demand-type pressure suit regulator senses the loss in pressure and maintains the suit at 4.6 psi.

In the event that the normal suit pressurization systems fails, an emer-

Seven Miles of Wiring

for any conceivable failure. Pilot himself would be only a back-up system for the instruments themselves

gency rate valve will immediately direct an oxygen flow of 0.01 lb./min. through the suit and out an exhaust port of the suit's regulator into the cabin; the pressure suit control system compressor is automatically turned off and a system shutoff valve closed.

If the suit's failure is not automatically sensed, the emergency rate valve also may be actuated manually by a control handle on the capsule instrument panel.

• **Cabin control system**—After launch, the astronaut will lift his visor and use the cabin's environmental system. A relief valve automatically controls the upper limit of cabin pressurization. The valve allows cabin pressure to follow ambient pressure up to 27,000 feet following launch. The oxygen is metered into the cabin between 10,000 and 27,000 feet, where the valve seals the cabin at 5.5 psi.

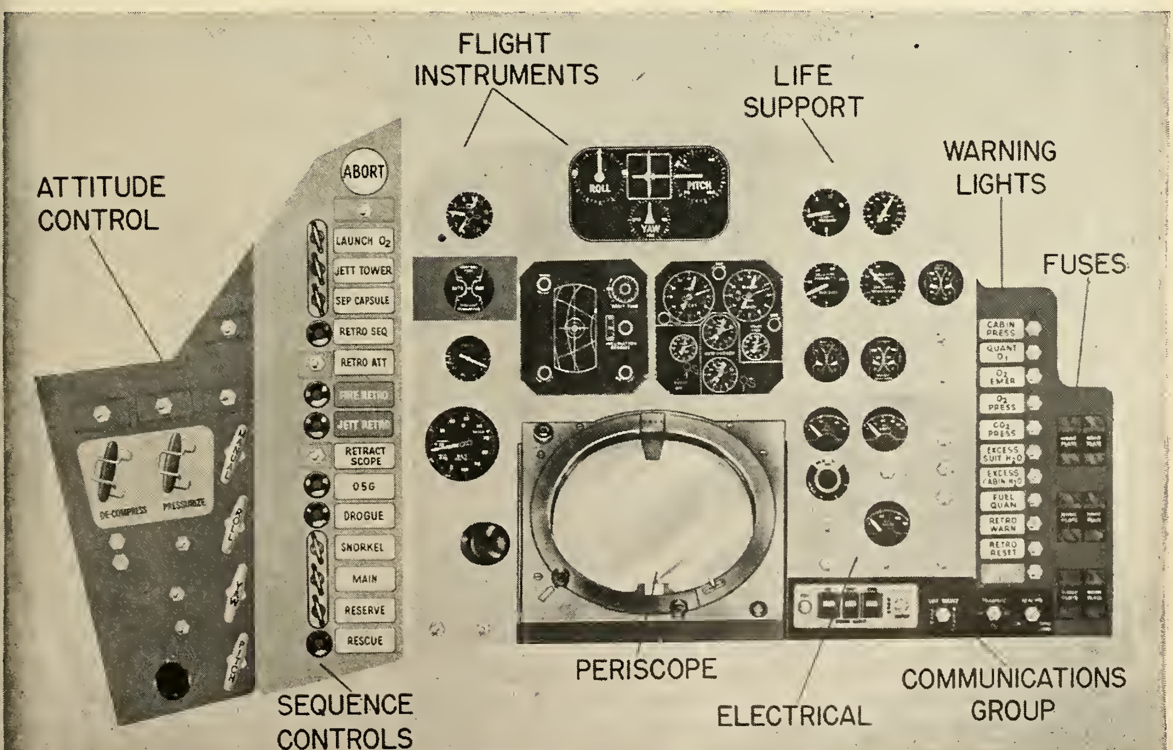
The astronaut's instrument panel also has a manual decompress lever, so that he can go back to his pressure suit's system and decompress the cabin in case of fire or buildup of toxic gasses. The regulator valve metering oxygen into the cabin shuts off during decompression when pressure has dropped below 4 psi so that cabin decompression does not deplete the oxygen supply. After decompression, another lever on the astronaut's console allows him to repressurize the cabin.

After re-entry when the capsule has dropped to 20,000 feet, snorkel inlet and outflow valves are opened by a barometric control. Simultaneously a shutoff valve in the pressure suit control system is closed and the emergency rate valve is opened. Ambient air is then drawn in through the snorkel, enriched with oxygen, forced through the pressure suit, and then exits into the cabin. The snorkel valve also has a manual backup on the sequence panel.

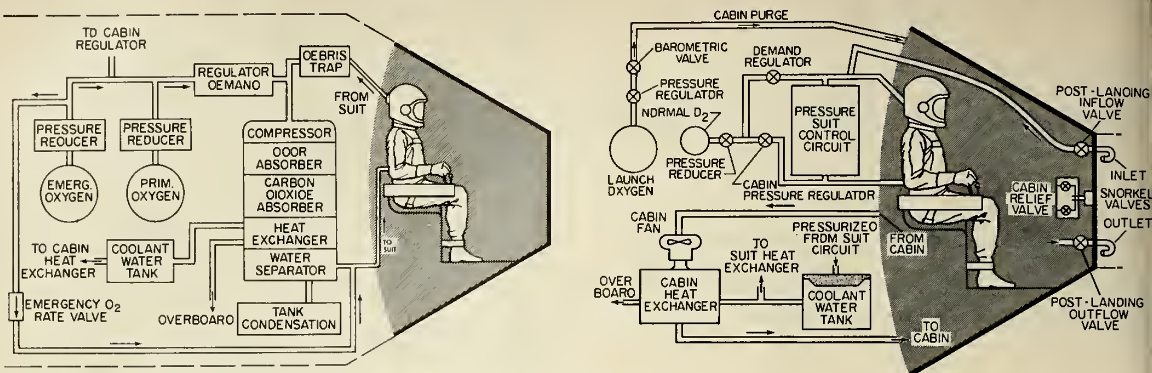
• **Controls**—The astronaut's controls for the environmental are grouped in the upper right-hand corner of the instrument panel (see cut). These give the pilot manual control over cabin pressure, temperature, relative humidity, oxygen partial pressure; primary and emergency oxygen supply pressure; and carbon dioxide partial pressure downstream of the lithium hydroxide canister in the pressure suit control system.

Warning lights are placed on the right-hand side of the console informing the astronaut when any particular facet of the environment system has failed. He then uses the instruments mentioned above to correct the situation.

Other manual controls provided on



A DRAWING of the Project *Mercury* capsule instrument panel to be used as a back-up.



TWO LIFE-SUPPORT SYSTEMS are available—the pressuresuit system (left) and the cabin system.

the instrument panel to maintain the cabin's environment are the system controls located on the left side for cabin decompression and repressurization. On the flight sequence panel (left) are the launch oxygen supply and snorkel operation controls. Failure of these operations is indicated by a red light, telling the astronaut to complete the functions semi-automatically by pushing the buttons next to the lights. Successful completion of these functions is indicated by a green light.

• **Testing**—Before the astronaut ever relies on the environmental system a "black box" human simulator will be flown in the capsule. The box squirts carbon dioxide and consumes oxygen at the rate a human would.

• **Communications and power supply**—Another important segment of the capsule's instrumentation are the transmitters, receivers, and power supplies that allow constant communication with ground stations and facilitate recovery after abort.

Two-way voice links with the ground are affected by use of high-frequency and ultra-high-frequency transmitters and receivers operating simultaneously. Backing up these two systems is the UHF recovery phase transmitter/receiver operating from a separate power supply.

The UHF and HF systems weigh about 2½ lbs. each. The HF system operates at five watts and the UHF system at either one-half watt or two watts.

The HF transmitter's range depends on time of day, season of year, sun spots, etc., but should be effective for 700-1000 miles, and tests show that it could be effective to 4000 miles. The system will be flight-tested by airplane in the near future.

There are two identical command receivers and decoders through which three functions may be initiated from the ground. These are resetting the retro timer, firing the retros, and aborting the missions. Weighing about 5 lbs. each, they can also receive voice communication simultaneously with the UHF and HF links when the capsule is in range of the command transmitters. This is the only system that may not be in constant contact with the ground at all times.

There are also two telemetry links, both in the UHF band, but one at a higher frequency than the other. These, together with the capsule's tape recorder, are the prime sources of data. These transmitters weigh about one lb. each with a one lb. power supply, and use about 3.3 watts a minute each.

The *Mercury* network uses both C-band and S-band radars and consequently both C- and S-band radar beacons are carried aboard the capsule. Each weighs about 12 lbs. The C-band unit operates on 400 watts and the S-band on 1000 watts.

The recovery HF and UHF rescue voice transmitter receivers, mentioned above, weigh approximately 2½ lbs. each. The HF system operates at one watt, and the UHF at ½ or 2 watts.

As an aid to search and recovery, a combination of the SARAH and SEA-SAVE beacon is carried on the capsule and is activated after the main parachute is deployed. This system operates on the international rescue frequency of 500 kc. This system weighs 3½ pounds, and uses 7.5 watts for the UHF system and 1 watt for the HF system.

Another UHF SARAH beacon will be used on manned flights, and will have another antenna and a completely different power supply. This system weighs about 3½ lbs. and power will be in excess of 1000 watts.

While in orbit, all communication links with the exception of the radar beacons are multiplexed into a common discone antenna located in the truncated cone at the rear of the capsule.

This antenna section is jettisoned at deployment of the parachute, at which time the UHF links are transferred to a monopole antenna which is directly in back of the cylindrical portion of the capsule. Upon contact with the water, the parachute is jettisoned and an HF antenna is deployed by a helium-filled balloon.

• **Power supply**—Electrical batteries are used as the power source and alternating current is produced by solid-state inverters. There is a main battery and an isolated auxiliary battery. Also aboard is a backup standby battery which is automatically switched on in event of failure of either of the other two batteries.

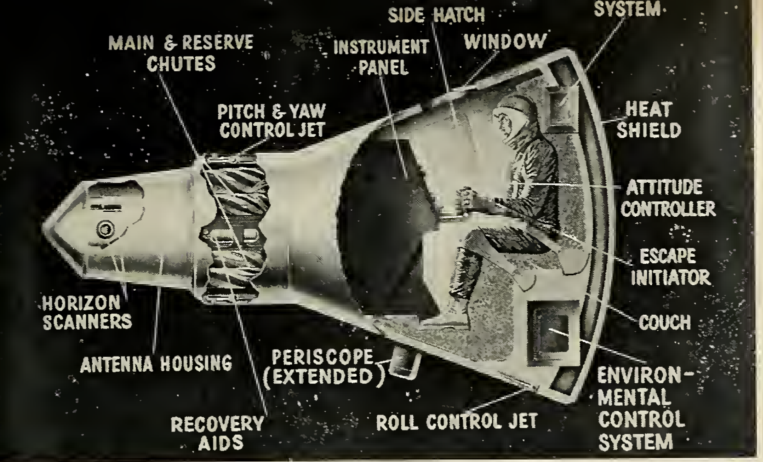
A standby inverter is also switched on in event of failure of either of the regular inverters.

Total rate of output capable by the battery systems is 1500 watt hours.

• **Control system**—If the control system functions properly, the astronaut's presence would not be needed, and his instrument panel would merely inform him when each of the sequenced events took place. The environmental control system, and its backups, have already been discussed. The important control systems direct the flight an abort of the capsule.

• **Attitude control**—Mounted in the top of the conical frustrum section are the infrared horizon scanners, whose signals are fed to the automatic control system. Capsule attitude is controlled by hydrogen peroxide reaction jets; the pitch and yaw are located in the main parachute housing, while the roll jets are located near the heat shield.

Six nozzles are used for each axis: three for positive and three for negative rotation. To conserve fuel, low-thrust jets are installed in addition to the high-thrust jets for the automatic system. The third nozzle is part of the variable thrust manually controlled system, operated by the astronaut with



his right-hand control.

The auto pilot used for automatic control consists of two attitude gyros, three rate gyros, and logic and programing circuits. During the flight, the vertical gyro is erected by the horizon scanners. Erection is programed every ten minutes. The vertical gyro is also constantly precessed in pitch to match the capsule's rotation about the earth. The directional gyro is also erected at the same time as the vertical gyro. This is accomplished by aligning the gyro axis to eliminate apparent precession due to yaw error as the capsule rotates in pitch as it circles the earth.

The thrust chambers are controlled by solenoid valves. The low H_2O_2 pitch and yaw chambers are one one-lb.-thrust units and the high-thrust chambers are 24-lb. units. For roll, six-lb. and one-lb. units are used.

The manual control system, which has another complete set of thrust chambers, is throttleable. The chambers are rated at 24 lbs. thrust for pitch and yaw and 6 lbs. of thrust for roll. Each chamber can be operated either through a solenoid valve or a mechanical valve, depending on the method by which the pilot is using his control system.

The pilot can, through his right-hand controller, command the rate of rotation in any of the three axes. Solenoid valves provide on-off control. Rate imput is obtained by an additional set of rate gyros. In the event of electrional failure, the pilot can elect to operate the same system directly through mechanical ligages using mechanical valves which are proportional. A third alternative available to the pilot is that he can control the thrust chambers of the automatic control system through electric switches on his controller, though proportional control or rate input would not be available.

During a normal mission, the automatic control system would use the damping mode (where the attitude sense is cut out) for a period of about five sec. Then the system would shift to the orientation mode while the capsule is rotated 180° in yaw and pitched up 34° into the retrorocket firing attitude.

The capsule stays in the retro attitude for five min. while range monitors determine whether the capsule is in a suitable orbit. Then the capsule is reoriented to the orbital attitude which is 14° nose up. This places the periscope axis normal to the earth.

At this point, the automatic control system is shifted to the orbit mode and remains there until it is time to fire the retros, when the control shifts back to the retro position. After the retros have fired, the system again shifts the capsule to the orientation mode, and reorients the capsule to the re-entry attitude of 1½° nose down. After entry into the atmosphere is sensed by a 1/20th-g acceleration switch, the automatic control system shifts into the damping mode where it remains until the main parachute is deployed, at which point the remaining H_2O_2 is jettisoned through the pitch and yaw thrust chambers.

• **Instrument panel**—The astronaut's console should allow him to safely complete his mission regardless of which automatic control fails to function, and even if the entire electrical system fails.

Simpler than the instrument panel in most aircraft, the controls and displays are grouped as to function. The left side (see picture) contains the controls concerned with attitude control and retros. The two large handles are used for decompression and repressurization, described earlier.

Next on the left side of the panel is the vertical sequence panel, which will indicate what functions have occurred automatically. If any of the lights come on red, it indicates a failure in the automatic sequence system, and the handle to the left is the pilot's control to actuate that particular system.

The next series of instruments indicate acceleration, quantity of control fuel remaining, rate of descent, and altitude. By watching the altimeter during descent the pilot will know when to manually deploy the parachutes if the automatic system malfunctions.

The instruments in the top center indicate capsule attitude and angular rates. With the aid of these instruments or the periscope, and the window, the pilot can orient the capsule and fire the retrorockets.

• **Periscope**—Designed by the Perkin-Elmer Corporation, the periscope will give the astronaut man's first view back to earth from space, and will provide him with visual navigational information about the satellite's flight path.

To minimize friction-causing proturbances in the capsule's outer shell, the periscope is mounted so that its objective cartridge extends and retracts through the skin of the space vehicle. The display area, on which light gathered by the objective lens passing through an optical system presents an image, is about 23 in. from the observer's nominal eye position, with an eye freedom of about one inch.

The satellite's altitude and attitude with respect to the earth and relative bearings of the sun and moon are displayed by reticle marks and associated controls.

The periscope uses a wide-angle objective lens with a field of about 180°; giving adequate coverage of the earth's horizon, which subtends an angle of roughly 151° at an altitude of 115 nautical miles.

When the earth is centered on the periscope's display, the outer part of the circular view shows the earth's horizon circle, and the center, which can be magnified by a mechanically linked power change lens, represents the end of a vertical line to the center of the earth, giving a true view with radial distortion less than 10%.

This view gives the astronaut the satellite's position relative to earth, drift, altitude, pitch, roll, true vertical, retrograde angle, and field of view of the earth sky camera.

*Editors note: Information for this article was obtained through personal interviews with Dr. Stanley White and Ralph Sawyer of NASA's Space Task Group, and from the following papers: "Manned Space Flight" by Warren J. North, head of NASA's Manned Satellites Program; "*Mercury *Capsule and its Flight Systems, by Maxime A. Faget and Robert O. Piland of NASA-Space Task Group; and "Review, Scope and Recent Results of Project* Mercury *Research and Development Program by Aleck C. Bond and Alan B. Kehlet of NASA-Space Task Group.*

FY '61 Missile Aid: $210.5 Million

The Administration plans to buy $210,511,000 worth of missiles and spare parts for its Free World allies during FY 1961.

The new military aid missile budget would bring to $780.5 million the total spent by the United States on deliveries of missiles to allied forces since July 1955.

The House released figures last week on U.S. military aid spending as:

• The Pentagon announced that Britain will buy Douglas *Sky Bolt* ALBM's when the missiles are operational—about 1965. The RAF will deploy the 1000-mile range nuclear-tipped missiles aboard their V-bombers and jet transports.

• Thirty-three members of the NATO Infrastructure Committee toured U.S. military installations and defense industries. Their primary interest was in possible purchase of Lockheed *Polarises* as an all-NATO IRBM. The NATO *Polaris* would be launched from fixed sites or mobile platforms rather than from ships.

• British defense officials also studied *Polaris* for possible use aboard British surface ships.

The newly-released House testimony shows that the United States has spent $282,068,000 to date on delivery of IRBM's to NATO nations. The FY '61 program includes another $31,900,000.

Each of the four 15-missile *Thor* squadrons deployed in Britain has cost the military assistance program $56 million. Each of the three 15-missile *Jupiter* squadrons that will be deployed in southern Europe—two in Italy, one in Turkey—will cost $77.9 million.

Total cost for all seven squadrons will be nearly $458 million. The figure does not include development costs.

Besides the IRBM's, the other three major items in the FY '61 foreign aid missile program are $53 million for Western Electric *Nikes*, $31 million for Convair *Terriers* and $31 million for Martin *Maces*.

The program also includes for th[e] first time some funds for the new *Dav[y] Crockett*—the short-range nuclear tipped missile that can be carried an[d] launched by two men.

Military Aid Missile Program

Missiles	Area of destination for operational missiles	Deliveries of fiscal years 1956-60 program through June 30, 1960 (in thousands)	Fiscal Year 1961 program (in thousands)
CORPORAL	Europe, undistributed	$ 20,875	
NIKE	NATO, Far East, undistributed	159,740	53,013
HONEST JOHN	NATO	32,077	8,533
SIDEWINDER	Europe, Near East and South Asia; Far East	15,883	5,848
IRBM	NATO	282,068	31,900
TARTAR	Europe, Far East	8,700	14,871
TERRIER	Europe	2,553	31,016
SS 10-11	Near East and South Asia; Far East	3,600	
TARGET DRONES	NATO, Far East		2,388
LACROSSE	Europe		10
MACE	Europe	18,526	31,415
SERGEANT	Europe		10,010
MISSILE SPARES AND COMPONENTS	Europe, Near East and South Asia, Far East	26,017	3,780
HAWK	Far East		16,400
DAVY CROCKETT	NATO		1,327
TOTAL		**$570,039**	**$210,511**

Strikes Threaten to Spread

"Selective" strikes called by the International Machinists Union last week threatened to spread throughout the entire missile industry.

By week's end, the Machinists' partial strikes were in force at General Dynamics Convair Division's facilities at San Diego and Palmdale, Calif.; at Holloman AFB and Patrick AFB; at the Vandenberg and Cape Canaveral missile test centers; and at *Atlas* missile base construction sites at Omaha, Neb., and Cheyenne, Wyo.

The Department of Defense stated the strikes had not hampered activities at Vandenberg operational *Atlas* sites, or launch activities at Cape Canaveral —except for *Atlas* tests.

Machinists at Douglas Aircraft's Santa Monica, Calif., plant took a strike vote Wednesday, and the company's El Segundo, Calif., plant has voted by 92.7% to authorize a strike. Members of the United Auto Workers at Douglas's Plants in Long Beach, Calif., Tulsa, Okla., and Charlotte, N.C., had also authorized or were in the process of authorizing strikes.

About 10,000 machinists at Lockheed Missile and Space Division plants at Van Nuys and Sunnyvale, Calif., have said they would file the required five-day strike notice if negotiations proved fruitless.

Major areas of disagreement have to do with separation allowances (severance pay), wages and cost of living increases.

Bomarc Burns at McGuire; Radiation Not Dangerous

A nuclear-armed *Bomarc* antiaircraft missile burned up on its pad near McGuire AFB, N.J., Tuesday when its launching shelter caught fire.

Air Force authorities combed the surrounding area with Geiger counters and quickly announced that no radiation danger existed.

First reports of the mishap had caused widespread concern among the civilian population.

The *Bomarc* base's 250 personnel, uninjured by the fire, are also being checked for radiation exposure.

Air Force spokesmen said they believed that the missile's fuel system created a minor explosion in the pad shelter.

Senate Toes Pentagon Budget Line

by James Baar

The resounding collapse of the Paris Summit Conference could hardly be heard at all this last week by the Senate Defense Appropriations Subcommittee as it approved a defense money bill of about $40 billion.

The final figure expected to go to the Senate floor this week was less than a billion dollars higher than the original Administration defense request for FY 1961 and the amount passed by the House.

Even as the subcommittee acted, GOP Gov. Nelson Rockefeller of New York denounced the Eisenhower Administration and called for an immediate $3-billion increase in the defense budget. The move was an open challenge to Vice-President Nixon for the GOP presidential nomination.

Earlier, the subcommittee itself had brushed aside an urgent proposal by Sen. Stuart Symington (D-Mo.), another presidential candidate, that the defense budget be increased by $3.5 billion.

The subcommittee, in reworking the defense money bill passed by the House:

- Restored $294 million for the *Bomarc B*.
- Restored $400 million cut across the board from military procurement funds.
- Restored $293 million for a conventionally-powered aircraft carrier.
- Added $285 million for development of the B-70 Mach 3 bomber—a move that would once again elevate the B-70 to the position of a major future weapon system.

At the same time, the subcommittee cut:

- $73 million added by the House for *Minuteman, Midas, Samos* and *Discoverer*.
- $115 million added by the House for a bomber alert.
- $58 million of $100 million added by the House for ASW R&D.

The subcommittee disregarded Administration objections and approved an extra $241 million passed by the House for two more *Polaris* submarines. This puts five Polaris submarines in the bill and long lead-time items for seven more.

However, when all of the numerous adjustments were added up and subtracted, the net result was that the only major increase made by the Senate was the money for the North American B-70.

Some attempts to add more to the bill on the Senate floor were expected—particularly the cuts for *Midas* and *Samos*. However, the chances of major changes in the bill before it goes before a House-Senate Conference Committee appeared slight.

The Symington defense proposals that were put before the subcommittee called for major additions for all three services.

Symington asked for: $900 million for Air Force strategic missiles; $159 million for *Midas* and *Samos* and *Discoverer;* $800 million for Army modernization procurement; $414 million for an airborne alert; $360 million for B-70; and $241 million for *Polaris*.

The Symington proposals also included $465 million for all ASW including R&D and $160 million for expanding the size of the Army and Marine Corps. The funds would increase the Army from 870,000 to 925,000 men; the Marines from 175,000 to 200,000.

Rockefeller called for spending $3 billion more immediately on "additional and improved bombers, airborne alert, more missiles, more *Polaris* submarines, modernized equipment for our ground forces." He also urged the immediate appropriation of $500 million for a civil defense program.

"Our long-range missiles are not only inferior in number to those at Soviet disposal but also are dangerously vulnerable to Soviet attack," he said. "Our strategic bombers, though reasonably large in number, are concentrated on less than 50 bases, all clearly identified by the Soviets, every one defenseless against a direct missile hit.

"For all our reliance upon *Polaris* submarines, not one is operational now, and only two will be operational at the start of 1961. For all the dangers of local aggression, our forces for limited war are inadequate in strength and mobility."

The Senate Defense Appropriations Subcommittee and the Administration didn't see it that way.

Tucson Group Protests Titan Ring

The first sizeable protest against installation of ICBM's on U.S. soil is raising a small sandstorm around Tucson, Ariz.

A group of Tucson residents headed by Dr. James E. McDonald, professor of meteorology at the University of Arizona, is loudly protesting Air Force plans to surround the city with two squadrons of *Titans*.

McDonald's group, which calls itself the Committee Against Ringing Tucson with Titans, contends primarily that:

- The *Titans* should not be installed west of Tucson because in the event of nuclear attack on the missile sites the prevailing westerly winds would carry fallout over the Tucson area's quarter-million inhabitants.
- ICBM's can and should be placed farther from all centers of population than under present Air Force plans.

The committee has written letters of protest to top Air Force generals and government officials and late last month sent a petition with some 1100 signatures to Defense Secretary Thomas Gates.

The committee's slogan is: "'Move the Titans East."

However, it apparently doesn't want to move them too far east. A leaflet distributed by the committee in Tucson includes the statement:

"Merely shifting all Titan bases east will not deprive Tucson of any economic benefits."

Hughes Gets NASA Award For Ion Engine Development

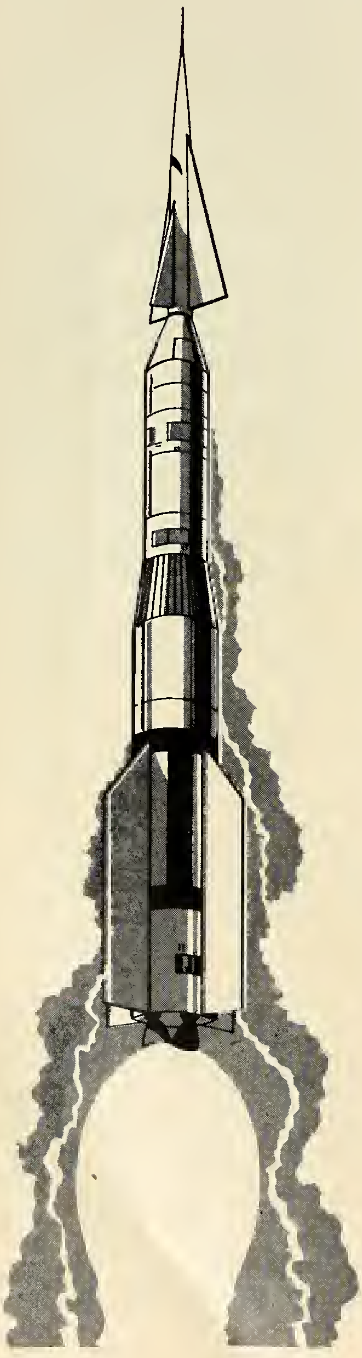
Hughes Aircraft Co. last week won a National Aeronautics and Space Administration competition on a contract to build a small laboratory-type ion rocket engine.

NASA, estimating cost at more than $500,000, said contract negotiations with Hughes would begin immediately. The engine, to be designed, developed and laboratory-tested in a year, will draw more than 3500 watts and generate 0.01 lb. thrust. If it proves the concept feasible, a later engine will generate 0.1 lb. thrust, drawing 30 KW—the output of a SNAP-8 nuclear powerplant.

The concept of the NASA engine is reported to be more sophisticated than that of a 0.1-lb.-thrust engine under development by Electro-Optical Systems Inc. for the Air Research and Development Command. The ARDC contract, awarded early this year, called for the construction of hardware at maximum speed under currently existing technology. Presumably, the ARDC engine also would be powered by SNAP-8.

Hughes was one of 11 bidders on the laboratory-type engine, which will be 8 in. long and about 4 in. in diameter.

Fins Likely on Titan Dyna-Soar Booster



BALTIMORE—It looks as though *Titan* will sprout fins to boost *Dyna-Soar*.

Martin Co. engineers have just about decided that the big ballistic missile needs aerodynamic control surfaces to provide stability on the upward flight through the atmosphere with a winged vehicle as payload.

The booster, according to present plans, will be the LOX-kerosene *Titan I*. If the bigger, storable-liquid-propelled *Titan II* develops as fast as proponents believe, the Air Force and contractors will take a new look at the booster system about a year from now. The decision might then be to go to *Titan II*.

Reliability is the foremost consideration in redesigning *Titan* to carry a manned vehicle, two Martin officials tolds M/R in an interview last week. Bastian (Buzz) Hello, *Dyna-Soar* program manager, and A. J. Kullas, technical director, said design would depend as much as possible on proven reliability—the principle of "Don't change what works."

This is why *Titan I* is preferred. It works. And by 1963, Martin engineers expect *Titan I* to have as good a reliability record as any missile in use. If the *Titan II* record can be forecast to be as good, a parallel development program will be proposed.

• **Questions raised**—Reliability is also the main reason for adding fins, Kullas declared. "Putting a winged vehicle aboard a ballistic missile," he said, "imposes problems of stability and control, raising questions in aerodynamics, structure and elastic response. For example, gusts of wind on launching could create a forcing function that would develop a greater load than could be handled by the control surfaces."

Although the weight of *Dyna-Soar* has not been disclosed, Martin says a *Titan I* is capable of putting 2 and ½ tons into a low orbit. Dr. Albert C. Hall, Martin vice president for engineering, has said it is possible to modify the missile to more than double the capability. Presumably, he refers to *Titan II*.

◄MANNED MISSILE—Here's an M/R artist's conception of how a *Titan* carrying a *Dyna-Soar* might look with fins. Actual configurations of *Dyna-Soar* and fins have not been released.

The *Dyna-Soar Titan* will be assembled and dynamic-tested in Baltimore, rather than Denver, where the ballistic missile is assembled. There will be no change in the location of manufacture of major parts, however.

At present, the fuel and LOX tanks for both stages of *Titan* are manufactured in Denver and other major parts—transition, skirt, tank splice, tail and fairing structures—are manufactured at Baltimore. The parts are shipped by rail to Denver.

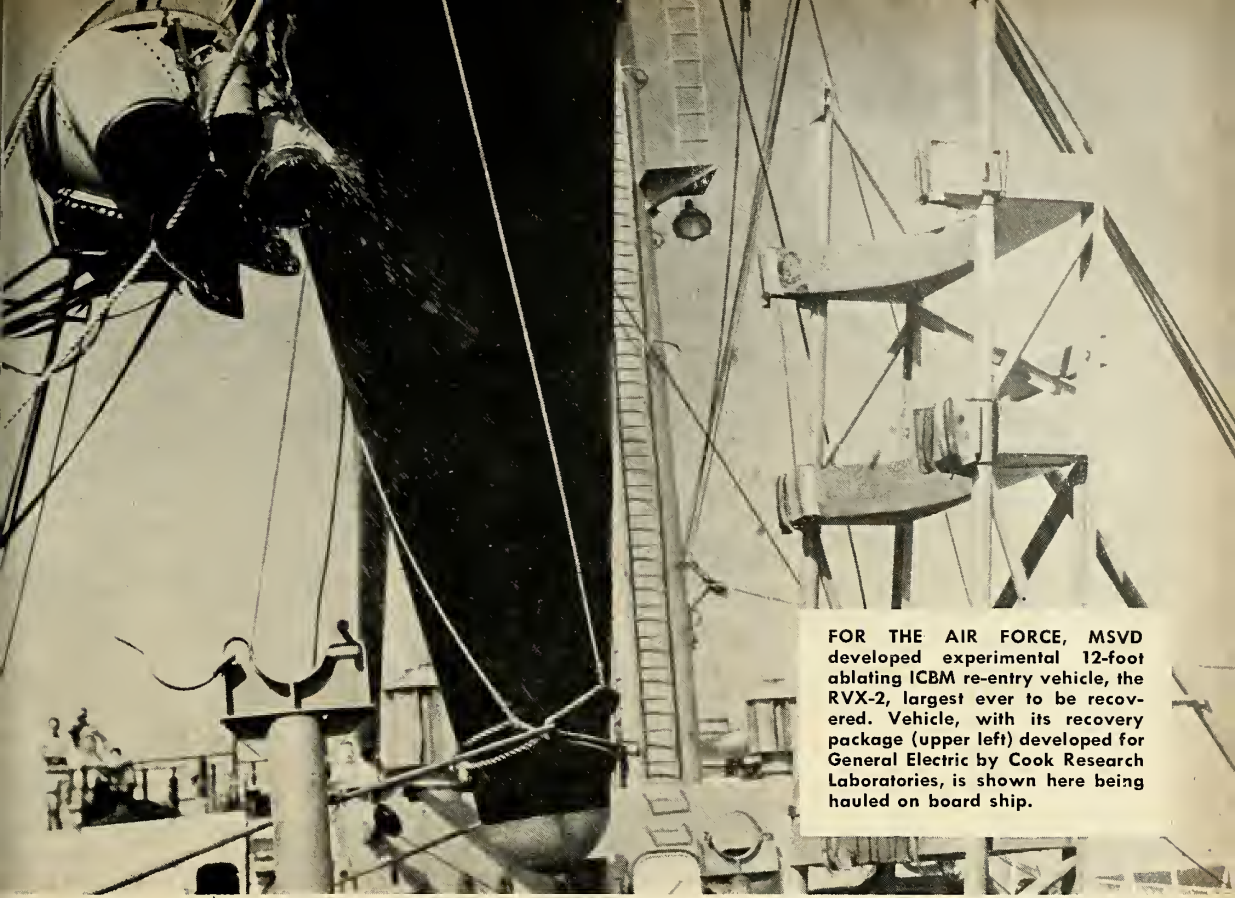
For *Dyna-Soar,* Hello said, the railroads will run east instead of west. Propellant tanks will be shipped to Baltimore for fabrication. Also to be manufactured here will be the new roll, pitch and yaw fins.

• **Heavy duty**—All firings of the new booster will be at Cape Canaveral. Dynamic tests will be performed in a special building built here originally for fabricating the P6M seaplane. Green Associates Inc., Baltimore engineers-architects who designed the building, report that the base slab of the 200-ft.-square building can resist uplift of 3 million lb. on any 30x100 ft. interior area. The roof trusses are designed to take a series of concentrated loads totaling 825,000 lb. per truss on any five consecutive panel points 20 ft. apart.

The structure is 65 ft. high. Martin engineers plan to knock one section out of the roof to accommodate the *Titan* erected vertically. A superstructure will be built atop the roof opening. During the testing, the booster will be subjected to all possible loadings to simulate loading caused by flight conditions.

Martin eventually is expected to receive contracts totaling $100 million for the five-year job entailed in its share of Phase I of the big project. A mockup of the booster is to be ready a year from now. Flight testing of the modified booster is due to begin in 1963. First flights will be suborbital, essentially to prove out the vehicle.

Since the release of Air Force funds April 27 for the first phase of the job, Martin has been assembling its technical staff here. Within a few months, the engineers and scientists will number a few hundred.



FOR THE AIR FORCE, MSVD developed experimental 12-foot ablating ICBM re-entry vehicle, the RVX-2, largest ever to be recovered. Vehicle, with its recovery package (upper left) developed for General Electric by Cook Research Laboratories, is shown here being hauled on board ship.

MISSILE AND SPACE VEHICLE DEPARTMENT

...center for missile and space technology research and development at General Electric

Progress in search and recovery

With each recovery of a space vehicle, scientists gain important new knowledge about the environment of space and its potential effect on man and the operation of vehicles and equipment. As more advanced vehicles are developed for space flight—some with life aboard—successful location and recovery become increasingly vital.

General Electric's Missile and Space Vehicle Department pioneered in the development of space vehicle search and recovery techniques as part of its re-entry and recovery vehicle program for the U.S. Air Force. MSVD developed and built the first payload to be recovered from space—an 18-inch data capsule ejected from an Air Force Thor re-entry vehicle on June 13, 1958. Many such data capsules have since been recovered from both Thor and Atlas flights—some carried cameras providing films from space. MSVD also developed and built the 12-foot long, one-ton re-entry vehicle shown above which the Air Force recovered on July 21, 1959—the largest to be returned to date. Today, as MSVD builds and flight tests more complex vehicles, it is continually expanding and improving its already successful search and recovery program.

Currently, this search and recovery experience is being applied to the development of such important space programs as the Air Force "Discoverer" recovery satellites and NASA's radiation research recovery vehicles (NERV).

For more information about MSVD's work in search and recovery, write to Section 160-79, General Electric Co., Missile and Space Vehicle Department, Philadelphia 4, Penna.

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A Department of the Defense Electronics Division

Scientists and Engineers interested in career opportunities in Space Technology, contact Mr. T. H. Sebring, Dept. 160, MSVD

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Expert Switched from AEC To Help Set Up Space Center

Morris to be Von Braun's administrative deputy; details of how ABMA will function under NASA after July 1

by Jay Holmes

HUNTSVILLE, ALA.—Veteran government administrator Delmar M. Morris has been transferred from the Atomic Energy Commission to the National Aeronautics and Space Administration to help Wernher von Braun organize the new Marshall Space Flight Center here.

Morris, until March deputy manager of the AEC's San Francisco Operations Office, has been assigned as Von Braun's deputy for administration and is organizing a staff of 1200 that will perform service functions for the 4300 technical workers now done by the Army.

The Von Braun group, which now is the Development Operations Division of the Army Ballistic Missile Agency at Redstone Arsenal, will move to NASA July 1 and become the George C. Marshall Space Flight Center. At the same time, 1200 acres of Redstone Arsenal will be turned over to NASA on a long-term, renewable, non-revocable lease.

The Army is setting up a new Research and Development Division of ABMA to replace the Von Braun group. The R&D Division will have a staff of about 350 July 1, and 1000 when fully staffed.

• **Hunting reciprocity**—Under a NASA-Army agreement, NASA will have a "hunting license" to recruit up to 815 of the needed 1200 support-type personnel from the Army at Redstone Arsenal. In turn, the Army will have a hunting license for up to 350 technical people to serve as the nucleus of the ABMA's R&D Division.

Dr. Arthur Rudolph, present *Redstone* and *Pershing* project director for ABMA, will head the new ABMA group. He will have a second "hat," however, as head of the Marshall Center Weapons Office.

The 10 laboratories of the Development Operations Division will be reduced to nine in the Marshall Center. The System Support Equipment Laboratory, which has been largely missile-oriented, will be abolished. Some of the people in the SSE Lab will go to the Army; the remainder will be distributed throughout the NASA center. A large group will join the new NASA Launch Directorate at Cape Canaveral, headed by Dr. Kurt Debus. Under the ABMA, the Debus group has been called the Missile Firing Laboratory.

Hans Heuter, head of the SSE Lab, will head a new office that will supervise the *Agena* and *Centaur* programs. *Agena* and *Centaur*, already NASA responsibility, will be supervised by the Marshall Center as part of its handling of all NASA launch vehicle development. Until now, these programs have been supervised for NASA by offices in the Air Force Ballistic Missile Division. On July 1, however, the Air Force will assign personnel in these offices directly to NASA.

• **Contract roles**—Under Morris, NASA is building up a support staff to handle such tasks as financial management, procurement, personnel, safety, supplies, plant maintenance etc. Contract administration is a difficult area, a Marshall Center spokesman said.

Under present plans, all contracts with the Army will be administered by the Army after the transfer until they come up for renewal, he said. Then NASA will do the renewing. A few major contracts, however, have already been awarded by NASA and will be administered by NASA. These include the Douglas Aircraft contract for developing a *Saturn* second stage and the contract to be negotiated with Rocketdyne for a 200,000-lb.-thrust *Saturn* engine.

Since the Marshall Center will be surrounded by Redstone Arsenal, the Army is providing exterior security. NASA will provide its own internal security. The Army will keep the satellite tracking station here; NASA will pay for its use. NASA will buy service from the Army for fire-fighting equipment and special laundry work on cleaning hazardous chemicals from clothing.

NASA will own the liquid rocket test area. The Army will own the solid rocket test area. Each will pay the owner for its use. The Army will have the right to ask the Von Braun group for technical services when needed and will pay for them. NASA will determine priority of the work.

Of the 1200 to be hired, for NASA, about 350 will be technical and the remainder support personnel. The build-up is to be completed during Fiscal 1961. It may not take that long, a spokesman said, noting that 1500 to 2000 people a year were brought here when Maj. Gen. John Medaris was building up ABMA a few years ago.

Morris, 47, is a civil engineer who has been employed by the government for 23 years. He spent seven years with the Tennessee Valley Authority, five years with the U.S. Bureau of Reclamation and nine years with the AEC, in addition to two years as a Navy Officer in World War II. A native of Champaign, Ill., he is married and has seven children.

• **Building uncertainty**—NASA has plans for extensive construction at Redstone after July 1. The 1961 budget includes $26 million for construction. The House cut $6½ million from this item, but there seems to be a good chance that the budget will be approved in full by the Senate. The fate of the building program in that case would be in the hands of a House-Senate conference committee.

The biggest item cut was $4½ million for a new headquarters building for the Marshall Center here. After July 1, the Marshall group will share headquarters facilities with ABMA. Spokesmen for both groups report that office space is at a premium in the headquarters building already. The House also cut plans for expanding the guidance and control building and the fabrication building.

Untouched were plans for constructing a second *Saturn* static test stand at a cost of $2 million. This is in addition to a plan already in the works for a dynamic test facility at Redstone, which will be used to check mechanical erection of the *Saturn* vehicle but will not be used for engine firings.

NASA Broadens Technical Information Distribution

NASA has set up a new office to expand distribution of information on its technological and research advances.

Heading up the new NASA Office of Technical Information and Educational Programs is Shelby Thompson, presently deputy director of the Atomic Energy Commission's Division of Information Services.

The new organization replaces NASA's present Technical Information Division of the Office of Business Administration. The division's head, Bertram A. Mulcahy, will be Thompson's assistant.

NASA inherited a good technical information service from the old NACA, which published a variety of technical papers, notes, and reports on its various activities. As the new organization grew, the process became overburdened.

EIA Backs Widening of Wage Law

Electronic Industries Association is strongly supporting a bill now before Congress to extend the minimum wage law to all industries affected by the Walsh-Healey and Davis-Bacon Acts.

EIA Executive Vice President James D. Secrest has disclosed that the Association has filed a statement with the Subcommittee on Labor Standards of the House Committee on Education and Labor in favor of a bill (HR 12170) introduced by Rep. Edgar W. Hiestand (R-Calif.). The statement cites "inconsistency in the basic public policy" between the minimum wage provisions contained in the two Acts and the Fair Labor Standards Act.

The EIA listed four reasons for its support of the Hiestand amendment:

- The Walsh-Healey Act stifles the growth of small business concerns and impairs their ability to secure Government business.
- The Walsh-Healey Act produces inflation and contributes to increased Government costs.
- Economic reasons for the enactment of the act no longer exist and can no longer be justified.
- The Act disrupts the economy of smaller industrial communities and increases unemployment in surplus labor areas.

The EIA reasons that since small firms have a lower wage scale than larger companies, they often elect to drop out of the government market rather than revise their wage structures in order to compete for government business. Thus, the statement declares, there is "little doubt" that the law favors large companies over small firms in obtaining government contracts.

Application of the Walsh-Healey Act and Davis-Bacon Acts not only raises wages to levels paid by large firms in industrial regions without due regard to local economic conditions and to the financial problems of small business, but it results in increased Government procurement costs and added taxpayer burden, the Association said.

Economic disruption is inevitable, the association feels, under existing conditions. It points out that industry faces conflicting minimum wage laws—issuing on one hand from Congress under the Fair Labor Standard Act, on the other from the Secretary of Labor.

EIA urged that the Heistand amendment be either incorporated into whatever wage legislation may be enacted this session, or passed separately.

mergers and expansions

GENERAL MILLS has added two electronic components companies to its missiles and electronics group, bringing its employe total to 3600 and its annual sales forecast to $40 million for missile/space and related business.

The Daven Company, Livingston, N.J. and Laible Manufacturing Co., Manchester, N.H. have been acquired by the company from owner Lewis Newman. Both businesses will retain their own names and continue at their present locations, but expansion of both plants is anticipated. Daven will operate as a wholly-owned subsidiary and Laible will become a division of The Daven Co.

General Mills vice president R. A. Wilson will serve as president of The Daven Co., with Newman acting as vice president and assistant to the president. Other officers of the Daven Co. will be: Edward L. Grayson, vice president-Marketing; Frederick A. Schaner, vice president-Engineering; Albert M. Steinbach, vice president and plant manager at Livingston, N.J.; Bernard J. Perry, vice president and plant manager at Manchester, N.H.

The second building, a 160,000 sq. ft. office and engineering laboratory will consolidate operations currently being conducted at several sites in the Syracuse area. Some expansion in the Department's applied research and development efforts will result. No substantial employment increase in the Heavy Military Electronics Department is expected.

GENERAL ELECTRIC CO.'s Heavy Military Electronics Dept. plans to lease two new buildings to be constructed in Geddes, N.Y. A 300,000 sq. ft. production plant will house defense work currently being done at other facilities, in turn providing room for expansion by the Company's Semi-Conductor Products Dept.

SYLVANIA ELECTRIC PRODUCTS INC.'s Special Tube Operations has become part of Sylvania Electronic Tubes in a realignment designed to intensify research, development and manufacturing efforts.

ELECTRO-TEC CORP. has acquired the business of Lambros Precious Metals Co., of New York City. The 25-year-old supplier to industry and jewel businesses will be operated through the company's recently-established subsidiary, Precimet Laboratories, Inc.

HORKEY-MOORE ASSOCIATES Plastics Division has moved into a 6000 sq. ft. building adjacent to the firm's main plant in Torrance, Calif.

HALLICRAFTERS CO. has purchased 30 acres in Northwestern Industrial Park, Rolling Meadows, Illinois for a 100,000 sq. ft. research facility. The company's 500-person electronic R&D staff will be moved to the plant. Production facilities for military work and commercial products are also expected to be expanded at Hallicrafters' 5th Avenue (Chicago) plant.

BAUSCH & LOMB OPTICAL CO., will change its name to Bausch & Lomb Inc., effective July 1. Founded in 1853 for the manufacture of eyewear frames and lenses, the company has moved into radiation measurement and electronics areas combining optics and electronics. Earlier this year the company formed a separate Military Products Division.

ATLANTIC RESEARCH CORP. has acquired Northeastern Engineering, Inc., of Manchester, N.H., engaged in development, engineering and manufacture of electronic equipment including a high-precision digital frequency counter, medical instrumentation, and heavy switchgear.

MARQUARDT CORP. has established a Special Projects Laboratory to develop security devices and systems for governmental and commercial application. Located near Washington, D.C. in Rockville, Md., the laboratory will be directed by Oleg C. Enikeieff, former Washington representative for the Propeller Division of Curtiss-Wright Corp.

AERONCA MANUFACTURING CORP. has purchased The United Welding Company of Middletown, Ohio, a former division of Baldwin-Lima-Hamilton Corp. Aeronca merged with Buensod-Stacey, Inc. of New York in March.

BENDIX CORP. has set up two complete facilities at Teterboro, N.J., and South Bend, Ind., to develop, manufacture and sell support equipment for missiles and military and commercial aircraft.

OUTSIDE LIVING

The Lunar Space Station project at Martin is one of astonishing magnitude, for it coordinates practically all areas of scientific thought into one common objective: *sustaining life in outer space.* If you have the scientific or engineering talent required to aid in the fulfillment of this objective, we urge you to write immediately to N. M. Pagan, Dir. of Tech. & Scientific Staffing, The Martin Company, (Dept. 9A), P. O. Box 179, Denver 1, Colo.

MARTIN
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Technical Countdown

ELECTRONICS

Space Vehicle APU Underway

The Air Force finally has announced the month-old award of a solar mechanical engine study contract to Sundstrand's Turbo Div., Pacoima, Calif. The $350,000 feasibility study is for design of a 15-kw generator for space vehicles. High-temperature working fluids for the Rankine-cycle conversion system and materials for solar concentrators (mirrors) are important phases of this study. System weight will approach 1000 lbs.

Higher Power for Detection

Cornell Aero Lab is now building a 50-megawatt peak-power radar transmitter—the world's most powerful. Development would have application in long-range detection and tracking of ICBM's.

Transducer Needed

School of Aviation Medicine at Brooks AFB, San Antonio, Tex., would welcome a sensor that would yield blood pressure readings of a subject continuously and relatively directly. Implanting a device in the subject would be a last resort because the sensor eventually would be used on man.

Earth's Rotation Measured

Guidance engineers at American Bosch-Arma Corp. using Arma inertial guidance system have obtained first such measurement of earth's rotation. A large precision centrifuge containing parts of the guidance package was spun first in the same direction as the earth's rotation and then in the opposite direction. An accelerometer was then used to sense the rate effect of the earth.

Acoustical Research Expanding

Watch for increase in reports on military acoustical research programs. Ling-Altec's Dr. Hilliard in California has been studying direct relation of sound intensity to rocket thrust and fuel consumption, among his many classified programs. Also, Stromberg-Carlson just delivered a unique high-intensity acoustical system to Wright-Patterson AFB for its Aerospace Medical Div. A total of 480 speakers are used in system to provide undistorted sound through full 11-octave range of normal audibility.

Cheaper Guidance Due

An advanced self-contained guidance subsystem, reported to be extremely reliable yet low in cost, is being developed by Chance Vought for the Air Force. Application is classified, but original development was for C-U's *SLAM,* nuclear-ramjet weapon system.

PROPULSION

Seller's Market

Liquid hydrogen capacity on the West Coast, even with the Linde Co. plant opening at Torrance, Calif., this summer, is far less than will be required now that Rocketdyne is developing the 200K *Saturn* upper-stage engine. The Linde plant also must meet liquid hydrogen demands for engines in Convair's *Centaur,* Douglas' *Saturn* upper stage (S-4), the *Rover* nuclear rocket, and several smaller users.

New Falcon Propellant Fired

A new high-impulse propellant for the *Falcon* air-to-air missile has been developed and successfully fired at temperatures ranging from —85° to +300°F, Thiokol reports. The new hydrocarbon propellant was developed at its Elkton, Md., plant under a contract with ARDC. Firing was in an operational-type motor with a highly stressed grain configuration. Similar motors were fired successfully after cycling from —65° to +200°F.

Electron/Ion Generator Promising

The German firm of Siemens-Schuckertwerke AG, Erlangen, has developed an electron and ion generator for accelerators with possible space-propulsion application. The generator reportedly supplies current up to about seven amps and ion currents up to about one amp during continuous operation. For ion currents, hydrogen is fed into generator. Suited also for pulse operation, emission currents could be increased considerably beyond the above figures.

MATERIALS

Honeycombing to Improve

Grumman's huge (50-sq.-ft.) new vacuum furnace will be used for production-scale brazing of the honeycomb structures in the Bendix *Eagle* air-to-air missile. Not only does the vacuum process do the job at less cost, but the brazing atmosphere is considered better than from an inert gas.

Another Materials Barrier

The dilemma persists for weight-conscious designers of *Saturn* upper stages. The problem is what material to use for liquid hydrogen tanks. Aluminum alloys currently considered gain in tensile strength when temperature falls to roughly 20°K, but increase in brittleness. Structural support will be necessary to protect the tanks against vibration.

ASW ENGINEERING

Kitchen-size Trainer

Republic Aviation is building an advanced pre-production model of a high-speed atomic-submarine simulator for the sub school at New London. It features a special scoring panel which automatically records the trainee's reaction-time to an ordered maneuver and to equipment failure.

More About Fuel Cells

Most exciting possibility reported lately is a fuel cell which would use conventional petroleum products and air as fuels. The general scheme—and several companies have such cells in early stages of development—is to use catalysts in the electrodes to separate hydrogen from the hydrocarbons and use oxygen as the other fuel. Cells have been demonstrated with efficiencies exceeding 35% at low temp. and up to 75% at higher temps. The problem is to keep them operating at high output levels for long periods without having impurities poison the catalysts, and thus reduce efficiency.

PMR System Guards Against Missile

by Charles D. LaFond

One chance in several millions might be the odds for a wayward ICBM, launched from the Pacific Missile Range, to impact somewhere in the State of Hawaii.

To make certain that such an unscheduled and unwanted flight cannot occur today, tomorrow, or ever, the Navy's Impact Prediction System was created. Operated under contract since 1959 by Land-Air, Inc., a subsidiary of California Eastern Aviation, Inc., the system is a real-time computer application providing an accurate visual display of missile trajectory.

Designed as an aid to the Range Safety Officer, impact prediction involves the process of continually estimating impact-point coordinates based on present position. Essentially, the system consists of a twelve-man crew, IBM 709 (8K type) and six plotting boards at the Naval Missile Facility, Pt. Arguello. Back-up is provided by another Land-Air group at Pt. Mugu, using a larger 709 computer facility.

System input is derived from two similar instrumentation radars, AN/FPS-16. One is a modified system capable of maintaining a radial track to a distance more than double that of the other radar. Each provides slant-range, azimuth, and elevation data in serial format, binary digital coded.

To further strengthen the impact prediction system, a new PMR microwave data link is under construction. This will feed real-time data to both the Arguello and Mugu computer groups from three sites (six radars) plus COTAR (Correlation Tracking and Ranging system, built by Cubic Corp.) outputs from several widely separated sites.

• **Input system**—Each radar outputs slant range, azimuth, and elevation in a serial format coded in binary. This output, plus PMR range time, is recorded on tape for postflight analysis.

The same output, less range time but with a shift line and an end-of-word indication, is supplied to a Collins TE-206 Kineplex transmitter. The transmitter uses the digital information to phase-shift four audio tones which are combined into a composite audio signal. This composite is then transmitted over land line from the radars to the computer site a few miles away.

In the computer room at the Range Operations Building, a Kineplex receiver accepts the composite signal and converts it into a serial digital form. This is passed to a Cubic DH-12 Data Handler where it is stored and converted to the parallel format acceptable to a data synchronizer.

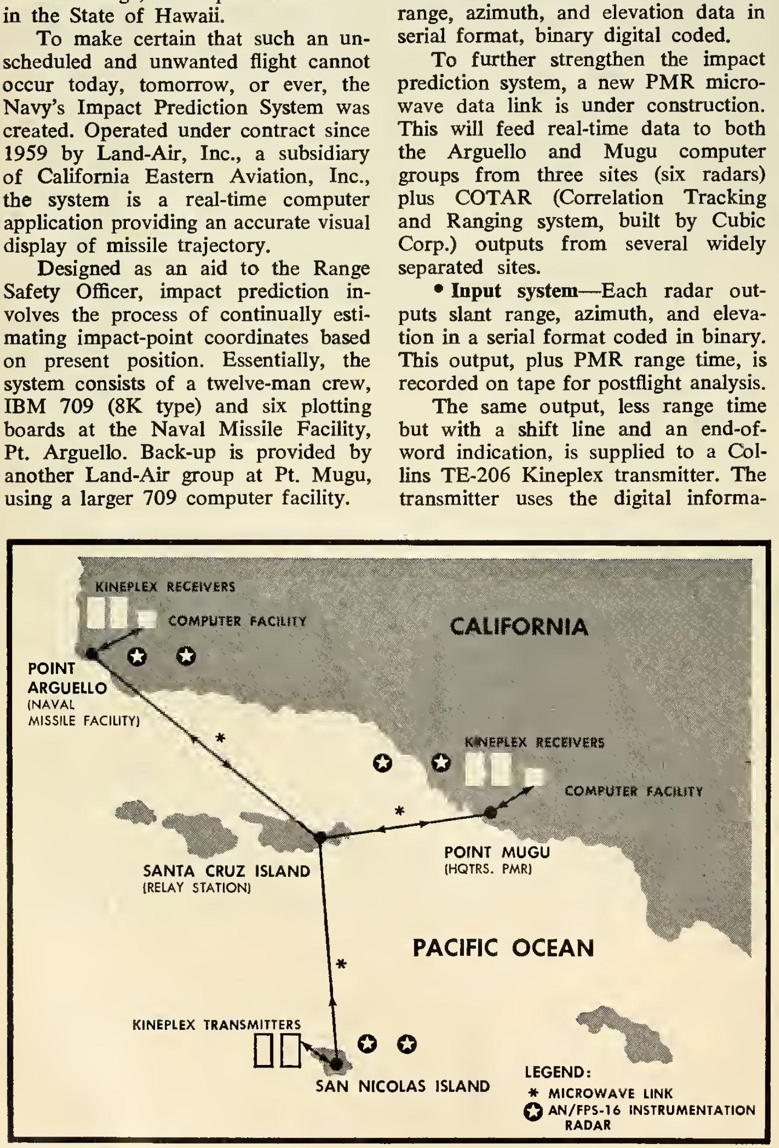
• **Programing**—The prediction of missile impact follows from straightforward mathematical reasoning. Errors due to mathematical flaws are trivial compared to those introduced by the total system. (The math portion of this subject is dealt with in "Derivation of the Equations for Impact Prediction" prepared by Mr. D. B. Alexander and published by Land-Air in late 1958.)

The actual programing of the problem was not begun until late spring when it was rushed through under a crash program by J. W. Brookshire, of Land-Air, with the cooperation of Bruce Glass and the counsel of Dr. H. H. Germond, both of the Atlantic Missile Range.

The initial programing effort had the benefit of quite loose specifications. The only output requirement was information to drive three plotting boards, two displaying the prediction and the other, present position. Computing the latter was a necessary step in arriving at the predicted point and not an extra requirement. Never in its earliest and most unrefined state did the one-tenth-second output frequency threaten machine speed and capacity.

Subsequent output requirements and provision for new microwave link and additional inputs have changed all of this, however, and now the program is getting tight. So tight in fact, that instead of outputting a prediction based on both radar and Cotar, the output will be one or the other.

The program for impact prediction is thought of as four logical function routines: the input, standardization, prediction computation, and the output routines. These depend upon elementary function sub-routines for



IMPACT PREDICTION computer centers currently providing data for Pacific Missile Range safety offices are shown. A new microwave data link from San Nicolas Island will significantly strengthen prediction capabilities.

Gone Astray

sine, cosine, arc tangent, and square root.

• **Input routine**—The input routine maintains a controlling counter in an index register which recycles after 64 counts. It initiates the program at the count of zero in this register, and recycles on the next count after 63. The counter increases one count per 0.1 second, which is the rate of the data sample input.

The routine encounters the data sample at the Data Synchronizer and places it in a table. This is in the form of 3 binary-coded 21-bit words representing elevation and azimuth angles and slant range.

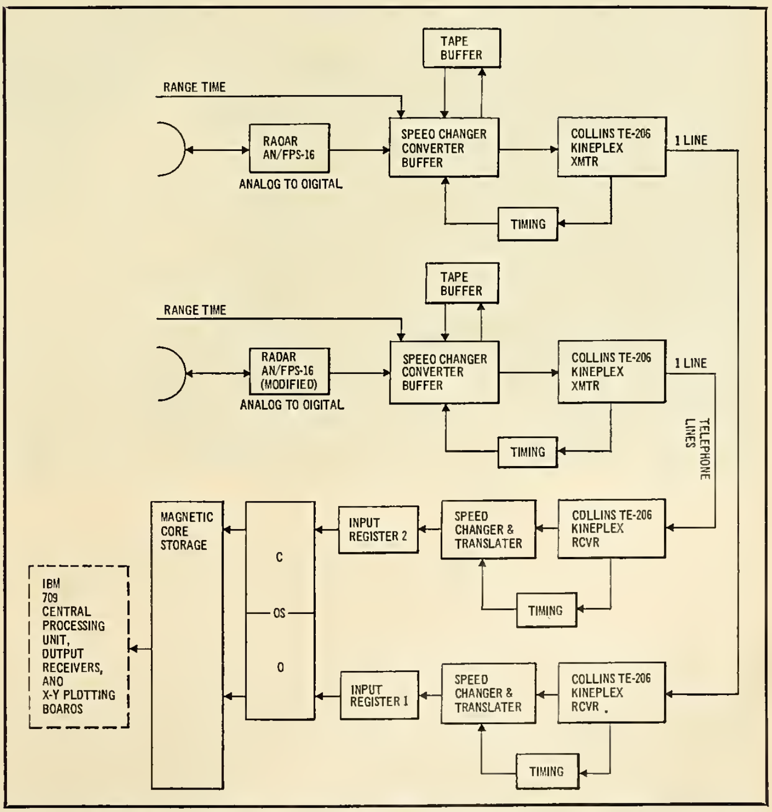
The first sample of data received will start the table when the counter reads zero. The next sample will be placed in the table vs. the count of 1. The sixty-fifth sample will enter the table opposite the count of zero on the counter. This can be thought of as occupying the position of, or replacing, the first sample which was stored vs. zero.

If any word is missing from the input, the program will store zeros in each of the three word positions for that count. The input routine is such that it will make three attempts to receive a sample before it accepts the missing data alternative. The count will continue, however, so that the data can be tabled properly when input resumes. Simultaneously with supplying input, this routine writes the raw data on magnetic tape for use in post-operation computations, and as a permanent record.

The input routine in use today is the tight spot (mentioned earlier) for expansion of the input system. Working against only two radars it is able to perform quite an elaborate edit operation. It uses the trend of points through time as a basis for its acceptance or rejection of a sample.

This consumes 0.01 seconds per input source, but is permissible since time is abundant. At this rate, however, as input sources are increased, editing alone could consume all the computation time. The routine to be put in service, when needed, therefore is modified to make its choice on the basis of instantaneous agreement among input from multiple sources,

ADDITIONAL INPUT is provided by many optical tracking stations, particularly during early thrust phase of an ICBM. Here, a large-bed Mann comparator permits rapid measuring of film to resolution of 1 micron. Output is fed to Telecorder (right), stored in digital form, then transferred to IBM summary punched cards.

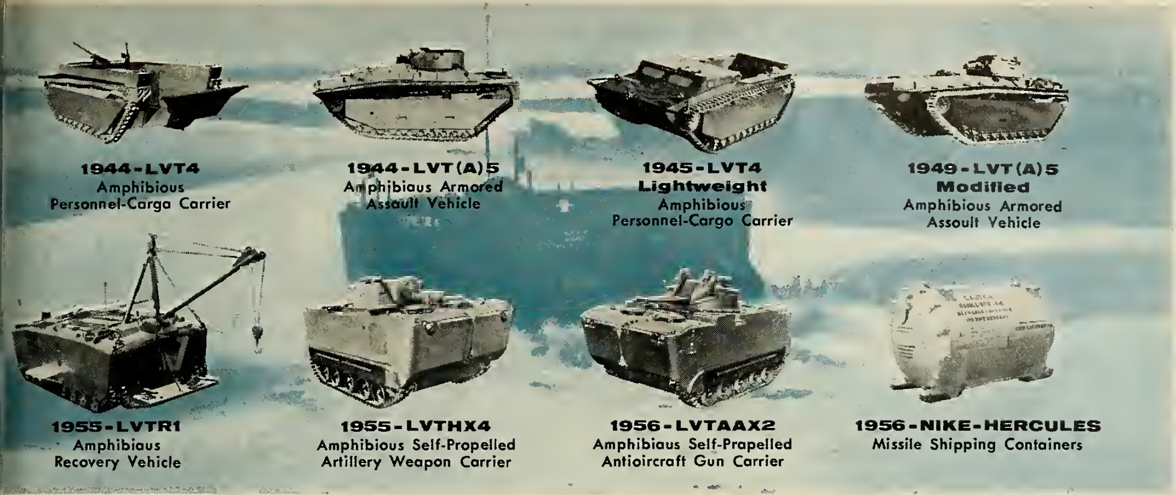


POINT ARGUELLO impact prediction input system currently in use is shown in block diagram. As many as six plotting boards as well as one or more strip or pen recorders can be tied into output display.

Effective deployment of tactical missiles and their supporting troops and equipment calls, today, for full *off-road mobility*. In this concept, FMC offers long and versatile experience, having since 1941 designed and built more types of military-standardized tracked vehicles than any other company in America.

In recent years FMC has pioneered many developments in missile launchers, and in light-weight aluminum-armored vehicles that can be airborne and parachute-dropped, ready for extended cross country operations. We provide full mobility for missile transporters and launchers, GSE, radar and communications equipment, field hospitals, troop transport and other equipment. The use of standard military components in vehicles cuts R&D costs and eases logistics problems in the field.

When the question is mobility, FMC has the answer—from original concept through production delivery.



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casting out obviously bad points as they are revealed by a least squares fit.

• **Standardization routine**—This routine receives the values for slant range, azimuth, and elevation from all good inputs passed to it by the input routine. Three earlier samples from each input source are used for simple edit of each respective input sample. The elevation value, in addition to this edit treatment, also receives a refraction correction.

The next operation is conversion of the polar coordinates to X, Y, and Z referred to the radar. This is followed by a transformation to geocentric coordinates. These coordinates are now expressed in feet and are in the fixed point system.

The final operation of the routine is the conversion of these values to floating point arithmetic. A data sample is generated in this manner from each of the inputs. These are placed in separate tables with the output from the routine determined by a built-in selection process, but this process is only semiautomatic.

Prior to the operation, a particular input is selected as the primary source and the others are ranked behind it. Criteria for this ranking are determined partly from the equipment performance during the preoperational checkout.

The program will try to live with the input designated as primary so long as the values are continuous and survive the wild-point edit. Console sense lights and switches are tested by the program in such a manner that the operator can override the program and change input selection manually.

The routine will accommodate the anticipated number of additional inputs and will accept any input which appears in the established format. Output from the COTARs will be received as a set of direction cosines and require a routine to convert these functions to the necessary rectangular coordinates before the data can be tabled along with the radar data.

• **Impact point computation**—The standardization routine supplies 31 consecutive samples each of X, Y, and Z in a geocentric rotating coordinate system, with the Z-axis coincident with the polar axis. The routine for computing impact continues by fitting a curve through each of the 31 values of these coordinates. Then components of velocity are obtained from the curve. X, Y, Z, and time completely define the position of the body at any time.

The remainder of the routine computes the position where the orbit intersects the earth's surface. The computation proceeds by assuming the earth's rotation temporarily halted at the time corresponding to each new data point. In this frozen coordinate system an impact point and the time of flight to this point is computed. The earth is then rotated the amount that it would have turned during this time of flight to output geocentric latitude and longitude of the impact point.

No attempt is made to include the effects of drag, or of the earth's oblateness on the gravity field, since the benefits from such a consideration would be marginal. System refinements are inevitable, however, such that ignorance of these effects ultimately will be intolerable. Day-to-day experience is stockpiling empirical data which will enable adjustment for drag effects.

Completed studies produced a method for end-point smoothing to replace the present simpler midpoint smoothing method and, in so doing, to eliminate a substantial time lag in the system.

• **Output routine**—The output routine receives the geocentric longitude and latitude and converts this information to plotter counts. This is done at such scales that it can be displayed on each of two plotting boards. One board covers the close-in ranges, and the other, the more remote points—including the splash areas.

The routine also reaches into storage for the geocentric present position coordinates placed there by the standardization routine. These are converted to plotter counts for display on the third plotting board.

• **Slope fields**—A set of three slope-field plotting board charts are prepared for each planned trajectory, one each for the planes X-Y, X-H, and Y-H. These are families of curves so drawn that when the present position is plotted the progress of points in relation to the curves will identify a potentially dangerous operation.

Coordinates in the launch-pad tangent-plane system for input to these plotting boards are obtained by tapping the standardization routine.

• **Accuracy**—The Navy feels the program is reliable and probably accurate beyond need. This accuracy exists in spite of deletions in the underlying mathematics. Besides failing to deal with atmospheric interference on re-entry, the program also assumes the earth to be a sphere. The treatment of radar refraction leaves room for improvement. Still, the performance of the system to date indicates complete adequacy for its intended purpose.

There is a tendency to want to use it as a measuring instrument—and it has correlated well with other range instrumentations when circumstances have permitted a comparison.

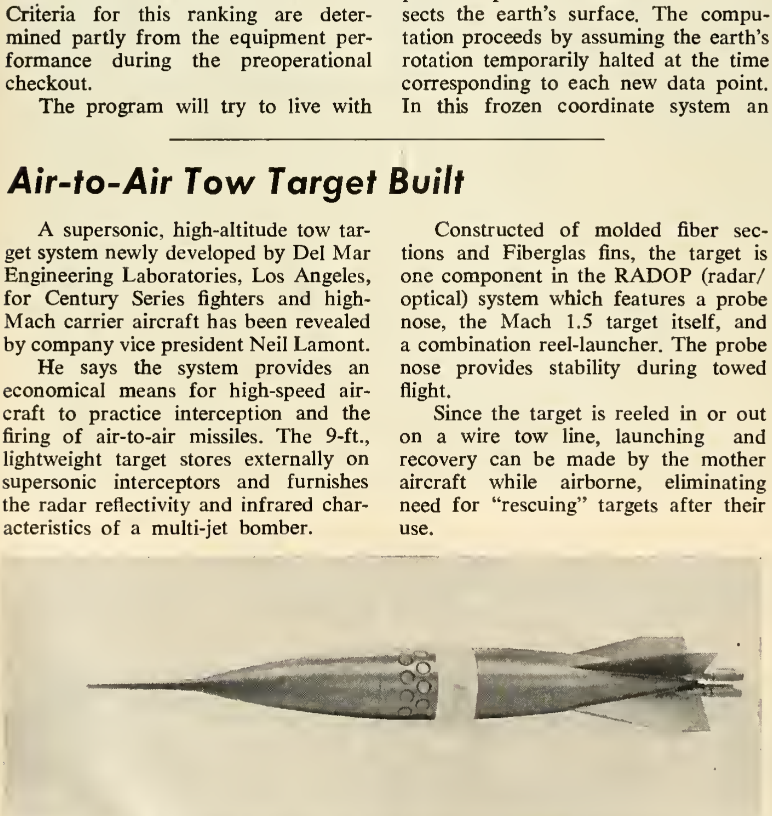
Air-to-Air Tow Target Built

A supersonic, high-altitude tow target system newly developed by Del Mar Engineering Laboratories, Los Angeles, for Century Series fighters and high-Mach carrier aircraft has been revealed by company vice president Neil Lamont.

He says the system provides an economical means for high-speed aircraft to practice interception and the firing of air-to-air missiles. The 9-ft., lightweight target stores externally on supersonic interceptors and furnishes the radar reflectivity and infrared characteristics of a multi-jet bomber.

Constructed of molded fiber sections and Fiberglas fins, the target is one component in the RADOP (radar/optical) system which features a probe nose, the Mach 1.5 target itself, and a combination reel-launcher. The probe nose provides stability during towed flight.

Since the target is reeled in or out on a wire tow line, launching and recovery can be made by the mother aircraft while airborne, eliminating need for "rescuing" targets after their use.



DEL MAR'S supersonic tow target, 9-feet long, features stabilizing nose probe, passive radar reflector giving 360° coverage, and a reel launcher that allows tow lengths to more than six miles.

Nuclear Engines Offer Good Stability

by Frank G. McGuire

Los Angeles—Theoretical work by Massachusetts Institute of Technology scientists shows stability and control of nuclear rocket engines in the one-million-pound-thrust class will not present serious problems.

In studies conducted for Pratt & Whitney Aircraft, MIT found nuclear rockets to be relatively stable and capable of rapid thrust level variation from 10% to full thrust in seconds. Work was reported by A. H. Stenning and H. P. Smith, of MIT to the American Rocket Society.

Using an analog computer during the P&W-funded research program, MIT investigated a system utilizing a bleed turbine pump drive, subjecting the theoretical powerplant to numerous variables. Rapid controlled starts were simulated, using a pressure controller on the turbine valve and a temperature controller on the reactor control rods.

Since thrust and temperature are essentially interdependent in nuclear rockets, requirements for control of these parameters will be stringent.

In its investigation, MIT chose the simplest possible model of the theoretical system under study, consistent with reasonable engineering accuracy. It avoided over-elaborate analysis, which might have obscured the significant results of the computer study. Conversely, it guarded against over-simplification by varying major parameters over a wide range, to determine where small changes can have large effects on system operation.

Of two possible systems, MIT chose the bleed turbine pump for study, rather than the alternate system using a topping turbine. In these arrangements, a small amount of liquid hydrogen propellant is bled off from the reactor and expanded down to atmospheric pressure in the turbine (bleed turbine pump method), or all of the propellant may be passed through the turbine after receiving some pre-heat in the cooling jacket and reflector, returning then to the main core heat transfer channels (topping method).

• **Varying temperatures**—Control of thrust and temperature in nuclear rockets is usually achieved by varying

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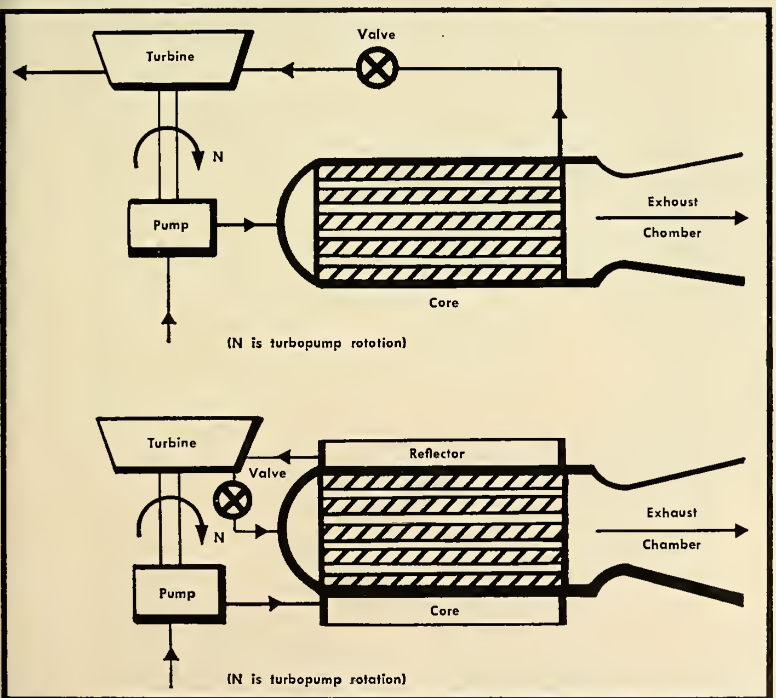

FIG. 1A (top)—Nuclear Rocket with Bleed Turbine. Turbopump is driven by a gas turbine fed with hot propellant. A small quantity of the propellant may be bled off the reactor and expanded down to atmospheric pressure in the turbine.

FIG. 1B—Nuclear Rocket with Topping Turbine. All of the propellant may pass through the turbine after receiving some pre-heat in the cooling jacket and reflector, and then return to the main core heat transfer channels. MIT study dealt mostly with the bleed turbine shown in Fig. 1A, but calculations showed that stability criteria for the two systems were similar.

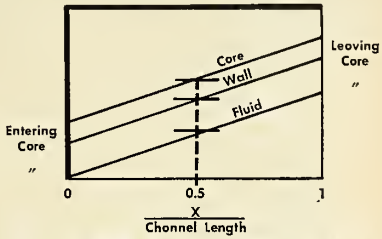

FIG. 2—With the assumption of linear axial temperature rise and constant properties, the temperature distribution along a heat transfer channel is shown here. If the thermal lag time of the propellant is much smaller than the thermal lag of the core, this expression may also be used in unsteady flow. The propellant thermal delay time is equal to the time the propellant spends in the core (milliseconds) and the thermal lag of the core is on the order of 0.5 sec., so that the propellant lag time can safely be neglected. For a cryogenic fluid, stagnation temperature leaving the core is much greater than the stagnation temperature entering the core.

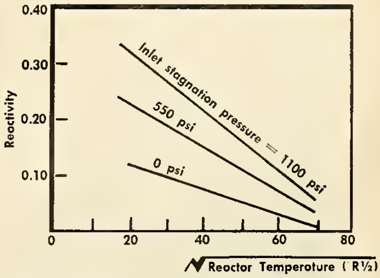

FIG. 3—Reactivity versus inlet stagnation pressure and reactor temperature for a typical nuclear rocket reactor with 30% hydrogen volume.


NASA / Little Jo
UNITED STATES
UNITED STATES

Consistently successful flight performance in Project Mercury confirms unsurpassed reliability of THIOKOL solid rocket motors.

Time after time, NASA's workhorse, Little Joe, has soared into space, checking out the workability of materials, propulsion and escape systems, and reaction of research animals to the environment of space flight.

Pollux, Recruit, Castor—solid rocket motors from THIOKOL's Elkton and Redstone Divisions—have unfailingly provided the thrust and power for Little Joe in its developmental flights.

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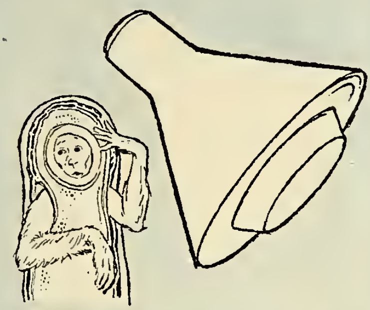
In NASA's Little Joe series, THIOKOL booster motors in various configurations have developed up to 250,000 lbs. thrust, today's ICBM class. Smaller THIOKOL rockets have been used to free escape capsule from booster.



Little Joe has carried this research and development capsule and research animals to varying altitudes to obtain engineering and medical data prior to launching man into orbit with subsequent safe recovery. The reliable THIOKOL solid rocket motors used in these missions are virtually off-the-shelf items and are available to other research groups.

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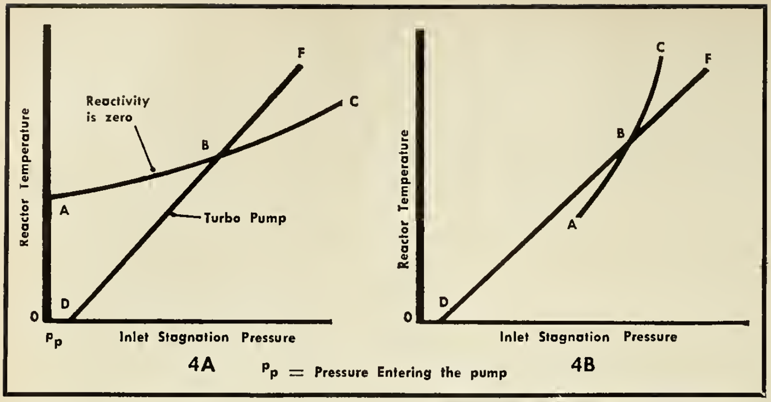

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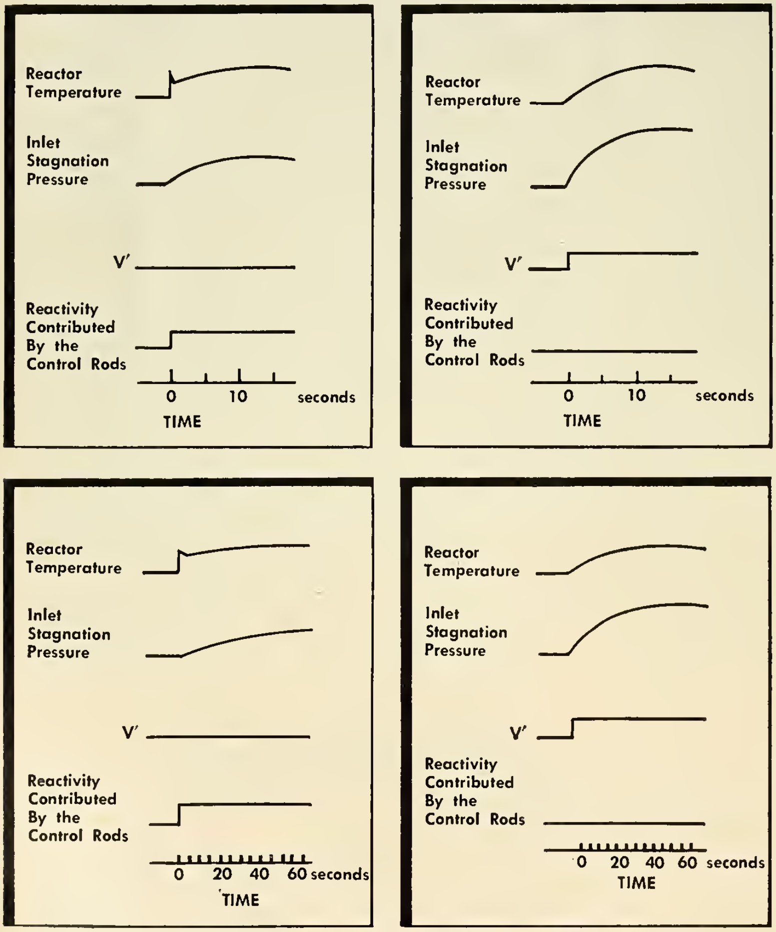
FIG. 4A—Physical significance of the stability criterion can be seen in this chart of the steady-state equilibrium operation of the system. On the chart, reactor temperature is plotted against inlet stagnation pressure, assuming steady reactor operation (reactivity zero). Values may be computed for reactivity contributed by control rods and represented as the line ABC. The equilibrium operating condition is the point of intersection B. Above the line ABC, the reactor is subcritical, and below the line ABC it is supercritical. This is a stable configuration because an increase in turbine inlet temperature drives the pressure up toward F. The operating point shifts into the subcritical region and the reactor power drops to restore the operating point to B.

FIG. 4B—This is an unstable configuration, because an increase in turbine inlet temperature drives the operating point from B towards F, into the supercritical area, and the reactor power increases further. The requirement for stability is therefore that the slope of DBF be greater than the slope of ABC at B.



(NOTE:) $V' = \frac{(p03/p02)}{(p03/p02)d}$ where p03 is the stagnation pressure entering the turbine

p02 is the stagnation pressure leaving the core

and d is the design value.

FIGS. 5 & 6—The response of the pressure and temperature to step changes in valve position and control rod reactivity are shown here for a rocket in the 10^6 pounds thrust class. In Fig. 5, the response in small steps to control rod reactivity and the V′ parameter is shown for initial conditions: average temperature of the reactor—1; inlet stagnation pressure—1. In Fig. 6, the initial conditions are: average reactor temperature—0.39; inlet stagnation pressure—0.1. The response is slower than the design point here, but the system is still very stable.

Continued from p. 29

chamber pressure and reactor core temperatures. Reactor control rods are a standard method of altering core temp., and turbine valves can act upon the pressure in the thrust chamber.

Cross coupling exists between these control elements, since a movement of the control rods results in changes in the turbine inlet temperature and core mass flow, therefore alteration in pump delivery pressure and thrust. On the other hand, changes in core inlet pressure alter the reactivity through the propellant density coefficient of reactivity, resulting in a change of core temperature.

Transient heat transfer from the core to the wall was handled by considering the core as a lumped system. Since MIT was interested mainly in the average core temperatures (which govern reactivity), there was no point in using a distributed parameter representation unless an equally sophisticated model for reactivity change was included in calculations.

Turbine control of the system is achieved through valve regulation of the turbine inlet pressure. The valve pressure ratio (stagnation pressure entering the turbine/stagnation pressure leaving the core) depends only on the valve setting.

• **Open loop stability**—With linearized equations, using the standard techniques of stability analysis, MIT found the open loop system stable and well damped, given certain provisions. The open loop stability depends on the sign of the temperature coefficient of reactivity of the empty reactor and is independent of the propellant density coefficient of reactivity.

Stability is insured by a negative temperature coefficient; if the temperature coefficient is positive, however, the system will be statically unstable. In this divergent condition, it will not return to equilibrium when disturbed. Hence indications are that the density coefficient of reactivity has no effect on the stability of the system, within the accuracy of MIT's approximations.

Fortunately, says MIT, the empty reactor will probably always have a negative temperature coefficient, although this may be a small value. Calculations have shown that the stability criteria applying to the bleed turbine pump drive also hold true for the topping turbine system.

• **Performance**—Using U^{235} fuel, and assuming a rocket of 1,000,000 lbs. thrust, the MIT scientists plotted response times of pressure and temperatures in the system. Controlled starts were conducted from a nominal idling condition of 10% of inlet pressure at the core and the average reactor temperature at 0.39.

These starts were simulated with a combined proportional plus integral controller with a delay on the turbine valve, and an integral controller with a delay on the reactor control rods.

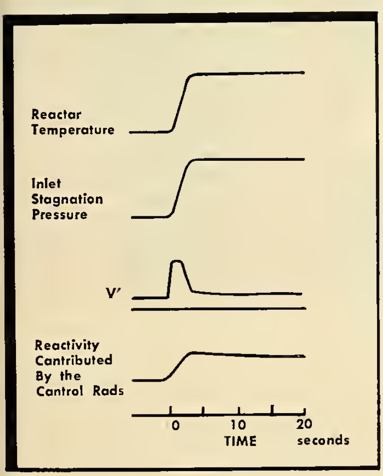


FIG. 7—Temperature and pressure response are shown for a fast start from idling conditions. Design conditions are attained in 3.5 seconds. The maximum rate of change of control rod reactivity is 0.013 per second. The turbine valve parameter V′ reaches a maximum value of 3, requiring a pressure ratio across the turbine valve of 0.33 at the design point to give a large margin for acceleration. This rapid response time is paid for in the necessity to incorporate a large turbine into the system, as well as loss of some specific impulse.

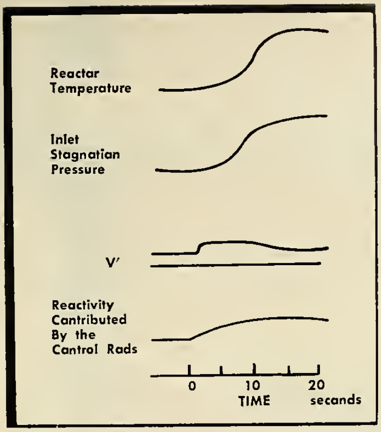


FIG. 8—With maximum pressure ratio of 0.75 across the turbine valve at the design point so that the maximum possible value of V′ is 1.33, the time from idling to full thrust is increased to 15 seconds, with corresponding thrust and temperature history shown here.

The controller actuation delay accounted for the time required to change the valve position and accelerate the control rods. This was about 0.2 sec. The gain on the temperature controller is limited primarily by the speed of actuation which is feasible, and in some cases by the requirement that the system be stable in event of failure of the turbine valve controller.

Another requirement limits the inlet controller gain to a value well above the feasible actuation rate. With values of temperature control gain satisfying these conditions, the pressure controller gains may be adjusted to give the most rapid response with no thrust overshoot.

In some cases, extremely rapid response (3.5 seconds) was achieved. Maximum rate of change of control rod reactivity in these cases was 0.013 per sec. The turbine valve parameter V′ (see Figs. 5 and 6) reached a maximum value of three, requiring a pressure ratio across the turbine valve of 0.33 at the design point to give a large margin for acceleration. (Illustrated in Fig. 7)

The penalty paid for such rapid response in the system is a greatly oversized turbine and some loss in specific impulse.

Designing for a pressure ratio of 0.75 across the turbine valve at the design point so that the maximum possible value of V′ is 1.33, and reducing the pressure controller gains until this value of V′ is reached but not exceeded during startup, the time from idling to full thrust is increased to 15 seconds. (Illustrated in Fig. 8)

Ford to Deliver 9 Scout Vehicles to AF in 1960

Ford Motor Co. will deliver nine *Scout* launching vehicles to the Air Force this year under its contract announced last month.

The Air Force has given the vehicle the official name Hyper-Environmental Test System 609A. *Scout* is a name given by the National Aeronautics and Space Administration. There have been reports that the Air Force is considering naming its version *Astron*.

The Aeronutronic Division of Ford will be system engineer and payload and test contractor for the Air Force system. Chance Vought will provide the vehicle frame and launcher and Minneapolis-Honeywell will provide guidance.

The solid-propelled satellite-launching vehicle consists of four stages: an Aerojet-General Senior as first stage, a Thiokol XM-33 as second stage, an Allegany Ballistics Laboratory (Hercules Powder Co.) X-254 as third stage and an ABL X-248 as fourth stage. However, in the Air Force version, both three and four-stage vehicles will be used, with each vehicle tailored to the requirements of an individual launch test.

First flights of the 609A rockets will be from Cape Canaveral before the end of the year, a Ford spokesman said. NASA plans to fire the first *Scout* from Wallops Island, Va., some time this summer.

J-2 Is Rocketdyne Name For 200K Saturn Engine

Rocketdyne Division of North American Aviation said last week it has given the designation J-2 to the liquid hydrogen-LOX, 200,000-lb.-thrust engine it will develop for upper stages of the *Saturn* vehicle. NASA announced May 31 that it would negotiate a $44-million contract with Rocketdyne to develop the engine.

Air Force Lays Out $20 Million for UDMH

Multi-million-pound quantities of unsymmetrical dimethylhydrazine will be supplied to the Air Force under a series of contracts totaling over $20 million, awarded to Food Machinery and Chemical Corp last week.

In a joint venture with National Distillers and Chemical Corp., FMC will produce Dimazine (R) in expanded facilities at Baltimore.

The storable, high-energy rocket fuel is the only synthetic propellant in use today, according to FMC spokesmen.

AC Seeks and Solves the Significant—AC has earned an enviable reputation for scientific accomplishment with national defense projects such as AChiever inertial guidance systems. But AC is not limiting its goal to leadership in the international technological race. Utilizing scientific "fallout," AC is also increasing its development of significant new commercial products. / This, too, is AC QUESTMANSHIP: the scientific quest for new ideas, methods, components and systems . . . to promote AC's many projects in guidance, navigation, control, detection and communication. / In the commercial field, AC is already producing communications systems, automotive controls and fuel controls for gas turbine engines. Some day they may even add such advanced projects as systems controls for "ground effect vehicles." According to Mr. B. H. Schwarze, AC Director of Commercial Engineering, "the proper application of scientific 'fallout' to commercial products leads to diversified career opportunities." / You may qualify for our specially selected staff . . . if you have a B.S., M.S. or Ph.D. in the electronics, scientific, electrical or mechanical fields, plus related experience. If you are a "seeker and solver," write the Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, 7929 So. Howell Ave., Milwaukee, Wisc.

GUIDANCE / NAVIGATION / CONTROL / DETECTION / COMMUNICATIONS / **AC SPARK PLUG** *The Electronics Division of General Motors*

NASA Backs Segmented Conical Motor

The National Aeronautics and Space Administration reported last week that United Technology Corp. will receive $186,000 over a six-to-nine month period on its contract to demonstrate the feasibility of a segmented, conical-shaped solid-propellant motor.

The contract, awarded late in May and announced last week (M/R, June 6, p. 15) was the first government contract won by the new United Aircraft Corp. subsidiary.

The study calls for the design, fabrication and testing of three experimental motors to prove the concept. Neither NASA nor UTC would disclose any details of the size of the experimental motors. However, it is understood they will be in the neighborhood of 15,000 lbs. thrust.

NASA spokesmen said UTC was selected for the negotiated contract because the company had filed for a patent on an interesting new concept in solid rocketry. A company spokesman said the patent application, still pending, describes as unique the conical shape and the method of joining segments together. The application did not claim that UTC originated the principle of segmenting solid rockets, the spokesman said.

Willem Schaafsma, manager of UTC's solid rocket branch, said the use of truncated cone-shaped segments makes possible economical development and manufacture of solid motors of very large size. He said such an approach would permit substantial savings in the cost of developing a motor of a million lbs. thrust. UTC is one of six industry bidders on an Air Force proposal, Project 3059, for a feasibility study on the development of a solid motor of 100 million pound-seconds total impulse.

Both NASA and Air Force spokesmen said that the NASA study is completely independent of Project 3059 and that it had been coordinated with the Air Force on the working level. Air Force spokesmen said that the Project 3059 contract is expected to be awarded soon. The amount of money involved will be several times that in the NASA contract.

• **Why conical?**—Schaafsma said the purpose of the conical shape is to eliminate erosive burning in long solid rockets. The propellant grain thickness (web thickness) is the same for the length of the conical rocket. The gas flow channel in the interior is cone-shaped with the narrower end at the head of the rocket.

Thus the flow area increases—and tends to slow the gas—as it rushes toward the rear of the rocket and out the nozzle. Otherwise, the burning would increase in rate as the rocket burned from the inside out and the burning area increased. This increase in burning area is not a major problem in small and medium-sized solid rockets. But it assumes major proportions in very large rockets such as contemplated in Project 3059.

THREE-STAGE ROCKET assembled of conical segments is shown with cases and connecting fairings transparent for demonstration.

By the elimination of erosive burning in conical segments, Schaafsma added, it becomes easier to predict the ballistic performance of the motor and testing can be reduced.

The conical shape also offers the advantage of simplified grain design. Since the web thickness constant along the entire motor length, adding conical segments to increase the total impulse does not require redesign of the grain, the UTC official explained.

He also listed as advantages the reduction of aerodynamic drag because of the tapered overall shape, reduction in structural weight and the impossibility of making improper field assembly, because of the differing cross sections of the segment ends.

• **White elephant?**—Schaafsma declared that UTC investigated and discarded as impractical the approach of on-site loading of very large rockets. He said the process is not feasible "because once the giant was loaded and an internal defect developed, it would become the biggest white elephant in the world. You couldn't move it and you wouldn't dare launch it for fear it would blow up."

UTC said hardware for its segmented rockets will be fabricated by Pratt & Whitney Aircraft, another division of United Aircraft. The propellant will be cast at UTC's new facilities under construction at Sunnyvale and San Jose, Calif.

Each of the three motors to be delivered will have at least three segments. The feasibility study calls for only static tests of the rockets. No flight tests are contemplated. If the feasibility proves successful, a UTC spokesman said, a proposal then will be made to NASA for development of larger hardware designed for flight.

UTC said it has already built and tested a scale model one 2000th the size proposed under the NASA study. The rocket segments will be built in standard sizes so that any number of them can be put together depending on mission requirements.

All stages of a vehicle would be made of the same basic components. The lowest stage would have the most components, the next stage a smaller number and the top stage the fewest.

Mahon Tells of Struggle to Push ASW

Special interview with key Congressman who outlines why he feels Navy has fought pressure to emphasize the effort under single manager

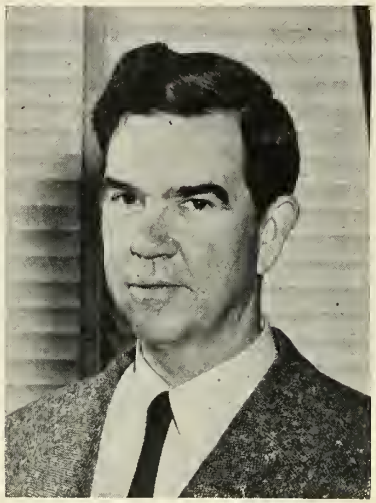
The Senate this week cut extra funds voted by the House for acceleration of lagging antisubmarine warfare research and development. House had voted $100 million but Senate's Military Appropriations Subcommittee chopped off $58 million. M/R takes you behind the scenes in this interview with the man who has one of the biggest jobs in Congress.

Q. You have stated that the Navy has failed to push undersea warfare programs with sufficient vigor. Why has the Navy so failed?

A. The Navy is not a body of men with but a single concept of military requirements. It is divided into factions or schools of thought as are all large organizations. The Navy was dominated prior to World War II by the advocates of the battleship. The dominant faction in the Navy today is made up of the proponents of Naval aviation. This Naval aviation requirement has attained such dominance that the President's budget for Fiscal Year 1961 proposed the procurement of more new aircraft for the Navy than for the Air Force. The factions within a service must contend with each other for funds and the most powerful group will tend to have more of its programs approved for funding than will the groups with less power or influence on top policy-makers.

Under these conditions, the Navy has chosen to emphasize the attack carrier with its supporting task forces, rather than antisubmarine warfare. The proponents of attack carrier forces are able men of strong conviction and earnest purposes, and we should have attack carrier forces, but it is an error to emphasize these forces to the detriment of those forces needed to face up adequately to the vast fleet of Soviet submarines which challenge our supremacy of the seas. Inability to cope adequately with this submarine threat could be decisive.

I make no pretense of being an expert in this field, but a man does not have to be very expert to understand that the Soviet submarine threat is tremendous, not only to our fleet and



Rep. George H. Mahon (D-Tex.)
Chairman of the House Military Appropriations Subcommittee

shipping, but in its missile-carrying configuration, to the cities and military installations within the continental United States. The Germans almost swept our shipping from the seas in World War II beginning in the early days of the war with a nucleus of only 48 submarines. It has been predicted by a high-ranking admiral in a position to know that before too many years have passed, it is likely that all submarines can be used to launch missiles.

The attack carrier does not have a major role as an antisubmarine weapon. Of course, it might perform the function of bombing enemy submarine bases, but land-based aircraft would probably have to be used in many of such strikes, as they were in World War II. Attack carriers are vulnerable to submarine attack and must be guarded by many ships and aircraft which seek to screen them from this threat. Our attack carrier forces would be significantly benefited by improvements in antisubmarine warfare capabilities.

The House Committee on Appropriations, without denying the importance and validity of requirements for carrier forces, has tried to bring to the forefront the urgent need for greater emphasis on antisubmarine warfare capability. This effort has met with strong resistance. It would almost seem that there are those who hope the submarine threat will just go away, but the submarine threat gets increasingly worse year by year and it will not just go away. Last year, Admiral Burke, Chief of Naval Operations, said, "We need to improve our capability to combat submarines. Since World War II, the submarine has progressed faster than the antisubmarine warfare capability to combat it."

Q. You have commended management of the *Polaris* fleet ballistic missile program and have emphasized that such a single manager system must be provided for the ASW effort. Do you expect opposition to this from certain quarters of the Navy? If so, why? How hard will you be willing to push for such a system?

A. In the report accompanying the Defense Appropriation bill this year, we made a recommendation for the application of the *Polaris* type of single manager system to the ASW problem. It should be readily understood that this does not apply to the operational aspects of the problem, although such a single manager would have to work very closely with the operational Navy. We are primarily interested in a single manager for research and development of weapons, equipment and the like, which will be adequate to do the ASW job.

Of course, the Navy has established a position called ASW Readiness Executive, directly under the Chief of Naval Operations. The two officers that have been assigned to this position are superior naval officers, but they have been able to exercise little or no actual authority to get things done. This is typical of the scatter-shot operation for antisubmarine warfare which the Navy has always had. The Navy would not, of course, want to change it. Resistance to change is traditional, especially in the Armed Services. It seems pretty simple to a layman that we should have a dynamic figure who spends his days and nights working as the director of

ASW. The problem is how to detect, identify, and destroy the enemy submarine.

This is no simple, easy job with solutions readily available. In almost every aspect of the ASW problem, we are literally pushing forward the boundaries of basic research. Technically and strategically, it is at least as demanding—if not more so—than nuclear propulsion or the *Polaris* program. When the Navy faced these problems, it went directly to an all-out single manager concept under Admiral Rickover and Admiral Raborn, needless to say with admirable results. Somebody must be given similar responsibility and authority to get this job done. The Chief of Naval Operations is a man of great ability but his time is so consumed with the multitudinous problems of operating the Navy, he cannot spend 16 hours a day devising ways to detect, identify, and destroy enemy submarines. That which is everybody's job tends to become nobody's job. If specific responsibility and authority are fixed in a director of a project and his reputation is at stake and he gets the credit for success and the blame for failure, the chance for real progress is enhanced.

Q. During this session of Congress, do you see the Navy's plans for another carrier, conventional or nuclear-powered, absolutely curtailed? How do you feel about eliminating the carrier? Why?

A. I have supported the elimination from the current budget of the conventional carrier. The House bill eliminated the $293 million in the budget for the conventional carrier. I had hoped that we could complete and test the construction of the nuclear-powered aircraft carrier Enterprise before determining what the next step should be with respect to further carrier construction.

Q. In the same vein, do you consider the nuclear-powered attack submarine as more valuable to ASW work than a carrier, and most surface ships?

A. I assume that in your question you have reference to the ASW-type carrier. There is considerable difference of opinion as to which type of vessel is the most effective in antisubmarine warfare work. Some Navy experts say that the nuclear-powered attack submarine will be the most effective warship in antisubmarine warfare. Our present antisubmarine warfare forces are built around aircraft carriers. It should be made perfectly clear that the carriers engaged in antisubmarine warfare are not the same type as the one proposed in the budget for Fiscal 1961. It is very doubtful that a direct comparison can or should be made between the attack submarine and the carrier for antisubmarine warfare work. Undoubtedly, both will be needed for this type of warfare for a long time to come. Not too much is known about how effective surface ships of any type will be against the deep-diving nuclear-powered submarine in actual war. Strangely enough, the use of the submarine as an ASW weapon system is a relatively new concept. We need much more study in these areas, but certainly such study should be made by experts primarily concerned with solving the problems, and not by people primarily concerned with supporting a particular point of view.

Q. What must be done to give the Navy more capability to kill submarines?

A. The answer must be found in research and development. A lukewarm, uncoordinated effort will not get the job done. The job must be tackled with confidence and determination and with the utmost of leadership and coordination. It is generally agreed that we can kill submarines, at the ranges at which they can be detected, with presently available weapons. As detection devices improve, and as Soviet antisubmarine submarine capabilities increase, new weapons, such as the *Subroc* rocket-torpedo, will be required. The nuclear-powered submarine, because of its performance under water and the depths to which it can go and remain, still performing at high speed, makes the kill possibility much more difficult with present-day weapons, except the atomic depth charge. It is possible that the deep diving high-performance nuclear submarine might be able to escape even an atomic depth charge because of the time required for such a charge to get down to sufficient depth to reach the submarine. What is needed is a weapon which will operate at great depths and with sufficient speed to make evasion most difficult. Rocket-type propulsion under water may provide a part of the answer.

Q. Your Committee has added $321,000,000 more to the 1961 Navy Appropriation portion of ASW. Do you consider this adequate? The Navy will be authorized to spend approximately $1.865 billion for ASW procurement, RDT&E in Fiscal Year 1961. Could you give an estimate of the percentage increase for FY 1962 and the next five-year period?

A. Money cannot buy back lost time or purchase knowledge not yet gained. The Committee added $321,000,000 to the Defense Appropriation bill for antisubmarine work, of which $100,000,000 is for research and development. This research money, when added to the approximately $180,000,000 which the budget contained for research and development is about all that can reasonably be expended. The other $221,000,000 is for attack submarines and destroyer escorts. Undoubtedly, much more could have been added in this latter category because many of our warships engaged in ASW are becoming over-aged. Very likely much more will need to be done in future years in the way of replacing these vessels. However, this should be done when we know more about the problem. What increases there may be in future years will depend on technical developments.

Q. It is well recognized that the missile/space industry sprang up virtually overnight because funding and priorities were given and American industry was called upon to provide the talent. Do you see a like emphasis in ASW and do you think American industry is being called upon by the Navy to do as much as it can?

A. It is doubtful that there will be a rapid growth, comparable to the missile/space industry, devoted exclusively to antisubmarine warfare. Unless, of course, the Russians undertake a mammoth program in the area of fleet ballistic missile development, such as our *Polaris* system. There should be considerable growth in our programs however, over the next few years, particularly in the fields of exploration and research. American industry has not contributed materially to our efforts in the antisubmarine warfare field in the past. The National Security Industrial Association has, however, formed an Antisubmarine Advisory Committee which, in April of this year, submitted its first report to the Navy. There are other indications in the business community that industry is tending to offer the assistance that is so greatly desired. There is no question but that industry can make valuable contribution—whole new concepts of such functions as tracking, identification, and classification need to be developed, explored, tested, and when proven, produced for use.

I should say, nevertheless, that our antisubmarine warfare efforts are not likely to have the same relative priority as our strategic missile programs. Antisubmarine warfare is a defensive operation. Strategic missiles relate to a build-up of our vital offensive capability. We must avoid developing a "Maginot Line" defensive concept.

Ways Sought to Ease Ordeal of Space

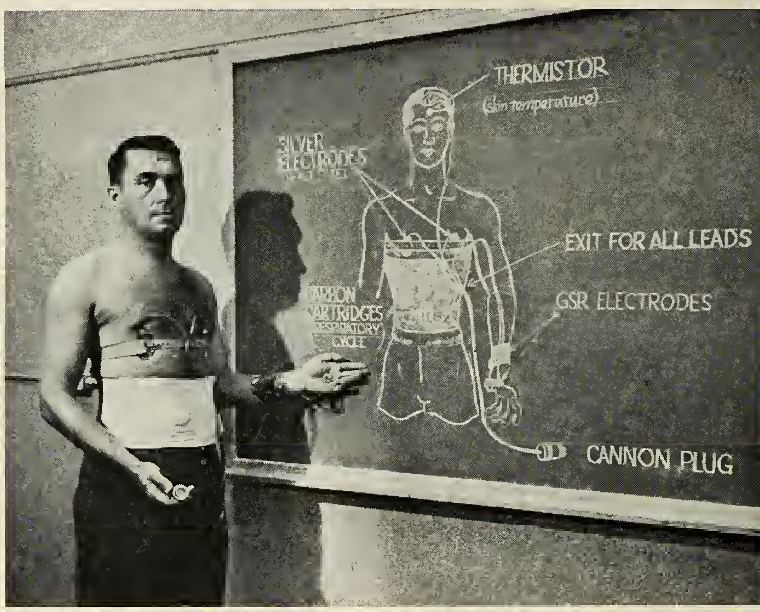
by William Beller

San Antonio—An astronaut en route through space for an extended period will have mental problems due to weightlessness, loneliness, or literally being bored to death, agreed aerospace medical experts at a recent meeting at the School of Aviation Medicine, USAF Aerospace Medical Center.

They said one way to solve his problems is to surround the traveler with more of the earth's environment such as artificial gravity, conversation with friends, and a full day's work.

A minority report filed by several of the experts questioned whether it might not be wiser to change man, making him more adaptable to space conditions as they are. If he is sufficiently changed, then not only will he be complacent but also specifications for the spacecraft's artificial environment could be greatly relaxed.

They suggested that man might be altered by radically lowering his body temperature, by conditioning and hypnosis, and by using drugs administered through a closed loop servo system tied to the space environment.



HARNESS AND SENSORS are worn by subject at Air Force space medicine school to measure his reactions to conditions of stress.

• **Astronaut selection**—Giving a close-to-first-hand report on experiences the first astronaut will be facing, Lt. Col. David Simons, SAM's chief of bioastronautics, contrasted his observations during a 32-hour balloon flight which reached an altitude of 101,000 ft., with a 30-hour simulated flight in a space chamber. He reported that he experienced hallucinations during the chamber run but not during the actual flight. Why this was so, Simons would not say without more tests. However, he surmised that space and time distortions might play an important role in hallucination forming.

Of high interest to the aerospace experts was Simons' statement that his "defense mechanism" for his Manhigh II balloon flight was his thorough familiarity with the Manhigh system. Further, he was totally concerned with "How can the job be done?" and not at all with "Can it be done?"

The Manhigh II pilot also made the following observations:

After 24 hours' continuous duty either in the chamber or during his flight, there was a definite decrease in his performance.

He experienced a deep sense of frustration early in the chamber run because he was not kept busy enough.

During the day, while he was making and reporting scientific observations, he resented interruptions from the ground crew. However, during the night, when he was threatened by environmental conditions outside the capsule, he welcomed every radio contact. These experiences contrasted with Simons' attitude during his chamber flight when he had no strong feelings one way or the other about communications with the outside world.

• **Weightlessness**—Dr. Hubertus Strughold, SAM's professor of space medicine, took pains to point out what he called a popular misconception about weightlessness. Observing that the orbiting of a vehicle around the earth is often described as a constant falling, he said that some people believe that this would produce in an astronaut the nightmare of a sensation of endless falling.

"If we consider the function of the otolith organ (vibrating substance in inner ear) we must come to the conclusion that this is not so," he pointed out. "The astronaut will have the sensation of falling perhaps for only a few seconds when he enters the gravity-free state. Thereafter this sensation should cease because the otoliths have attained a new equilibrium."

Going deeper into the probable problems of weightlessness to the astronaut, Bryce Hartman, chief of SAM's neuropsychiatry branch, emphasized that the astronaut's real difficulty would be his ability to readjust to a one-g state on his return trip. The investigator felt that the physiological effects, for instance those of circulation, digestion and muscular function, of returning to normal gravity environment would involve major disturbances. Yet it is exactly at this point, upon re-entry, that the astronaut would be in most danger.

To dramatize his warning, Hartman told of one subject who for seven days had been in a water tank, a means to simulate a quasi-weightless state. Slowly the subject began losing his ability to perform tasks that previously had been easy for him. Most dramatic of all was when the subject was brought back to his normal one-g state. Then even tasks that he could have performed in the tank were difficult if not impossible for him to do. Hartman observed that, "If these results are valid, we have been dangerously complacent about the effectiveness of man in space flight."

To the astronaut's advantage is that the energy he would use to do a given piece of work in the weightless condition would be less than that used in a one-g system. If it can be said that consequently the astronaut will suffer less fatigue then, Hartman reasoned, "It means that an astronaut will be able to perform steady work for considerably longer periods without deterious effects."

• **Sensory deprivation**—By reducing an individual's ability to sense a stimulation, investigators reported, they brought on a range of responses including hallucinations in "normal" subjects and marked changes in the body scheme in several mental patients. If the responses of the mental patients were included as the limiting condition of a normal tendency, then these studies could also pertain to an astronaut in a spacecraft. He would be deprived of a sense of weight, perhaps of sight, and—perhaps at times—of sound.

Speaking further about reducing the sensations that could get through to a person, D. Ewen Cameron, McGill University professor of psychiatry, said that one of his working assumptions is that all humans want to keep and extend their control over all matters that affect them. "Where this control is interfered with, as, for instance, in loss of control over body equilibrium, in disorientation, in amnesia, in organic brain disease, or where the individual is forced to operate in a dangerous situation without adequate means of control, anxiety constantly appears."

• **Astronaut a monitor**—Hartman considered the astronaut as part of a man-machine system. He saw space flight as merely an extension of military aviation, and the military aviator not as a pilot but rather as an operator of complex systems. In effect, said Hartman, the astronaut will be a monitor.

"While monitoring, he will be required to continuously diagnose the state of the system. When this state deviates from the desired one, he will be required to respond. If a new mode of operation is indicated, he will give the appropriate command to the system. If a malfunction or deviation from a specified mode occurs, he will give corrective commands."

From this analysis, Hartman derived the general characteristics of the tasks performed by the astronaut as follows:

• They are multivariate. The op-

erator is required to perform a large number of different functions.

• They involve a complex combination of skillful responses requiring precision and simple discrete responses such as throwing a switch.

• There is an increasing requirement for detection of signals, interpretation of the information contained in these signals, and making decisions about alternate modes of system operation.

• The rate of performance is variable, and involves intermittent responding and controlling interspersed with periods of monitoring.

• The sequences of responses is highly variable, for the requirements placed upon the operator are based upon minor deviations and major failures of automatic and semi-automatic machine processes which are basically unpredictable.

• **Altered day length**—In an attempt to increase man's efficiency and alertness, experimenters have recently tried altering the 24-hour cycle that man usually lives by. This cycle is reflected in a person's body-temperature curve. It is absent at birth and is individually established and maintained by being made to follow the customary routine of family and community.

Under emergency conditions, almost everyone has lived on a shortened or extended day for a brief period. To look into this question scientifically, the aeromedical experts tried to make their subjects adjust to cycles different than the 24-hour one, and with success. Subjects have thrived on cycles of 18, 21 and 28 hours. Such cycles, or rhythms, could be more easily followed off the earth and during space flight, and a particular rhythm might be of strong advantage to the mission. Certainly, the 28-hour cycle would have helped Simons during Manhigh II.

Nathaniel Kleitman, professor of physiology at the University of Chicago, said that in a reasonably long cycle—one greater than 24 hours but not too greatly extended—the longer the cycle the greater the body temperature range. "This means that one can expect to reach a greater degree of alertness and heightened performance on the one hand, and a more complete relaxation, perhaps better sleep, on the other."

• **Sensory overloading**—In critical situations, the astronaut may suddenly find himself overloaded with things to look at and things to do. As a result, he might be unable to process everything adequately, and a serious breakdown in performance might result, according to James G. Miller, professor of psychiatry at the University of Michigan.

Hartman tied astronaut reliability in with what he called "sensory overload." He emphasized that it was the engineer, the designer of the systems and subsystems, who would have a more direct influence on operator reliability insofar as loading is concerned than the human factors specialist. When designing a system, Hartman asked that engineers consider the following factors:

• When periods of high load density occur, performance drops off gradually, and the effects do not become apparent for some time.

• For the high task load situation, the operator is limited by a built-in, fixed ceiling in his ability to integrate, organize, and respond to a sequence of events.

• Operator reliability can be achieved by redesigning the system to eliminate these periods of operator load. Only a segment-by-segment analysis of the operators' job can isolate those periods where the task has exceeded the operator's capabilities.

• Vigilance, which involves very low signal rates, is highly susceptible to fatigue effects and probably should be engineered out of the astronaut's job. A low-signal-rate item would probably be a dial reading telling of a meteor shower.

• On the other hand, moitoring, which involves moderate signal rates, is an inherent part of the job of a systems operator. When carried out against a background of related activities, monitoring can be maintained at an efficient level over extended periods.

• It may be necessary to make reentry largely automatic until space flight itself establishes the limits of man's capability at this point in the mission.

• The long-term effects of fatigue and diurnal variation will probably be less critical than early workers in space medicine anticipated. Exploratory research suggests that considerably less sleep will be required in the weightless environment.

• Reliability is not accidentally achieved. The astronaut's job must be structured to insure that proficiency is maintained at a high level.

• **Hypnosis and hypothermia**—When it comes to changing man so that he can more easily adapt to his environment and also that he may be tested for proficiency in a new environment, Roy Dorcus, UCLA professor of psychology, saw hypnosis ready to play an important role. He outlined areas in which it might be useful:

• In creating realism in models constructed for simulating space conditions.

• In implanting ideas for reducing fear and anxiety involving unknown situations.

• In reducing boredom by compressing unoccupied time and creating illusions of stimuli to fill time.

• In directing attention to specific tasks to be performed under stress.

• In lowering metabolic rate and reducing oxygen intake.

• In maintaining awkward positions in such a manner as to make them more tolerable.

• In training individuals to induce self-hypnosis so that they may bring about sleep when desired and awaken at any time in an alert condition.

In another exotic method to change man to meet the space environment more easily, F. John Lewis, professor of surgery at Northwestern University School of Medicine, described some of his work in the intense cooling of warm-blooded animals, hypothermia. He observed that to match the shortage of oxygen, the shortage of food, the monotony in the small cabins, that the greatly reduced metabolic activity in the deep narcosis produced by hypothermia would be ideal.

"Attractive, indeed, for the space traveler would be the choice of hibernating during long periods when there was nothing that he had to do." Unfortunately, though, "this desirable state can not be attained yet in homeothermic animals." He added that "short intense cooling to near freezing temperature is quite well tolerated by warm-blooded animals even though prolonged cooling is not."

• **Drugs and servos**—The most imaginative alteration in man was proposed by Nathan Kline, director of research of Rockland State Hospital, Orangeburg, N.Y. Based upon the unconscious control our body exerts over our nervous system and glands, Kline's proposal was that machinery external to man be devised as additional servo loops to make him more efficient.

"This self-regulation needs to function without the benefit of consciousness in order to cooperate with the body's own autonomous homeostatic controls. One such device, which is already available, is the ingenious osmotic pressure pump capsule developed by S. Rose for the continuous slow injections of biochemically active substances at a biological rate." Kline pointed out that this device could be buried in an animal which would lead a reasonable normal life even while the injection was going on. Such a system is possible today, he said, with the selection of appropriate drugs.

Inert Fabrication Plant Operational

BRIDGEVILLE, PA.—The world's first airless, high-temperature, metal processing plant is in operation at Universal-Cyclops Steel Corp.

Designed by the firm's Refractomet Division, with the cooperation of the Navy's Bureau of Weapons, the facility turns out refractory mill products of unusually high integrity insured by the absence of the contaminating elements in air and by working temperatures up to 4500°F.

The Inert Fabrication (Infab) plant is a welded steel enclosure 42 ft. wide x 97 ft. long x 23 ft. high containing an impactor, a rolling mill, furnaces, a ten ton crane and 84,000 cubic feet of 99.995% pure argon. There is additional space available for more equipment.

The inert atmosphere is directly responsible for elimination of many of the operations in the conventional processing of refractories—operations necessitated by the catastrophic oxidation and air contamination which occurs when metals such as molybdenum are heated above 1500°F in air.

The optimum working temperature of a metal is about 85% of its melting point. This insures maximum utilization of the inherent strength properties. In the case of refractories, these hot working temperatures are usually approximately twice that needed for steel.

• **Inert atmosphere**—The argon pressure within the Infab room is maintained at 0.5 oz psi above the outside atmospheric pressure to minimize the entry of contaminating air. Due to the high temperatures generated by the fabrication process, argon is withdrawn from the room at 120°F, cooled, purified and returned at 30°F. Mean temperature within the room averages between 80 and 100°F. Specifications, exceeded in operation, call for the entering argon to contain no more than 150 ppm of nitrogen, 40 ppm of oxygen, 50 ppm of water vapor, and 5-10 ppm of oil and other hydrocarbon vapors.

• **Mill facilities**—The horizontal forging impactor is fully automatic and normally controlled from a console outside the room. A large picture window of special glass screens out the ultraviolet radiation emitted from the heated metal. Driven by compressed argon, the impactor dies strike with 15,000 ft. lbs. per blow on opposite sides of the heated ingot.

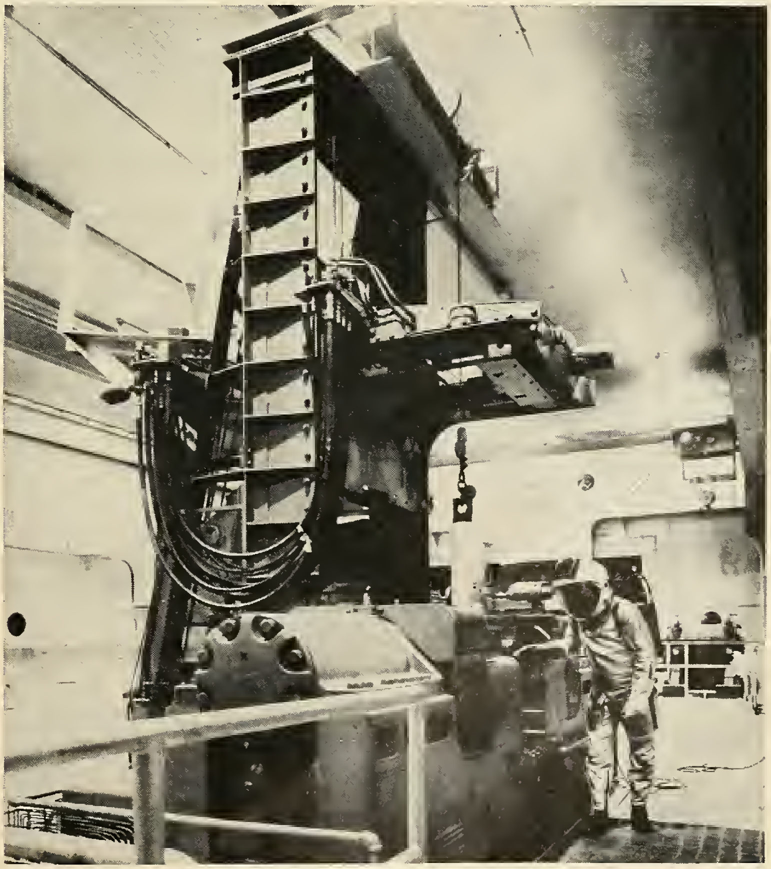
Ingots are heated in induction furnaces located immediately below the forging zone. Transfer takes two seconds and keeps heat losses to a minimum. Normal impact products are 4 in. round cornered square billets and sheet bars 2 in. x 10 in. in cross-section.

The Birdsboro rolling mill is equipped with motorized screw-down, automatic feeding and is normally operated from an outside console similar to the impactor. Two induction furnaces at the end of the rolling table can take the metal up to 4000°F.

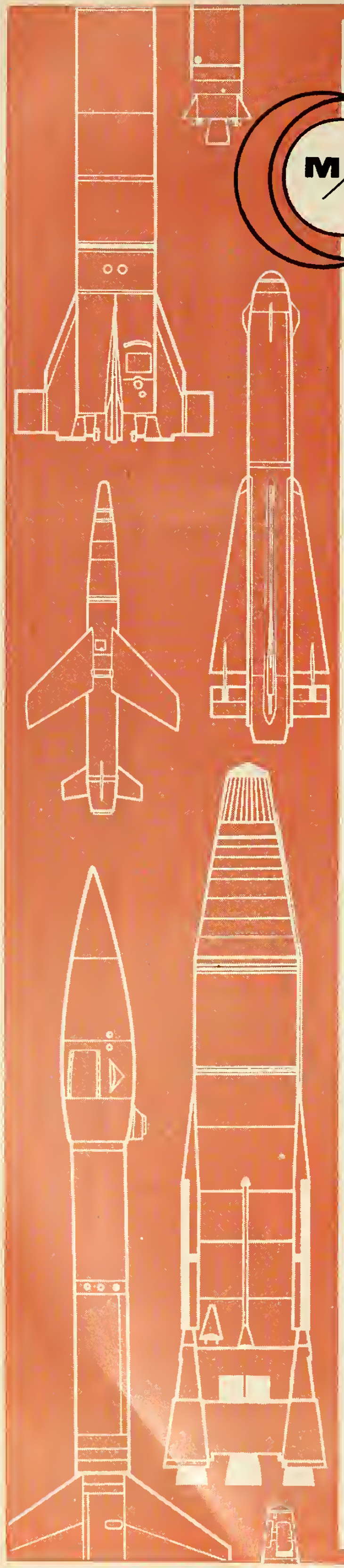
The mill has both flat and grooved rolls and can produce bars down to 0.5 in. diameter and sheet up to 15 in. across and 96 in. long. Through pack rolling, sheet gages of 0.020 in. are obtainable. To avoid contamination of the room, all lubricating points on the machines have been sealed.

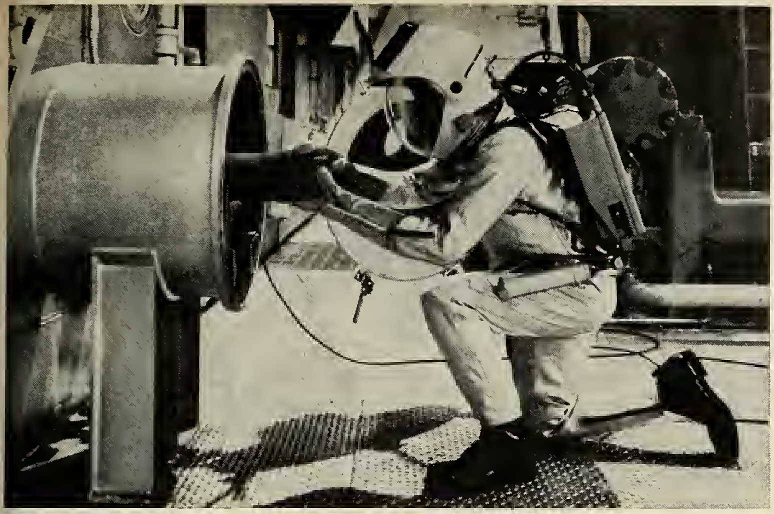
• **Personnel locks**—The Infab room has three personnel locks. One is used for normal passage and the other two for emergency exits. The main lock is flushed with nitrogen to remove the air before the inner door is opened. The argon purification cycle rapidly removes the nitrogen. Personnel carry their air supply and a cooling unit on their back. Communications and power outlets are located around the room. Each technician wears a four-layer, gas-tight suit. Maximum care is taken to insure that none of the normal body oils escape to contaminate the room.

Optimum safety standards are ob-



MOLYBDENUM INGOT passes through the jaws of the impactor into the induction furnace. Three furnaces with induction coils of varying size can heat it to 4500°F.





METAL WORKPIECES are admitted through this materials lock. The suited technician can use a 10-ton overhead crane to move the heavy ingots.

served. Each man has a spare oxygen bottle which can be activated by pulling a lanyard. The two emergency exits can be reached easily from any point in the room. In addition, a man is stationed outside of each of the personnel locks.

The actual work performed by personnel within the room will be light. They serve as trouble shooters in case of mechanical difficulties and aid in the movement of the metal workpieces.

• **Ingot entry**—A cylindrical materials lock, 2 ft. in diameter and 16 ft. long containing roller tables, admits the prepared ingots. Large pieces of equipment and materials enter the room through the fifth lock. This chamber is 8 ft. high, 16 ft. long, and 8 ft. wide.

Normal powder metallurgy methods are followed in preparation of ingots for milling operations. Powdered metal is initially formed into a controlled shape through vacuum and mechanical agitation in a bag loading device.

The powder, and its plastic container, is compacted isostatically in a converted naval gun barrel using water pressure. The compacted electrode is sintered with final density reaching 95% of theoretical.

The electrode is then melted in a modified General Electric consumable vacuum arc furnace—producing .12 in. diameter ingots 70 in. long and weighing up to 3000 lbs. Other facilities at Universal-Cyclops can produce ingots of the same length, 17 in. in diameter and weighing up to 6000 lbs., depending on the metal. The ingot is then admitted to the Infab room after conditioning.

The firm will concentrate on molybdenum, tantalum, tungsten, columbium and their alloys. Company spokesmen point out that Infab is a pilot production plant capable of around 2000 lbs. of finished mill products daily.

NBS Presses Research on Hot Gas, Plasma

The space-fostered interest in the behavior of hot gases and plasmas has prompted the National Bureau of Standards to establish a special research program to unify and strengthen its activities in this field.

NBS has planned a long-range experimental and theoretical program to develop the necessary measurement standards, basic data, theoretical guidance and interpretative techniques for determining relevant properties of hot gases.

Many long-standing NBS projects—investigations of ionosperic and solar phenomena, atomic properties and hot gas research, and study of radio wave propagation in plasmas—are to be included.

Data necessary to prediction of hot gas behavior will be derived from atomic-energy-level investigations, studies of transition probabilities and work on collision cross-sections.

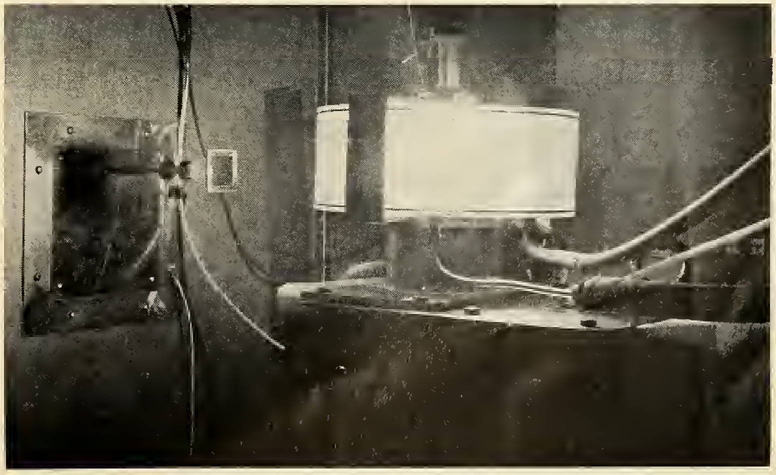
Efforts to characterize plasmas accurately involve:

• Searching for a meaningful substitution for temperature when local thermodynamic equilibrium does not exist.

• Theoretical studies devoted to the application of non-equilibrium statistical mechanics to hot gases.

• Development of thermodynamic data for ionized plasma over the range of 10,000°K to 10,000,000°K. As of now, there is no experimental data of state above 1000°K. NBS is immediately interested in determining thermal conductivities of hydrogen and helium in shock wave between 10,000° and 50,000°K.

In addition, microwave diagnostic techniques are being developed to provide a physical understanding of plasma configurations. Theoretical work on the physics of stellar and planetary atmospheres is also included—since these provide convenient and important examples of non-local thermodynamic equilibrium, high-temperature gases.



DISCHARGE OF EXPLODING WIRE at the Bureau of Standards. Cylindrical shock waves so generated provide needed data in plasma research.

Graphite R&D Boosted With $12 Million From AF

New types of graphite and graphite-based materials for nozzles, nose cones and leading edges of space vehicles will be provided through an accelerated development program conducted by Union Carbide under a $12-million Air Force contract.

Morse G. Dial, chairman of the board of Union Carbide, announced last week that an Advanced Material Laboratory will be constructed at Lawrenceburg, Tenn., to carry out the program.

Built by the firm and equipped by the Air Force, the laboratory will consist of a raw materials plant, a pilot processing plant, a completely equipped laboratory and office facilities.

The primary objectives are to explore raw materials and processing techniques which may cut by one third the variation of mechanical and physical properties found in the best grades of graphite currently available, and reduce manufacturing time from weeks to days. These objectives are to be attained for pieces larger than 3 x 6 ft. Finally, a processing facility will be developed to produce such graphites in quantity for proper evaluation under full-scale conditions.

Experienced scientists at National Carbon Co., a division of Union Carbide, will participate in the program.

The Air Force says that if the high-temperature properties of graphite can be improved, several knotty problems in missile and space vehicle design will be simplified. Graphite is known to be stronger than any material above 2700°F—and this strength increases up to 4500°F. (M/R, Nov. 23, 1959, p. 16)

GE Develops Low-thermal Alloy for Ceramic Seals

A new alloy with thermal expansion properties close to those of alumina has been developed by General Electric, Schenectady, N.Y.

This means that the electric industry can now take full advantage of the high strength, high heat resistance and insulating properties of alumina in metal-to-ceramic seals, according to Dr. Guy Suits, Director of Research.

Designated Fernico-5, the alloy is a result of combining iron, nickel and cobalt in such a way as to optimize the ferromagnetic properties. The low thermal expansion is a direct consequence of this.

The alloy is vacuum-melted—eliminating oxygen-level control additives, providing low gas content in the melt, and allowing better control of the iron-nickel-cobalt ratio.

names

Henry J. Hirtzer: Manager of engineering for the past 2½ years, elected vice president of Donner Scientific Co., a subsidiary of Systron-Donner Corp. Prior to joining the firm in 1956 as senior engineer, he served as project engineer for Statham Laboratories; senior areodynamicist, McCullough Motors Corp.; and stress analyst with North American Aviation, Inc.


HIRTZER

Dr. Hanns S. Wolff: Formerly on the engineering staff of W. L. Maxon Corp., appointed chief of the new Electronics Laboratory at Republic Aviation Corp. Is the holder of more than 125 patents.

Horace G. Irwin: Named space systems project engineer for the Douglas Aircraft Co.'s *Delta* and *Thor-Able* space vehicle programs, succeeding **Ted J. Gordon** named project engineer for the *Saturn* S-IV second stage.

Arthur W. Dobson: Joins Perkin-Elmer Corp. as manager of marketing research, responsible for directing all activities of the Central Marketing Research Dept. Was previously assistant manager of product analysis with American Machine and Foundry Co.


DOBSON

G. T. Atkins, (USN ret.)—Appointed head of the Project Management Dept. at Thiokol Chemical Corp.'s Elkton Division.

Sherwin U. Miller, M.D.: Elected director of the Life Sciences Division of Space Systems Laboratories, Space Systems & Industrial Automation, Inc. Was formerly director of space medicine at the Space Research Laboratories of Litton Industries.

Ernest N. Ljunggren: Appointed vice president for the Minuteman Systems Management division of Autonetics, division of North American Aviation, Inc.

Robert M. Snow and **Dr. Glenn E. Fellows:** Formerly manager and assistant manager, respectively, at Melpar's Applied Science Division, join Bay State Electronics Corp. to establish a research division.

D. W. Hege: Manager of the Advanced Design subdivision of Rocketdyne, division of North American Aviation, Inc., named a consultant to the Propulsion Panel of the Air Force's Scientific Advisory Board. Prior to his present position was for four years program manager of the *Atlas* rocket engine development.

Thomas W. Donohue: Former sales manager for Statham Development Co., appointed to the new post of director of marketing for Missimers Inc. Previously served as general manager of Tomlee Tool and Engineering Co. and as chief engineer of General Mills Inc.'s Mechanical Development Division.

Dr. Grant E. St. John: Appointed director of research and development, Tube Division of Microwave Associates, Inc. Was previously senior project engineer with Watkins-Johnson Co. and prior to that was supervisor of a research and development group with Bell Telephone Laboratories, Electron Tube Development Dept.


ST. JOHN

Murray A. Schwartz: Joins the technical staff of United Technology Corp.'s Research Division as head of its high-temperature materials program. Was formerly manager of the ceramics section of Ford Motor Co.'s Aeronutronic Division.

David E. Hemingway: Appointed general manager of the environmental engineering laboratories of Richard D. Brew & Co., responsible for all testing activities, laboratory development and marketing programs.

Sam Polur: Named sales and advertising director of Electro Networks, Inc.

Benjamin J. Pensiero: Formerly with a private consulting firm, joins Philco Corp.'s Government and Industrial Group as manager of marketing administration.

G. William De Sousa: Named marketing manager of Sperry Semiconductor Division, Sperry Rand Corp. Was formerly vice-president-marketing in the Semi-conductor Division at Hoffman Electronics Corp.

Ray Primmer: Joins National Astro Laboratories as manager, Quality Assurance Division.

Beryl L. McArdle: Former manager of the Intelligence Systems Dept., Electronics Division, appointed scientific advisor on the staff of **Dr. Royal Weller,** vice president-engineering for Stromberg-Carlson Division of General Dynamics Corp.

Frederick J. Senft: Joins the Condenser Products Co., a division of The New Haven Clock and Watch Co., as chief engineer.

Edward F. Canfield: Named marketing manager for Philco Corp.'s Research Division.

By DR. ALBERT PARRY

Marshal of rocketry

is the latest high office created in the Soviet armed forces. The revelation of the new command in Moscow went almost unnoticed in the tumult caused by the shooting down of our U-2. Yet the official confirmation by Nikita Khrushchev of this long-rumored news constitutes an important development in the organization of Russia's rocket-and-missile arms. Rocketry is now definitely a separate Soviet command, on an equal footing with the army, the navy, and the air force of the U.S.S.R., if indeed not higher than the three older services.

The earliest indication

of the new Soviet organization came from England late last year. A report by the Institute of Strategic Studies in London stated: "The personnel operating the Soviet missiles have been organized into what is virtually a fourth arm of the services numbering about 200,000 men under the command of an engineer general who has under his control all factories in which nuclear bombs are manufactured, all testing sites, all factories in which rockets and guided missiles are produced, and rocket and guided missile units." The number of the main Soviet missile bases under this "engineer general" was given in the London report as some 100.

The Soviets remained mum

on this London report even after it was cited as authentic in the December, 1959, issue of *The NATO Letter*. But finally, on May 1, 1960, Soviet Minister of Defense Marshal Rodion Malinovsky greeted the Red Square parade as "soldiers of the army, fleet, and rocketry," using the word "rocketry" for the first time in such a salutation. Malinovsky spoke just a few hours after his subordinates had notified him that a Soviet rocket shot down the American U-2 plane. Three days later, on the evening of May 4, Nikita Khrushchev himself, while chatting at a reception at the Czechoslovak embassy in Moscow, turned to a nearby Russian marshal and casually introduced him as "Nedelin, Marshal of Rocketry." Thus the new command and its chief were officially unveiled.

Marshal Mitrofan Ivanovich Nedelin

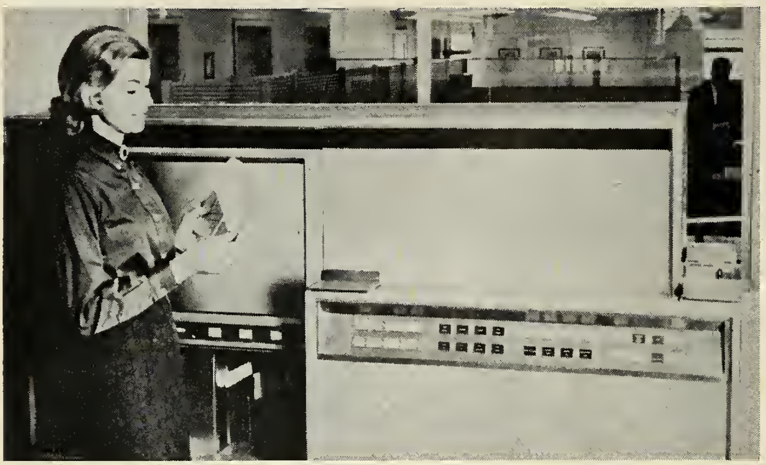
is indeed an "engineer general" of long standing, with a distinguished career in Soviet artillery. He has been a marshal since 1953 (the year of Stalin's death), and until quite recently his official titles were "Marshal of Artillery; Commander in Chief, Soviet Army Artillery; chief of the Main Artillery Administration, U.S.S.R. Ministry of Defense." Born in either 1903 or 1904 (Soviet records are not too exact on this), he joined the Red army after the Russian civil war, and was graduated in the late 1920's from an artillery training school, and in 1935 from the Dzerzhinsky Artillery Academy in Moscow.

He fought in Spain

in 1936-39 as an artillery adviser to the Loyalists. On returning home he was a colonel of artillery in and around Moscow. In World War II he organized and commanded large artillery units, particularly proving himself as one of Russia's ablest organizers of artillery logistics. He was credited with successful moving up of artillery supplies during major mobile operations in the Soviet offenses beyond Russia's borders. He emerged from the war a colonel general, with numerous decorations. A zealous Communist, this head of Soviet rocketry is an alternate member of his party's central committee, which may mean that he is one of the Soviet military men playing a political role as well.

Thanks to Nedelin's rocket men

in Sverdlovsk, who were praised for reportedly knocking down the U-2, the marshal himself will doubtless get another medal to add to his collection. And now that his post has at last been publicly revealed, the world may well expect further news of him.



Univac Card Printer Developed

Punched cards, used by the billions in many business operations, can now be computed, edited, punched and printed on both sides in a single operation by a system developed by the Remington Rand Univac Division of Sperry Rand Corp.

The system is based on a new unit, called the Univac On-Line Card-Punching printer, which prints a total of 1820 characters of information on one punched card at speeds up to 1560 lines a minute, permitting users of the Univac Solid-State 80 computer to reduce the size of their files and speed up search time.

The "one-line" principle permits data to be fed directly at high speed from the central computer to the printing unit and eliminates intermediary steps.

A storage capacity of 50,000 characters of data allows a wide variety of programing, control, editing and arithmetic operations.

The new unit punches alphabetic or numeric data in as many as 80 columns simultaneously at the rate of 150 cards a minute, while reading and verifying the accuracy of the information punched. At the same time, it prints up to 13 lines, 70 characters wide, on one or both sides of the cards. Printing is done between rows of punching. This makes it impossible to print over previously punched holes, thus preserving valuable printed data.

Circle No. 225 on Subscriber Service Card.

Mercury Vapor Filter

A respirator cartridge developed for protection against the vapors of elemental mercury in air is being marketed by American Optical Co. Designed for use with the R-5000 series of interchangeable respirators, each cartridge includes a particulate filter for retention of airborne particulate and a vapor adsorbent bed for retention of metallic mercury vapors.

The R-88 cartridge will also protect against organic vapors as well.

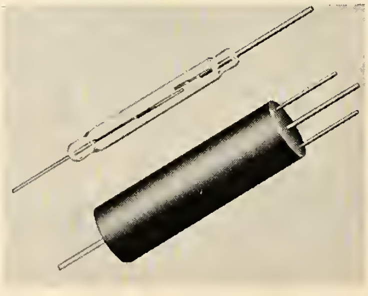
Circle No. 226 on Subscriber Service Card.

High-Speed Reed Relays

Reed relays developed by Struthers-Dunn, Inc., are based on an unusual design incorporating a short pole piece with a longer moving reed which permits higher operating speeds with conventional reed switches.

A hermetically-sealed, glass-encapsulated magnetic reed switch is surrounded by an operating coil to provide SP-ST normally open relay action. Maximum operating current is 1 ampere. Load life at one-quarter of maximum rating is on the order of 200 million operations. Minimum operating power is approximately 100 milliwatts.

The switch itself is 3¼ in. long by



.215 in. diameter. A single contact relay with coil as illustrated is approximately 9/16 in. in diameter.

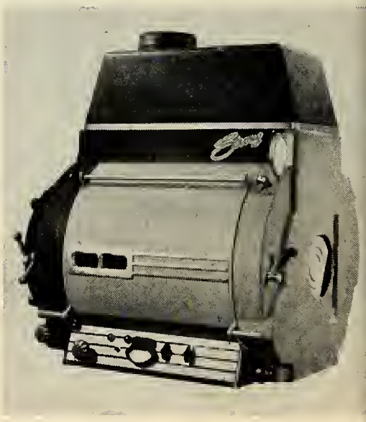
Circle No. 227 on Subscriber Service Card.

Solar Energy Simulator

A blown type arc for artificial simulation of solar energy is being manufactured by Strong Electric Corp.

Known as the Jetarc, it efficiently collects useful radiation by first-surface reflectors and concentrates it at the reimaging point, from where it can be projected by a quartz objective system in a pattern shaped to fit the work area.

A circular radiation pattern totals 374 watts with an 80% uniformity of field or a total of 668 watts with a 60% uniformity of field. Higher- or lower-energy unit areas can be obtained by variation in optics or projection distance. Larger areas can be covered by multiple employment of lamps using either superimposed or overlapping pattern technique.



A continuous spectrum is available from .25 to 5.+ microns, with a spectral energy distribution very close to solar energy distribution above the earth's atmosphere. The Jetarc source can be oriented in any plane without loss of stability.

Circle No. 228 on Subscriber Service Card.

Solid-State Decommutator

A solid-state, completely digital telemetry decommutator is now available from Electro-Mechanical Research, Inc. The new decommutator, designated the Model 185A, accepts most pulse-type telemetry signal inputs, PAM, PDM or PCM, over the extremely wide sampling-rate range of 10 to 4600 pps, and provides digital or analog outputs. PCM bit rates (serial) to 60,000 bits per sec. and word lengths of 16 bits (serial or parallel) can be handled. Between 10 and 128 channels or words per frame can be accommodated.

The Model 185A employs all solid-state circuitry for ruggedness and low power consumption. Through solid-state design a complete 48-channel decommutator occupies only 52½ in. of rack height. Modular, computer-type construction is used throughout.

Circle No. 229 on Subscriber Service Card.

Epoxy Glass Rolled Tubing

Continental-Diamond Fibre Corp., a subsidiary of The Budd Co., announced production of rolled epoxy-glass tubing that has the electrical and physical properties required of NEMA G-11 sheets.

Known as Dilecto GB-125EFT, this rolled tubing is made from epoxy resin impregnated glass cloth that is rolled and cured-in mandrels. The new tubing grade is designed for use in transformers and other heavy electrical equipment and for use in military electronic equipment. In such use, it features excellent physical properties, flame retardance, arc resistance, and high flexural strength at 150°C.

CDF's new Dilecto GB-125EFR tubing is available in 3/16-in. to 12¾-in. ID and ¼-in. to 13½-in. OD with a minimum wall thickness of 1/32 in. The tubing length is 38 in.

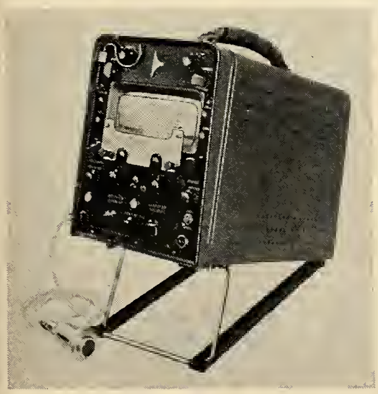
Circle No. 230 on Subscriber Service Card.

Non-Destructive Tester

An ultrasonic materials tester for non-destructive inspection of material which can support ultrasonic waves is being manufactured by Circo Ultrasonic Corp.

The Circosonic Model CM100 is completely portable, designed for in-plant use, simple and economical to operate, and can use any common plant power supply. Accessories for a wide range of applications are available.

Components are a generator and receiver for high frequency vibrations sent in a pulsed beam through material to be inspected and discontinuities, as well as the opposite end, reflect vibrations back to receiver indicating size and location of reflecting areas on the viewing screen.

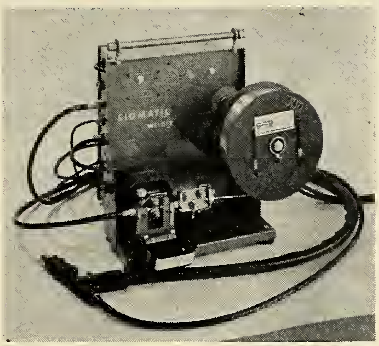


Circle No. 231 on Subscriber Service Card.

Welder Line Announced

A new line of "Sigmatic" welding machines for consumable electrode, inert-gas welding of the fullest range of metals and thicknesses has been announced by Linde Co. Three mountings of standardized welder components are available: SWM-11 frame-type unit; SWM-12 sled-type unit; and SWM-13 cart-type unit.

Adaptable electronic controls, which are primarily designed for the constant-



potential power source, are easily converted to use conventional (constant current) power supplies. Other optional control features include a wire-feed delay until the arc is struck (useful in welding the .030- to .100-in. thickness range), and continuous operation without depressing the torch trigger.

Circle No. 232 on Subscriber Service Card.

C-Band Oscillator Cavity

A miniaturized C-Band Oscillator Cavity, tunable from 5350 mc to 5950 mc, has been announced by Trak Electronics. Tuning is accomplished by adjusting a screw located at one end of the Trak Cavity. The C-Band Trak Oscillator Cavity is used in beacons, transponders, and similar applications. Preliminary specifications are as follows:

There is a 10w peak minimum over the band. (0.001 duty cycle, 1 microsecond pulse). Higher powers may be obtained using higher pulse voltages. Depending upon the individual tube selected, output powers exceeding 50W peak have been obtained at the low end of the band. It can withstand 100 G for 3 milliseconds in each of three major axes.

Circle No. 233 on Subscriber Service Card.

Constant Cutting Lathe

A Universal Constant Cutting Speed Lathe that eliminates the need for speed control cams and computations has been announced by the Lodge & Shipley Co., Cincinnati, Ohio.

Built in Powerturn 45° Copymatic models in sizes from 2013 to 3220-37, the new lathe provides constant cutting speed at any point, regardless of contours. Beside giving greater accuracy and smoother finish, this machine eliminates the cost and delay of providing a special speed control cam for each job, gives longer tool life and minimizes tool grinding.

Circle No. 234 on Subscriber Service Card.

Motionless Computer

Servomechanisms Inc. has developed a new form of analog computer that can solve problems without mechanical motion of any kind.

The computer, technically called a "solid-state analog computer," performs the specialized functions of an analog computer, but with no moving parts. It is a miniature solid block of "vacuum-deposited" material which has sufficient versatility to simulate the components of the standard analog computers, requiring the same inputs and supply the same type of outputs. Initial use will be in aircraft and space flight applications.

Circle No. 235 on Subscriber Service Card.

new literature

VECO CHOPPERETTE DATA SHEET. The VECO "Chopperette" solid-state transistorized chopper is described and illustrated in a 4-page data sheet now available. Complete details of operation are included: typical applications with diagrams, switching characteristics of the Chopperette and its use, plus electrical characteristics.

Circle No. 200 on Subscriber Service Card.

TANTALUM FOIL CAPACITORS. With the introduction of a line of etched tantalum foil electrolytic capacitors, Ohmite Manufacturing Company has released a new bulletin describing this line and its existing plain foil line. The literature lists the extensive range of values in both the etched and plain foil capacitors stocked by Ohmite. Clearly shown are the MIL values in plain foil capacitors stocked by Ohmite distributors.

Circle No. 201 on Subscriber Service Card.

EPOXIES IN THE FOUNDRY. Ten applications enabling savings of up to 60% are outlined in a new three-color, eight-page brochure. Blow core boxes, loose pieces, spotting slugs, match plates, core sticks, cope and drag patterns, fillet pastes and pattern coating resins are but a few of the applications described in the booklet published by Furane Plastics Incorporated.

Circle No. 202 on Subscriber Service Card.

BALANCING MACHINES. Two complete lines of static-dynamic balancing machines are described in a 20-page bulletin from the Tinius Olsen Testing Machine Company. The brochure describes Olsen compensator and pivoted cradle machines, including special adaptations for jet engines and components, automobile engines and completely automatic balancing machines. In addition, the bulletin includes an informative dissertation on the nature, causes and correction of unbalance with descriptions and schematic diagrams of four different balancing methods—compensator, nodal bar, pivoted cradle and electrical network.

Circle No. 203 on Subscriber Service Card.

PRECIOUS METALS — INDUSTRIAL APPLICATIONS. The brochure outlines sizes, compositions, and uses of solid and clad gold and silver strip, tubing, wire, brazing alloys, and waveguide tubing. Typical platinum and platinum alloy clad-metal combinations are noted, along with basic specifications for sheet, strip, rod, wire, foil, and tubing. The brochure also contains information on platinum thermocouple wire, platinum-clad electrical contacts, rhodium plating solutions, and other platinum products.

Circle No. 204 on Subscriber Service Card.

BALL BEARING ENGINEERING. A 28-page brochure presenting concepts for applying thin-sectioned large bore ball bearings to equipment designs is available from Kaydon Engineering. Installation drawings illustrate how thin Kaydon Reali-Slim bearings save weight, space and cost. Applications shown range from wire-twisting machines to paper-making machine press rolls, and from heavy-duty lathes to submarine periscopes.

Circle No. 205 on Subscriber Service Card.

SILICONE GUIDE. An up-to-the-minute summary of the forms, properties and applications of Dow Corning Silicones is contained in this 16-page brochure. Silicone products reviewed range from adhesives to release agents, laminating resins to rubber compounds, and electrical insulation to water repellents. The table of contents is arranged according to applications — enabling quick, easy reference to silicone materials that resist the effects of time, heat, moisture, weathering, oxidation, and chemical attack.

Circle No. 206 on Subscriber Service Card.

when and where

JUNE

American Nuclear Society, National Meeting, Palmer House, Chicago, June 12-14.

Seminar in Design Engineering, Pennsylvania State University, University Park, June 12-17.

1960 Radio Frequency Interference Symposium, sponsored by the IRE, Shoreham Hotel, Washington, D.C., June 13-14.

American Institute of Mining, Metallurgical and Petroleum Engineers, International Powder Metallurgy Conference, Biltmore Hotel, New York City, June 13-15.

Symposium on Molecular Structure and Spectroscopy, Dept. of Physics and Astronomy, Ohio University, Columbus, June 13-17.

1960 Cornell University Industrial Engineering Seminars, Ithaca, N.Y., June 14-17.

Special Summer Program on Fluid Power Control, Massachusetts Institute of Technology, Cambridge, June 14-24.

American Institute of Chemical Engineers, Del Prado Hotel, Mexico City, Mexico, June 19-22.

AIEE Summer General Meeting. Atlantic City, June 19-24.

University of Connecticut, Institute for Practical Research on Operations, Storrs, June 19-25.

Atomic and Molecular Gas Beams Symposium, University of Denver, Denver, June 20-22.

ASME Applied Mechanics Conference, Pennsylvania State University, University Park, June 20-22.

Gordon Research Conference, Colby Junior College, New London, N.H., June 20-24.

Institute of Navigation, 16th Annual Meeting, Air Force Academy, Colorado Springs, June 23-25.

International Machine Tool Trades Exhibition, Brettenham House, Lancaster Place, London, W. C. 2, June 24-July 8.

Fourth National Convention on Military Electronics, sponsored by IRE PGMIL Sheraton Park Hotel, Washington, D.C., June 27-29.

JULY

Metallurgical Society of AIME Conference on The Response of Materials to High-Velocity Deformation, Estes Park, Colo., July 11-12.

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

Pennsylvania State University, R&D Management Development Seminar, University Park, July 24-29.

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

contracts

NASA

$44,000,000—Rocketdyne, a division of North American Aviation, Inc., Canoga Park, Calif., for development of a 200,000-pound-thrust liquid hydrogen-fueled engine.

$124,480—Doyle and Russell, Norfolk, Va., for services and materials for liquid fuel storage at Wallops Island.

$87,600—The T. J. Hume Co., Lorain, Ohio, for construction of the High Energy Rocket Research Facility Control Building for Plum Brook Facilities, Sandusky, Ohio.

$42,000—Consolidated Aerodynamics Corp., Washington, D.C., for recorder, amplifier and systems.

$38,840—The Klein Steel Co., Bellevue, Ohio, for fabrication and erection of structural steel for the Altitude Rocket Test Facility at Plum Brook Facilities, Sandusky, O.

AIR FORCE

Solverine Diesel Power Co., Detroit, for precise power ground support generator sets which may be used with the newest supersonic jet planes and missiles. Amt. not disclosed.

$20,000,000—Food Machinery & Chemical Corp., New York, N.Y., for multi-million-pound quantities of Dimazine storable, high-energy liquid rocket fuel.

$15,000,000—Siegler Corp., for automatic electronic launch control equipment for the *Atlas*. Subcontract from **Convair-Astronautics Division.**

$12,000,000—National Carbon Co., a div. of Union Carbide Corp., for research and development of space aeronautical-vehicle grade graphites.

$1,700,000—Astronautics Div., Chance Vought Aircraft, Inc., for constructing airframe and special support equipment for the *TS-609A* space research and test rocket.

$126,008—Sperry Rand Corp., Phoenix, Ariz., for flight path computing system law/exhibit.

$62,776—The J. C. Carter Co., Costa Mesa, Calif., for propellant flow control valves.

NAVY

$3,300,000—The Martin Co., Orlando, for *Bullpup* missiles.

$3,139,448—Raytheon Co., Missile Systems Div., Oxnard, Calif., for missile spare parts and evaluation flight tests.

$238,750—The Cardan Company, Los Angeles, for construction of high explosive magazines, Naval Missile Facility, Point Arguello, Lompoc, Calif.

$77,453—Magnetic Controls Co., Minneapolis, for portable temperature control systems to be used with missile inertial guidance gyroscopes.

$74,800—Consolidated Electrodynamics Corp., San Diego, for magnetic tape record-reproduce equipment.

$65,951—Northwestern University Aerial Measnrement Laboratory, Evanston, Ill., for labor and materials to conduct a weapons system study relating to the Sidewinder 1C.

$57,991—Chrysler Corp., Engineering Div., Detroit, for conducting a research program on semiconducting compounds for thermo-electric power generation at high temperatures.

ARMY

Hogan Faximile Corp., a subsidiary of Tel-autograph Corp., for high-speed recorders to be used in connection with *Nike-Zeus* missile program. Amt. not disclosed.

$9,238,454—Hercules Powder Co., Wilmington, Del., for continued production and plant maintenance at Radford, Va., arsenal.

$7,335,285—Thiokol Chemical Corp., Bristol, Pa., for continued production and plant maintenance at Longhorn Ordnance Works, Marshall, Tex.

$6,642,496—Chrysler Corp., Detroit, three contracts for repair parts and modification services on the *Jupiter* missile.

$4,341,750—Western Electric Co., New York, N.Y., for the *Nike-Hercules* program. Work will be done at Winston-Salem, N.C. and at Douglas Aircraft, Santa Monica.

$4,114,000—Johnson, Drake & Piper, Inc., Downey, Calif., for construction of two *Atlas* missile launching silos at L. A. Ordnance District.

$2,700,000—Martin Co., Orlando, Fla., for the *Pershing* missile system.

ARMY

$1,950,000—Raytheon Co., Waltham, Mass., for engineering services for the *Hawk* missile system.

$1,887,763—Chrysler Corp., Detroit, for *Redstone* missile engineering services.

$1,741,500—The Wurlitzer Co., North Tonawanda, N.Y., for multi-purpose electronic bomb fuzes.

$513,350—Sperry Rand Corp., Salt Lake City, Utah, for repair parts for *Sergeant* guided missile system (two contracts).

$300,000—Sperry Rand Corp., Salt Lake City, for publications for the *Sergeant* guided missile system.

$223,092—Douglas Aircraft Co., Santa Monica, Calif., for launching area items: *Nike-Hercules*.

$208,256—Gilfillan Bros., Inc., Los Angeles, for repair parts for *Corporal* missile system.

$119,778—Douglas Aircraft, Santa Monica, Calif., for spare parts for the *Nike* system.

$113,350—Sperry Rand Corp., Salt Lake City, for repair parts for *Sergeant* guided missile system.

$109,250—North American Aviation Inc., Rocketdyne Div., Canoga Park, for research of high-energy monopropellants.

$97,058—General Machine Products Co., Inc., Trevase, Pa., for *Thruster*.

$96,250—Radioplane, Div. of Northrop, Van Nuys, Calif., for C-2B flight control system for the *OQ-19B* target missile.

$85,330—Ryan Aeronautical Co., San Diego, for target missile flight service.

$74,975—Hughes Aircraft Co., Culver City, Calif., for development, demonstration of breadboard reflector scanned high power radar.

$69,989—Sperry Rand Corp., Salt Lake City, for *Sergeant* Missiles.

$60,000—Packard Bell Computer Corp., Los Angeles, for digital arbitrary function generator.

$53,417—Firestone Tire & Rubber Co., Los Angeles, for spare parts for *Corporal* missile system.

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editorial . . .

Nuclear Testing—Morals vs. Survival

It is easy for people who have no responsibility for defending this country or its allies to call for a complete cessation of nuclear weapons testing. From a moral point of view, they are right.

But war and the weapons of war aren't moral. They are designed—from the longbow to the big bomb—to surprise, bewilder, terrify, overwhelm and overpower the enemy. Let's consider a few hard facts of our defense or military situation:

There are only three countries on this earth which can wage an all-out war—Soviet Russia, the United States and Red China. Any world holocaust today must involve at least two of those powers.

It is inconceivable in the present climate that the United States would go to war against any of the Western nations or a coalition of Western nations. It is most remote that we should be involved in fighting Israel. But if they are involved in a war with Russia or China—so would we be.

There are no other nations in the world with armed forces powerful enough to pose any military threat.

This being the case, we have two things to fear. The first is that we might blunder into war with Russia or Red China, or both. The second is that we might intervene to stop communist aggression and find U.S. forces (even within a NATO or United Nations framework) pitted against Chinese or Russian forces in the guise of volunteers or otherwise.

In the first instance we would obviously use nuclear weapons. In the second we might or might not. If the aggression occurred in the Western hemisphere we would have the advantage of short logistic lines for both supplies and manpower.

If, as is most likely, it occurred in the other side of the world, either the Russians or the Red Chinese could pour into the conflict supplies and men sufficient to overwhelm us unless we had superior firepower.

Equally or perhaps more important is the fact that our military forces—Army, Navy and Air Force—are geared to the use of atomic weapons. Numbers have been sacrificed for firepower. Restricted to conventional weapons, we would be defeated by attrition.

Whether the situation we have reached is the best or worst is not a point here. It is a situation we're stuck with—and we must make the best of it.

Which brings us again to the testing of nuclear weapons. On the authority of Dr. Edward Teller, possibly the free world's foremost nuclear technician, we are on the verge of perfecting small "clean" nuclear weapons. They lack only further testing.

They would be comparable in effectiveness to an artillery barrage. They could arm small commando forces. They would reduce the warhead size and weight of small missiles for all forces. They would add immeasurably to the mobility and firepower of our ground forces. These weapons would, according to Dr. Teller, reduce our armament costs greatly; he further argued that they should also be given to our allies for all of the foregoing reasons.

Because of the time element involved—because the missiles are second-generation—there is a possibility that the small warheads of *Minuteman* and *Polaris* may not have been sufficiently tested to absolutely guarantee their reliability. These are the ballistic missiles which will provide the bulk of our retaliatory defense for the next several years.

So, ordering the cessation of testing of all nuclear weapons is not as simple as the moral problem involved. Survival is a factor, too, and we doubt very much if a few more tests would raise the world's tension noticeably. Not after the events of recent weeks.

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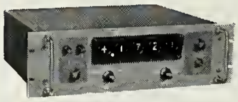

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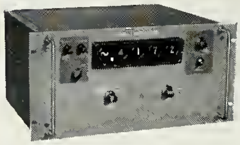

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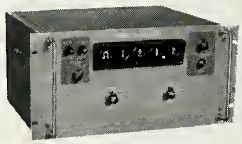

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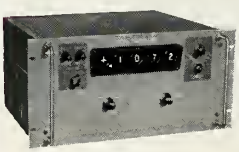

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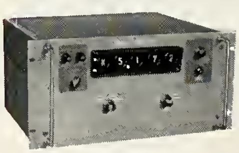

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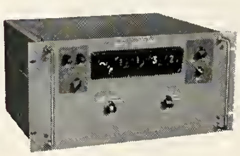

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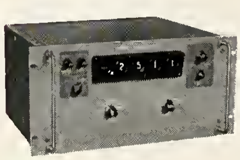

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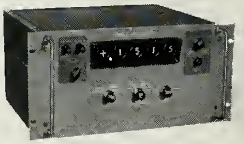

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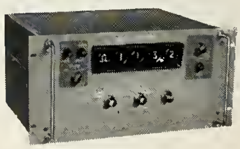

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