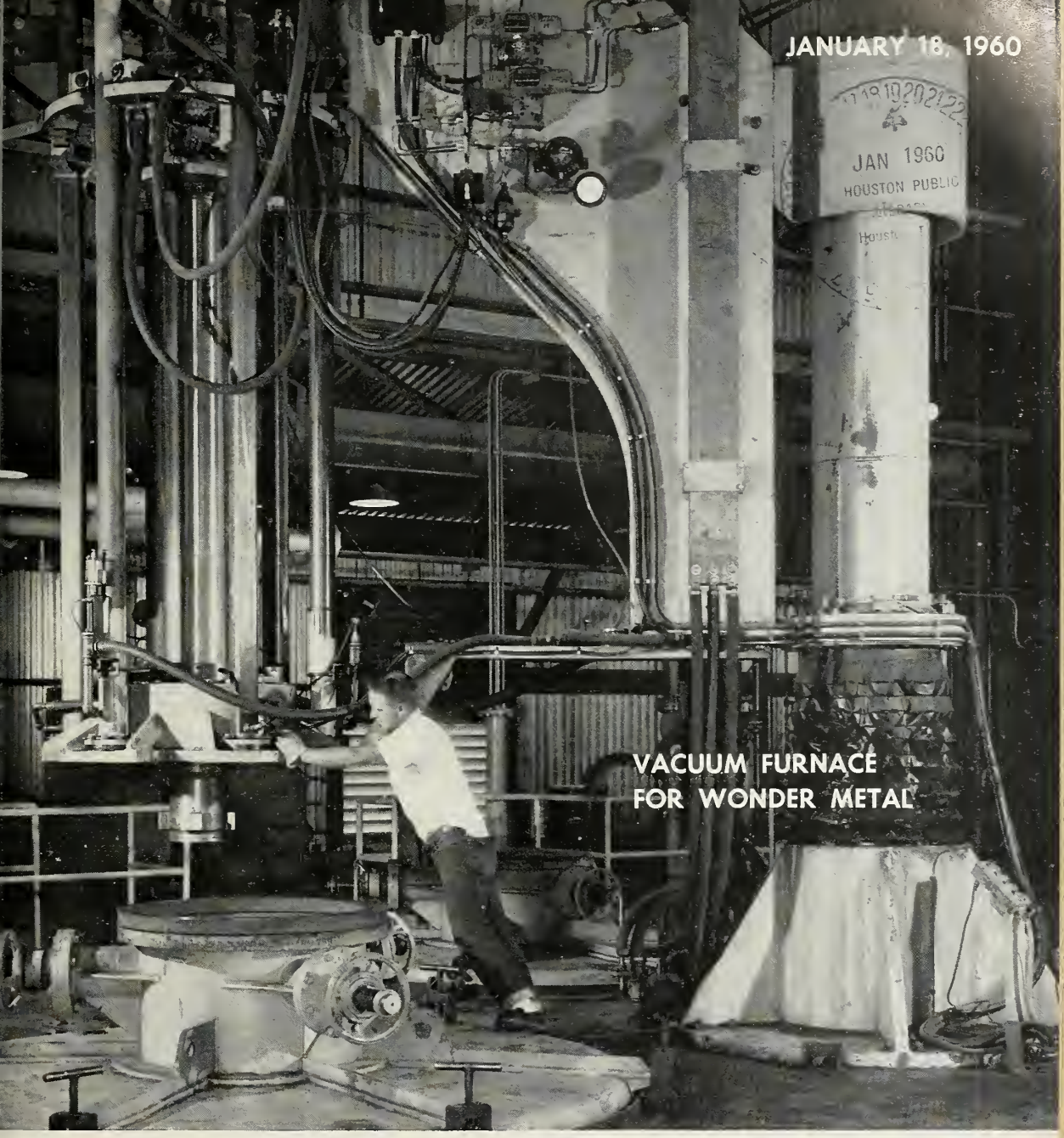
JANUARY 18, 1960



VACUUM FURNACE
FOR WONDER METAL

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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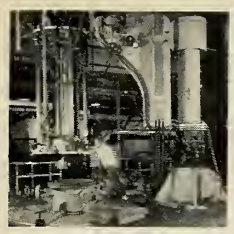
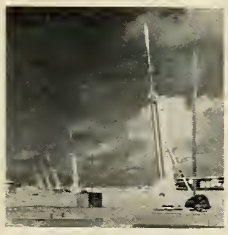


COVER: Final remelting of primary titanium ingots is accomplished in a consumable-arc double-melt vacuum furnace at Titanium Metals Corp.'s Henderson, Nev., plant. Huge ingots are ready for missile makers.

RIBBON-WRAPPED channel chamber is removed from brazing furnace at Solar Aircraft Co. at completion of brazing cycle in novel technique employing U-channels to make thrust chambers. See p. 14.



CHAFF ROCKETS developed by the Sandia Corporation stand ready to study RF attenuation caused by nuclear detonations. A story on the firm's unique role starts on p. 19.

FIN IS mounted on sled prior to high-speed test at Holloman AFB, N.M. Little publicized, such testing is of vital importance to missile development. A report starts on p. 26.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

30,900 copies of this issue printed

JANUARY 18 HEADLINES

ASTRONAUTICS ENGINEERING

U.S. Reg. Pdg.

ASTRIONICS

MISSILE SUPPORT

U.S. Reg. Pdg.

NEW MISSILE PRODUCTS

THE MISSILE WEEK

U.S. Reg. Pdg.

DEPARTMENTS

Washington Countdown

IN THE PENTAGON

ICBM squadron increases . . .
planned by the Administration are reported to be more illusory than concrete. Rather than a speed-up to meet the Missile Gap, the increases are understood to be a follow-on program stretching into the mid-1960's.

• • •

***Dyna-Soar* is walking . . .**
not running—under the present funding of the big Air Force project. On the present schedule, the **Boeing** space bomber is expected to be operational about 1969 or 1970. However, a big speed-up in funding could cut the time to 1966.

• • •

***Transit* is slipping . . .**
at least a month behind in its R&D test schedule. The next of the ARPA-Navy navigational test satellites now will be launched in March instead of February. Delay in getting a booster is reported to be the reason.

• • •

Cash for Zeus . . .
obligated by the Army through FY 1960 stands at a total of $590 million. Official Army figures on total direct obligations for the big **Western Electric** AICBM are $70 million for FY 1958 and before, $220 million for FY 1959 and $300 million for FY 1960.

• • •

The new name *Sky Bolt* . . .
is the only thing new about the **Douglas** ALBM, despite widespread headlines. Seven-month old design studies for the Air Force missile are continuing while the Defense Department makes up its mind whether the missile ever will be developed.

• • •

Fundless *Suzano* . . .
ARPA's space platform project, has disappeared altogether. The project has been cancelled in the latest reorganization of ARPA.

ON CAPITOL HILL

The curtain goes up . . .
during the week of Jan. 18 on three congressional space and missile investigations:

. . . Defense Secretary Thomas S. Gates will be the first witness at hearings before the Senate Armed Services Committee Jan. 19.

. . . Secretary of State Christian Herter on Jan. 20 will open the sweeping hearings planned by the House Space Committee.

. . . Gates will open hearings before the House Armed Services Committee Jan. 21.

The key issues . . .
that the congressmen will dig into include:

. . . The Missile Gap and how it can be filled.

. . . The Space Lag and the failure of the Administration to spend enough to catch up with Russia.

. . . The lack of defense against Soviet ICBM's and the decision not to go ahead with production of the *Nike-Zeus* AICBM.

. . . Whether U.S. limited war capability should be expanded.

• • •

Another reorganization . . .
of U.S. space programs as indicated by President Eisenhower is receiving a cool reception among congressmen. Many are beginning to feel that shuffling the pieces around the board is not the answer to Russian successes.

AT NASA

The big "doubled space budget" . . .
read into President Eisenhower's State of the Union Address is the offspring of poor semantics and wishful thinking. The President said the Administration would double space expenditures in FY 1961—not double the space budget. NASA spent only about $300 million on space in FY 1960.

• • •

Another delay . . .
has been added to the hard-luck record of *Thor-Able IV*—the belated sun-orbit satellite. Originally, it was scheduled to be launched last June . . . then last Dec. 15 . . . then Jan. 15. NASA and **STL** hope to have the sensitive payload ready to go sometime in February.

ALONG EMBASSY ROW

Initial French funding . . .
for SEREB—the organization set up to develop a French IRBM—is about $1.2 million. Meantime, the French are sounding out the British on cooperative development of a whole line of missiles including the **de Havilland** *Blue Streak*.

• • •

Atlantic polar launchings . . .
over Cuba and Panama may be coming soon. U.S. officials are reported to be checking informally whether the two Latin American countries would agree to the launchings from Cape Canaveral.

SPIN FORGE TO 120" ON NEWEST HUFFORD GIANT

The largest Spin Forge facility in the United States (currently producing surface-of-revolution parts up to 72" diameter), Hufford, El Segundo, will soon place in operation a new "four story" unit capable of forming hardest metals to 120" diameter and beyond...30 feet in length. Designed, built and wholly owned by The Hufford Corporation, this massive, fully automated machine, together with complete engineering service and production follow-through, will be available to simplify parts production for you by midsummer, 1960. Outstanding advantages of the Spin Forge process include marked improvement in material grain...elimination of welding seams... production of parts heretofore considered difficult or totally impossible. Complete information will be sent in answer to your request to: The Hufford Corporation, 1700 E. Grand Ave., El Segundo, Calif.

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Industry Countdown

MANUFACTURING

Look for renewal . . .

of the *Bomarc-Nike-Hercules* battle for funds in the forthcoming budget hearings. Industry sources say the AF wants to triple the number of planned launchers for the 400-mile **Boeing** *Bomarc*—from 504 to around 1624. The FY '61 budget reportedly will contain $400 million for production of *Bomarc*. This may eat into appropriations for the build-up by the Army of its point defense *Nike-Hercules* made by **Western Electric.** There is also some agitation to harden *Bomarc* installations and this could further complicate the scrap over how much should be spent on the two interceptor missiles.

• • •

Big Navy contract . . .

in the works now is for a sub-chasing hydrofoil which presumably would carry nuclear depth bombs. Boeing and **Puget Sound Bridge & Dry Dock** (a **Lockheed** subsidiary) are among several companies in the competition.

• • •

Switch in NASA patent . . .

policy is now in the congressional mill. Legislation has been introduced to allow NASA more flexibility to waive its claim to title on inventions developed under its contracts. The measure (H.R. 9484) was requested by NASA to bring the agency's patent rules more in line with those of DOD.

PROPULSION

Split ring deflector . . .

for rocket exhaust has been patented by the Navy (US 2,919,544). The deflector is mounted circumferentially around the nozzle orifice and is movable so it can deflect the exhaust in any desired direction.

• • •

First production runs . . .

of more than 100 *Polaris* motor cases are now in high gear with the return of steel supplies to normal. **A. O. Smith,** Milwaukee; **Norris Thermador,** Los Angeles, and **Kaiser Metal Products,** Bristol, Pa., are turning out the first-stage cases. Norris Thermador, Kaiser and Aerojet-Downey are making cases for the second stage of the solid-fueled, 900-mile missile.

• • •

Enlarged fuel cell R&D . . .

program is now under way at **Pratt & Whitney** and **Leesona Corp.** Leesona, with **National Research Corp.** of London, will conduct chemical and electromechanical research; P&W will be responsible for mechanical and systems development as well as manufacture and sales.

ASTRIONICS

NASA's *Mercury* tracking . . .

range is now expected to cost between $50 million and $60 million—more than double the original estimate when the contract was let last year. The contract is still being negotiated with a team headed by Western Electric.

• • •

Australia is competing . . .

in this country with gyro makers. It has come up with a patented gyro driving means (US 2,918,869) for short-range missiles.

• • •

First successful . . .

test of an inertial guidance system in *Polaris* was made in the shot from Cape Canaveral on Jan. 7. The system was designed, developed and assembled at Massachusetts Institute of Technology.

WE HEAR THAT—

Choice of helicopters . . .

among combat ICBM missilemen is the **Kaman** H-43B. Look for the AF to make some large buys of "choppers" this year to help solve the communications and logistic problem around dispersed ICBM sites . . . **Rocketdyne** will lay off about 600 personnel in California plants in the next few weeks due to reduced engine development work . . . Molecular electronics—or some similar technique—is now considered by the experts to be the solution to the reliability problem . . . **Telecomputing Corp.,** Los Angeles, is seeking to buy **Narmco Industries . . . General Telephone & Electronics** has formed a new subsidiary in the advanced communications field—**General Telephone & Electronics Laboratories** (see p. 30) . . . **Servonics Inc.,** Alexandria, Va., is thinking of splitting its stock—now selling for about $9 a share.

More About the Missile Week on Page 12

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CAMDEN, NEW JERSEY

AF Attacks 'Secret' Navy Space Plan

Navy accused of pirating Dyna-Soar to build competing 'manned maneuverable space system.' Details of Navy's 'Ops 54' bid for top space role told in exclusive M/R report

by James Baar and William E. Howard

WASHINGTON—The Air Force is preparing to tell Congress that the Navy is secretly trying to use its Pacific Missile Range as a springboard to launch a competing military space program—including sailors in space.

The Senate Space Committee, which already is investigating the bitter Navy-Air Force struggle over PMR, is planning to hold public hearings probing deep into the issue in the next few months. The House Space Committee is expected to do the same.

There is widespread concern that the interservice dispute is jeopardizing the national interest. The Air Force wants it out in the open.

M/R has learned that Air Force officials are now ready to charge from the witness chair that:

• The Navy is working on a "manned maneuverable space system" that is a carbon copy of the Air Force's *Dyna-Soar* manned space bomber.

• The Navy is developing a "super" *Polaris*—possibly to be clustered—for use as a space vehicle booster.

• The Navy is seeking through its experts at PMR to "bleed" information from advanced Air Force programs to build up its own technical know-how in space.

• All of these moves are part of a top-level "master plan" laid down in a supersecret report aimed at giving the Navy a major role in space within the next few years.

• **Counterattack**—Navy officials are certain to counter that the Air Force—which DOD has given the primary military space mission—has "drummed up" this list of charges to block further development of PMR.

The Navy contends that it is merely trying to develop PMR according to its charter—a national range designed to service the missile and space programs of the Navy and any other user. On space development, the Navy program so far is comprised mainly of the development of the *Transit* navigational satellite. However, the Navy insists, as it has for some time, that it expects to have an operational need for other space systems in the future.

The Air Force rejoinder to this argument is that tracking, read-out instrumentation and other phases of the ground environment are all part of an operational military system and cannot be used in common.

Disclosure of the Air Force charges and the forthcoming congressional hearings follows the recent reports (M/R Dec. 21 and Dec. 28) of the new interservice space battle centered on the West Coast at Vandenberg AFB and PMR's adjacent Point Arguello.

• **Alleged master plan**—The Air Force is expected to build its case on the Navy's so-called master plan for space—known to insiders as the Connolly Report. This four-inch-thick document—prepared last summer by a committee headed by Rear Adm. Thomas F. Connolly for submission to Chief of Naval Operations Arleigh Burke—is understood to outline in technical detail Navy space plans for the next decade.

It's said that basic recommendations in the report have already been implemented. These include:

• Establishment of a special office, known as "Ops 54," under the Chief of Naval Operations to monitor and carry out the program.

• Establishment in the new Bureau of Naval Weapons of an office of the Pacific Missile Range and Astronautic Development. Connolly, an assistant chief of the bureau, heads it.

• Redesignation and reorientation of the Naval Missile Center, Point Mugu, Calif., to provide a Division of Astronautics and including new laboratories for bioastronautics, life sciences and other systems to support manned military missions in space.

• **Selective pushing?**—The Air Force charges the only projects the Navy is pushing for PMR are those to give it the capability for carrying out the long-range space programs laid down in the Connolly Report. By doing this the Navy hopes to "make a quantum jump" for equal status with the Air Force in space.

One example cited by the Air Force is the Navy's proposal to build a "multi-purpose" pad at Point Arguello capable of firing *Atlas, Titan, Thor, Jupiter* and the Navy's *Polaris*. Air Force sources claim that the Navy is angling to get NASA to pay for the project and is trying to prevent the Air Force at the same time from turning over some of its *Thor* pads at Vandenberg to NASA for *Thor-Delta* launchings.

"Instead of providing range service to the Air Force—the principal user of PMR," says one Air Force official, "the Navy all down the line is giving us competition from this tremendous thing it is trying to grow."

He said that PMR has a host of technical experts who evaluate every detail of Air Force projects they can get hold of, to see how they will fit into the Navy's plans. He said the Navy even tried to get—and was refused—a complete need-to-know of all Air Force Ballistic Missile Division space programs.

However, this official claims the Navy did succeed in "bleeding out" from **Martin** and **Boeing** information about the *Dyna-Soar* program for its own Manned Maneuverable Space System. Other Air Force officials say the Navy Ordnance Test Station, China Lake, Calif., is working on the clustering of *Polaris* and other propulsion systems for the MMSS.

The Air Force, moreover, contends that as chief user it has no need for most of the facilities that PMR has recently completed or under construction. These include such expensive items as a central launch control building, tracking facilities and a missile assembly building. It claims these installations only duplicate existing facilities at Vandenberg.

The Navy, on the other hand, claims these facilities are the heart of its long-range, $4-billion program for developing PMR into the world's greatest space range.

The Air Force holds that these facilities are nothing less than the heart of the Navy's future competitive space program—built mostly at Air Force expense.

This is the issue that will soon be before Congress.

DOD Considers Asking Reds To Pacific 'Missile Match'

WASHINGTON — Pentagon officials now are considering a proposal to challenge the Soviet Union to a "missile shooting match" in the Pacific Ocean.

The proposal was made after the Russian announcement Jan. 7 that one or more rockets would be fired into the Central Pacific, starting in the period between Jan. 15 and Feb. 15.

Informed sources speculated that the big Soviet rocket might be used to:

- Test a Soviet reconnaissance satellite similar to the Air Force's *Samos*.
- Launch a manned capsule preparatory to putting a Russian space craft into orbit.
- Test a Soviet version of the U.S. *Dyna-Soar* space bomber now in the early stages of development.

Under the plan put forward by a top-ranking Air Force officer connected with the U.S. missile program, the Russians would be invited to use the so-called "splash net" of the Pacific Missile Range for a competition on missile accuracy.

The splash net is the instrumented ballistic missile impact area near Wake Island which has been used by the U.S. Air Force *Atlas* intercontinental missile.

Any decision to invite the Russians to engage in such a politically-slanted competition would have to be made, of course, at highest Administration levels. Such approval is not considered likely. It would, in effect, be acceptance of a challenge issued many months ago by Soviet Premier Khrushchev for a "rocket shoot" to compare capabilities of U.S. and Soviet missiles.

The Russian firings will be into the heart of a heavily instrumented area of the U.S. Pacific Missile Range operated for all services by the Navy.

• Interloper—Perhaps more significant from the U.S. military viewpoint, it also will take the Soviet rocket right into the teeth of the test range being set up to evaluate the *Nike-Zeus* defensive missile, which was developed specifically to knock down Soviet intercontinental ballistic missiles.

Nike-Zeus firings are scheduled to begin this year from Kwajalein Island. Facilities now are under construction there as well as at Johnston Island, firing site for target missiles to be used in *Nike-Zeus* testing, probably *Redstones* and *Jupiters*.

Center of the U.S. ballistic missile impact area in the Pacific at which the Russians could be invited to take aim is a target circle 20 miles in diameter located approximately 75 miles northeast of Wake Island. Exact impact points are monitored by SOFAR (sound fixing and ranging) units. Radar impact prediction systems also are used.

This U.S. impact area is, however, some 2000 miles west of the area the Russians have outlined for their use. It is not likely U.S. instrumentation in the area could easily be shifted to monitor the Soviet shot.

There is little doubt, however, that considerable U.S. effort will be devoted to following the Soviet rocket with the instrumentation already available at the other range areas in the Central Pacific.

National Aeronautics and Space Administration Chief T. Keith Glennan already has offered to let the Soviet Union use the U.S. *Mercury* tracking network in its man-in-space program.

NASA Accepting New Bids for *Saturn* Stages

WASHINGTON—NASA announced last week it was accepting bids for *Saturn's* second and third stages which indicates that a timetable for the ABMA project will be:

- Firing of first stage 1.5 million lb. thrust cluster with dummy upper stages in 1963;
- Firing of two, three, and four stage configurations in 1964-65;
- Firing of four and five stage configurations in 1965-66.

The NASA-DOD announcement (predicted by M/R Dec. 14, p. 9, 38) gave ABMA the authority to initiate negotiations with industry for a second stage cluster of four liquid hydrogen-LOX engines producing more than 600,000 lbs. of thrust, and a third stage configuration of two engines producing about 300,000 lbs. of thrust.

The fourth stage will be four of **Pratt & Whitney's** *Centaur* XLR 115-P-1 engines producing 80,000 lbs. of thrust, and an optional fifth stage would be two of these engines.

The above timetable could be speeded up if NASA funds *Saturn* for more money than ARPA intended to, and if the second and third stage hydrogen engines experience rapid development.

Because the Pratt & Whitney engines will be ready before the second and third stages, the ABMA *Saturn* team may design an interim configuration using the third and fourth stages atop the *Saturn* cluster.

news briefs

• Washington—Missile and aircraft contracts accounted for 64% of defense contracts for more than $500,000 awarded to 100 major contractors and 129 subsidiaries in FY 1959. This compares with 60% in the period Jan.-Dec., 1958.

• Nice, France—Soviet Space Expert A. A. Blaganravov said the French have expressed interest in having the Russians launch a French satellite into orbit with a Soviet space vehicle. He said Russia will consider the project if France proposes it officially.

• Athens—The Greek government reported that NATO is considering establishment of a missile training center in Greece. It said it would agree to establishment of the center if NATO decides to put it on Greek soil.

• Washington—The Army awarded $35,271,000 in contracts to **Raytheon** for various phases of the *Hawk* program. The biggest contract—$18,287,000—is for the missiles themselves. The other two are for engineering services and field maintenance equipment. All work will be done at the company's plant at Andover, Mass.

• Washington—The Navy is postponing construction of $300 million worth of missile ships (one cruiser, three frigates) because of cost increases since the drafting of the FY '60 budget. There was no indication when work will start.

• Washington—Air Force Chief of Staff Thomas D. White indicated he would be willing to defend before Congress development of the B-70 bomber against Administration budget cutters. When asked about the B-70, White said "you can be certain I'll testify honestly and according to my convictions." He said there is still a need for this high-performance aircraft for launching ballistic missiles at 70,000 ft., airborne early warning and fast transport of tactical missiles.

• Andrews AFB, Md.—The Air Research and Development Command is reported to be planning two major organizational changes: the Ballistic Missile Division would be made the Ballistic Missile Development Division with more operational control of development programs; the Air Force Office of Scientific Research would become the Air Force Research Division.

Conference Expected to Attract 800

LT. GEN. BERNARD SCHRIEVER
. . . Goddard Dinner Speaker

KRAFFT EHRICKE
. . . Tuesday Luncheon Speaker

ARTHUR KANTROWITZ
. . . Wednesday Luncheon Speaker

WASHINGTON—The third Annual Missile/Space Industry Conference will be held in Washington on Tuesday and Wednesday, February 16-17 at the Sheraton Park Hotel under the sponsorship of the National Rocket Club. The theme of the meeting will be The Space Challenge.

The conference, expected to attract some 800 industrial and military leaders in the missile and space field, will culminate in the Dr. Robert H. Goddard Memorial Dinner, Wednesday night, Feb. 17. Among the guests of honor will be Mrs. Esther C. Goddard, widow of the pioneer rocket scientist.

Principal speaker at this dinner will be Lt. Gen. Bernard A. Schriever, Commanding General of the Air Research and Development Command. Master of ceremonies will be Peter Hackes, NBC radio and television commentator.

Four panels are scheduled for the conference, two each day, following the Space Challenge theme, as follows:

Tuesday morning: "Philosophy and Policy," moderator Dr. S. Fred Singer, Professor of Physics, University of Maryland. This panel will be composed of leading space scientists and officials and proposes to go into the significance and meaning of the challenge man faces in exploring space.

Tuesday afternoon: "Legislative Aspects," moderated by Theodore F. Koop, CBS vice-president and former president of the National Press Club. This panel, to be drawn from the Senate and House Space Committees, will discuss new space legislation, changes in present laws and whether or not the U.S. space program is likely to become an issue in the coming national elections.

Wednesday morning: "Future Space Programs." This panel will be conducted by Kurt R. Stehling, Aeronautical Research Scientist, NASA, and will be composed of NASA and other government officials. It will attempt to point out the direction and progress of our national space program and perhaps give something of a forecast of the future.

Thursday afternoon: "Missile/Space Marketing." This panel will be moderated by a top official in the Defense Department office of Supply and Logistics and will be made up of procurement officers of the Army, Navy, Air Force, ARPA and NASA. The panel will discuss recent changes in missile/space procurement due to new agency alignments and shifts in policy recently effective in the services.

Luncheons will be held each of the two days. Speaker for the luncheon Tuesday will be Krafft Ehricke, assistant to the Technical Director, **Convair Astronautics Division.** Dr. Arthur Kantrowitz, vice president and director **Avco Corporation** and director of the Avco-Everett Research Laboratory, will address the Wednesday luncheon.

Three awards will be presented at the Memorial dinner Wednesday night:

The Dr. Robert H. Goddard Memorial Trophy, awarded by MISSILES AND ROCKETS MAGAZINE. Previous winners have been Dr. Wernher von Braun of ABMA, and S. K. Hoffman, **Rocketdyne.**

The **Borg-Warner** Missile Industry Award. Previous winners have been **Lockheed** and **Rocketdyne.**

The Astronautics Engineer Achievement Award, previous winner Dr. Rudolph F. Hoelker.

General Chairman of the Conference is N. P. Jackson, Manager of Government Office, **Joy Manufacturing Co.,** Washington. Jackson defined the objective of the conference as follows:

"To promote policies, programs and legislation necessary to establish and maintain United States space leadership, and to stimulate civil and military space programs for the benefit of mankind."

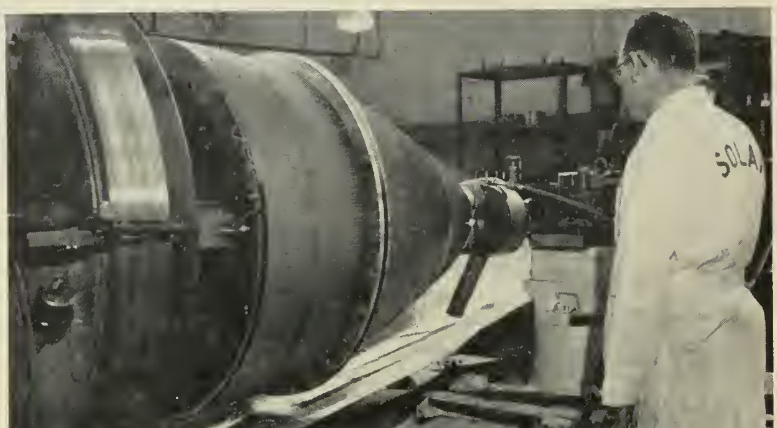
STL Moves Into New 40-acre Facility Complex

LOS ANGELES—**Space Technology Laboratories Inc.** has announced consolidation and expansion of its operations with a move to new facilities in El Segundo, Calif.

The new STL complex of eight buildings occupies an area of nearly 40 acres. Buildings contain some 900,000 sq. ft. of office and laboratory space for the more than 4600 STL technical and administrative personnel.

STL, a former division of **Ramo-Wooldridge,** provides systems engineering and technical direction to the *Atlas, Titan, Minuteman* and *Thor* programs. The research firm, employing more than 1500 scientific and engineering specialists, also assists ARPA and NASA in advanced space technology experiments.

U-Channels Used to Make Thrust Chambers



ON LATHE, thrust chamber is electroground following spot welding of channels. This precision operation provides the highly accurate geometry demanded by the design concept of the unique chambers.

AFTER GRINDING, while still on the lathe, the turning chamber is wrapped with strips of ribbon-wrap and copper braze alloy fed out by Solar technicians from a spool geared to lathe's revolutions.

SAN DIEGO—An unusual concept fabrication of rocket thrust chambers- ribbon-wrapped, U-shaped channels- is being used by **Solar Aircraft Company** on a project for the National Aeronautics and Space Administratio

Designed for engine thrust rang between 13,000 and 20,000 lbs., th lightweight, low-cost, brazed chambe will be used by NASA at the Lew Research Center in Cleveland, for tes ing new high-energy liquid propellant

The sheet metal channels provi an easy, yet precise, method of co trolling coolant passage area throug out the chamber by varying the fu coolant velocity to meet local heat co ditions.

In fabricating the chambers, 3(straight strips of 0.008 in. AM35 stainless steel sheet are blanked ou then formed and sized into a "U" cha nel in one operation on a one-piece d representing the angular segment of th engine.

• **Assembly**—Following this opera tion, 180 of the channels are assemble on a stainless steel mandrel that ha been cast and machine-contoured to de sired chamber configuration. Then 18 more channels are joined piggy-back a the neck of the hourglass-shaped cham ber and gradually fed into a skirt wit the other 180.

The channels are racked, with th open side facing out, through the us of notched clamping devices, and the welded together with approximatel 100,000 spot welds. The welds ar easily and quickly applied in a specifi pattern to insure close fit-up and hol dimensional and configuration require ments.

The assembly is annealed in a hy drogen atmosphere to hot-size the cha nels to exact shape of the mandrel.

• **Grinding & wrapping**—The cham ber is then put on a lathe where th channels are sized and electro-groun to specified heights along the entir chamber length. This precision grin ing provides the accurate coolant pas sage geometry necessary to the desig concept.

Following the grinding, while sti on the lathe, the chamber is wrappe tightly with approximately 2650 feet o 0.008 in. AM350 stainless steel ribbo This ribbon, along with a copper bra ing ribbon, is fed automatically aroun the chamber from a feeding spool gea ed to the revolutions of the lathe.

• **Brazing & cooling**—After wrap ping, additional copper braze filler sprayed onto the chamber to provid external sealing of interlocked ribbon The chamber is then ready for brazin which will integrate the wrapping an channels into tube-like fuel passages.

Brazing is done in a welded muff with controlled argon or hydrogen a

osphere. In the brazing cycle, the amber is taken above 1980°F in out one hour.

After brazing, the chamber is slow-furnace-cooled to 1800°F to allow stressed solidification; then it is re-oved from the furnace and air cooled room temperature. Protective atmos-ere is maintained to insure a clean sembly.

Hardware attachments such as fuel anifold, reinforcing rings and injector nge are fitted to the chamber and the cond braze operation begins. This kes place at approximately 1875°F. copper-tin brazing alloy is used in is operation.

• **Heat treating**—The chamber is achined to mate the injector and en-ne mount and the assembly is heat eated—necessary to achieve the de-ed metallurgical properties of pre-pitation hardened AM350. This is ne in a split cycle of −100°F for ree hours followed by three hours at 00°F.

The chamber undergoes a series of sts including leak pressure using 200 i helium in the fuel passages while bmerged in a water tank.

The lightweight chambers stand out five feet high and measure 39 in diameter at the skirt, 7.8 in. in e diameter of the throat and 10.5 in. the diameter of the head.

The fuel manifold fits around the ck, and in operation the fuel enters e chamber here and flows down 180 annels to the gathering at the bot-m, then returns up another 180 chan-ls to the fuel injector at the top of e head.

ABOUT 100,000 spot welds are applied to channels in a specific pattern to insure close fit and to hold dimensional and configuration requirements of the chamber being fabricated for NASA.

Aerojet Builds Cell to Test 'Exotic' Fuels

SACRAMENTO—The **Aerojet-General rp.** is building a test cell at its liquid cket plant for development of new gh-energy rocket propellants. The fa-ity is designed to bridge the gap be-een laboratory studies and large-ale engine development.

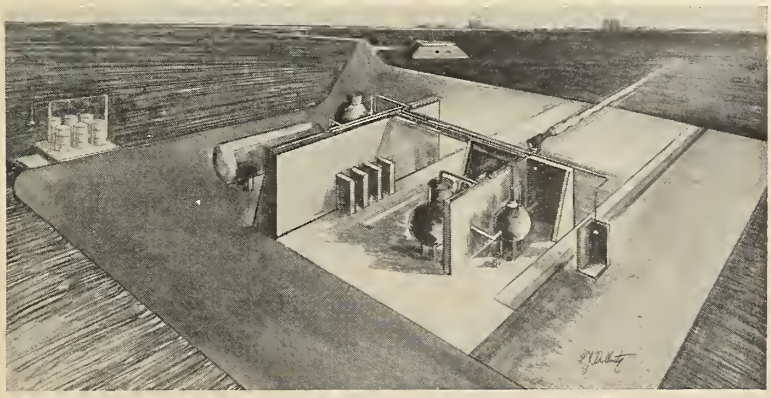
Performance data on engines in the 00-to-20,000-pound-thrust class will obtained, and engineers will gain perience in handling the exotic pro-llants. Operation is expected to com-ence in March.

Some of the propellants scheduled r test in the new facility are: liquid orine (F_2), nitrogen tetroxide $_2O_4$), hydrazine (N_2H_4), mono-ethylhydrazine (MMH), hydrogen roxide (H_2O_2), pentaborane (B_5H_9), rogen trifluoride (NF_3), perfluori-ted hydrazine (N_2F_4), and bromide ntafluoride (BrF_5).

A major portion of the work will aimed at the liquid hydrogen/liquid orine combination, giving the highest theoretical specific impulse among chemical propellants. A liquid hydrogen storage facility will be added to the site soon.

The test stand has been isolated from the general test area because of the toxicity of the propellants to be tested, and special safety precautions have been set up for operations, which will be conducted by remote control.

The facility, built with Aerojet funds, cost approximately $350,000.



ARTIST'S DRAWING of Aerojet's high-energy liquid fuel test facility.

Multiplexer Solves Telemetry Problem

CEC's Plexicoder handles millivolt-level inputs from many transducers, permitting high-volume telemetry without amplification

PASADENA, CALIF.—A novel approach to low-level PDM telemetry multiplexing has satisfactorily overcome noise and signal distortion, usually produced by its predecessors. (Pulse-duration-modulation (PDM) multiplexing is a means of providing high-volume telemetry—that is, a large number of transducer outputs time-share one radio frequency.)

Developed by **Consolidated Electrodynamics Corp.**, the unit commutates millivolt-level signals without amplification from as many as 90 transducers at rates up to 900 samples per second. Full-scale pulse duration is produced by a signal as low as 6 millivolts, said CEC.

Called "Plexicoder," the unit employs light beams and a photomultiplier tube to replace more conventional wiper-arm assemblies and chopper-stabilized amplifiers—often sources of signal degradation.

Chief feature of the unit, according to CEC, is its long operational performance—a minimum service-free life of 1000 hours with commutator life above 2500 hours. In addition, it is reportedly compatible with most standard telemetering equipment.

Low-level output transducers have been used widely in the missile industry for test applications because they meet the necessary requirements for accuracy and environmental tolerance. As requirements have become more demanding, the quantity of telemetered data from these devices has grown exponentially.

Multiplexing is especially desirable whenever steady state or slowly changing data are to be transmitted. Much elaborate wiring is eliminated, and regular and frequent sampling of transducers instead of a continuous record eliminates much superfluous data that must later be handled.

• **Troubles overcome**—In the past, multiplexing usually produced high noise level and signal distortion from wiper arm assemblies or mechanical commutators. The low-voltage levels of thermocouples and strain gages, often less than 10 millivolts, previously had not been successfully commutated by mechanical or transistorized switches. Also, amplification of signals before commutation was determined to be impractical because of the great number of channels to be sampled.

The Plexicoder uses light beams for commutation. A photomultiplier tube converts these light beams into modulated electrical impulses. The output of the tube and associated electronics is in reality an almost perfect square wave whose duration is a direct function of the original transducer signal. Error is less than 1%, according to CEC.

Normal operating range from –65° to 100°F will withstand static acceleration up to 30 g, and impact shock up to 15 g.

CEC's 80-pound Plexicoder, with cover off, features compact packaging, is only 25½" long. It is shock mounted.

Typical of uses that missile developers are making of this multiplexer is that by the Structural Plastics Division of **Aerojet-General Corporation**, Azusa, Calif. There it is used as a multiple, strain gaged, automatic, data-reduction system for measuring structural stresses of metals and plastics used in the fabrication of missiles and rockets. Currently it is being used in *Polaris*.

The multiplexer is mounted on a mobile control console, which can be wheeled to the test site. Strain gages are wired directly to the Plexicoder inputs. The commutated data goes out on one line to a magnetic tape recorder. The tape is then sent to a central computer facility where data is processed and entered into a computer. It is now being used in testing Boeing's B52G, *Hound Dog* and **Convair's** *Terrier-Tartar* group.

• **Undistorted signals**—The principle of operation of the Plexicoder, said the company, eliminates any chance that signals will be distorted as they are being commutated. The incoming signal takes a unique path through the instrument.

A signal from the transducer deflects a galvanometer which reflects light from a light source. The reflected light beam is directed at a rotating disk in which is cut an aperture in the shape of a right triangle. As the triangular opening moves across the light path, light is admitted to the photomultiplier tube for a period of time proportional to the position of the light beam along the hypotenuse of the triangular opening. A voltage pulse is developed and maintained in the tube output for as long as the light beam strikes the photomultiplier tube.

Because the galvanometer, with its inherent filtering characteristics, is the terminating element in the signal input circuit of each data channel being sampled, filters between the transducer and commutator are unnecessary.

• **Operational sequence**—The switch assembly enables each of 15 galvanometers to sample six input channels in sequence. Operation of the Plexicoder can be shown by following a signal through one data channel.

The input signal is fed through a pair of glass-enclosed, magnetically

ctuated, hermetically sealed switches. This combination of two separate witches for each channel acts as a louble-pole, single-throw switch.

Each switch is magnetically biased o a normally closed position by a sta- ionary magnet. Both switch and mag- et are potted in epoxy resin. The field f the bias magnet is nulled by a mag- etic field rotating on a flat disk on a lane whose arc approaches the two witches, and the spring constant of a novable switch leaf pulls the switch pen. The rotating disk, however, has radial gap of non-magnetic material. The magnetic field in the gap is insuffi- ient to null out the action of the bias nagnets, so the switch is closed by the ias magnet.

Because the stationary field of a ias magnet is used to close the data- hannel switches during the critical pe- iod when the current through the witch is being converted to PDM, no ioving magnetic field affects the signal ircuit. This type of switch is believed specially suitable for low-level signals.

The three actuating magnetic disks re mounted on a common shaft. Gaps re staggered 4° apart to keep the signals in sequence. Each switch is closed before the modulating circuit is timed to convert the electrical signal to PDM. Actually, they remain closed for a period of time required to sample 10 to 12 channels. There are always 12±1 closed data-channel switches. The rotating disk cutting off the light beams from the galvanometers does the actual commutating, however. All light beams except the one intersected by the triangular aperture are cut off from the photomultiplier tube.

When the pickup signal reaches the galvanometer via the data channel switch, the signal causes an angular deflection of the galvanometer light beam. The deflection of the galvanometer mirror, and the resultant displacement of the light beam, are directly proportional to the amplitude of the original signal source. The light beam from the galvanometer is reflected to the surface of the photomultiplier tube by two mirrors. The first is one of 15 toroidal mirrors (one for each galvanometer) mounted on a common base plate encircling the center shaft. The second is inside the shaft, to which light is admitted through a hole in the shaft.

• **Compatible speeds**—Short bursts of light passing through the triangular aperture strike the photomultiplier tube for a length of time proportional to the galvanometer displacement. Because the photomultiplier tube converts light energy into electrical energy, the burst of light is converted into a duration-modulated pulse in its output. The voltage pulse is reshaped electronically to form a perfect square wave.

These pulses are transmitted to data recording devices at speeds of 90, 112.5, 225 or 900 samples per second, depending on the choice of models. All these speeds are compatible with the standard IRIG (Interrange Instrumentation Group) playback speed of 900 samples per second by recording at the slower speed and playing back at a faster speed. For example, 112.5 samples per second recorded at a tape speed of 3.75 inches per second can be played back at 30 ips (eight times as fast). This time compression and expansion makes possible economies of tape and recording equipment.

The output also may be used to modulate directly an FM subcarrier oscillator or telemetering transmitter.

DOD Chided at Reliability Symposium

WASHINGTON—An accusing finger as waved at the military services here ast week for too often waiving test equirements and lot-by-lot control pro- edures for electronic components in ie interest of lower costs.

And the practice of "disproportion- te" concentration on "breakthrough esearch"—instead of fostering more ong-range R&D programs aimed at general and systematic upgrading of eliability"—also was scored.

The remarks came from Julian K. prague, president of **Sprague Electric Co.**, who delivered the opening address o the Sixth Annual Symposium on Re- ability and Quality Control in Elec- ronics. Some 1100 scientists, mathe- naticians, and engineers from industry nd government attended the meeting ponsored by the Institute of Radio Engineers, American Society for Qual- y Control, Electronics Industries As- ociation, and the American Institute f Electrical Engineers. Some six for- ign countries were represented at the hree-day conference.

Sprague stressed that "reliability" nd "responsibility" are inseparable; but e said that unfortunately the two have een too seldom tied together.

• **Qualified bidders**—Sprague rec- mmended that current procurement ractices be altered to improve reliability on an overall basis. He proposed that the system of competitive bidding, where high levels of reliability are required, be limited to manufacturers who have demonstrated capability for meeting the required standards. This, he said, would assure that both grade and bid price would be factors in selecting a successful bidder—not just price.

Initially it is the responsibility of the Department of Defense to emphasize throughout the military structure the importance of reliability and quality as major weapon system ingredients, he said. In addition, DOD must insure uniform interpretation of these directives.

Secondly, he said, military departments must provide complete and uniform specifications—impartial and without loopholes. Departmental responsibility also includes broad dissemination of parts and materials data bearing on reliability.

• **Industry obligation**—Industry too must maintain an honest and conscientious policy striving for better reliability and quality control—and see that it is carried out, Sprague said. This means that the initiative to carry out a tough approach is needed to achieve reliability goals.

Some 65 papers were presented. Here are brief summaries of a few of the papers more specifically applicable to the missile/space industry:

• **Swapping data**—One unusual approach to reliability in ballistic missiles, is the IDEP (Interservice Data Exchange Program) described by Martin Barbe of **Space Technology Laboratories** *Titan* program office. Some 40-50 contractors will be involved in this program, exchanging test data generated by any ballistic missile contractor or service agency with all other ballistic missile contractors of all three services.

According to Barbe, this will do much to eliminate duplication without centralization of test facilities under a government agency or dictation of parts procurement policies by government. Expected actual cost savings were not included in the paper, but Barke said the program would undoubtedly bring significant savings in an annual national parts test bill now running close to $100 million.

• **Legal angle of standardization**—An interesting legal sidelight on the oft-repeated cry for standardization as a panacea for reliability problems was given by E. F. Howrey, former chairman of the Federal Trade Commission and now a member of Howrey & Simon, Washington law firm. Citing examples, he pointed out that industry

standardization programs are fraught with serious anti-trust dangers if not carefully planned and diligently administered. Even when not designed to achieve an illegal purpose—price fixing, production limitations, etc.—they may serve as circumstantial evidence from which an illegal agreement may be inferred.

• **Heat cuts failures**—Improvement in failure rate of silicon diodes can be delivered by high-temperature burn-in, according to a paper delivered by David Cowan of **Continental Device Corp.** He cited results of preliminary investigations that showed significant improvement in failure rate after 200° storage for 200 hours.

• **Redundancy no cure-all**—Redundancy, apparently, is not the total answer to reliability, either, as some proponents might have us believe. Work by **ARINC Research Corp.**, described by H. S. Balaban, shows that redundancy must be applied with careful concern for other factors—primarily, "reliability per dollar." One comparison between similar systems—one with two standard elements in active parallel and the other a single element—showed that after a certain time the non-redundant system had a higher reliability figure than the other. He pointed out that in many cases the use of improved elements in non-redundant configurations is equal to or better than a redundant system using less reliable elements.

The lack of data on past life-expectancy was cited by another ARINC member, J. M. Farrier, as a further problem in meeting reliability specifications. He spoke particularly of the notable deficiency of information regarding failure rates and operating characteristics of components under various environmental and circuit conditions.

• **Small sampling valuable**—Contrary to some beliefs widely held by quality control experts, small samples can be significant in missile failure control, according to S. J. Wilson of **Martin-Orlando.** Creative use of electronic computers and an integrated data approach have yielded economical and significant help in improvement of engineering decisions in the one-year-old Martin program described by Wilson.

• **Subcontracting reliability**—A program to assure reliability of subcontracted items was detailed by M. H. Saltz of **Hughes Aircraft.** Briefly, the Hughes program places responsibility for detailing the program on the bidder, an incorporation of agreed-to procedures in the contract, and close supervision and monitoring by the prime.

• **Building-block design**—The use of building-block methods in the design of test equipment as a new approach to automatic testing and fault location in large-scale electronic systems was described by D. H. Breslow of **Raytheon.** Two recently developed components—a comparator network and an expandable d-c voltage analyzer—are cascaded as necessary to analyze large systems and pinpoint malfunctions. Such a system is characterized by rapid fault location with a minimum of test equipment and engineering design time.

• **Batch testing**—Selected environmental tests on small samples of electrical and electronic parts can indicate quickly and cheaply any change in parts quality and reliability from earlier batches, according to D. C. Fleming of **AC Spark Plug Div.**, Milwaukee. He presents a list of critical parts for one type of ballistic missile guidance system, reasons for being critical, and the performance tests to which they were subjected.

TPR Promises Wide Military Potential

NEW YORK—Details of the new **General Electric** thermoplastic recording process (TPR) revealed here last week show promise of tremendous potential in all facets of military and space recording as well as broad commercial use.

Developed by Dr. William E. Glenn, of GE's Schenectady Research Laboratory, the technique has been likened in importance to the invention of photography, the phonograph, and magnetic recording.

The tape used in the developmental process is ordinary 16-mm film; only half the width was used for recording. The recording vehicle is a thin film of low-melting-point thermoplastic, forming the surface on the more heat-resistant standard film base. Between the surface film and the base is a very thin transparent conductor film. The recording, made in the form of small ripples on the surface of the plastic film, is impressed by an electron beam which horizontally scans the film surface. Tape motion provides vertical scan.

An electrical input, similar to a magnetic tape recorder, is used; the resulting image output, similar to photographic film, can be changed to an electrical output signal by standard optical-electronic techniques.

GE says TPR, even in developmental form, can concentrate 100 times as much information in a given space as can magnetic recording. With a digital system, 4 x 10^7 bits/sq. in. can be recorded. And it has the potential for a vastly greater concentration.

As an example of its speed, GE said TPR could record all 24 volumes of the Encyclopedia Britannica on a small reel—and it would take only one minute to record each volume.

Although like photography in that it provides an instantaneous recording and produces pictures in either color or black and white, TPR requires none of the chemical processing required by photographic film. In addition, it can be erased and reused as desired.

Company spokesmen stressed that much work still must be done before practical equipment is available for the military or commercial market. Original R&D was company-sponsored, but at least part of the work is now being done under a military developmental contract.

• **Military uses**—A multitude of military applications exist in radar and infrared detection, electronic countermeasures, missile guidance, and military communications. TPR has been described as a "natural" for military aerial reconnaissance and recording cameras. The instantaneous monitoring or readout which it provides has the obvious advantage of on-the-spot evaluation of results, so that a rerecording can be made if necessary.

It also was pointed out that TPR would be especially important in satellites and space vehicles where size and weight are critical. GE says satellites equipped with TPR might be assigned such complex duties as world weather reporting and military surveillance.

TPR promises to greatly extend the range and reliability of radar. It will greatly enhance hopes of devising a positive and instantaneous method of identifying radar targets—"optical correlation." M/R has learned that GE holds a classified Air Force developmental contract in this area.

Sandia Corp.: 1 Customer, 1 Competitor

Yet it deals with 3600 suppliers in $80-million facilities and holds the real 'trigger finger' in development of nuclear weapons for missilery

by Frank G. McGuire

ALBUQUERQUE, N.M.—No nuclear-tipped U.S. missile is developed without feeling the influence of the **Sandia Corporation.** From the first engineering drawing of a new missile to its final operational impact on target, Sandia has a finger—a trigger finger—in the program.

Sandia and its working partners, Los Alamos Scientific Laboratory and the Livermore Radiation Laboratory of the University of California, form an organization with one product: nuclear weapons . . . one customer: the military . . . one competitor: Russia. This organization, dealing with 3600 suppliers, has been described by former AEC Chairman Lewis L. Strauss as "the nation's biggest industry."

Although much of Sandia's work is still classified, the story of how it develops nuclear warheads for U.S. missiles can be told.

• **The "weaponizer"**—Employing 8000 persons at its $80-million facilities, Sandia "weaponizes" the nuclear explosive systems developed at Los Alamos and Livermore.

Formerly a part of the University of California, Sandia is now operated as a subsidiary of **Western Electric Company** under a non-profit contract with the Atomic Energy Commission.

Sandia is AEC's major laboratory for the non-nuclear phases of nuclear weapons research and development. It designs the electro-mechanical components necessary to make a basic nuclear device into a reliable nuclear weapon.

This includes fuzing and firing system design, component design (power supplies, timers, radars, barometric switches, and other circuitry), and casing or body design. After the weapon package is complete and proven, Sandia arranges for production of the weapon.

• **Heavy subcontracting**—Little actual production work is done at Sandia, most of it being subcontracted to manufacturers around the country. Over 50,000 separate procurement contracts are let by the company each year to more than 3600 suppliers in nearly every state in the country, and several foreign countries.

In carrying out its mission, the company engages in basic research in those scientific fields bordering on its activities, and applied research into new weapon concepts and improvements on current weapons. Development of the ordnance phases of nuclear weapons is then conducted before testing the weapon in laboratories and at the Nevada or Pacific test sites.

Further steps in the process include

SANDIA-developed chaff rockets studied RF attenuation caused by nuclear detonations in the *Hardtack I* series, with 65 firings.

manufacturing engineering for component and system production, delivery of the weapon to AEC, quality assurance and stockpile surveillance to guarantee reliability, and, finally, training of the armed forces in assembly and usage of the weapon.

When a nuclear weapon takes the form of a missile warhead, Sandia acts as a teammate of the missile prime contractor to assure compatibility of the warhead with the delivery vehicle. The weapon must be designed to fit the available space in the nose or re-entry body of the missile. In addition, it must meet all operational requirements.

• **Research areas**—To develop nuclear missile warheads and other weapons, Sandia has separated its research activities into five areas: fundamental research, applied research, weapons output studies, mathematics, and aerodynamics.

1) Fundamental research in the physical sciences is aimed at new knowledge and understanding in the fields related to Sandia's work. This embraces solid state physics, physical electronics, hydromagnetics, radiation effects, combustion processes, high temperature physics, theoretical mechanics, and geophysics.

2) Applied research, as its name implies, is aimed at a specific objective which Sandia hopes will be fruitful in weapon development. The emphasis is on understanding the physical phenomena involved, rather than engineering aspects. The applied research program is a continuous one, and is not affected by time scales established for the development of any particular weapon. Scientists investigate new fields of weaponry, searching for new and unusual components which might aid in nuclear weapon development.

3) Weapons output studies are conducted to establish exactly what happens when a nuclear weapon is detonated. Attempts are made to understand the physical phenomena associated with an explosion, rather than merely to study the damage caused. Much of the test data is gained through explosions of conventional materials in small amounts, rather than nuclear detonation.

4) Mathematical studies at Sandia cover systems analysis, statistics and numerical analysis. Evaluation of the role of nuclear weapons in warfare is carried out by system analysts, who then use the data to design weapons most likely to fit the needs of the military in any future conflict. Research and development activities are guided by recommendations from these analysts.

Statistical research is conducted on reliability and quality control of weapons, Monte Carlo processes, and design of various experiments. The mathematicians also act as consultants on applied problems in the development phases of programs.

5) Aerodynamic research and design must be a vital part of a project from the outset, if the weapon is ever to reach its target successfully. A casing, or aerodynamic shape, must be designed to house the weapon, and this must be compatible with the delivery vehicle.

Considerations included in such design are: parachute and drogue design, barosensing at high mach speeds, high-temperature effects on ballistic shapes, stability and control of weapons in flight and fall, and other phenomena.

• **Rocket test vehicles**—Included in Sandia's area of interest is information on high-altitude research. To carry out such studies, the company has designed its own family of high altitude test vehicles (Sandia makes no missiles). Data obtained from these is applied to future weapon design.

Latest of the test vehicles is the HAS rocket (the company declines to spell out its designation) which will take a 60-pound payload to 250-500 miles altitude. The recoverable vehicle is 304" overall and will cost about $30,000 per copy. The multi-stage vehicle consists of seven *Vipers* and a *Nike* or *Lance*.

In its rocket test vehicle program, Sandia subcontracts 75% of the work, producing an average of 35 to 40 vehicles per type developed. The most vehicles of one type ever produced was approximately 225. A high degree of organization and capability enables Sandia engineers to fire a vehicle on an average of six months after establishment of a requirement.

Built around shelf hardware for the most part, the vehicles use *Nike* boosters as workhorses, and recovery of about 75% of the payloads launched has been accomplished.

• **Special equipment**—To carry out its research and development activities, the company has a considerable amount of specialized equipment, and more under construction.

• A Van de Graaf accelerator capable of accelerating protons, neutrons, and electrons to energies as high as 2,000,000 electron volts.

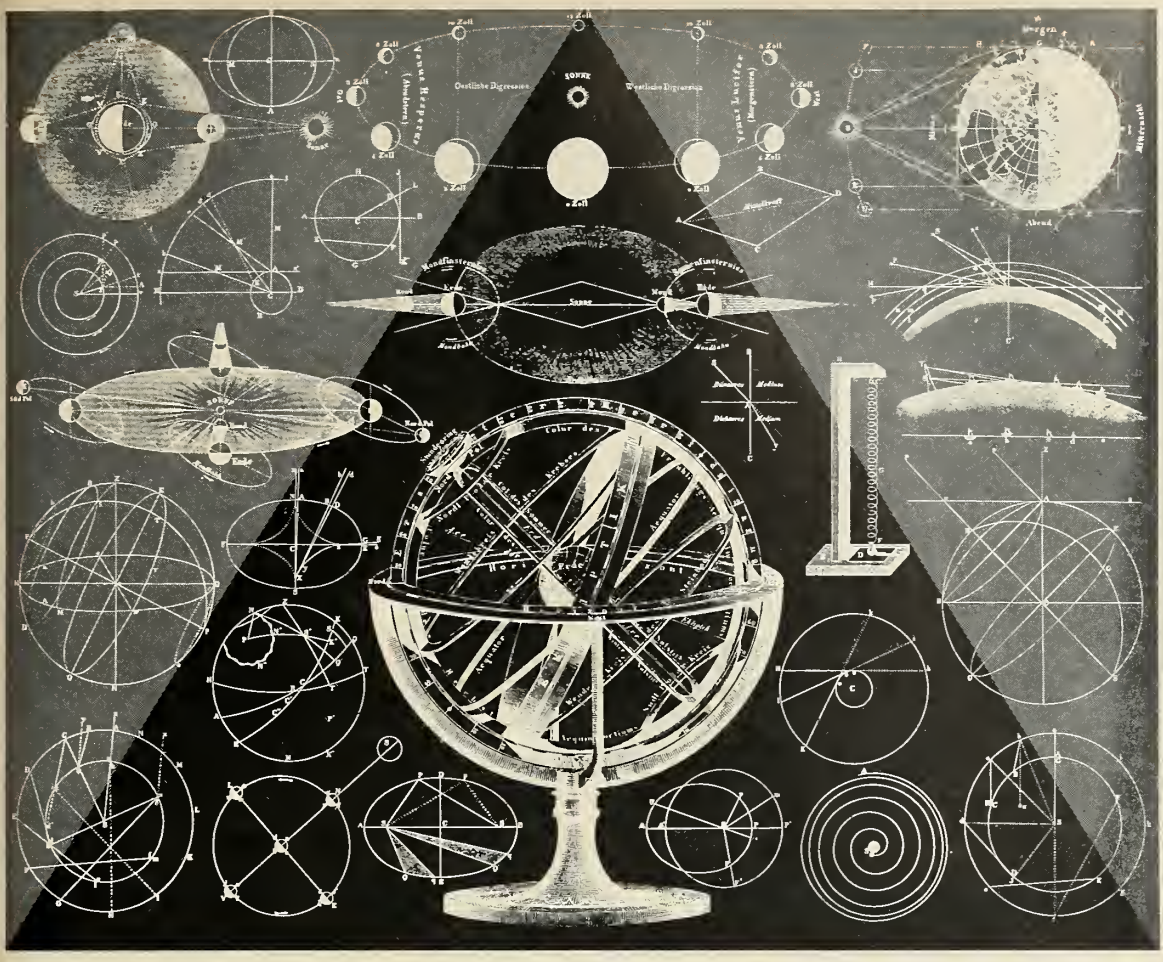
• A 5000 kw tank-type heterogeneous nuclear reactor for testing the effects of radiation on materials. (Under construction)

• Modern commercial and Sandia-designed analog and digital computers.

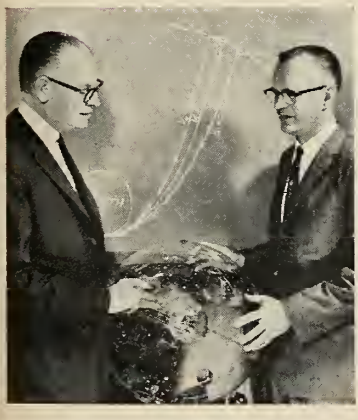
• Two high-temperature solar furnaces.

• Two high-speed wind tunnels. (Now under construction is a high-temperature, high-speed tunnel to provide wind speeds ranging from Mach 3 to Mach 9 at temperatures to 2500°F.)

• A 3000-foot rocket sled track



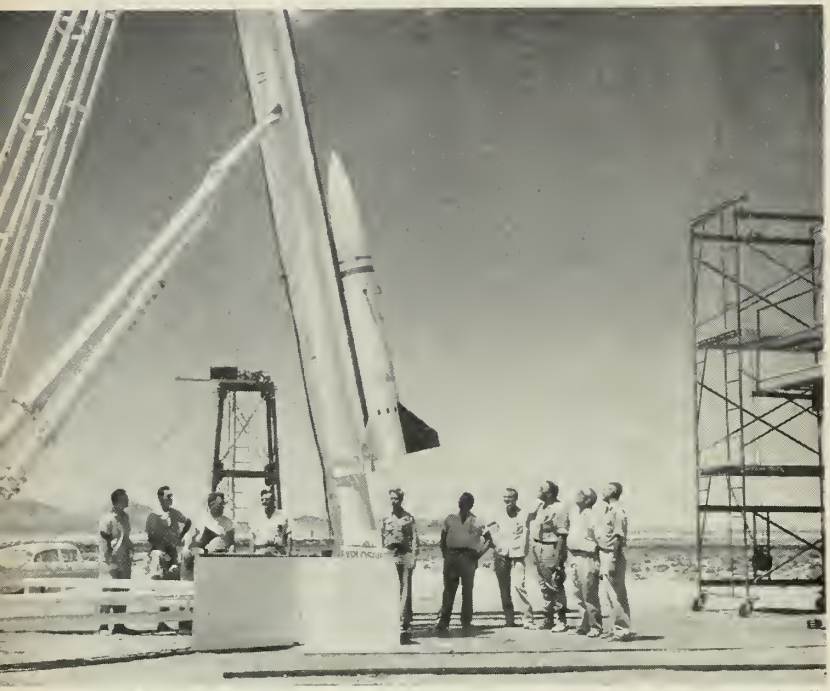
Guided tour of the solar system



The new NASA Thor-boosted research rocket, DELTA, now being constructed by Douglas, will set up big signposts for further space explorations. Combining elements already proved in space projects with an advanced radio-inertial guidance system developed by the Bell Telephone Laboratories of Western Electric Company, DELTA will have the versatility and accuracy for a wide variety of satellite, lunar and solar missions. Douglas insistence on reliability will be riding with these 90 foot, three-stage rockets on every shoot. At Douglas we are seeking qualified engineers to join us on this and other equally stimulating projects. Some of our requirements are listed in our column on the facing page.

Maxwell Hunter, Asst. Chief Engineer—Space Systems, goes over a proposed lunar trajectory with Arthur E. Raymond, Senior Engineering Vice President of **DOUGLAS**

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



SINGLE-STAGE version of *Doorknob* rocket. Two-stage version developed by Sandia Corp. is capable of lifting 150 pounds to 250,000 feet.

with Mach 2 capability.

• A hydraulic centrifuge, one of the largest in the world, designed by Sandia, and several smaller centrifuges, including a rocket-powered model.

• A 300-foot drop tower for impact studies.

• A "slingshot" accelerator for impact and acceleration studies.

• Two field sites for scale model studies of blast effects, using conventional explosives.

• Test ranges at Salton Sea, California, Tonopah, Nevada, and the use of military ranges, such as Cape Canaveral and Point Mugu.

• An "air gun" with 26" inside diameter to subject components to initial accelerations as high as 5000 g.

• Complete environmental, electronic, mechanical, and chemical structure testing laboratories at Albuquerque and Livermore, Calif.

• Instrumentation for the study of nuclear and electron magnetic resonance, X-ray and electron diffraction, mass spectrometry, ultraviolet, visible, and infrared spectrometry.

• A 170-foot drop tower for heavier load tests.

• Low g test facility, which will deliver as low as zero-g.

• Acoustic test facility.

• Radiant heat facility with heat transfer rate of 500 btu per square foot per second.

• A 21,500-pound peak force complex wave vibration facility.

• Climatic exposure test chamber to simulate temperature, altitude and humidity.

• Material development laboratories.

Construction currently underway at Sandia, to provide better facilities and equipment, totals approximately $5 million.

• **Nuclear weapon development**—When a military requirement is established for a particular type of nuclear weapon, either warhead or bomb, and research has shown that such a weapon is feasible, development is under way.

The Atomic Energy Commission assigns Los Alamos or Livermore to concentrate on development of the nuclear components of the weapon (a phase still secrecy-shrouded), and the resulting basic nuclear device is handed to Sandia to be weaponized.

A project group at Sandia is charged with design of the complete ordnance system, as well as all individual components. The development engineers comprising this project group are primarily electrical and mechanical. They perform logical engineering steps in the overall development process.

First, a block design of the proposed system is laid out, with each block representing a separate function. Investigation then determines what component or group of components will perform that assigned task. If the desired device does not exist, either commercially or in a previous nuclear system, the component design department is asked to create one.

The component development engineers develop the devices for specific use in a system, as specified by the project group, with a sharp eye on reliability and ingenuity.

After accepting a design, the project group undertakes to package the weapon, meeting all the operational requirements. The final phase in the process is test and evaluation of prototype models, after which the design is released for manufacture. Project group personnel then aid in selection of suppliers, and suggest fabrication methods, as well as take part in tests.

The systems engineer therefore establishes requirements for new component development, designs and tests the complete system, and coordinates the work on the project from inception to stockpile.

Simplicity, ruggedness and reliability are prime considerations in the program. Prevention of both premature explosions and duds dictate greatest reliability. Efforts are made to use previously developed, tested and proven components before going about the job of creating new ones.

• **Environmental testing**—After fabrication of a prototype device in the model shop, which is believed to be the best equipped west of the Mississippi, environmental testing is begun.

High-temperature test: component is cycled for 30 tests of 24 hours duration, during which it is exposed to temperatures of 90 to 160°F.

Humidity test: component is exposed to relative humidities of 90 to 98% in ten 48-hour periods at temperatures of 68 to 149°F.

Temperature shock test: component is subjected to 160°F for four hours and −65°F for four more hours, three times.

Vibration test: mechanical resonant frequency is determined and the component vibrated at 10 g along each mutually perpendicular axis for one hour at room temperature; 15 minutes at 160°F and 15 minutes at −65°F.

Mechanical shock test: component is impacted 18 times at 15 g along each mutually perpendicular axis.

Acceleration test: component is subjected to 50 g along each mutually perpendicular axis in each direction.

Salt spray test: component is subjected to atmosphere of wet, dense, salt

fog for 50 hours at 95°F.

Other tests include subjection of components to high and low pressure, explosive vapor, fungus, sand and dust, rain and ice, and bright sunshine. Optimum efficiency is required throughout all these tests.

In addition to these environmental tests, Sandia has spectrographic, chemical and analytical equipment for materials testing. Lab equipment also includes that for determining measurements of length, mass, radiation, pressure, high and low electrical frequencies, and for determining magnetic resonance. Other equipment tests components and systems for effects of radiation.

• **Field tests**—Two basic types of field tests are carried out by Sandia: non-explosive and full-scale. The former consists of a complete system except for the nuclear components, with which ballistic behavior and electromechanical operation are studied.

Flight data obtained for analysis includes roll, yaw, pitch, accelerations, vibration at critical points, temperatures inside and outside the shell, internal and external pressure, structural strain, and voltages.

Sandia has developed a "DigiTel" data processing machine to select and punch test information onto IBM cards in digital form. The method represents considerable change since early nuclear days, when tin cans were placed at varying distances from an explosion, and pressure data gained from the extent to which cans were crushed.

Full-scale tests are carried out at the Nevada and Pacific test sites of AEC. Fissionable or fusionable material is detonated at these tests to prove out the design of an explosion system, and also to gain data on shock wave, heat, radiation, and other weapon effects. Such tests are sometimes conducted with nuclear "devices" which consist merely of nuclear material and a detonation system, rather than a complete, operational weapon. This enables Sandia and its partners in the program to test the explosive system before all the electro-mechanical details are worked out.

Upon completion of tests, Sandia arranges for production in desired quantities, inspection, delivery, storage, and stockpile surveillance. Production facilities are considerably decentralized, partly for security reasons and partly because of economic and time factors. Specialized facilities, even though scattered throughout the country, are valuable for the capability and experience they represent.

To coordinate the work of the widely dispersed facilities, Sandia has a corps of manufacturing engineers who maintain liaison between these plants and Sandia's facilities.

• **Quality assurance**—Although extremely reliability-minded, Sandia never freezes a weapon design, but frequently modifies existing weapons to improve their characteristics. This goes so far as to include reworking of already-stockpiled weapons, and in some cases, results in complete replacement of weapons with later models.

There are few areas where quality assurance is more vital than in a nuclear weapon. A continuing and intensive program is carried on by Sandia for the AEC and the military. For determining quality, the company has a four-phased approach including (1) Verification Inspection, (2) Destructive Testing, (3) Field Reports, and (4) Quality Surveys.

1) Verification inspection is based on examination of engineering drawings and specifications, resulting in establishment of later inspection procedures and pinpointing of specific characteristics to be checked, determination of sample sizes to be taken, and the acceptance criteria to be used. The amount and type of defects allowable are also established, based on the type of weapon and its relationship to other segments of the system.

2) Destructive testing, a self-explanatory term, leads to complete analysis of components, and in some cases, results in redesign of parts. Such testing is done at various intervals in the life of the weapon, so that effects of age may be determined.

3) Analysis of field reports follows Sandia's inspection of the military stockpile. Although maintenance of this stockpile is a military responsibility, Sandia provides technical assistance and instruction. Results are collected and punched on data cards, keeping a complete record of every weapon, from its production to its destruction.

4) Two types of quality surveys are conducted on a continuing basis: the Supplier Survey and the Product Survey. The former is mainly concerned with the facilities and performance of each supplier in the AEC network, and covers raw materials procurement, process controls, inspection methods and other quality-affecting factors.

The Product Survey examines the status of all drawings, specifications, factors affecting manufacture, and the maintenance of specific important material which may affect quality.

Although quality assurance provides AEC with information on quality and adequacy of the existing stockpile, it also provides feedback to the design and manufacturing agencies which results in improved weapons, as well as a means of producing future weapons more cheaply and with greater reliability.

• **Nuclear test ban**—The future path of Sandia Corporation depends on whether the ban on testing of nuclear weapons is continued or broken by either the United States or the Soviet Union. If the ban is broken, then Sandia will continue making even-more-deadly nuclear weapons.

If the ban is extended permanently, the company foresees a two-year period of fulfilling its present weapon-design obligations, then a greater channeling of its capabilities into Project Plowshare—the peaceful use of nuclear energy.

Navy Materials Needs Up For Review at AIME Meet

NEW YORK—First-hand descriptions of the Navy's needs in materials will highlight the annual meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers Feb. 15.

The one-day forum, sponsored by the Metallurgical Society of the AIME, will involve materials problems in deep-diving submarines, missiles, the metallurgical aspects of energy conversion and the development of naval weapons. The program also includes reviews of current Navy materials research programs in an afternoon session.

The forum concept will be used to present the Army's problems at the fall meeting of the Metallurgical Society in Philadelphia and the Air Force's defense questions will be handled at the AIME Annual Meeting, February, 1961, in St. Louis.

New Firm Tackling Boundary Lubrication

FORT WORTH, TEX.—Boundary lubrication problems are the primary concern of a new firm, the **Almasol Corporation.**

A wholly owned subsidiary of **Lubrication Engineers, Inc.,** Almasol was founded by two lubrication chemists to provide customized products for particular applications—high-temperature lubricants.

The basic ingredient in the company's line is almasol, a material which retains its qualities up to 1900°F.

The new firm will not license or franchise its products or processes. It says the work involves an extremely high degree of precise quality control, and personnel must be thoroughly trained in the various operations.

Air Force Weighs Hardening of *Bomarc*

Decision on whether to bury launchers and disperse them is related to added cost and debatable value of making defensive weapon 'hard'; if done, 'twill be done quickly

WASHINGTON—A midstream switch from "soft" to "hard" underground launchers for *Bomarc* interceptor missiles is being contemplated by the Air Force.

M/R has learned that a recommendation has been made to harden and disperse *Bomarc* bases being sought in the 1961 budget. There is a possibility that some of the bases already funded, but still on paper, may also be changed.

However, the decision to go ahead is being weighed carefully in terms of increased cost and the strategic value—if any—of hardening a strictly defensive weapon that is effective only against aircraft. Time is the most important factor. It is argued that unless hardening commences at once it will have little value.

The main objective of hardening would be to preserve *Bomarcs* from an initial Russian ICBM or submarine-launched missile attack so they could be fired at an expected mop-up wave by DA (Russia's SAC) strategic bombers in the event of war within the next few years. By 1965, however, Russia is expected to have such a large missile capability that aircraft would play only a minor part in an all-out war.

Of the 14 *Bomarc* bases now in the North American Defense Command's program, only one—at McGuire AFB, N.J., guarding the Trenton area—is operational. McGuire has two squadrons, each numbering 28 *Bomarcs*. The two groups of shelters are closely clustered in rows and look much like a suburban home development. They could easily be erased by a single nuclear warhead.

Three other bases situated at Dow AFB, Bangor, Me.; Otis AFB on Cape Cod, Mass.; and Suffolk, L.I., are almost identical to McGuire. They are virtually complete and are expected to be operational before the year is out. Ten others are in various stages of construction, including two at Glasgow, Mont., and Malmstrom AFB, Mont., which are scheduled to be advertised for bids in April by the Corps of Engineers.

All 14 of these bases are costing more than $500 million total to construct and equip for combat use. While most presently are being restricted to either one or two squadrons, all are being designed to be augmented to handle a total of 112 missiles, four squadrons.

It is some of these later squadrons that are up for consideration for hardening, perhaps in the "Hollywood hard" type configuration that puts the top of the shelter flush with ground level.

Any decision to put *Bomarc* launchers underground would run up the construction cost—now pegged at $9 million per squadron of 28—by a factor of 30% to 50% depending upon the degree of hardening.

• **Shelter evolution**—If a hardened launcher is developed for *Bomarc*, it

EVOLUTION OF *Bomarc* launching shelters began with this prototype Model I. The building required nearly 1000 tons of concrete.

MATERIEL REQUIREMENTS were cut sharply in this Model II shelter now operational at McGuire AFB, N.J. The structure is steel.

would be another step in the evolution of its shelters which dates back to late 1952. The fully-automated launcher for the new 400-mile-range *Bomarc B* now being built for the nine most recent squadrons is a far cry from the prototype Model I launcher erected at the beginning of the program at Cape Canaveral.

In a paper given last week at the Society of Automotive Engineers annual meeting in Detroit, R.V. Ostling and P. M. Kelly of **Boeing Airplane Co.** show the Model I shelter to be a massive device in comparison to the latest, streamlined Model, 1V-A.

The preliminary design prepared by **Anderson-Greenwood Co.,** Houston, actually laid down the basic definition of the system which has been adhered to ever since. It embodied a horizontal-storage shelter with a hydraulically operated bi-parting roof and a permanently installed launcher erector.

This model—later modified to become the prototype Model I—was for the early version of *Bomarc* which required a fueling system for its **Aerojet-General** liquid booster. The "B" type missile eliminated fueling with its **Thiokol** 50,000-lb.-thrust solid booster. The upper stage is powered by two **Marquardt** ramjets—which burn a storable jet fuel.

The two Boeing Aero-Space division engineers report that soon after the Model I had evolved into a design in late 1955, it was criticized unfavorably for its excessive size, complexity and cost. Two of the more controversial features were an involved deluge and sprinkler fire protection system and an overhead traveling crane to handle the missile. Model I actually was considerably larger than the "low profile, compact configuration" of the preliminary shelter design by Anderson-Greenwood.

One Model I was built at the Cape and performed successfully. Four more were erected at Eglin AFB, Fla., for training at the same time it was decided to scrap this shelter for tactical use and redesign it. The result was the Model II, which is now operational at McGuire AFB.

In this model, the length was reduced from 75 to about 62 ft. and the height from about 28 ft. to approximately 15 ft. The width remained at approximately 60 ft. Total inside volume from something over 40,000 cu. ft., to a little less than 18,000 cu. ft.

The big reduction was in materials. The 950 tons of concrete required by the Model 1 was cut almost in half as was the 55-ton original structural steel requirement.

This resulted in a per unit price drop from $113,000 to $85,000.

• **Still not satisfied**—Ostling and Kelly say that even this substantial cut did not satisfy the Air Force. So the AF Office of Installations Engineers contracted for design and construction of a Model III prototype structure.

The Model III cost $76,830 based on 28 units per site, but it "represented the ultimate in mechanical complexity." Built on a concrete floor and foundation identical to the Model II, the Model III had a roof opening mechanism comprised of four rolling panels and four hinged panels operated by 12 hydraulic actuators—plus three chain drives and an electrical motor.

Just one was constructed before the concept was abandoned.

Boeing in August, 1958, obtained Air Force permission to design and prepare its own A&E drawings for what was to become the Model IV-A, still for a liquid-fueled booster.

The prototype of this model with its flat split roof was subjected to over 600 roof operating tests under simulated snow loads of 30 psf and wind loads up to 60 mph. Say Ostling and Kelly:

"Throughout, the roof opening proved to be fast (4 secs.), dependable and, of course, automatic. Additional tests have raised the total number of roof operations on this prototype to 1296.

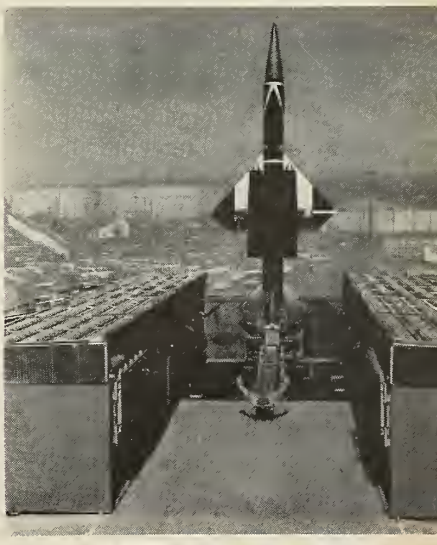
"The heating and ventilating systems of the shelter also were thoroughly tested and found completely satisfactory, while the roof seals were tested under simulated rainstorm conditions and (also) found satisfactory. The electrical lighting, power, and control systems were thoroughly checked, and in addition, a laboratory test was run to select the most economical rolling roof support beams which would ensure freedom from wear and cold working during the operational life of a tactical launcher-shelter."

The "IV-A" has a per unit cost of $60,357. And its sister model for the *Bomarc B* costs $42,906.

This latest model also represents a rather dramatic reduction in cost of a 28-unit squadron. The Corps of Engineers puts the Model II at $13 million to build per squadron and the Model IV at $9 million.

Further reductions in squadron costs appear unlikely—particularly if the Air Force decides to go ahead with the hardening of *Bomarc* bases.

THIS IS THE ONLY Model III shelter yet built. While cheaper than Model II, this type proved to be "ultimate in complexity," so Air Force quickly dropped it.



LATEST MODEL IV has roof which opens in 4 sec. New squadrons will use it.

Sled Tests Evaluate Fin Materials

There's little glamor in such 'pick and shovel' testing but important data is gained along Holloman's seven-mile-long sled track

PYLON for fin mounting to avoid aerodynamic interface with the sled was fabricated by AFMDC personnel to Narmco recommendations. During static tests, loads were applied to the pylon at the predicted center of pressure under maximum fin loads. Procedure enabled determination of load-deflection curves for pylon and to proof-load pylon and sled in a structural check.

HOLLOMAN AFB, N.M.—Evaluation of components through high-speed sled testing probably is one of the most underpublicized phases of missile activity.

Although relatively unromantic compared to big, blasting vehicles launched from Florida or California, detail testing is no less important.

The photos on these pages show "pick and shovel" testing on a pair of missile fins. Test results, to be released as WADC TR 59-581, "Development of a Reinforced Plastic Sandwich Missile Fin," are typical of routine operations for technicians and engineers at the USAF's Holloman Missile Development Center. It is typical also of projects that can be accomplished only on the Center's new seven-mile-long track.

The test objective—to demonstrate such advantages as may be gained by using reinforced plastics in primary structures under elevated temperatures.

One fin was conventional metal construction with titanium ribs and skins, and forged aluminum ribs—a total weight of 60 lbs. The second fin, constructed and designed by the Research and Development Div., **Narmco Industries, Inc.**, was a full-depth sandwich with Conolon 508 plastic laminate facings, 17-7 PH stainless steel core forward 30%, aluminum core aft 70% and aluminum torque box attachment fittings. Facing to core adhesive was Metlbond 304/1 and facing to attachment fitting adhesive was Metlbond 4041. Total unit weight was 42.8 lbs.

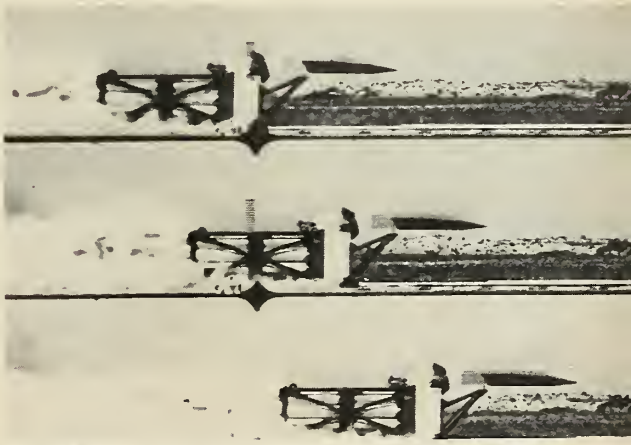
The tests were conducted with an AFMDC sled designed and built by **Coleman Engineering Co.** Power was nine 30,000-lb.-thrust **Grand Central Rocket Co.** *Javelin* units.

PLASTIC FIN is at left, titanium at right. Fins were mounted as fixed units on pylon at a negative angle of attack of –4.82°. Both units were painted black for high uniform thermal absorptivity.

PRIOR TO run start, each fin was heated to approximately 600°F by GE-T3 quartz heating lamps to simulate aerodynamic heating since such heating would not occur during short duration of test. Lamp reflectors, originally used in fin static tests, were modified by Narmco, which also designed reflector carriages and withdrawal track to pull heater panels back prior to sled start. Lamps were re-spaced in reflectors for correct maximum temperature distribution with constant power input to eliminate complex and elaborate temperature controllers.

SLED AND FINS are re-checked after run. Test program included highest thrust operation (about 270,000 lbs.) ever attempted at Holloman track. Titanium fin (right) shows some indication of high loads. No material was ablated from either fin. Velocity of sled was approximately 2400 ft. per sec. (1636 smph). Vehicle weighed 6500 lbs. and required a run of 27,000 ft. AFMC sled was designed and built by Coleman Engineering Co. Power is nine 30,000-lb. thrust Grand Central *Javelin* rockets.

NOZZLE END of Grand Central *Javelin* rockets after Narmco fin test. Note nozzle erosion towards center of cluster in "hot spot" areas.



HIGH-SPEED camera shot of sled start and run. Test of fin materials is typical of projects that can be accomplished on seven-mile track.

THESE RACKS were used to hold quart lamp heaters (which simulated aerodynamic heating) at the start of the sled's run.

THIS PRIMARY TOWER in "boresight range" is one of two tall structures at Ryan's newly opened facility which are important in microwave study. Transmitting tower stands on a concrete base 15 ft. above ground with about 38 ft. underground.

astrionics

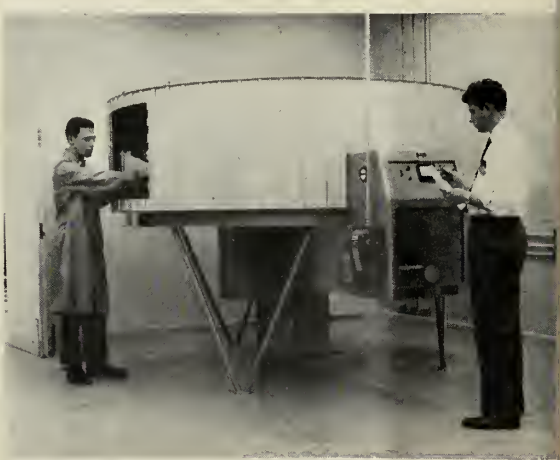
Ryan Opens Versatile New Resear

SAN DIEGO—What may be one of the missile industry's most complete and best equipped laboratories for research and development of electronic components has been opened by **Ryan Electronics.**

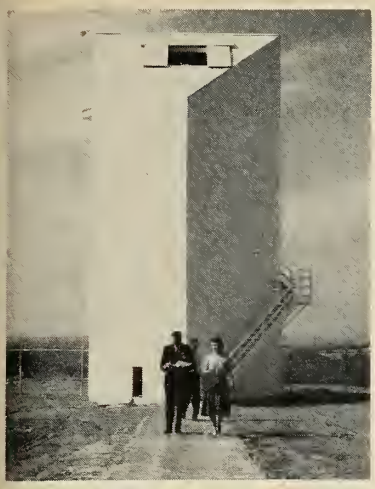
The facilities are housed in a two-story, 28,000-square-foot building specially designed to function as an electronics laboratory. An Environmental Test Laboratory can simulate altitudes from ambient to 150,000 feet, temperatures from minus 100°F to plus 500°F, humidity from 20% to 95%, shock of 2.2 to 32 milliseconds plus duration and magnitudes from 4.5 to 210 g, centrifugal forces from 0.1 to 175 g, vibration to 5000 force pounds sine wave 5-25000 cps and 4600 pounds rms random 20-2000 cps. complete with oil film slip table for vibrating in a horizontal plane, compression and tension testing up to 20,000 pounds, and salt fog corrosion from ambient to 125°F.

A Microwave Laboratory includes six bays, permitting six different types of testing at the same time. To provide the nearest condition possible to ideal free space for measurement of microwave beams, doors on the bays open onto a balcony facing across the barren flight pattern of Miramar NAS.

ANTENNA for test on "boresight range" is mounted to huge gimbal (foreground). Gimbal's surface plates are adjustable to provide perfect horizontal reference for boresight mechanism in transmitting tower.



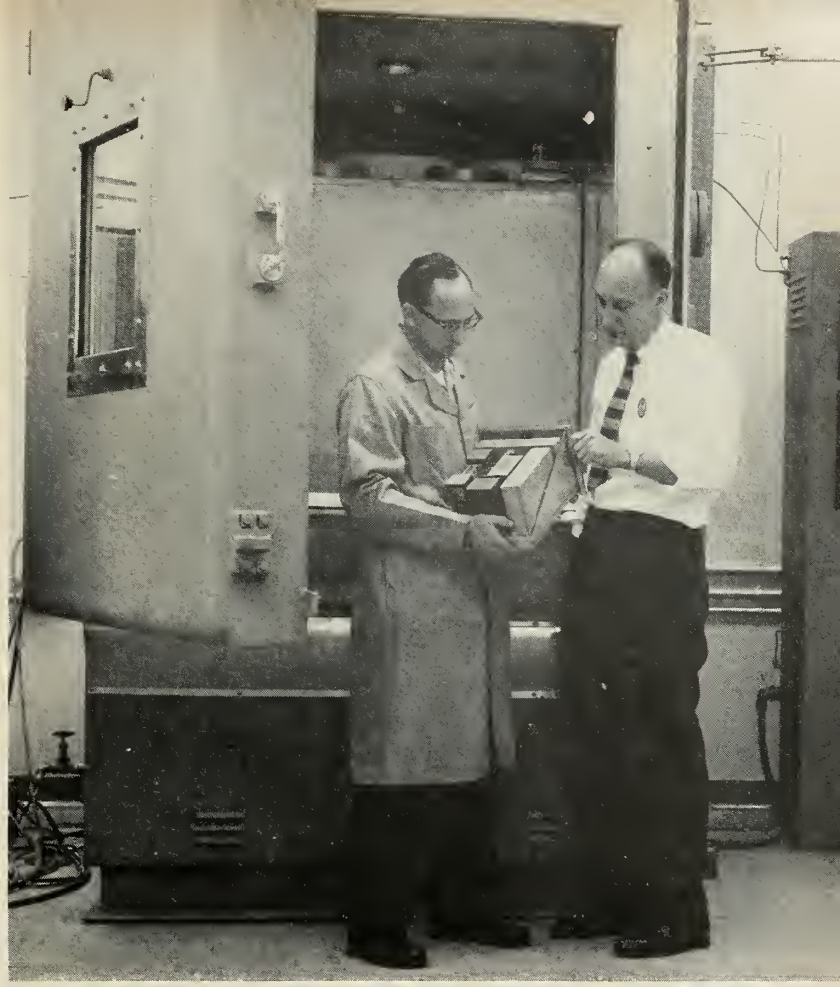
THIS MISSILE centrifuge can apply as much as 175-g force t test reliability of electronic components. Left, Warren Rinehart, lab technician, and Robert Inabinette, environmental test engineer.



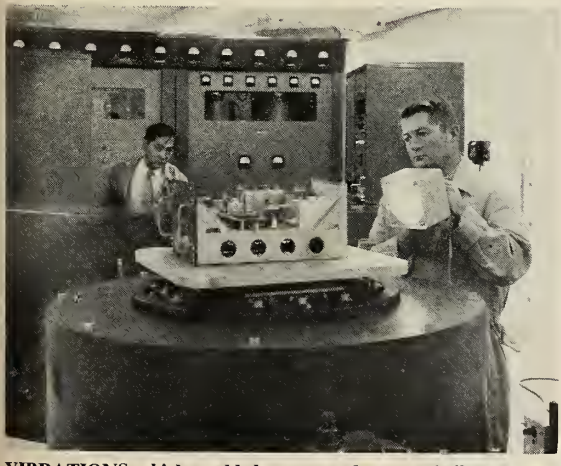
SECONDARY tower has antenna dish to return transmitter tower's signal. Odd building design prevents signal bounce back from surfaces other than dish.

acilities

A Boresight Tower Range has been designed to permit boresighting of antenna beam angles to within one minute of arc. The range has a primary and secondary tower. Each tower is about 38 ft. above ground, but the height is adjusted to sea level rather than ground level to provide a true horizontal for antenna beam axes. The facility will be used extensively for doppler navigation research.



WIDE RANGE OF temperature, altitude and humidity can be provided in this environmental chamber. Russell Holmes, left, technican, and Grant Hubbell, supervisor, prepare component for test.



VIBRATIONS which could damage or destroy missile parts can be simulated on Ryan's new vibration exciter. R. V. Peters uses strobe light. Stanley Ave monitors control console.

IRREGULAR SHAPE of wall and ceiling helps reduce noise in vibration test facility. Acoustical materials bring sound level down from 120 decibels at source to 45 decibels, equal to a radio's hum.

GT&E Ups R&D

$20 Billion Annually Seen in Next 8 Years

NEW YORK—**General Telephone & Electronics Corp.**, taking a major step to assure that its divisions and subsidiaries keep abreast of technological progress, has formed the **General Telephone & Electronics Laboratories, Inc.**, a wholly-owned subsidiary to be engaged solely in scientific research activities in the communications and electronics field.

The new research facility will be based around the Bayside, N.Y. Research Laboratories of **Sylvania Electric Products, Inc.**, a GT&E subsidiary. Additional facilities will be added later, according to Donald C. Power, chairman and executive officer of GT&E.

Power said the laboratory will be responsible for basic research and advanced development in major technical fields of broad interest to the current operations of GT&E, as well as exploration of new technical fields having potential interest to the company.

The 50-acre installation at Bayside employs about 350 persons engaged in physical electronics, chemistry, solid-state physics, metallurgy, and systems and circuits research. Specific projects include work on new principles of data processing and display, communications, lighting, television and radio, power transmission, semiconductor devices and electron tubes and related projects.

Dr. Herbert Trotter, Jr., senior vice president-research and engineering for Sylvania, will head the new subsidiary with offices at the General Telephone Building in New York. He will also coordinate the research engineering activities of the Sylvania, **Automatic Electric Co., Leich Electric Co., Lenkurt Electric Co., Inc.**, all manufacturing subisidaries of GT&E.

The new subsidiary is partly the result of a study by Lt. Gen. James D. O'Connell, retired Chief Signal Officer of the U.S. Army, who has been consultant to the company since July. He will now act as a vice president of the laboratories. Other officers include Dr. Robert M. Bowie, vice president and general manager; Dr. Bennett S. Ellefson, vice president-finance; Ralph D. Heusel, treasurer; and H. H. Howlett, secretary.

Predicting a $20 billion annual expenditure for research and development by industry, government, universities and private laboratories in the next seven or eight years, Power emphasized the necessity of industry to gear its long-range planning to research and development on a broad scale.

1 Ton in *Titan*

Magnesium Usage Growing in Missiles

MIDLAND, MICH.—A ton of magnesium-thorium sheet and extrusions is used in current models of the *Titan* ICBM, according to **Dow Chemical Co.**

This is one of the newest uses for magnesium, one of the lightest metals, as a missile structural material. Two-fifths of the *Titan* skin structure, in addition to external conduits and internal structure, is magnesium-thorium alloy.

Earlier ballistic missile uses of magnesium alloys include a skirt structure between the propellant tanks and nose cone of the *Jupiter* IRBM, and skin and internal structure of the *Vanguard* launching vehicle. Eight *Vanguard* and *Discoverer* satellites, constructed primarily of magnesium alloys, have been placed in orbit.

More than 600 lbs. of magnesium alloys are used for skins, fairings and internal structure of the *Discoverer* vehicle. Cast and wrought magnesium alloys are used for several re-entry vehicles covered by ablative material and for housings of missile electronic equipment, such as the Arma inertial guidance system for ICBM's.

Subsonic missiles such as the *Snark* and *Mace* use magnesium sheet for fuselage skins. The *Falcon* uses magnesium sheet, extrusions, forgings and castings for skins, internal structure and fins. The *Nike-Hercules, Talos, Bomarc, Terrier* and *Tartar* use magnesium cast and wrought alloys.

Designers select magnesium alloys for weight saving, thermal properties and simplified construction. Low density (average .065 lb./cu. in.) permits use of thicker gauges at less weight than other structural materials. This increases stiffness and buckling strength, reducing the need for complex stiffeners. The strength of magnesium-thorium alloys makes possible their use at temperatures up to 800°F.

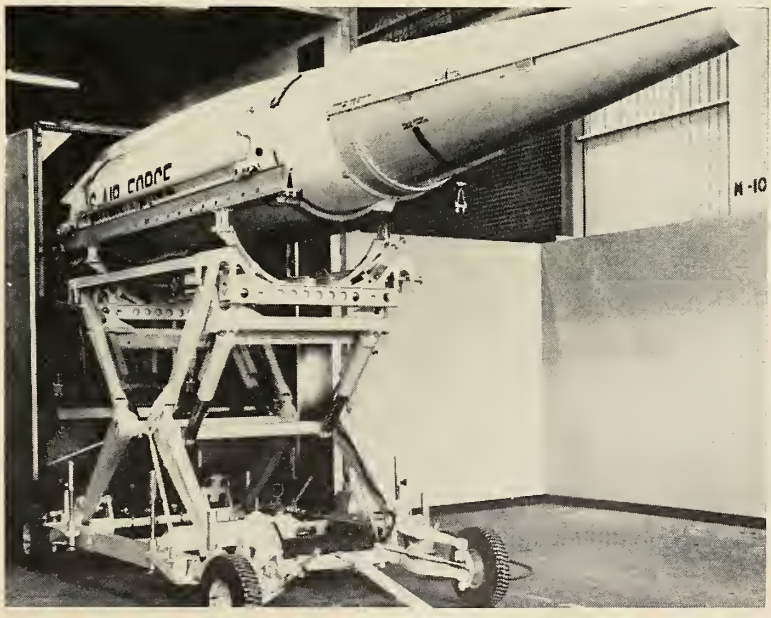
High specific heat values over a wide temperature range permit magnesium-thorium alloy skin structures to operate at lower temperatures than equal weight structures of other metals subject to short-time heating. This can reduce the weight of equipment needed for cooling internal areas and also can reduce thermal shock problems.

Fabrication techniques are well established for magnesium-thorium alloys. Both tungsten arc and consumable electrode arc welding, with inert gas shielding, permit attainment of weld strength efficiencies of 80-90% at room temperature and considerably higher at elevated temperatures.

JPL Adds to Edwards Facilities

THIS 1000-foot-long tunnel system, housing hundreds of connections that assist in measuring temperatures, vibrations, thrust, and other data of rockets as they are test-fired, is part of an expansion program at California Institute of Technology Jet Propulsion Laboratory's test station at Edwards Air Force Base, Calif. The bulk of the pioneering rocket research facility's work is now being performed under contract to the National Aeronautics and Space Administration.

Truck Vans for Bomarc



NEW METHOD of transporting *Bomarc* IM-99B's by motor truck vans—instead of air delivery as in the case of *Bomarc A*—has been developed by Air Logistics Corp., manufacturers of its handling and tie-down equipment. The Boeing missile will be delivered, two to a standard van, partially dismantled for loading. There are 14 *Bomarc* bases planned for North American Air Defense Command, although the McGuire AFB is the only one operational.

Ceramic Cutting Material

The Soviet technical journal *Tsvetnyye metally* (No. 11, 1959), reports that the Russian All-Union Scientific Research Institute of Hard Alloys has discovered the following high-temperature properties of an alumina-base ceramic material used for cutting tools:

- The bend strength decreases very slowly from 33 kg/mm² at 20°C to 29 kg/mm² at 800°C, but decreases more rapidly at higher temperatures—to 14 kg/mm² at 1200°C.
- The Vickers hardness test under 1-kg load revealed that the material remains brittle in the whole temperature range of 20°C to 1200°C, and all indentations showed cracks originating in the corners.
- Hardness decreases linearly from 1800-1900 H_v at 20°C to 350 H_v at 1100°C, but cracks did not form during micro-hardness tests under 100-g loads and hardness values were 100-200 H_v higher.

Organic Tin Polymers

The publication *Vysokomolekulyarnyye soyedineniya* reports that organometallic and organoelemental polymers of silicon, germanium, aluminum and tin are currently receiving considerable attention in the USSR. (Vol. 1, No. 10, 1959.)

The article reports that members of the Scientific Research Institute of Plastics have polymerized methacrylates of alkylated tin. Among the compounds obtained, polymers of triethylstannyl methacrylate displayed high adhesion to glass and metals.

New Astrophysical Lab

According to the Latvian publication *Sovetskaya Latviya*, an astrophysical laboratory has just been built at the Pulkovo Observatory. (Nov. 5, p. 4).

The underground section of the lab is said to contain the world's largest optical tunnel—120 meters—in which a half-meter diameter steel pipe has been installed. Mirrors fastened at the ends of the pipe will reflect rays, and on a six-meter arc, spectra will be formed of light waves of various lengths.

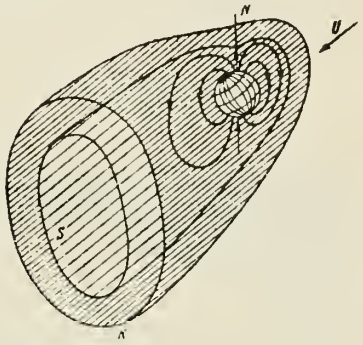
The laboratory will be equipped with a specially designed seven-meter vacuum spectrograph to study the so-called perturbations in the solar atmosphere; a quartz and glass prismatic spectrograph; and an infrared spectrometer for studying the thermal part of the spectrum. Also to be installed is a large electromagnet with alternating telescopic steel tips and a high-temperature vacuum electric furnace.

The article quotes Prof. O. A. Mel'nikov, head of the Observatory's division of stellar physics, as stating that the use of the various machines, pumps, and compressors will create an artificial low-pressure atmosphere in the laboratory which will make it possible to conduct solar spectral research under "natural" conditions. A television telescope connected to the laboratory by a special cable will also be installed.

Aurora Explanation Given

A possible explanation for the aurora borealis has been revealed by Russian scientists studying problems connected with the orbital progress of the Earth through plasma.

Particular attention was paid to the interaction of the ionized plasma streams and the terrestrial magnetic



field. On the basis of previous studies it was assumed that the interaction of the flow of ionized gas with the Earth's magnetic field brings about the appearance of a magnetic "squeeze-out," i.e., the ionized gas in motion flows around a hollow or cavity containing the magnetic field.

Outside this cavity the magnetic field is not present; on the boundary of the cavity the magnetic pressure is balanced by the dynamic gas pressures. Strictly speaking, the boundary of the cavity is a magnetic boundary layer along which electric currents flow. The "squeeze-out" effect is explained by the existence of ponderomotive forces created by these electric currents. Conditions here are considered to be hypersonic since the gas moves around the cavity at a speed higher than Mach 3.

An unperturbed gas flow, after having passed shock wave K (see illustration), flows around surface S. Formulas are given for calculating approximately the pressure of gases on the cavity. The cavity is symmetrical in relation to the Q-plane which passes through the magnetic axis of the Earth running parallel to stream U. Electric currents on the boundary of the cavity S flow approximately in planes parallel to the equatorial in a westerly direction. The order of dimensions of the cavity is related to the value M of the magnetic dipole of the Earth.

The Russians note that the intensity of the magnetic field equals zero at points along the boundary of the cavity S in the neighborhood of its intersection with the Earth's magnetic axis N. The presence of these critical points allows the ionized particles to enter the cavity and diffuse inside it. Thus, they conclude, the aurora borealis may be explained by the unipolar induction occurring when masses of ionized gases enter the cavity and come in contact with the gases moving in the magnetic boundary layer.

Outlined also is a quantitive approach to the problem of finding mathematical expressions for the cavity and the magnetic field inside it. Analytical expressions are given for the force P and momentum L applied to the magnetic dipole as a result of interaction with the plasma.

The article concludes with the thought that this concept is important in plasma aerodynamics since it shows that with the aid of a magnetic dipole it is possible to create remote force loads within a broad range on a moving, conducting medium. *(Doklady Akademii nauk SSR, Vol. 127, No. 5, 1959, pp. 1001-1004.)*

Life on Mars?

The contention that life exists on the planet Mars has been further supported by N. I. Kucherov, well-known Soviet scientist.

He reports that the observed color of the dark spots or "seas" on the planet changes according to the time of the year: blue-green in the spring, brown or grey-brown in the fall. In certain years, the Martian "seas" change in outline and size, thus refuting the conclusion that they are geological formations. Many scientists reason that if the "seas" were tremendous accumulations of mineral salts, changing color according to the humidity, they would have been covered up by dust and sand during the frequent sand storms occurring on Mars. Only relatively tall vegetation could withstand the drifts of sand and

the accumulation of dust.

G. A. Tikhov, Soviet astrophysicist, demonstrated that the spectral curves of the "seas" of Mars coincide with the same curves for Earth plants growing in severe climatic conditions, particularly in the Pamirs and in Tien Shan.

A band in the far infrared range on the 3.4-micron wavelength, inherent in many terrestrial plants, was recently discovered on the Mars spectrum by the American scientist Sinton.

The Soviets plan further study of Mars at the new Planetary Division to be opened at the Pulkovo Observatory. *(Komsomol'skaya pravda, December 13. 1959, p. 6, cols. 1-2.)*

Magnetic Field Research

Data on the intensity of the Earth's magnetic field procured by *Lunik I*, Soviet space rocket, has been released by S. Sh. Dolginov and N. V. Pushkov.

Field intensity was computed theoretically, taking into account the Earth's magnetic dipole and using spherical functions, with graphical representation of results. Real intensity was measured by a magnetometer with a saturation-type transmitter. All three magnetic components at various altitudes were measured.

A comparison of results obtained from measurements and those computed theoretically shows some discrepancies. The difference at a distance of 14.7 x 10^3 km is 300 gamma. With growing distance the difference increases up to 800 gamma at an altitude between 19 x 10^3 and 20.5 x 10^3 km. Maximum negative difference occurs at an altitude of 22 x 10^3, the second most significant difference occurring between 32 x 10^3 and 36 x 10^3 km.

The curve of measured intensities was compared with curves of cosmic radiation intensities obtained by Soviet scientists S. I. Vernox, A. Ye. Chudakov and the U.S. scientist Van Allen. The comparison shows the integral effect of the influence of cosmic radiation on anomalies in the distribution of the magnetic field. The existence of an outer magnetic field caused by electrically changed particles is named. *(Doklady Akademii nauk SSSR, Vol. 129, No. 1, 1959, pp. 77-80.)*

Isotope 'Fire Sale?'

Isotopes will go on sale soon in a shop on Lenin Avenue in Moscow.

Industry and research organizations will be able to procure isotopes at the new store, which will also feature exhibits and instruction in the use of isotopes in industry, medicine and agriculture.

Protective clothing and equipment will also be offered. *(Pravda, Dec. 15, 1959, p. 4, cols. 4-5.)*

NEW PRINCIPLES IN QUANTUM MECHANICS, H. C. Dudley, Exposition Press N. Y., 155 pp. $5.00.

Doctor Dudley, a Captain in the Navy Medical Service, takes a healthy swipe at the Theory of Relativity, attacks the "wedding of mathematics and philosophy," and bores away at the foundations of what is commonly known as "modern physics."

One of the contentions of the author is that Relativity attained its present exalted position not because of any inherent quality, but simply as a result of the best managed public relations effort the world has ever seen.

There is a collection of most of the early doubters of Lorentz and later theorizes and an excellent bibliography permits the more energetic reader to extend his knowledge of the matter.

The entire purpose of the work is best explained by the author himself when he said it stemmed from an awareness of "the illogical, impossible prediction which result when 'modern' mathematical processes are carried to their ultimate conclusion."

THE MOON AND INTERPLANETARY SPACE FLIGHTS, Summary translation of Izvestiya (USSR). Order AF 1165884 from Photoduplication Service, Publication Board Project, Library of Congress, Washington 25, D.C. $1.80.

The article, popular in its approach, is largely speculative. It is stated that the moon will become a populated world, and that it will be the first station on the road to the conquest of space.

RESULTS OF OBSERVATIONS OF SOVIET ARTIFICIAL EARTH SATELLITES NO. 1, SPUTNIK 1958. Order 59-11510 from Office of Technical Services, Department of Commerce, Washington 25, D.C. $.75.

Presented are selected translations of Soviet-bloc International Geophysical Year Literature.

The purpose of the work consisted in determining the orbit of the carrier rocket of the third Soviet artificial earth satellite. The data for the computations consisted of reports sent by Soviet and foreign optical-observation stations to the Astronomical Council of the Academy of Sciences USSR.

GUIDED MISSILE INFORMATION, Order AF 1255956 from Photoduplication Service, Publication Board Project, Library of Congress, Washington 25, D.C. $1.80.

Included are translations of excerpts from open USSR Soviet Bloc and other foreign sources.

AUTOMATIC COMPUTATION AS AN AID TO SCIENTIFIC RESEARCH, Summary technical report, National Bureau of Standards. Order STR-2432 from National Bureau of Standards Office of Technical Information, Washington 25, D.C.

The Bureau reports it has increased the effectiveness of its own scientific program and that of other Government agencies through a computing service.

Problems solved range from calculation of satellite orbits to evaluation of molecular models. The computations are performed on a high-speed computer and frequently aid the development of theory.

FUNDAMENTALS OF GUIDED MISSILES, Aero Publishers Inc. Order from Aero Publishers Inc. Los Angeles 26, California. $12.50.

This profusely illustrated book covering theory, design, operation and maintenance can be used as an introduction for the beginner, but is complete enough to serve as a technical reference for those in the industry. It includes 576 photos and drawings.

The first 46 pages are a glossary of guided missile terms and a short history of guided missiles. The balance of the volume gives comprehensive coverage of guided missile aerodynamics, propulsion systems, physics involved in design, trajectory considerations, control systems and their components, guidance systems and their components, tactics, instrumentation, telemetering, etc.

ENCYCLOPEDIA ON CATHODE-RAY OSCILLOSCOPES AND THEIR USES, John F. Rider and Seymour D. Uslan. John F. Rider Publisher, Inc. New York. $21.95.

The authors have strived to present in one large volume a cross-section of cathode-ray theory, as well as applications in all fields of research where oscilloscopes might be used.

The present book is a revision and expansion of the first edition, published in 1950.

Sections include: "Cathode-Ray Tubes: Theory of Operation and Basic Construction," "Oscilloscope Circuitry and Operation," "Oscilloscope Applications," "Waveform Analysis," and "Commercial Oscilloscopes."

Included in the latter section are specifications and schematics of commercial oscilloscopes.

ADVANCED MAGNETISM AND ELECTROMAGNETISM, edited by Alexander Schure. Order Cat. No. 166-26 from John F. Rider Publisher, Inc. New York, N.Y. 104 pp. $2.25.

This volume in the Electronic Technology Series is devoted to explaining advanced concepts of magnetism and electromagnetism.

It explores various underlying magnetic and electrical phenomena and covers details of the force acting on a charge moving through a magnetic field, induction lines, magnetic flux, Biot's Law, Faraday's Law, Lenz's Law, and the Curie-Weiss Law. Material on the domain theory of magnetism is also presented.

The most modern concepts of magnetism and electromagnetism are explained, together with such items as the cyclotron, the mass spectrograph, and terrestrial magnetism.

Filter Cores Weigh Only 1/3 Ozs.

Acting like tiny telephone operators in space, sub-miniature and microminiature filters used to transmit and receive information from missiles and satellites are growing smaller but better.

The Burnell & Co., Inc., pioneers in toroids, filters and related networks, have reduced the size of these sending-and-receiving units. With the help of the **Arnold Engineering Co.**, a subsidiary of **Allegheny Ludlum Steel Corp.**, the special core units in the filters have been reduced from 4¼ lbs. to 1/3 oz. Since there are 23 filters in a complete set or "package," the weight saving alone is tremendous.

Arnold Engineering supplies the powder core, which is the working member of the filter unit. These cores are made of molybdenum permalloy powder compressed under high pressures, annealed and then finished. The filter can transmit and receive information on certain frequencies and filters out other frequencies.

By using certain type filters, a missile or satellite can transmit such information as altitude, pressures, radiation, direction, various gases in the stratosphere or ionosphere and other valuable information. Also, with the filter, changes in direction are made possible.

With such filters as Burnell Company makes, it is possible to receive several messages over the same wire.

In 1947, the telemetering system, which uses 23 filters, and auxiliary equipment weighed a total of 207 lbs. This same type equipment with the subminiature units would weigh 11.1 oz.

While it was necessary to get compactness and light weight into the systems, it was vitally necessary to get reliability. All Burnell filters are triple-checked, and must withstand tests to have 100% reliability. The filter units are tested for 100-G's or 100 times the force of gravity and at 2000 cycles per second vibration test. In addition, they are tested for electrical loads. Each unit must withstand ultra high voltage loads far in excess of the load it might be expected to encounter in use.

The unit is hermetically sealed or encapsulated. It is then ready to meet the tests of space.

Circle No. 225 on Subscriber Service Card.

Refractory Material Withstands 6500°F

"Asbestosite," a new refractory material developed for use under extremely high temperature conditions, has been announced by **Harco Laboratories Inc.**

The material is said to withstand continual exposure to temperatures in the 1000°F to 3000°F range and is also capable of being subjected to much higher temperatures during intermittent periods of time.

Tests recently concluded on cylindrical specimen parts with ½" wall thicknesses, indicated a continuous OD temperature of 650°F, while ID temperature readings were a continuous 2500°F. Asbestosite is easily fabricated in a wide variety of shapes and sizes and Harco plans on making the material available in metal-clad configurations.

Strong, rugged and possessing the ability to withstand extreme thermal shock, Asbestosite has stirred interest at Army Ordnance for possible use in heavy tank exhaust systems. Surveys involving the use of Asbestosite in rocket and jet constructions and in cases where materials in a liquid state are to be transferred at extremely high temperatures, are also underway.

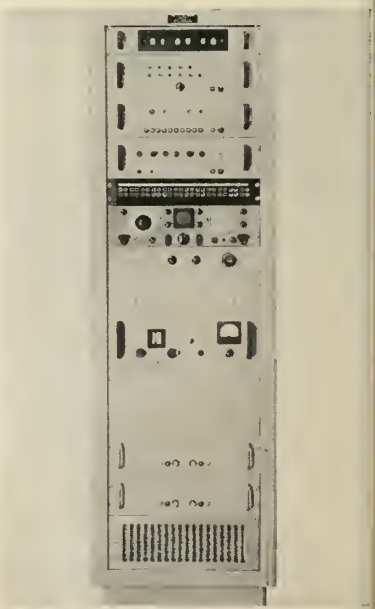
"As a result of the studies we have undertaken, it is obviously clear that Asbestosite materials to be used as tubing, or that may be subjected to heating from within, can definitely be formulated to withstand temperatures above 3000 degrees F. for several hours," reports M. B. Marshall, Harco Vice President and General Manager.

Circle No. 226 on Subscriber Service Card.

Missile Tracking, Control Timing System Available

Hermes Electronics Co. has announced production of a precision timing system for tracking and control of missiles, a binary-to-decimal readout.

This timing system can be incorporated in missile range instrumenta-



tion to provide time references for correlation of events and accurate measurement of missile position and performance.

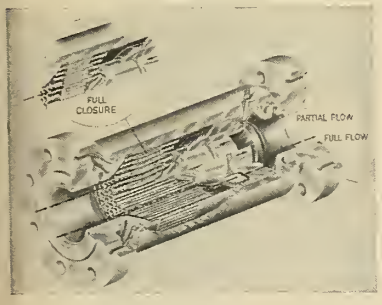
During a missile launching, for example, it is necessary to have accurate information regarding the missile's exact position, the exact time a given event occurs, and knowledge of the time relationships among different events. The new Hermes system fulfills all of these requirements. It is composed basically of a master oscillator which serves as a time base, combined with Hermes' ultratable oscillator (stable to 5 parts in 10 billion per day) with its standard digital frequency dividers and time code generators.

The company's binary-to-decimal converter (model 260) is a new digital product which will translate from any binary language into a decimal readout. It can be used with all computers which process data in a binary code and require an output in the more common decimal code. Semiconductors are used for all conversion and memory functions.

Circle No. 227 on Subscriber Service Card.

Higher Efficiency Claimed For Flexible Silent Valve

Aeration, cavitation, surging, vibration and the resultant noise, all undesirable physical phenomena associated with the rapid flow of fluids, is now virtually eliminated by **Aerojet-General**



Corp.'s new silent valve.

This method of flow control is expected to have wide application in industrial and military fluid systems.

This new principle of flow control was conceived and developed by Aerojet's Anti-Submarine Warfare Division which is managed by Calvin A. Gongwer. S. G. Coon, Jr. is the project engineer. The valve is flexible in size and scope and can be supplied for installation in systems with line sizes from one-inch to many feet in diameter, handling a wide variety of fluids.

The heart of the Silent Valve is a cylindrical plug of elastomer having a

large number of axially aligned holes which serve as flow passages. This plug is contained in a tubular housing between two perforated plates, one of which is either mechanically or hydraulically actuated to compress the elastic insert.

As the plug is compressed, the flow passages are reduced in diameter thereby throttling the fluid flow. At full compression, these channels are closed and complete shut-off is attained. Extremely fine gradations of throttling resistance assure precision flow control over the complete range of operating positions with a minimum pressure loss when the valve is wide open.

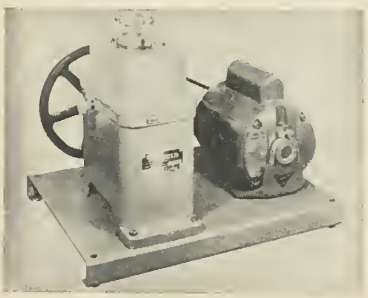
The use of a large number of small-diameter flow passages permits the energy associated with large pressure drops to be dissipated smoothly by fluid friction within the tiny channels. Dynamic underpressures are virtually eliminated from the throttling process. Both cylindrical insert plug and valve body can be made compatible with a variety of fluids including water and petroleum products.

Circle No. 228 on Subscriber Service Card.

German Vacuum Pump Now Available in U.S.

Leybold Rotary Gas Ballast Vacuum Pumps are now being distributed in North America by **Arthur S. LaPine and Co.**

Manufactured in West Germany by **E. Leybold's Nachfolger,** these vacuum pumps are equipped with a gas ballast device that prevents condensation of



vapor in the pump. They have evolved from designs of Gaede, the outstanding figure in modern vacuum pump invention.

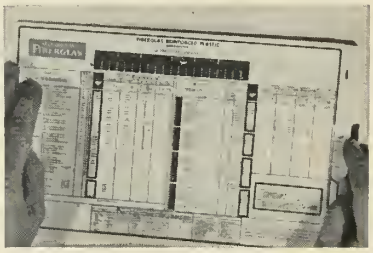
Models available include single-stage pumps that can attain an ultimate vacuum of 2 x 10^{-3} millimeters of mercury, and the two-stage pumps with an ultimate vacuum of 2 x 10^{-5} millimeters of mercury.

Both single- and two-stage pumps are available in two sizes: one with a speed of 33 liters per minute, and a larger size with a speed of 100 liters per minute. All are oil-sealed rotary vane vacuum pumps and can be operated with or without gas ballast device.

Circle No. 229 on Subscriber Service Card.

Plastic Comparator Gives Quick Reference Data

A reinforced plastic comparator, known as the Vis-Tec Comparator, has been developed by engineers of **Douglas Aircraft** (who hold the copyright) under the sponsorship of **Owens-Corning Fiberglas.** The materials evaluator condenses many thousands of data units for visual, quick reference for the engineer—an amount which in its original form would be represented by a 2½′ stack of technical information.



The device is in the form of a large slide rule, allowing a design engineer to compare rapidly specific properties of twelve proprietary laminate materials. On the reverse side are charts and tables compiled from military sources and manufacturers' literature, bringing together all the basic design criteria the engineer will need for initial evaluation of various laminate systems.

Circle No. 230 on Subscriber Service Card.

Isotopes Provide Gamma Spectrometry Standards

Calibrated radiation reference sources specifically designed for use as gamma spectrometry standards are available from **Tracerlab, Keleket.** A selection of eight radioisotopes are available, prepared either for use with standard or well-type detectors. These sources may be purchased separately but are most commonly sold in sets of five, each set packaged in a walnut storage case.

The available isotopes have been chosen so as to provide as useful a selection of calibrated photopeaks as possible, considering the practical limitations imposed by 1) availability and 2) unusually short half lives. The isotopes employed are Cadmium 109, Barium 133, Tin 113, Cesium 137, Sodium 22, Manganese 54, Zinc 65, Cobalt 60.

Type R-34 is intended for use with sample holders and changes accepting disc-shaped samples. These sources are sealed in plastic discs 0.94″ diameter x 0.027″ thick. Type R-35 is designed for use with liquid-type well counters. The sources supplied with this set are sealed in plastic cylinders 2″ high and 0.625″ in diameter. All sources contain approximately .01 to .05 micro curies of activity and are calibrated in gammas per minute at a specified photopeak.

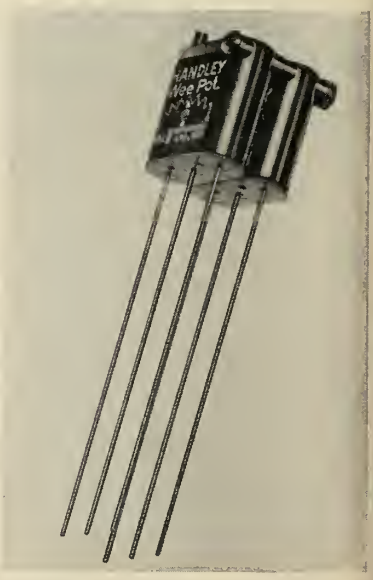
Circle No. 231 on Subscriber Service Card.

Stackable Potentiometer Offers Good Accessibility

A new potentiometer, Model 1W-STK, was announced today by **Handley, Inc.** manufacturers of precision trimming potentiometers. This is a new addition to Handley's Wee Line, and is a stackable trimming pot. Two to ten may be stacked in a row and firmly held together by a steel bolt and nut.

Because of the unusual configuration, placement and length of the leads, lead screw position (on top), this stacking feature offers above-average accessability and compactness.

The 1W-STK precision wire wound trimmer is different in many respects from other potentiometers, combining an unusual configuration, long leads,



and other design features for greater accuracy and extra rugged construction. It withstands 100 g's acceleration, exceeding MIL-R-19; withstands 50g's shock, exceeding NAS 710, Proc. III; and temperature range is from −55°C to 140°C with 1.3 watts at 40C.

Small worm gear adjustment, free of back lash, delivers high-friction loading. 360° wiper maintains its setting under extreme temperature and vibration excursions. It can be sealed to meet MIL-E-5272A. Inductive reactance is so low that it is not measurable at 100 KC, but it may be measurable at 900 KC.

Circle No. 232 on Subscriber Service Card.

Measuring System Gets Smaller Pressure Balance

The Transducer Division of **Consolidated Electrodynamics Corp.**, has introduced a substantially smaller and

lighter Type 4-332 Precision Pressure Balance for use with its Electromanometer precision pressure measuring system.

The transducer portion of the system, which also includes a standard or high-speed servoamplifier assembly, has been reduced in size from a cylinder 5¼" in diameter and 6 3/8" high, to a compact aluminum case measuring only 4 x 3 x 2½". Weight was reduced from 10.7 to 2.6 lb.

Seven pressure ranges are available from 0 - 1½ to 0 - 150 psi differential. Output of the transducer is ±100 volts full scale. Combined effects of linearity and hysteresis are less than .05%.

The transducer can be down ranged to 10% of its rated pressure without loss of accuracy and still provide ±10 volts at this suppressed range. This makes it usable with lower differential pressure, and also enables the instrument to withstand surges at the 10-times-higher pressure (normal full scale) without damage. It also makes possible pressure measurements as low as .15 psid full scale (10% of the unit having the lowest pressure range). The user can make his own modification between the two ranges.

The new transducer employs one force-summing bellows instead of two. The reference pressure (any clean, dry, non-corrosive gas) is admitted to the inside of the aluminum case to surround the bellows being affected by the inlet pressure.

Circle No. 233 on Subscriber Service Card.

Automatic Switch Device Speeds Satellite Data

A compact electronic automatic switching device that will speed information from missiles and satellites to ground installations has been developed by **Electronic Systems Development Corp.**, a subsidiary of **Solar Aircraft Co.**

The corporation has received a contract for an Air Force evaluation of the electronic static commutator.

The miniaturized switching device consists entirely of compact electronic circuits and has no moving parts. It is capable of operating more than 500 times faster than the less reliable mechanical switches it will replace.

For space exploration the static commutator will consecutively open and close 60 different channels between sensing devices in a missile and the missile's radio transmitter. Signals from these sensing devices, measuring such items as pressure, temperature and radioactivity, are sent in sequence through the transmitter and back to a control station on the ground where the data is recorded for study.

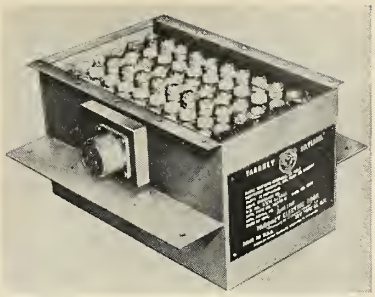
Circle No. 234 on Subscriber Service Card.

New Silvercel Battery For Missiles Announced

Development of the Silvercel Battery 3381R-2 for missile applications has been announced by **Yardney Electric Corp.**

A rechargeable silver-zinc power pack, this 10-amp.-hour unit has a nominal voltage of 28 volts when discharging at 45 amps in 12 minutes. It can also be discharged at 60 amps, or at lower rates. It has a volume of 239 cubic inches and weighs 15 lbs. Its dry shelf life is a minimum of two years.

Designed to meet stringent requirements for missile electric power systems, the new battery has met test specifications of MIL E5272: up to 5 g vibrations; 15 g, 11 milliseconds in all directions mechanical shock; −65°F low



temperature; 160° high temperature; 95% humidity at 160°F; 55,000 feet at 80°F high altitude.

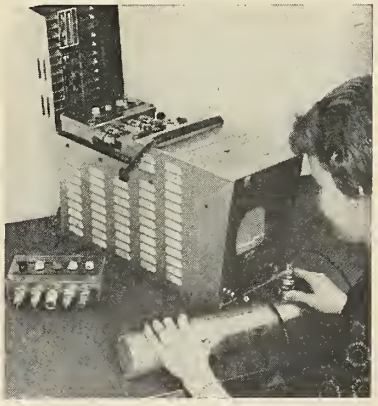
Circle No. 235 on Subscriber Service Card.

Flaw Alarm Devised For Electronic Monitoring

Three new flaw alarms for electronic monitoring are now available as accessories for Sonoray ultrasonic pulse-echo flaw detectors built by **Branson Instruments, Inc.** Test signals which appear within preset limits are detected by the flaw alarm to actuate recorders or warning devices. Also, the alarm signal may be used to initiate corrective action automatically.

A flaw alarm lets the operator pay closer attention to materials under test, instead of constantly having to watch the cathode-ray tube. The Sonoray screen is referred to only when evaluating defects noted by the alarm.

Each new flaw alarm has a single



time gate which is adjustable for position, length, and duration. The alarm may be turned on or off without disturbing work in progress or changing the settings of the Sonoray.

All three flaw alarms have two outputs in common. The first is a red defect-indicator light mounted on the Sonoray front panel. The other is a 5 v dc (no-load) signal fed through a coaxial connector on the back panel, which will trigger audible alarms or

markers, or start corrective action. It can also be used to actuate a simple go/no-go recorder.

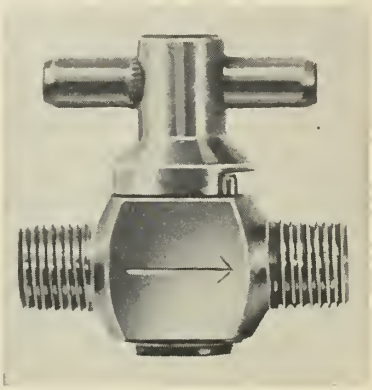
A remote warning light outlet forms part of the indicator light circuit. Remote signals are particularly useful for complex tests requiring the operator's full concentration. For convenience, the remote light can be attached to the test probe itself.

Circle No. 236 on Subscriber Service Card.

Leakproof Valve Uses O-Ring Principle

A miniature leakproof shutoff valve designed for use in vacuum or pressure service is now available from **Circle Seal Products Co., Inc.** The O-ring principle makes the valve leak-proof and easy to operate. The "T" handle is color-coded for gas or liquid service such as oxygen, air, nitrogen, hydraulic fluids, water, oil and many others. Some typical applications include instrumentation, inert gas test stands, hydraulic clamps, and jacks.

The Circle Seal 9500 Series valve features an O-ring on the cylindrical face of the straight plug which prevents leakage past the inlet port as well as the critical stem area. A quick glance at the "T" handle position instantly indicates exact valve position. A quarter turn is all that is required from full open to dead tight close. No spring is



used; no complicated adjustments are necessary.

Repair can be effected without removing valve from the line. O-ring seals are said to virtually eliminate wear. It can be used for metering by turning the handle between full on and off positions.

The 9500 Series valve is available in brass or stainless 303 with either male or female connections in 1/8" or ¼" size.

Circle No. 237 on Subscriber Service Card.

Proportional Counter Detects Thermal Neutrons

A new "Long" type neutron proportional counter for neutron monitoring applications is announced by **The Victoreen Company.**

Designed by Victoreen's Tullamore Laboratories, the Model NC-1 Neutron Proportional Counter detects thermal neutrons by means of a BF3-filled counter.

In fast neutron counting, the instrument is used with either the Model MC-1, a non-directional moderator, or with the Model SMC-1, a shielded directional moderator. Since both moderators are cylindrical in shape, the BF3 counter can be inserted readily. This detector-moderator combination gives the system a relatively flat response over a wide range of neutron energies of from 100 Kev to 5 Mev with the MC-1 unshielded moderator, and from 10 Kev to 5 Mev with the shielded SMC-1 moderator.

The Model NC-1 Neutron Proportional Counter consists of a preamplifier, amplifier-count rate meter, scaler-high voltage supply and thermal neutron detector. The instrument features a pulse-height discriminator circuit to minimize gamma ray response. Since the boron trifluoride detector produces neutron-induced pulses of greater amplitude than those generated by gamma rays, electronic discrimination of pulse heights is very effective. A 10-turn discriminator control is mounted on the amplifier front panel for this purpose.

Cart-mounting of the equipment is suggested for utmost mobility in health physics applications near nuclear reactors and other neutron producing applications.

In experimental applications such as foil transmission of fissionable isotope studies, shielding investigations, etc., the Model NC-1 and moderators can become part of a more permanent laboratory installation.

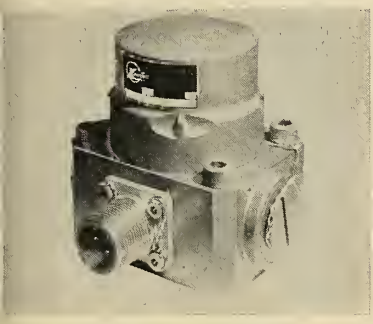
Circle No. 238 on Subscriber Service Card.

Servo Valve Designed For Hydraulic Systems

Kearfott, Inc., a subsidiary of **General Precision Equipment Corp.,** announced the availability of the 6104 electrohydraulic servo valve designed to provide extreme reliability under the most severe environments encountered

in high performance hydraulic systems.

Constructed of titanium, the unit features the exclusive Kearfott development of unity-coupled hydromechanical feedback, which substantially reduces flow force reactions and accomplishes hydraulic centering of pilot position without spring hysteresis and null shift. Springs and mechanical null adjustments Kearfott says, are eliminated completely and high null accuracy is



provided by an electrically operated balancing control. Simply designed to enhance reliability, the valve contains only two moving parts.

The unit is basically a two-stage, four-way flow control valve. An electrical torque motor and "shear seal" orifice hydraulic amplifier constitute the first stage, and an accurately matched spool and sleeve arrangement constitute the second or control stage. The unique feature of the Kearfott design is the hydromechanical unity feedback manner in which the two stages are coupled.

Circle No. 239 on Subscriber Service Card.

New Literature

ALLOY DATA. Two new technical bulletins covering performance data on vacuum induction melted WASPALOY and M-252 superalloys have just been released by Metals Division of the **Kelsey-Hayes Co.** Each bulletin is 8 pages and includes: alloy description and chemical composition, physical constants, tables and charts on mechanical properties, isostress curves, and information on heat treatment and finishing. Both WASPALOY and M-252 are high-temperature, high-stress superalloys produced by the vacuum induction melting process. They are presently being used in missiles, electronic tubes, and process- and nuclear-industry applications.

Circle No. 200 on Subscriber Service Card.

TENSILE TESTORS. A 4-page illustrated booklet, Bulletin T-859, describes a line of tensile-testing machines with capacities up to 40,000 lb. Specifications, descriptions and methods of operation listed for manual and motorized hydraulic models. Procedures for calibrating these units and using them for compression tests are fully covered.

Circle No. 201 on Subscriber Service Card.

CAPACITORS. Four-page data sheets on glass-dielectric wafer capacitors are available from the Electronic Components Department of **Corning Glass Works.** Suited for printed circuit, modular or encapsulated assemblies requiring high reliability, the items are said to be the smallest high stability capacitors currently available. The capacitors are flat. Thus, types without leads can be flat or slot mounted. Because dielectric and conductor layers are sealed together at high temperatures and pressure, they will operate under high heat and humidity environments without further encasing. They meet performance requirements of MIL-C-11272A. Capacitances range from one to 10,000 uuf at 300 DCVW. They have fixed temperature coefficient, high insulation resistance and low dielectric absorption.

Circle No. 202 on Subscriber Service Card.

—when and where—

JANUARY

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

American Management Association, Special Research and Development Conference, Roosevelt Hotel, New York, Jan. 20-22.

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

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

Second Annual Symposium on High Speed Testing sponsored by Plas-Tech Equipment Corp., Somerset Hotel, Boston, Jan. 27.

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

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

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

FEBRUARY

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

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

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

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

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

Missile Industry Conference (National), Sheraton Park Hotel, Washington, D.C., Feb. 16-17.

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

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

—letters—

Asbestos Availability

To the Editor:

Subject: Your 23 November Issue, Page 71.

Any design engineer reading the subject article might naturally assume that "chrysotile asbestos," jewel bearings, and diamond dies are the three most strategic groups of products in short supply today . . .

In order to obtain top level official confirmation of the true situation, I wrote a letter to Mr. H. B. Sharpe, Director of Miscellaneous Metals & Minerals Division of the Business and Defense Services Administration. A photostatic copy of Mr. Sharpe's reply is enclosed. Please note that the national stockpile goal for the purchase of chrysotile asbestos fiber has long since been achieved.

The facts of the situation are these. The present ability of Canadian asbestos mines to provide chrysotile fiber to the U.S. mills far exceeds the consuming capacity of the combined industry. If asbestos textile products are ever again in short supply, it will be occasioned by a temporary lack of adequate manufacturing capacity in this country, not by a shortage of chrysotile asbestos fiber itself . . .

Almost every operational missile today contains one or more parts made from asbestos-phenolic base materials. Asbestos-phenolics are rapidly becoming the most widely used materials to line the combustion chamber of solid-fuel rockets. We certainly do not want to deter design engineers from specifying so useful a material because of a mistaken idea the basic component is in short supply . . .

Mr. J. A. Bettes, Jr.
Manager, Asbestos Textile Division
Raybestos-Manhattan, Inc.

Mr. Sharpe's letter stated in part: "In a recent check of the material it was discovered that a small portion did not meet stockpile specifications. It therefore became necessary to purchase sufficient fibers to replace the non-specification material in order that the stockpile goal be attained." The article in question was necessarily brief and did not elaborate on the situation. Chrysotile asbestos is officially listed by the Office of Civil and Defense Mobilization under "Strategic and Critical Materials for Stockpiling." However, although the government is contracting for a supply for the stockpile, this does not mean it is in short supply throughout the country, a fact which the article may have left unclear. We certainly do not wish to misrepresent the situation.—Ed.

Saturn versus F-1

To the Editor:

Regarding the editorial ("Let the People Know") in the Dec. 28 issue, let me try to help you with the question you pose: *Saturn* is a vehicle. F-1 is an engine.

It so happens that the propulsion system of *Saturn* is in the same thrust class as the F-1.

Therefore, your question "*Saturn* versus F-1" makes little sense. Perhaps you meant to ask why *Saturn* uses a cluster of smaller engines for propulsion system instead of the F-1? This is a sensible question. The answer is well known and has to do with reliability, availability and cost. Besides, the experience will be handy for *Nova*, which is the vehicle to use the clustered F-1 . . .

Harry O. Ruppe
412 McClung Street
Huntsville, Ala.

M/R was comparing the Saturn and the F-1 as boosters, not as entities, and also pointed out the gain of experience in clustering. Otherwise, Reader Ruppe falls into his own word snare. Only the engine for Saturn is available—not Saturn itself. As for reliability and cost—these are debatable factors also.—Ed.

To the Editor:

Regarding your editorial of Dec. 28 as to NASA's reason for both Project *Saturn* and the F-1, as a government Quality Control Representative at Rocketdyne, I feel that you have been misinformed as to the status of the two programs. You state that both boosters will materialize at the same time. This doesn't seem possible when the engines of one booster have completed R&D testing and reliability testing and are now in production, while the other booster is still in the development stage. In addition to lack of funds, slipping in the *Saturn* program may be caused by the second stage *Titan*.

Gordon Drake
10125 Sunland Blvd.,
Sunland, Calif.

Credit Arguello Engineers

To the Editor:

We have noted with interest the article (M/R, Dec. 28) on the Point Arguello facilities for the Pacific Missile Range. The treatment of the data was extensive and the article was quite informative. We hesitate to add what might be considered a discordant note, but it strikes us that there is little, if any, mention of the engineers who strive to bring these facilities into being.

Perhaps you intend to bring attention to this aspect in other articles. Engineers are prone to let their "works" speak for themselves. Accordingly, they go unsung more often than not. I consider that the engineers concerned, however, should merit recognition even if only by an occasional mention. You will, I am sure, recognize that this is only asking for their due.

P. Corradi
Captain, CEC, USN
Deputy Chief of Bureau
of Yards and Docks
Washington, D.C.

missile business . . .

By WILLIAM E. HOWARD

Congress is setting up what amounts to a unified complaint department to handle criticism of DOD procurement and supply procedures. A new procurement subcommittee of the Joint Economic Committee will assume this function when it opens public hearings on Jan. 28.

Among the first critics to be heard . . .

will be Sen. Jacob Javits (R-N.Y.) who is protesting the concentration of defense contracts in California. Javits is backing legislation to beef up New York's dwindling share of DOD work.

Committee Chairman Paul Douglas (D-Ill.) is expected to revive his long-standing complaints about loose purchasing procedures turned up periodically by the Government Accounting Office. Douglas says the upcoming inquiry will shy away from questions involving military strategy and weapons and deal mostly with budgetary and economic issues.

In the financial limelight . . .

Atlantic Research Corp., Alexandria, Va., reveals that it has sold 25,000 shares of its common stock to the **Axe Science and Electronics Fund** for $1 million. This is about $5 per share under the current (over-the-counter) market price. ARC, founded on a shoestring about 10 years ago, is now a $10 million-a-year enterprise in the rocket propulsion field. In the past four months it has bought up four smaller companies in the Washington area.

The Marquardt Corp. stock has just been listed . . .

for trading on the New York Stock Exchange. The big ramjet engine producer has 1.3 million shares outstanding.

Look for a pick up in General Dynamics Corp. earnings...

This is the word from company president Frank Pace, Jr., who says G-D is on "the threshold of a growth potential that we have not had in the past."

Pace won't predict exactly how much earnings will rise in the 1960's. But he says they will reflect reduced expendtiures on R&D—particularly for the Convair 880 and 600 transports which are already largely written off. The Convair Division of G-D, incidentally, has just revealed it paid out more than one half billion dollars in wages during 1959. The breakdown: San Diego—$271 million; Fort Worth—$137 million, and Pomona—$39 million. Convair expects employment to drop from 40,900 at San Diego to 36,000 this year and from 18,500 to 16,000 at Fort Worth. Ponoma will remain at 6000.

Latest prediction for a record-breaking year . . .

in the electronics industry comes from the Business and Defense Services Administration. The 1960 forecast: $10 billion. BSDA says the military electronics share of this total—up 17% in 1959—"should continue upward in 1960 at the rate of better than 15%."

IBM has established a missile/aircraft marketing . . .

and service district for Southern California. The company's new setup consists of offices at Burbank, Inglewood, Westchester and San Diego, Calif., and Phoenix, Ariz.

Space Technology Laboratories is moving into a 40-acre complex of eight buildings at El Segundo, Calif.

The Air Force is getting ready to build . . .

a $6.6-million laboratory at Wright Air Development Division, Dayton, Ohio, to determine sonic fatigue rates of large structural components of missiles and aircraft. System will utilize 25 sirens run by a 40,000 hp electric motor. Bids are expected to be let next fall.

propulsion engineering . . .

By JAY HOLMES

Ladish Co. has patented D6 steel . . .

after 14 years of company secrecy. The die steel contains about 1% molybdenum, 1% chromium, ½% nickel, ¾% manganese and traces of carbon, phosphorus, sulfur and silicon. Ladish kept the formula secret to prevent competitors from using the steel for forging dies.

Now, however, D6 is in wide use as a material for rocket cases. **Allison Division** of **General Motors, Solar Aircraft** and **Pratt & Whitney** all are making development first-stage 65″ *Minuteman* cases of D6. Allison is using it on the 44″ second stage and Solar is using it for the 38″ third stage.

Ladish claims D6 can be heat treated to practical use as a rocket case material up to more than 250,000 psi for a 0.2% elongation when consumable vacuum arc melted.

Metallurgical test facilities . . .

and personnel have been increased at **Thiokol's** Utah development center. The company wants to exercise closer control and supervision over rocket case manufacturing, now that *Minuteman* is getting closer to production.

Electron beam welding is a process that interests Thiokol metallurgists. Tests of the technique are planned with all major missile metals, to see whether the process can completely eliminate weld weakness. If so, Thiokol is toying with the idea of electron-beam welding cases on the long seam to avoid the cost of forged rings or spinning processes.

Differing specifications . . .

for essentially the same metal are causing headaches among metal suppliers. One supplier has been given 100 steel specifications for common steels. Every missile metallurgist has his own specification for AISI 4340; there are almost as many for AISI 4140.

Some in industry think this is a terrific waste. They say that Germany fought World War II with five steels. Designers specified metal properties instead of composition. It was up to the supplier to provide a metal that would meet the specifications.

Their argument is that this is just one more area where inefficient practices run the cost of missiles far out of proportion. It also adds to the amount of study suppliers must make in bidding on metal subcontracts—which the government of course pays for in the end.

The sheer number of suppliers bidding on a given job is another factor. One shop recently quoted prices on a forging to 27 different companies—and then didn't get the job. The reason for this is the number of possible suppliers increases geometrically as the degree of subcontracting is increased. A prime may ask bids of three or more propulsion companies on a solid-propellant job. Each of these may ask bids from a dozen casemakers. And each of the casemakers goes to several metal suppliers.

Thus the supplier at the end of the line spends half of his time bidding on jobs he never expects to get. He doesn't dare refuse, lest he offend the potential customer, who may come up with a job next month that he has a good chance of winning.

Quoting would be simple . . .

if everyone's specifications were exactly the same. Figure it once and then quote the same price to everyone. But by the time they come down to the metal supplier, the specifications aren't exactly the same. Each fellow in the middle wants to put his own trademark on the job.

More Big Missile Firms Likely to Merge

by G. V. E. Thompson

LONDON—Britain's major missile companies are expected to complete a series of mergers under pressure from the U.K. government, which has repeatedly emphasized its view that there is room for only two or three firms in the nation's missile/aircraft industry.

Because it controls spending by both the military and the nationalised air lines, the government can ensure that its desires are followed.

Last week, **Vickers Armstrong, English Electric** and **Bristol** announced they will amalgamate their aircraft and missile divisions. English Electric and Vickers Armstrong will each hold 40% of the shares, and Bristol Aeroplane Co., Ltd., 20%.

One of the firms expected to remain after the wave of mergers is the **Hawker Siddeley** group. Earlier in 1959, Hawker Siddeley swallowed up **Folland Aircraft**; within the past month, it has made share exchange offers for both the **Blackburn** group and **de Havilland.** Both the latter offers are likely to be accepted.

Blackburn capital was valued at over $10 million, and in this case the offer was an issue of 2,750,000 Ordinary Hawker Siddeley shares. To de Havilland, the Hawker Siddeley group offered one of its Ordinary for each de Havilland Ordinary, and three Hawker Siddeley 5½% Preference plus $2.80 in cash for every four de Havilland 5¼% Preference, which is considered generous (last year de Havilland made a loss and paid no dividend).

The Hawker group also is connected with the Bristol engine group (through **Bristol Siddeley**), and with **Fairey** and **Hunting Aircraft** (through **Airco**).

Other mergers are likely to follow; government pressure and the need to measure up to the Hawker group will force this upon the remaining firms.

• **Jodrell's future role uncertain**—It is uncertain whether Jodrell Bank—at present the world's largest radio telescope—will be kept available for satellite and space probe tracking after it is completely paid for.

Prof. A. B. Lovell, who is in charge of the telescope, has made no secret of the fact that he regards such tracking as an intrusion upon the regular work of his department. This is despite the fact that the owners of the telescope (Manchester University) have taken payments from U.S. organizations for the tracking work, in an effort to raise money to pay for the capital cost of the telescope. These groups, and other users, have been required to contribute to the capital cost as well as to the direct cost of using the facility for their particular project. Contributions paid during December are expected to total $55,000.

Jodrell Bank is still in the red, in spite of these contributions and additional government grants and subscriptions from industry, scientific organizations and individuals amounting to more than $180,000 during the last year. Modifications and construction delays greatly increased the initial cost, and the University has still to find about $170,000 out of the full capital cost of $2.1 million.

Prof. Lovell's attitude comes also despite the prestige which his association with satellite and probe tracking has given him in the eyes of the public. It is an attitude symptomatic of the view too prevalent among top British scientists—that pure science is superior to technology.

So, the Jodrell Bank telescope may or may not be placed at the disposal of space research teams when its capital cost has been raised completely. In any event, still larger telescopes are being built in both the U.S.A. and U.S.S.R.

• **New missile gyro developed**—**De Havilland Propellers Ltd.** have designed a gyro for use where compactness, low weight and reliability are important—as in missile instrument packs. The MG 300 miniature rate gyro is hermetically sealed and consists of rotor, spring and pick-off. Driven by a 24,000 rpm synchronous hysteresis motor, the rotor has a high polar/diametral moment of inertial ratio; the angular momentum is 9.6 x 10^4g.cm.^{2}/sec. Stiff in all planes, the spring allows rotation about its axis, and the pick-off armature is riveted to its end-plate. Normally energized by 2.4Kc, 80 V (mean) current, the pick-off takes 55mA.

• **Anglo-German joint rocket work**—The U.K. and West German governments have agreed to cooperate in research and manufacture of arms. The agreement, following meetings of Mr. Watkinson and Herr Strauss, defense ministers of the two countries, will include German participation in further development of *Blue Water*, the British ground-to-ground artillery rocket.

Blue Water is designed to be fitted with a nuclear warhead; it will have a range of about 100 miles and a maximum speed of 2000 mph. **English Electric** will manufacture it, but it is apparently still at the drawing board stage. German technicians will thus be associated with its development from an early stage. If it proves successful, both countries are expected to recommend its adoption by NATO.

• **Disquiet over German rearmament**—The opposition Labour Party, meanwhile, is uneasy over the supply to the Bundeswehr of missiles of nuclear capacity. Apart from the future development of *Blue Water*, Germany is to receive several U.S. missiles, including *Nike-Ajax, Nike-Hercules, Honest John, Matador* and *Mace*. The *Sidewinder* and *Hawk* are to be produced jointly by Germany, Belgium, France, Holland and Italy. The *SS.10, SS.11* and *Cobra* anti-tank missiles are to be produced jointly by France and Germany. Particular disquiet is being expressed over *Mace*, which would provide the Germans with the means of landing nuclear warheads within 100 miles of Moscow.

• **Woomera developments**—Recent launching of three *Skylark* research rockets within 24 hours was the fastest rate of firing yet achieved. The first rocket was used for sodium vapour experiments at altitudes of more than 40 miles, to yield data on upper atmosphere temperatures and wind structure. The second ejected grenades at regular intervals and also fired metal foil, to give two independent estimates of wind distribution. The third repeated these experiments and also measured electron densities in the ionosphere. All three firings were successful and heights of 90-100 miles were reached.

Neil A. Marshall: appointed chief engineer of Leach Corp.'s special products division, producer of components and systems for air and space vehicles. Was formerly chief engineer of the special products systems department and acting chief engineer of the instruments department.


MARSHALL

Previous position: systems engineer on the *Polaris* project at Lockheed's Missile and Space Division.

A. Clyde Flackbert: named manager of administration for tactical weapon systems operations at Aeronutronic division of Ford Motor Co.


FLACKBERT

Prior to joining the division, was one of three managers at the Airborne Instruments Laboratory division of Cutler - Hammer. Also did system reliability engineering and analysis at The Martin Co., where he was chief engineer for reliability for the *Titan* ICBM, and at American Bosch Arma, where he supervised work on ICBM inertial guidance system.

Alfred A. Crivelle: appointed chief microwave engineer at John Gombos Co., Inc., to lead research and development of microwave components.

Was formerly manager of the microwave section of ACF Industries' Avion division, responsible for design and development of microwave products.

A. M. "Rocky" Rochlen, director of public relations and vice president of Douglas Aircraft Co., retires after 23 years.


ROCHLEN

A veteran newsman prior to joining Douglas, he will continue to be a consultant to the company.

Richard J. Davis, currently Washington public relations representative, becomes director of public relations. Davis joined Douglas in 1958 after 18 years with *Newsweek*.

Howard P. Maginniss, currently assistant to the vice president-public relations, will replace Davis in Washington.

Leslie D. Catlin: named director of management services and **David Y. Keim,** director of engineering, for Stromberg-Carlson's Electronics Division.

Catlin, who joined the company in 1956 as an engineering staff assistant to the general manager, will supervise plant engineering and value engineering activities, and direct organization of a new management engineering section.

Keim will administer design and development engineering work. He joined the firm in March, 1959, as chief engineer of military products in the Electronics division.

Dr. Theodor F. Hueter: elected manager of Minneapolis-Honeywell Regulator Co.'s Seattle Development Laboratory, responsible for work on sonar, underwater ordnance devices and systems, radar and communications.


HUETER

Formerly manager of the acoustics department of Raytheon-Submarine Signal Division, and prior to that, research associate with the physics department of MIT.

Succeeds **Roy A. Malm,** who has left the company.

Dr. J. Robert Downing: named president of Space Recovery Systems, Inc., succeeding **Augustus J. Steinthal,** who will continue as a member of the board of directors.


DOWNING

Dr. Downing earlier served as director of Cook Electric Co.'s research and development division, was responsible for development of recovery systems used in the *Jupiter-C* nose cone, including the one which contained Able and Baker.

Col. Thomas W. Cooke: designated chief of staff, Army Ordnance Missile Command, succeeding **Col. John G. Zierdt.** Col. Zierdt becomes deputy commander, Army Rocket and Guided Missile Agency, in charge of anti-missile and space defense programs including *Nike Zeus*.

Bernhard A. Hohmann: senior staff member and chief, aeromechanical section, *Atlas* weapon system at Space Technology Laboratories, Inc.: appointed project engineer for the *Atlas/Mercury* program.

Before joining STL, Hohmann was chief, flight development section at WADC.

Martin John Timmons and **Merl Watchke:** join the engineering staff of FluiDyne Engineering Corp., assigned to development and instrumentation projects connected with high-altitude simulation chambers, rocket motor test facilities and shock tubes.

The following appointments have also been announced:

Kenneth G. Farrar: named vice president in charge of manufacturing for Douglas Aircraft Co., succeeding **Frederic W. Conant,** who has retired.

Dr. Lloyd T. DeVore: succeeds **Richard A. Maher** as director of engineering at the Laboratories Division of Hoffman Electronics Corp.

Donald A. Bewkes: elected manager of production planning and customer service at Tung-Sol Electric, Inc.

H. William Thomas: formerly manager of the industrial and aviation departments, project development division of Ralph M. Parsons Co., joins the Astronautics Division of Chance Vought Aircraft, Inc., as market development manager.

Charles R. Rowe: named general manager of the newly created West Coast division of Oak Mfg. Co.

Dr. Erwin O. A. Naumann: former chief of advanced studies, elected manager of development in the R&D engineering division at Solar Aircraft Co.

Jackson S. Kolp: former manager of commercial engineering, appointed product line manager-germanium switching transistors for the Semiconductor division of Sylvania Electric Products, Inc.

Lincoln Van Camp: named vice president-production at Wyle Manufacturing Corp.

Forbes Morse: president of Electro-Mec Laboratory, Inc., elected a director of the Waltham Precision Instrument Co.

Alfred Schall, Jr.: formerly with Aerojet-General Corp., elected executive vice president and general manager of The Allegheny Instrument Co.

Dr. Robert W. Cairns: director of research for Hercules Powder Co., named a member of the board of directors.

Dr. Earl A. Weilmuenster: former director of fuels research of the energy division of Olin Mathieson Chemical Corp., joins the technical staff of the United Research Corporation of Menlo Park as assistant manager of propellant development.

contracts

NASA

$47,533—Ampex Corp., Birmingham, Mich., for magnetic tape recording system for Lewis Research Center, Cleveland.

ACF Industries, Inc., Avion Division, received a contract for engineering, laboratory and model shop work associated with printed circuit electronics. Amount not disclosed.

MISCELLANEOUS

$500,000—Automation Products, Inc., for electronic systems engineering and electronic cabling.

NAVY

$1,600,000—Allen B. DuMont Laboratories, Inc., Clifton, N.J., for the production of telemetry equipment and associated test equipment for the *Talos* missile. Subcontract from Bendix Products Division-Missiles.

ARMY

$5,816,800—Western Electric Co., for research and development of the *Nike-Hercules*.

$4,552,402—Douglas Aircraft Co., for repair and missile parts for *Nike-Hercules*. (Two contracts.)

$2,491,644—Sperry Rand Corp., Salt Lake City, Utah, for research and development on the *Sergeant* missile system.

$2,350,214—Raytheon Co., Waltham, Mass., for *Hawk* missile field maintenance equipment.

$1,249,500—RCA, Moorestown, N.J., for research and development on the down range anti-missile program.

$1,148,263—Swanson & Youngdale Construction Co., Minneapolis, for construction of guided missile assembly building and warehouse at Fairchild AFB.

$500,000—Chrysler Corp., Detroit, for *Jupiter* program.

$314,332—Machlett Laboratories, Inc., Springdale, Conn., for electron tubes.

$239,192—Raytheon Co., Andover, Mass., for replenishment repair parts for *Hawk* missile system.

$118,353—Nichols-Sonthern Div., Yuba Consolidated Indnstries, Inc., Baton Rouge, La., for construction of umbilical tower for *Saturn*, Patrick AFB.

$85,480—Raytheon Co., for repair parts for *Hawk* missile system.

$64,887—Douglas Aircraft Co., Santa Monica, Calif., for *Nike-Hercules* launching equipment.

$62,283—AiResearch Mfg. Co., Los Angeles, for *Nike-Hercules* replenishment repair parts.

$44,378—Research Institnte of Temple University, Philadelphia, for test of aerodynamic heating.

$25,500—University of Pittsbnrgh, for research and development on "Electron Density Distribution in Semi-Conductors".

AIR FORCE

$500,000—Weston Instruments div. of Daystrom, Inc., for bearing distance heading indicators.

$150,008—Big Three Welding Snpply Co., Fort Worth, for oxygen.

$102,060—Marks Oxygen Co., Inc., Augusta, Ga., for oxygen.

$100,445—Johns Hopkins University, for basic research on "New Particle Interactions and Properties".

$98,957—Cornell Aeronautical Laboratory, Inc., for research entitled "Molecular Interactions at High Temperatures".

$80,000—North American Aviation, Inc., Missile Div., Downey, Calif., for installation, checkout and testing of *GAM-77* ground support equipment.

$73,195—University of Rochester, for basic research entitled "Primary Cosmic Radiation and Interaction".

$70,852—Aerojet-General Corp., Azusa, Calif., for research entitled "Ultra-Energy Fuels for Rocket Propulsion".

$57,018—University of Maryland, for research entitled "Mathematics of Fluid Dynamics & Elasticity".

$53,766—University of Syracnse, for research entitled "Quantum Field Theory & Elementary Particles".

$52,120—Cornell Aeronantical Laboratory, Inc., for research entitled "Nonequilibrium Flows".

$49,958—Massachusetts Institute of Technology, for research on "Mechanical Behavior of Metal Composites".

$48,576—Cornell Aeronautical Laboratory, Inc., research in "Boundary Layers in High-Temperature Gas Flows".

$40,049—Duke University, for research on "Psychophysiological Mechanisms of Stress".

$39,600—Boeing Airplane Co., Pilotless Aircraft Div., for data in support of *IM99Z* missile.

$33,980—University of Pennsylvania, for research re "Scattering and Polarization of Electrons".

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

$32,530—Yale University, for research re "Mechanical Properties of Intermetallics".

$31,460—Case Institute of Technology, for research entitled "Phthalocyanine Polymers".

$29,800—Northrop Corp., Norair Div., for data in support of SM62A missile.

$29,079—Texas Tech. College, for research entitled "Kinetics and Mechanism of Coordination Compounds".

A-C Power Produced By Direct Energy Conversion

SAN DIEGO, CALIF.—The direct conversion of heat into alternating current electricity in significant amounts—without use of rotating machinery or dc-ac converter—has been reported by scientists of **General Dynamics Corporation's General Atomic Division.** A high-temperature cesium cell converter was used in the successful experiments which produced sufficient alternating current to illuminate a series of small light bulbs. Frequencies generated were in the range of 100 kc.

In the cesium cell, a metal plate is heated white hot. The electrons boiled out of the hot plate, or emitter (the "Edison effect"), are collected on an adjacent cold plate, or collector. The hot and cold plates act as the poles of a battery, delivering current to electronic wires for distribution. Part of the heat put into the hot plate is converted directly into electric current.

AN ANNOUNCEMENT OF BROAD SIGNIFICANCE TO

CHEMISTS, ENGINEERS & PHYSICISTS

WITH SPECIAL KNOWLEDGE OF SOLID FUEL & COMPONENT R&D

AMCEL
PROPULSION INC.
A New Subsidiary of
Celanese Corporation of America

NOW FORMING RESEARCH & DEVELOPMENT GROUPS TO INVESTIGATE PROPELLANTS & PROPULSION DEVICES

AMCEL is uniquely qualified to advance high energy fuel technology. It can draw upon Celanese's 35 years of research experience in organic chemicals, polymers and plastics. Years of experience in nitration techniques, organic chemicals and polymers provide a solid basis for growth in this field.

Initial research and development effort at AMCEL will be on solid fuel, fuel components and design of improved thrust chambers. Later, complete propulsion systems, auxiliary power units and related projects will be added to the roster.

The 1300-acre site includes a missile and rocket test-firing range, fully equipped manufacturing and assembly facilities and laboratory. The location (2300 feet above sea level), on the outskirts of the famous Asheville, North Carolina resort, offers professional people an opportunity to live in an exhilarating climate amid glorious scenery (half way between the Great Smokies and the Blue Ridge Mountains) where educational, cultural and recreational facilities are available far beyond the usual "small city" calibre.

Opportunities are now available to qualified engineers and scientists to become "founder members" and to initiate programs in the propellant field. Your inquiries are invited. Please address Mr. E. O. Whitman.

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Human Factors Scientists and Engineers

THE MAN-MACHINE INTERFACE ...a broad systems challenge at General Electric's Ordnance Department

The growing sophistication and complexity of such weapon systems as the Talos, Mk. 44 Torpedo and Polaris require that engineering design must consider the parameters imposed by man's abilities, reactions and motivations. Utilizing existing knowledge drawn from such fields as psychology, physiology, anthropology and medicine, Ordnance Department Human Factors Scientists have the responsibility of optimizing machine effectiveness and system operation by ensuring the compatibility and integration of the many and varied man-machine interactions and interdependencies.

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beyond man's first flight into the space environment are being designed and developed at REPUBLIC AVIATION

One day in the not too distant future man will be projected into orbit and will return to earth safely. Monumental as this exploit will be, the inevitable question will then arise: "What next?"

It is the "what next" that is being answered *today* at Republic Aviation where research and development is focused on the future. A short orbital flight or a brief landing on the moon will never satisfy man's curiosity or his needs. Space must be further explored and its secrets more fully understood so that some day man can freely traverse its vast distances.

Republic Aviation is proud of the part it is playing to make man's greatest adventure successful. Here every aspect of the space technology is under active investigation. A few of the challenging programs now underway include:

- Unique guidance systems for manned space vehicles
- Plasma and nuclear propulsion systems
- Space vehicle materials and processing techniques
- Control systems that remain efficient at temperatures in excess of 1500°F
- Studies in low-pressure plant growth for lunar base application
- Hyper-accurate space vehicle trajectory studies

All of these programs — and many others — are being substantially augmented with a view toward the early occupancy of Republic's new $14 million Research and Development Center.

Senior engineers or scientists with superior skills and a desire to pioneer in research so that man may pioneer in space are invited to inquire about positions in these important areas:

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REPUBLIC AVIATION

Farmingdale, Long Island, New York

PMR—One Battle We Don't Need

As if the nation's space program weren't weird and wonderful enough, we are now being treated to a new spectacular—the Battle of the Pacific Missile Range. (see p. 11).

It could probably be termed a limited war, contained within the Pentagon and a small West Coast area, and it alternately rages and smoulders between the Air Force and Navy. It would be ridiculous if it weren't for the fact that it is costing the government a lot of money—and could cost much, much more. Also, it demonstrates anew two facts:

- The Department of Defense's frequent delays and failure in clearly defining the roles and missions of the Services;
- The failure of the Services to abide by those rules even when they are laid down. This has been described by one high ranking Defense official as "almost complete lack of discipline among top military officers."

The situation has been detailed in a recent M/R series and in the lead story of this issue. The Senate Space Committee, already investigating the Air Force-Navy struggle over the PMR, will go more deeply into the matter at public hearings within the next few months. It is likely that other congressional committees will also hear PMR witnesses.

The situation at the Pacific Missile Range is roughly this:

The Defense Department has given the Air Force the primary military space mission, including control (and assembly integration) of all military space boosters. To the Navy, DOD gave the mission of operating the Pacific Missile Range.

On the surface this seems simple enough. The Air Force has Vandenberg AFB, with its training, operation and experimental launching pads for various missiles and boosters. Adjacent to Vandenberg, the Navy has Point Arguello, which supplies all basic range facilities. These include the normal tracking along a far-flung downrange course, and the usual supplies and services.

What has evolved, however, is a disgraceful and unpretty squabble between the two services.

The Navy is building two launch pads on Arguello (*Samos* pads for the AF on ARPA orders), and has plans for more. The Navy also has plans for a host of other structures on Point Arguello to eventually turn it into a $4-billion space installation—which the Navy says it needs.

The Air Force is prepared to tell Congress that the facilities the Navy proposes simply duplicate those on Vandenberg, that the Navy is actually setting up a duplicating military space program, and that it has even established a special office in the Pentagon for this purpose—"Ops 54," which is reminescent of the old "Ops 23" of the bitter B-36 fight.

It is not our purpose here to take sides. The Navy may be right—or the Air Force. But if the facts are as they indicate, and there is a vast duplication of effort and money in the Battle of the PMR—then someone must make a decision and impose sufficient discipline to make that decision stick. The Defense Department hasn't been willing or able in the past, so we suspect it will be up to Congress. We would like to see the whole silly affair aired, and the resolution of what seems to be a potentially very expensive situation.

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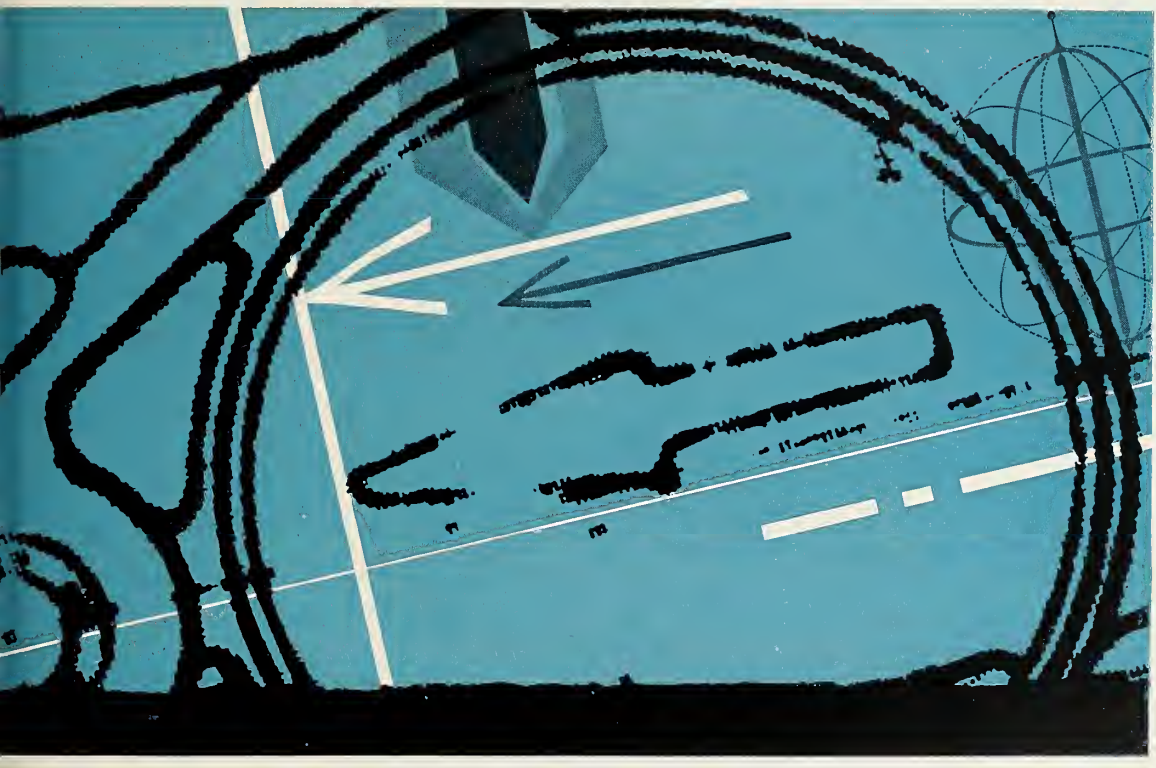

AC Seeks and Solves the Significant—AC Design and Development is moving far ahead in new technology—the result of GM's commitment to make ever larger contributions to the defense establishment. AC plans to resolve problems even more advanced than AChiever inertial guidance for Titan / This is AC QUESTMANSHIP. It's a scientific quest for the development of significant new components and systems . . . to advance AC's many projects in guidance, navigation, control and detection / Dr. James H. Bell, AC's Director of Navigation and Guidance, sees this as a "creative challenge". His group takes new concepts and designs them into producible hardware having performance, reliability and long life. He strongly supports the fact that an AC future offers scientists and engineers "a great opportunity to progress with a successful and aggressive organization" / If you have a B.S., M.S., or Ph.D. in the electronics, scientific, electrical or mechanical fields, plus related experience, you may qualify for our specially selected staff. If you are a "Seeker and Solver", write the Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, Box 746, South Milwaukee, Wisconsin.

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