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Space TECHNICAL INFORMATION DIGEST

SPACE SYSTEMS INFORMATION BRANCH, GEORGE C. MARSHALL SPACE FLIGHT CENTER

March 4, 1963 Vol. 4 No. 9

IN THIS ISSUE

UNIVERSITY USES GUN FOR SPACE LAUNCHES.

In what was claimed to be the first launching of a high altitude probe by using a gun,.a 210-kg (475-lb) weather capsule was shot almost vertically 24 km (15 mi) into the atmosphere. The 406-mm (16-in.) U. S. Navy gun had been converted for use as a space probe launcher for a research team at McGill University in Canada. (See also STID, Vol. 3, No. 36).

The instrumented payload, launched on January 26, 1962, was aloft for about 3 min; it fell into the sea 14.4 km (9 mi) SE of the launch site (near Barbados, W. Indies). Telemetry was received by ground stations on upper atmosphere data; cameras along the island's coast recorded the flight. No effort was made to recover the capsule from the sea.

The first launching of a seven-shot series, the launching was preceded by one test firing that lofted a 320-kg (700-lb) wooden projectile to an altitude of 3.2 km (2 mi). University researchers hope eventually to achieve space probe heights up to 960 km (600 mi). (Source: The Evening Star (Washington, D. C.), January 28, 1962)

NEW ANTENNA RANGE DESCRIBED. A new outdoor antenna test range at General Dynamics (Pomona) makes possible angular interferometric measurements accurate to within 5 sec. Outstanding features of the new range are extremely accurate angle measurements, stability provided by a reinforced concrete tower, and maximum isolation through use of a new all-weather absorption material. Main function of the new range (Fig. 1) will be the testing of missile antennas. However, the range can also be used for subsystem evaluations and checking dark room test results. Range distance is 10 m (32 ft); range height is 5 m (16.25 ft).

The tower, a square silo of reinforced concrete, provides rigid support for rotating hardware and test specimens. Coupled directly to the rotating shaft in the tower is a Davidson Spectrometer, an optical precision angle reading instrument providing accuracy to 1 sec of arc. Antibacklash provisions minimize slack in the system.

The illuminator is a 46-cm (18-in.) diameter parabolic dish with coaxial feed. Vertical beams, which serve as support and track, provide vertical adjustment for the illuminator carriage. Rigid support of the beam structure is provided by cross bracing.

A new rf absorption material, developed by B. F. Goodrich, was "weatherized" for the outdoor installation. Several spray coats of a special vinyl formation were applied before the surfaces were dipped. The absorption material was applied to tower surfaces facing the illuminator, support fixture, and parking lot fence behind the antenna tower (Fig. 1). Another absorption material covers the top of the antenna tower.

The effectiveness of the rf absorber has been found to exceed noise level near 60 db at normal incidence and has been measured to be greater than 40 db at an angle of 65 deg from normal incidence. Evaluation at the company has confirmed these results assuming a 10-db downward slope per octave of frequency. (Source: Data supplied by General Dynamics/Pomona)

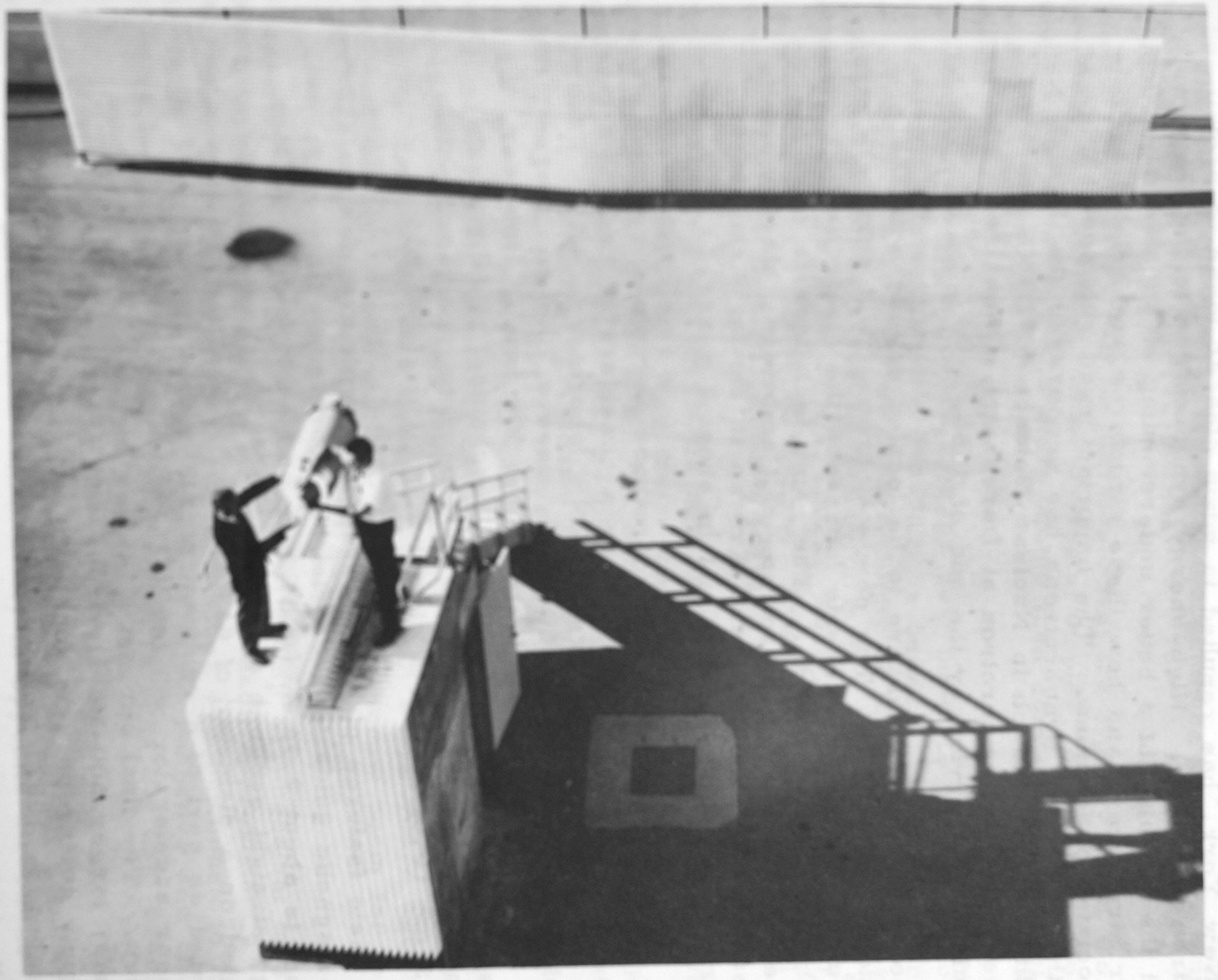

FIG. 1

PHYSICISTS PLAN 4-GEV ELECTRON SYNCHROTRON.

Work with the electron linear accelerator at Stanford University in California and with the electron synchrotron at Cornell University in New York, has resulted in much clearer ideas of proton and neutron structure. High-energy synchrotrons in the Gev range hold the promise of a better understanding of subatomic particles, their structures, and how these structures are related to their associated phenomena. The important research possibilities afforded by these electron synchrotrons has encouraged the British National Institute for Research in Nuclear Science (NIRNS) to build a 4-Gev electron synchrotron at Daresbury, Cheshire. The facility should be in service by the end of 1966.

Associated laboratories are to be located on-site with the new particle accelerator. The new synchrotron will employ a strong "focusing magnet" that exerts forces on the electrons to keep them on their appointed rounds. The same technique is used for the three other similar synchrotrons at Cambridge, Massachusetts (operational), Hamburg, and Erevan in Soviet Armenia (the latter two are to be operational in about 2 years).

The magnet used in these synchrotrons permits a reduced electron-path aperture, and hence permits a considerable reduction in size. For a comparison, the first NIRNS laboratory, with a linear accelerator (operational, 50 Mev), uses a 7000-ton magnet; their new facility's magnet will weigh about 500 tons. However, the newer device is very sensitive to mechanical misalignments: The magnets that provide the guide field must be positioned within 0.025 cm (0.01 in.) in a diameter of 61 m (200 ft).

The basic features of the 4-Gev synchrotron are now established. The magnetic guide field consists of 40 magnets in a ring; each magnet is about 2.75 m (9 ft) long and each weighs 10 tons. Long, straight sections about 3-m (10 ft) long separate the magnets. Erected on a diameter of 61 m (200 ft), the magnet as a whole is operated as part of a resonant circuit with a frequency of 50 cps. A linear accelerator will inject electrons with an energy of about 40 Mev. The final current of 4-Gev electrons will be about 5 μ amp; larger 500-Mc klystrons will probably be used for the rf supply during particle acceleration. (Source: New Scientist, November 8, 1962)

RING LASER ACTS AS GUIDANCE DEVICE. A new closed-circuit laser that emits contrarotating beams of light around a square "ring" to measure changes in direction may soon compete with the gyroscope as an automatic guidance device for ships, planes, missiles and space vehicles.

Called a "ring laser" by its developers at the Sperry Rand Corp., the device may make guidance systems simpler, cheaper to produce, more sensitive, and more stable than conventional inertial gyroscopes.

Company scientists explained that the new laser is not a gyroscope, but a device whose sensing capability is based on a different physical principle: that of the constant velocity of light. This constant value gives the ring laser its sense of motion. This is unlike a gyroscope that depends on the slower rotation of a small, machine-made wheel for its sense of motion. Even the best mechanical gyros are prone to slight errors (drift).

The unique new laser requires neither bearings nor other moving mechanical parts, which are major drawbacks of conventional inertial guidance instruments. In addition, a gyro's rotating wheel is pulled both by gravity and by changes in the speed of the guided vehicle. The laser's light beams are immune to both forces, according to the company.

The company also claims that this is the first time that the coherence of a laser beam has been fully exploited. Most development work since the first laser was demonstrated about 2-1/2 years ago has emphasized only its intense light output and narrow beam for long-range radars, communications, surgery and welding.

Presently, the new laser setup is a table-top arrangement of 4 0.9-m (3-ft) long helium-neon gas tubes, each approximately 1.27 cm (0.5 in.) in diameter. The tubes are positioned to form the sides of a square. Four mirrors, three reflective and one partially transparent, are at the corners to bend the light beams around the ring.

In operation the laser produces two light beams at the same frequency. The beams rotate continuously in opposite directions around the ring. At one corner the two beams are picked off through the partially transparent mirror and fed into a light-sensing device called a photodetector.

If the turntable (representing a space vehicle) is not rotating relative to the stars, the photodetector "sees" no difference in frequency between the two light beams. But the slightest rotation of the vehicle will cause one beam to travel slightly farther than the other around the ring to close the circuit. The frequency of the two beams therefore will vary slightly, with the difference being proportional to the rate of rotation.

This difference, actually a measurement of rate, may then be used to redirect the orientation of the vehicle to maintain its correct flight path. The laser will also measure the angular displacement of the vehicle with a compass accuracy equal to 0.015 deg. Sperry scientists explained that the ultimate aim of these experiments is the attainment of what gyro specialists would call perfect stability, or "zero drift." (Source: Data supplied by Sperry Rand Corp)

NAVIGATION SATELLITES DISCUSSED. As presently planned, Navy's satellite navigation system will utilize four satellites in a polar orbit at an altitude of 964 km (600 mi). A network of ground stations will track the satellites and transmit Doppler-time information to a computer. The orbit of each satellite will be calculated by the computer with predictions for at lease 12 hr in advance.

The satellites will store orbital elements transmitted to them from Earth once every 12 hr. These orbital elements and timing information will then be transmitted back to Earth by the satellite every 2 min.

Relative motion between the satellite and the receiving station produces an apparent frequency shift (Doppler effect) in the signal from the ultra-stable transmitter in the satellite. Latitude can be determined from this information and the time that the Doppler frequency passes through zero. Longitude can be calculated by the rate of change of the Doppler frequency. For instance, the nearer a receiver is to the orbital trace on the Earth, the greater is the rate of change.

Although the ellipticity of the satellite's orbit and the shape of the Earth slightly affect these measurements, these small differences can be determined with a sufficiently sensitive receiver and a precise knowledge of the satellite's orbit. An averaging process of several measurements can be made to overcome fading and noise effects.

Another problem, ionospheric refraction, is corrected for by having the satellite transmit on two frequencies with an integral relation. To a first order approximation, refraction is inversely proportional to the frequency of the transmitted signal. By combining the two separate but integral frequencies from the satellite in inverse proportion to the frequency, the ground receiver gives a single true frequency (vacuum Doppler frequency). (Source: Westinghouse Engineer, January, 1963)

GIMBALLED NOZZLE OFFERS WEIGHT REDUCTION.

A low-cost, omidirectional gimballed rocket nozzle that promises significant weight saving for giant solid propellant space boosters has been successfully tested by Lockheed Propulsion Company.

The free-moving nozzle is highly efficient at wide-amplitude thrust vector control corrections. Other systems, such as fluid injection, result in severe weight problems in this regime. Fluid injection systems, now being used effectively for upper stages of the Minuteman and the Polaris A-3, become less efficient as greater thrust deflection is required.

The gimballed nozzle, with a unique differential hydraulic seal, deflected the stream from a subscale rocket motor (Fig. 2) ±9 deg in both pitch and yaw planes. It was constructed of presently available materials.

Using the company's "big booster" propellant, Polycarbutene R, the gimballed nozzle was successfully fired for 165 sec. A company spokesman said the firing "ran about five times as long as any previous gimballed nozzle test known to have been made in the industry."

The gimballed nozzle also offers the advantages of simplicity and resultant reliability. The nozzle is attached to a ring with pinions at opposite axes, in the manner of a gyrocompass. It is actuated by hydraulic pistons, one controlling pitch and the other yaw; the pistons in turn are driven by the motor's integral power source. Deflection is accomplished by turning the motor nozzle itself, rather than by changing the course of the gas stream under liquid pressure or by using vanes or tabs.

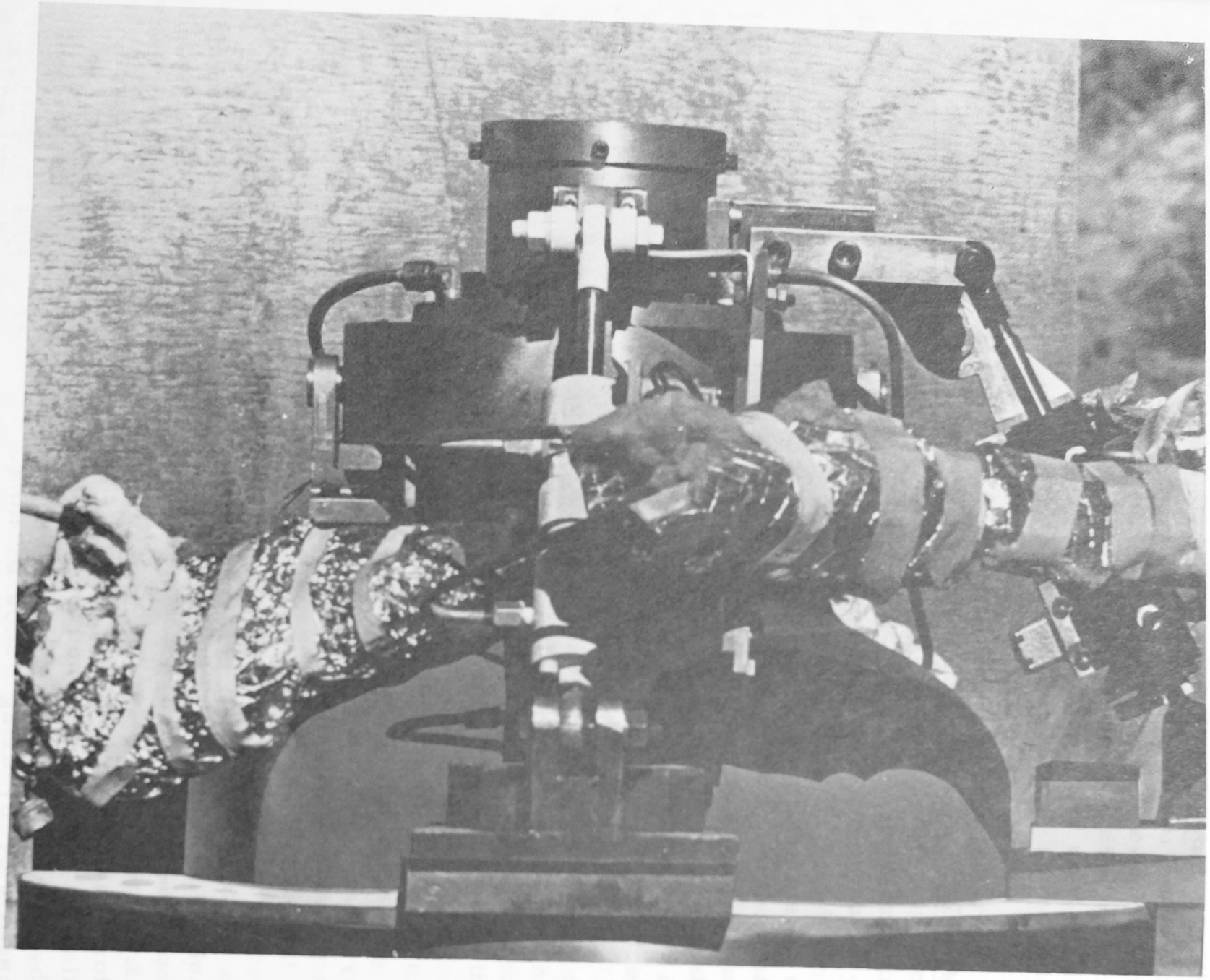

FIG. 2

The unique differential hydraulic seal prevents excessive heating of the apparatus. During the recent test it was claimed that the temperature inside the seal did not go above 150° C (300° F).

Concerning the weight factor, it was recalled that a secondary fluid injection system for thrust vector control was demonstrated by the company in May, 1962. This was purported to have been the largest diameter solid fuel rocket motor yet tested in this country.

"The new gimballed nozzle went from design to test in three months," the company reported. "Use of [this] nozzle could reduce the gross weight of a large rocket motor by 20,000 pounds or more."

Plans have been developed for testing the gimballed nozzle approach on larger scale hardware as a further demonstration of its advantages. (Source: Data supplied by Lockheed Aircraft Corp.)

TECHNICAL REPORTS AVAILABLE. The following listed technical reports can be requested through the NASA library, M-MS-IPL, Bldg. 4481.

NOTE: Those reports with an AD number may be on file in the local ASTIA branch in Bldg. 4484. Readers can save time by calling 876-6088 and inquiring if such reports are available before ordering them through NASA.

1. HIGH TEMPERATURE PRESSURE TRANSDUCER, L. H. Thacker. LA-2727
2. ENERGY CONVERSION STUDY OF SEMICONDUCTOR ELECTRODES, I. R. Tannenbaum. AD 282 849
3. HIGH-VACUUM EFFECTS ON ELECTRONIC PARTS, MATERIALS, AND RELATED PROBLEMS: AN ANNOTATED BIBLIOGRAPHY, E. E. Graziano. AD 282 717
4. EFFECT OF STATE OF STRESS ON THE FAILURE OF METALS AT VARIOUS TEMPERATURES, R. M. Haythornthwaite and D. R. Jenkins. AD 278 746
5. ANALYTICAL STUDY OF APPROXIMATE LONGITUDINAL TRANSFER FUNCTIONS FOR A FLEXIBLE AIRFRAME, B. F. Pearce and others. AD 283 978

6. INELASTIC DESIGN OF LOAD CARRYING MEMBERS, PART V, THEORETICAL AND EXPERIMENTAL ANALYSES OF BEAM-COLUMNS, D. L. Dewhirst and O. M. Sidebottom. PB 181 343
7. EFFECTS OF SIMULATED WEIGHTLESSNESS UPON POSITIONING RESPONSES, W. N. Kama. AD 277 288
8. SIMULATION TECHNIQUES FOR SPACECREW TRAINING STATE OF THE ART REVIEW, C. F. McNulty. AD 283 343
9. THE FUNCTIONAL DESIGN OF A SPECIAL PURPOSE DIGITAL COMPUTER FOR REAL TIME FLIGHT SIMULATION, L. M. Krasny. AD 283 099
10. DEVELOPMENT OF AN AUTOMATIC MONITORING SYSTEM FOR FLIGHT SIMULATORS, A. T. Benenati and others. AD 283 008