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Space TECHNICAL INFORMATION DIGEST

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

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RIFT STAGE ASSEMBLY SET FOR NAVY HANGER.

A dirigible hanger at the Naval Air Station, Moffatt Field, California, will be used for manufacture and assembly of NASA's RIFT (Reactor in Flight Test) nuclear rocket stage. RIFT, now in an early design phase, will be used to flight test NERVA (Nuclear Engine for Rocket Vehicle Applications).

The huge steel Navy hanger (Fig. 1), built early in the 1930's, will be renovated and converted to an assembly plant for about one-third the cost of a comparable new facility. It is located about 32 km (2 mi) from the plant of Lockheed Missiles and Space Company, Sunnyvale, California.

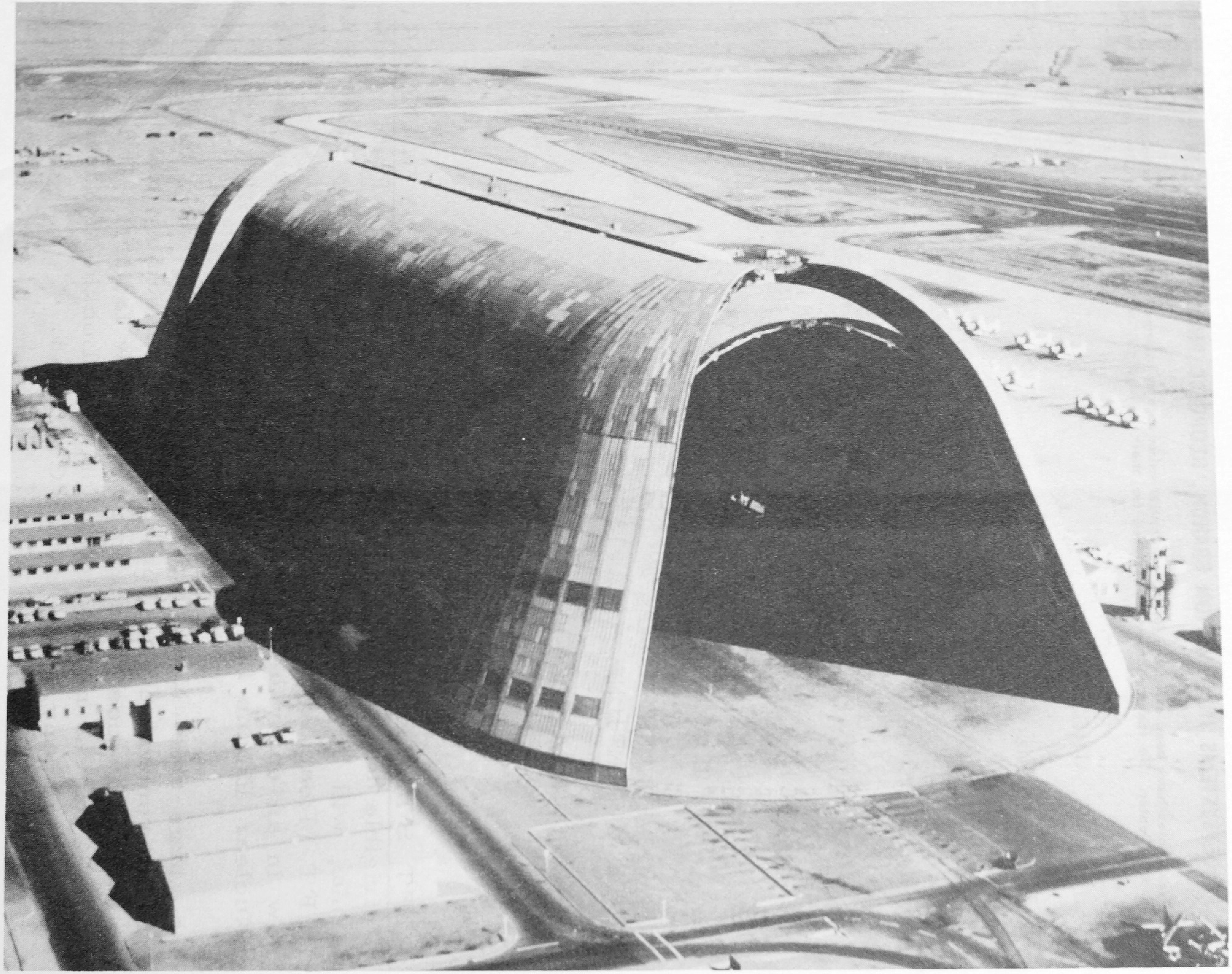

FIG. 1

The RIFT stage will be 10 m (33 ft) in diameter and 27 m (88 ft) in length. It will flight test the NERVA rocket engine which will use liquid hydrogen as a propellant. RIFT will be flight tested in the 1967-68 period as the top stage of the Advanced Saturn (C-5) rocket.

The renovated hanger will provide space for assembly support, final assembly, and reliability testing in addition to major component manufacture and assembly. Cryogenic flow and hydrostatic test facilities will be built near the fabrication area. Eventually some 1200 persons will be employed in the hanger, which measures 335 m (1100 ft) long, 92 m (300 ft) wide and 56 m (195 ft) tall. (Source: NASA news release)

A SEISMOGRAPH FOR MOON STUDIES. A seismometer capable of withstanding hard landings on the Moon has been designed for research studies applicable to programs such as the Ranger project. Survival of 3000 G impacts have been achieved. The instrument includes automatic devices for adjusting the suspended mass position and a solid-state pulse generator to verify its performance.

Development of the seismic device was begun in mid-1959 by the California Institute of Technology and Columbia University, appointed by NASA for the study.

The seismometer is contained in a "survival sphere" together with necessary support instrumentation. Comprising a part of the whole spacecraft, the sphere is ejected before lunar landing. The sphere is equipped with a retrorocket that slows the package to a velocity of less than 75 m/sec (240 ft/sec) before the Moon landing.

After landing, the instrument aligns itself with the local vertical, and signals are sent to the Earth for tape-recording. The seismograph signal is amplified and logarithmetically compressed before transmission.

Ground tests have shown that the maximum usable magnification (trace amplitude versus ground amplitude) is 1.7×10^6. (Source: Journal of Geophysical Research, November, 1962)

NEW INFRARED TRACKING SYSTEM DISCLOSED. A high resolution infrared tracking system developed by ITT Federal Laboratories at San Fernando, California, has been placed in operation at Cape Canaveral. It will provide reliable tracking data on missiles and other space vehicles during launch when radar equipment experiences difficulty due to interfering ground signal returns.

The optical unit of this infrared tracking system is mounted on the antenna pedestal of an instrumentation radar (Fig. 2). Angle error signals from the infrared tracker drive of the radar antenna serve to keep the radar pedestal on target until a reliable radar track can be obtained.

To provide this reliability, the high resolution infrared tracking system must use a high degree of background suppression due to the brightly lighted cumulus clouds frequently encountered in Florida. It is equipped to handle dynamic ranges of 100,000:1 because of its close proximity to large missiles at launch and the requirement to track small missiles at great range.

According to Dr. Norman E. Friedmann, assistant vice president at California operations for ITT Federal Laboratories, the exceptional advantage of this unique new tracking technique is that it allows one detector cell to provide radiometric as well as tracking information, thus simplifying the unit and improving its reliability.

The system features automatic as well as manual switching between infrared and radar. An automatic Sun shutter closes off the main optical path to protect the sensitive infrared detector from damage if sunlight should enter the field of view. The basic system is readily adaptable to a number of different tracking and radiometric applications. (Source: Data supplied by the International Telephone and Telegraph Corporation)

VELOCITY OF LIGHT DETERMINATIONS REVIEWED. One of the fundamental constants in physical and astronomical investigation is the value of the velocity of light. Its importance has been recently emphasized by successes achieved in radar reflections from the Moon and Venus; greatly improved values for solar system dimensions have resulted.

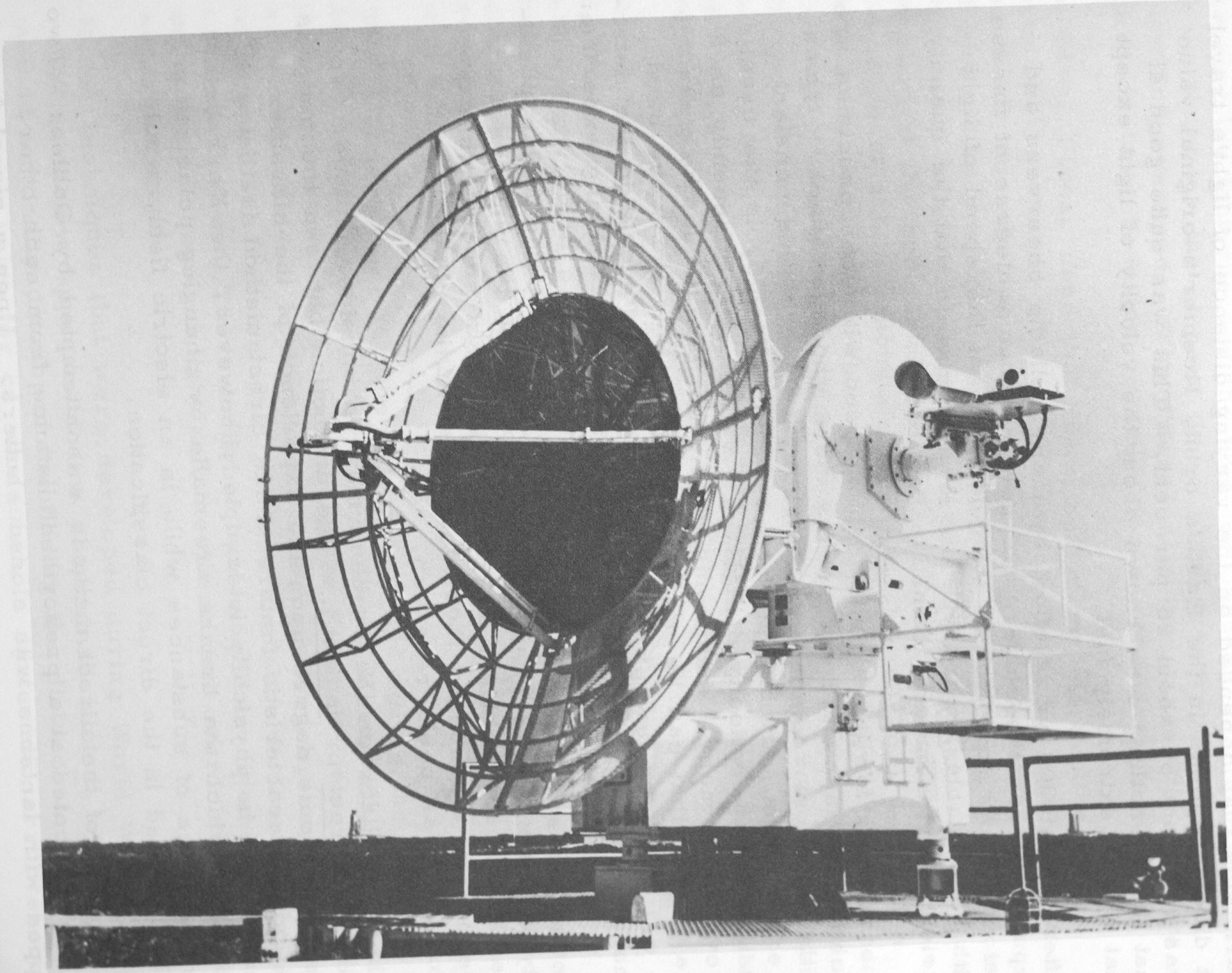

FIG. 2

A finite velocity for the speed of light was first computed by Roemer who had observed discrepancies between computer and Earth-based times of the eclipses of some Jovian satellites. Using variations that depended on the varying distance of light's travel at differing points in the Earth's orbit, Roemer's original value was in error by about 25 per cent. This was quite good at that time: nothing was known about the velocity of light except that it was extremely fast.

After almost 300 yr of effort by many reliable observers and experimenters, the subject has now reached a degree of finesse that we might expect. As to a definition of the speed of light with "acceptable accuracy," one can only state that the quantity varies with the nature of the application.

The reasons for determining light's speed with such precision are probably as many and diverse as the methods of attack. Some of the foremost reasons are found in the use of this constant c in experimental physical science. (The value, c, is the usual notation for the velocity of light in a vacuum.) Frequently used in evaluating many experiments, the value of c limits the results to a degree that can be no more accurate than the value used for c. Although few experiments approach in precision the determination of c, greater accuracy is desirable for coming experiments.

Another reason for more precision in the value of c is the possibility that it may vary with time and position in the universe. In addition, the problem may be considered a subdiscipline of experimental science by those interested in the elimination of errors in c as basic research.

Methods of attack on the problem may be considered under two headings, direct or indirect. The distinction between the methods depends to some degree upon the experience of the classifier. The most characteristic feature of the direct method is that a beam of light is physically interrupted; however, the Kerr cell method, in which the breaks are made by changing polarization characteristics of substances while in an electric field, would not be included in the direct classification.

The earliest of the direct methods was attempted by Galileo: Two men were located at a prescribed distance from each other, equipped with lanterns with closed shutters. Upon a signal from a timer at one lantern, the shutter was opened; when he saw the light so produced, the man with the second lantern would then open his shutter. The sum of the reaction times of the men uncovering the lanterns and the time for passage of light was recorded by the timer as the elapsed time. This was repeated several times and averaged. The difference in the elapsed time is now known to have been too negligible for a measurable result.

In 1849, Fizeau used the direct method by interrupting a light beam with a toothed wheel. From 1882 to 1932, Michelson used the most accurate application of the direct method with apparatus of increasing power during this period. Rapidly rotating mirrors were used to interrupt and reflect the light. A light source was installed at the summit of Mount Wilson, and a mirror was set on the slope of another mountain. The 35-km (22-mi) separation was determined within about 0.25 cm (0.1 in.) by a Coast and Geodetic Survey team. However, other parts of the experiment introduced relatively large errors, and the result had an intrinsic error of about 0.001 per cent. Later experiments, conducted with an evacuated pipe 1.6 km (1 mi) in length and with multiple reflections, resulted in unexplained differences.

A number of successful indirect methods followed the earlier direct methods for the determination of <u>c</u>. The indirect methods show very small errors, and they agree closely. Because of their great potential accuracy, these methods probably will have continued use in the future. Electro-optical methods were introduced as early as 1929; highly accurate results were possible with less ponderous equipment.

The "official" value for the velocity of light during the 1940's--299,776 km/sec--was obtained by using a Kerr cell. W. C. Anderson conducted the experiment at Harvard University. When an electric field is applied to the cell's electrodes, the molecules of a liquid are reoriented to produce a change in the polarizing characteristics. The velocity of light was then determined by using a split beam of light and the Kerr cell over comparatively short distances.

Radar techniques that were developed during World War II resulted in a new approach to the determination of <u>c</u>. When a method originally developed for finding the distance to aircraft (assuming a value for <u>c</u>) was used, a systematic error seemed to be present when a "fix" on several stations was attempted. By using distances surveyed with great accuracy, Aslakson showed that consistent results were obtained with a value of c larger than had been assumed.

Perhaps the most accurate recent determinations of c were made in 1952-1957 by Froome. He used a microwave interferometer that used the principle of interference in a way similar to the technique for testing optical flats. Radio waves of longer wave lengths reduced the error in distance measurement. Results by this method are extremely accurate: the probable error is 1 part in 10 million. This accuracy results from the combining of recent electronic advances and the best methods of physical measurement. The velocity of light (in a vacuum) attributed to Froome is 299,792.5 km/sec, with a probable error of ±0.1 km/sec. (Source: Astronomical Society of the Pacific Leaflet No. 402, December 1962)

THREE PUFFS INFLATE MERCURY RADAR REFLECTOR. The pocket-sized plastic bag shown in Fig. 3 is to be carried by the nation's Project Mercury astronauts as part of their survival equipment. It becomes an aluminized mylar reflector when inflated (See Fig. 3) with three puffs. The 198-g (7-oz) device was developed to specifications of NASA's Manned Spacecraft Center by the Geophysics Corporation. It has been tested in the Atlantic ocean where it was sighted in the water by radar aboard aircraft flying at a distance of 76 km (48 mi). Similar devices are expected to be applicable for use by stranded yachtsmen, explorers, or survivors of downed aircraft. (Source: Data supplied by Gaynor and Ducas, Inc.)

GOVERNMENT WANTS AERONAUTICAL AND MISSILE INVENTIONS. The Federal government is looking for inventions in the field of aeronautics and guided missiles as well as associated areas. The National Inventors Council is coordinating the search for over 300 different scientific and technological inventions, some of which are listed below:

Method of positively feeding fluids including cryogenic propellants (liquid hydrogen and oxygen).
Steerable parachutes.

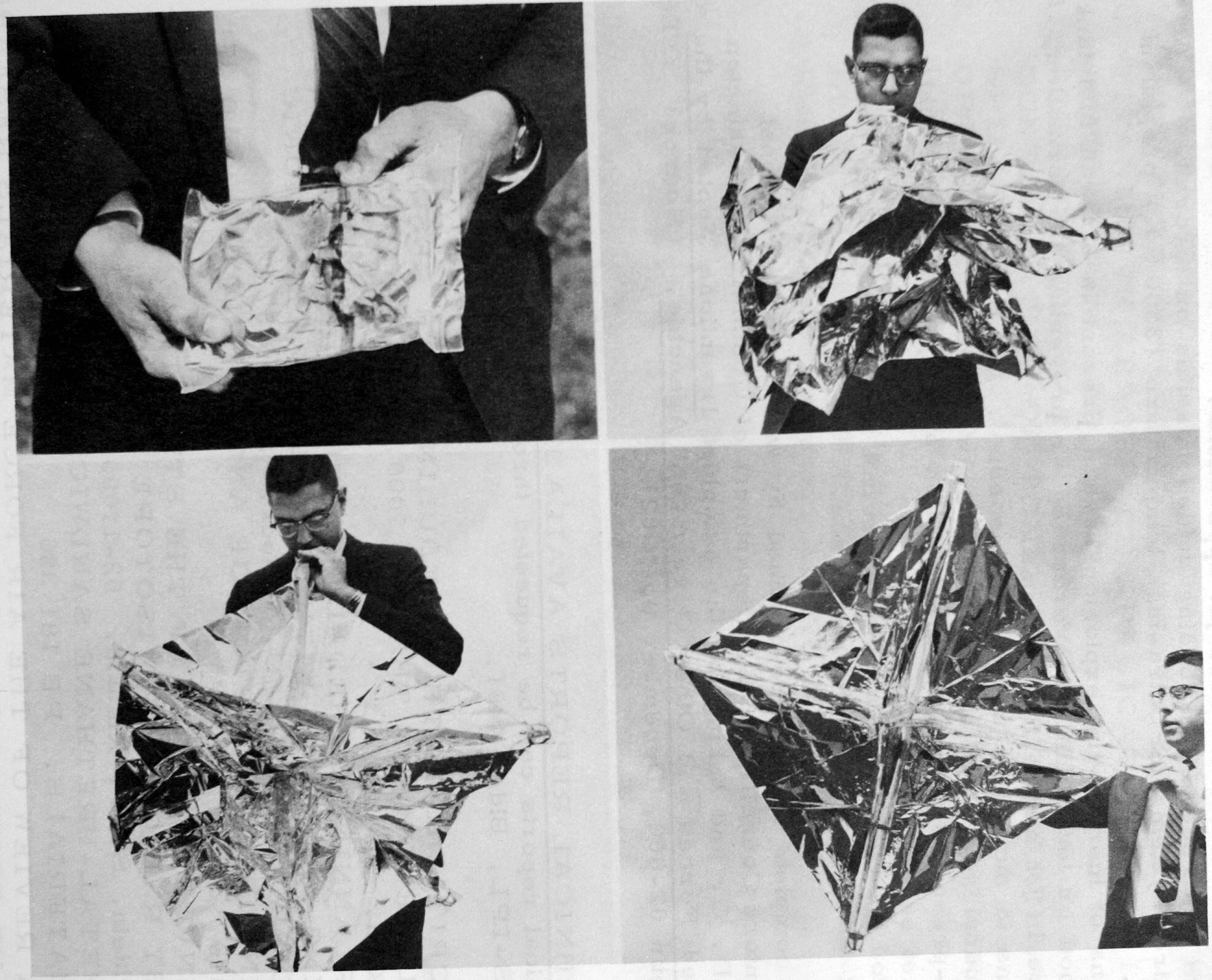

FIG. 3

Reentry recovery decelerator.
Means of eliminating fuel contamination during the operation of Army aircraft.
Variable nozzles for free-jet applications.
More rapid method of loading guided missiles on aircraft.
Control systems for ultra-high temperature (3500° K) propellant gas.
Means of inerting the explosion hazard present in aircraft fuel tanks.
Method or technique for overcoming or preventing the formation of ice in jet engine fuel systems.
Means to suppress turbojet engine noise.
Chemical source of oxygen for aircrew breathing systems.
Self-pressurizing system for injection of propellants into liquid rocket engines.
Method or technique to predict aircraft fuel system surge pressures.
New small power source for fuzes.

The complete list can be obtained by writing to the National Inventors Council, U. S. Department of Commerce, Washington 25, D. C. and asking for the pamphlet Inventions Wanted by the Armed Forces and Other Government Agencies. (Source: OTS Bulletin 62-660, December 9, 1962)

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

1. CRITICAL PATH SCHEDULING WITH RESOURCE LEVELING ON THE IBM 7090, W. A. Gray and E. M. Kidd. K-1499
2. PLANNING SCHEDULING AND EXPEDITING ENGINEERING PROJECTS WITH THE AID OF ELECTRONIC COMPUTERS, J. C. Pollock. ANL-6557
3. INFORMATION STORAGE AND RETRIEVAL. AD 274 816
4. INVESTIGATION OF THE STRUCTURE OF METALS BY RADIOACTIVE ISOTOPE METHODS, S. Z. Bokshtein, S. T. Kishkin. 62-11095
5. METAL-URETHANE SANDWICHES AS ENGINEERING MATERIALS. PB 181 336
6. A REVIEW OF THE AIR FORCE MATERIALS RESEARCH AND DEVELOPMENT PROGRAM, J. J. Banks and D. J. Tate, AD 276 709

7. AUTOMATIC TESTER FOR ELECTRICAL FUSES, C. D. Longerot. SCT-254-61(14)
8. MAINTENANCE ENGINEERING GUIDE FOR ORDNANCE DESIGN. PB 181 321
9. DESIGN AND CONSTRUCTION OF A PELTIER TEMPERATURE-CONTROL DEVICE. AD 257 333
10. TITANIUM IN AEROSPACE APPLICATIONS, R. I. Jaffee and others. AD 266 927
11. RESEARCH ON MATERIALS AND METHODS FOR DECONTAMINATION OF TOXIC MISSILE PROPELLANT SPILLAGE, R. B. Jackson and others. AD 281 818
12. OPTIMUM DESIGN OF LIQUID OXYGEN CONTAINERS, R. W. Arnett, K. A. Warren, and L. O. Mullen. PB 181 108
13. RESEARCH ON THE FEASIBILITY OF PROPELLANT DETECTION BY INDUCED RADIOACTIVE TECHNIQUES, Richard Bersin and others. AD 273 262