Space TECHNICAL INFORMATION DIGEST

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

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IN THIS ISSUE

NASA SCIENTISTS OFFER THEORY ON LUNAR SURFACE. Two NASA scientists added to the scientific controversy of whether the Moon's surface is covered with a dust layer, as well as just how deep it is and whether it would support the weight of a landing vehicle. They said it is estimated that it ranges from 10.2 cm (4 in.) to 0.91 m (3 ft) thick, and they supported one group of scientists who say that its porous cobweb-like structure would crumble underfoot like a fairy castle.

The scientists, Curtis W. McCracken of Goddard Space Flight Center and Maurice Dubin of NASA Headquarters, made their estimate in a paper, "Dust Bombardment of the Lunar Surface," that was presented at a Lunar Surface Materials Conference held recently in Boston.

Considerable controversy has raged for some time over the interpretation of radio, radar, and infrared observations of the lunar surface. Some scientists have said that the lunar surface may be covered by deep layers of low-density material into which any landing vehicle might easily sink out of sight.

However, McCracken and Dubin base their estimate of the thickness of the dust on data gained from spacecraft and ground observations of interplanetary dust particles. Most of these particles originate from comets. The scientists said that available data on the flow of these particles show that the material accreted by the Moon during the past 4.5 billion years amounts to approximately 1 g/cm^2 if the flow has remained fairly constant, and they believe it has (1 cm^2 = 1/6 $in.^2$).

These particles travel at hypervelocities, depending on their size. Their average speeds are approximately 9.7 km/sec (6 mi/sec) for dust particles with dimensions of microns, 30.6 km/sec (19 mi/sec) for particles with dimensions of millimeters, and 14.5 km/sec (9 mi/sec) for bodies with dimensions of meters. These high speeds lead to hypervelocity impacts, events of explosive violence that result in destruction of both the particle and portion of the target; hence significant amounts of dust could be created.

However, whether the Moon is gaining or losing mass as a result of these bombardments is still controversial. Some scientists feel that the Moon is continually being eroded away by these impacts and has to expose new surface material.

McCracken and Dubin suggest that the Moon is gaining in mass because the impacting particles do not necessarily escape the Moon's gravity and thus form a layer of dust and rubble on the surface. They support Professor Thomas Gold and his associates at Cornell University, who under contract to NASA recently made measurements simulating the effect of radiations and fast-moving dust particles impacting on layers of loose particles. The Cornell investigators examined a large number of terrestrial materials and compared these with the observed reflection coefficient of the lunar surface. One material had a cobweb-like structure and was composed of cement powder which has a chemical composition similar to that which might be expected on the lunar surface.

McCracken and Dubin said that such a structure, popularly referred to as "fairy castles," would largely retain the ejecta created by hypervelocity impacts of dust particles. Their opinion is that the low value for the accretion rate for the small particles is not adequate to produce large-scale dust erosion or to form deep layers of dust on the Moon. (Source: NASA news release No. 63-109)

METEORITES' BIRTH ATTRIBUTED TO COLLISIONS.

Meteorites, which strike our planet about once a day, are probably products of collisions between bodies orbiting within the Solar System that have been banging against one another for the last billion years or longer, according to a theory presented at the annual meeting of the American Geophysical Union held in Washington in April.

The new theory would rule out the popularly held view that meteorites are debris from a single planet which exploded at some time in the geologic past. Such a concept was based in part on the varying compositions of these objects. About 6 per cent of the meteorites found are metallic (iron and nickel mixtures), thought to be derived from the molten core of the planet; 2 per cent are iron packed with stony fragments, thought to be from the transitional zone between the core and the mantle of the planet; and the remaining 92 per cent are grainy rocks, thought to be from the mantle of the destroyed planet.

But observed differences in ages of meteorites have led some scientists to refute this "exploded planet" theory in favor of the belief that the meteorites are largely the result of collisions of asteroids--small planets--circling the Sun between the orbits of Mars and Jupiter.

The histories of meteorites are being reconstructed by techniques utilizing the rates of decay of radioactive elements and isotopes. These radioactive "clocks," with varying degrees of accuracy, make it possible to estimate:

1. The time when the material solidified from the molten state
2. The time when the material cooled to temperatures such as those in the Earth's crust
3. The time when the meteorite was ejected from its parent body

4. The approximate time that it fell to Earth
5. Its general shape and size before its flaming plunge through the Earth's atmosphere.

These techniques have been devised within the past few years and are still very approximate. (Source: The New York Times, April 28, 1963)

RECORD-SETTING TIROS 5 STOPS TRANSMITTING.

The NASA Tiros 5 meteorological satellite has closed its weather eye in space after setting a record of 10.5 months of continuous operations, a lifetime longer than any previous Tiros. During this lifetime, the satellite not only operated longer than any other Tiros but also transmitted more Earth cloud cover pictures.

Through orbit 4579 (May 4), when pictures of excellent quality were received, Tiros 5 had sent more than 57,857 Earth cloud cover pictures. Of this total, 49,212 (more than 80 per cent) were usable for meteorological purposes. The US Weather Bureau sent 396 storm advisories to nations around the world based on Tiros 5 cloud cover pictures, including two hurricanes and four typhoons observed last August.

First indication of a malfunction in the satellite came when cloud cover pictures being received at the Tiros ground station at Wallops Island, Virginia, began yielding only blank frames. The analysis of the data from the satellite points to a failure in the shutter operation mechanism as the most probable cause. The other camera on board failed because of a random electrical failure on July 6, 1962, 17 days after launch from Cape Canaveral.

Goddard Space Flight Center, Greenbelt, Maryland, worked in conjunction with the Radio Corporation of America, the spacecraft builder, to monitor transmissions from Tiros 5 in an attempt to pinpoint the problem even further. This data, as well as telemetry tapes from recent passes of the satellite, will be analyzed by RCA technicians at Princeton, New Jersey.

Tiros 6, launched September 17, 1962, continues to provide cloud cover pictures of excellent quality. Since April 1, 1960, six Tiros spacecraft have been successfully orbited out of six attempts. (Source: NASA news release No. 63-93)

MODULAR FLIGHT DISPLAY DEVICE ANNOUNCED. General Precision's Kearfott Division has started production on a unique electroluminescent indicator. Designed as an answer to a supersonic flight problem, the indicator will accept binary coded decimal information for display in numeric, symbolic, or alphabetic form. Having no moving parts because of its solid state circuitry, the device offers users greater reliability and longer life than mechanical readout systems. In addition to cockpit applications, there are other potential uses; these include computer readout displays, indicators, remote readouts, annunciator boards, mapping displays, and vertical displays.

The basic package is completely modular (Fig. 1). It gives in-line, in-phase readouts, and its rectangular design permits in-line mounting of digits and stack mounting into a system. It can also be packaged in multiple-character configurations; a five-character unit is about the size of a package of cigarettes. It rapidly converts computer information to decimal outputs, and amplifies the resulting signals to drive gate circuits of a bank of controlled rectifier switches. These signals are steered to the proper switches by means of a diode-encoding matrix.

The device contains a lamp with seven segments, each connected electrically in series with a 240-v ac supply and the anode circuit of the controlled switch. A dc signal applied to the gate of the controlled switch causes the associated segment to light. (Source: Data supplied by General Precision, Inc.)

A NEW PROCESS FOR ELECTROCLADDING AND ELECTROFORMING REFRACTORY METALS. The laboratories of Union Carbide Corporation have completed the development of a new process for electrocladding and electroforming the refractory metals columbium and tantalum on other metals or graphite. The process is also useful for depositing tungsten, molybdenum, vanadium, zirconium, chromium, and hafnium.

Coherent dense deposits of extremely pure refractory metal can be made in unlimited thicknesses. The deposits are at least 99.8 per cent of theoretical density and equivalent in mechanical properties to electron beam melted stock (Table 1).

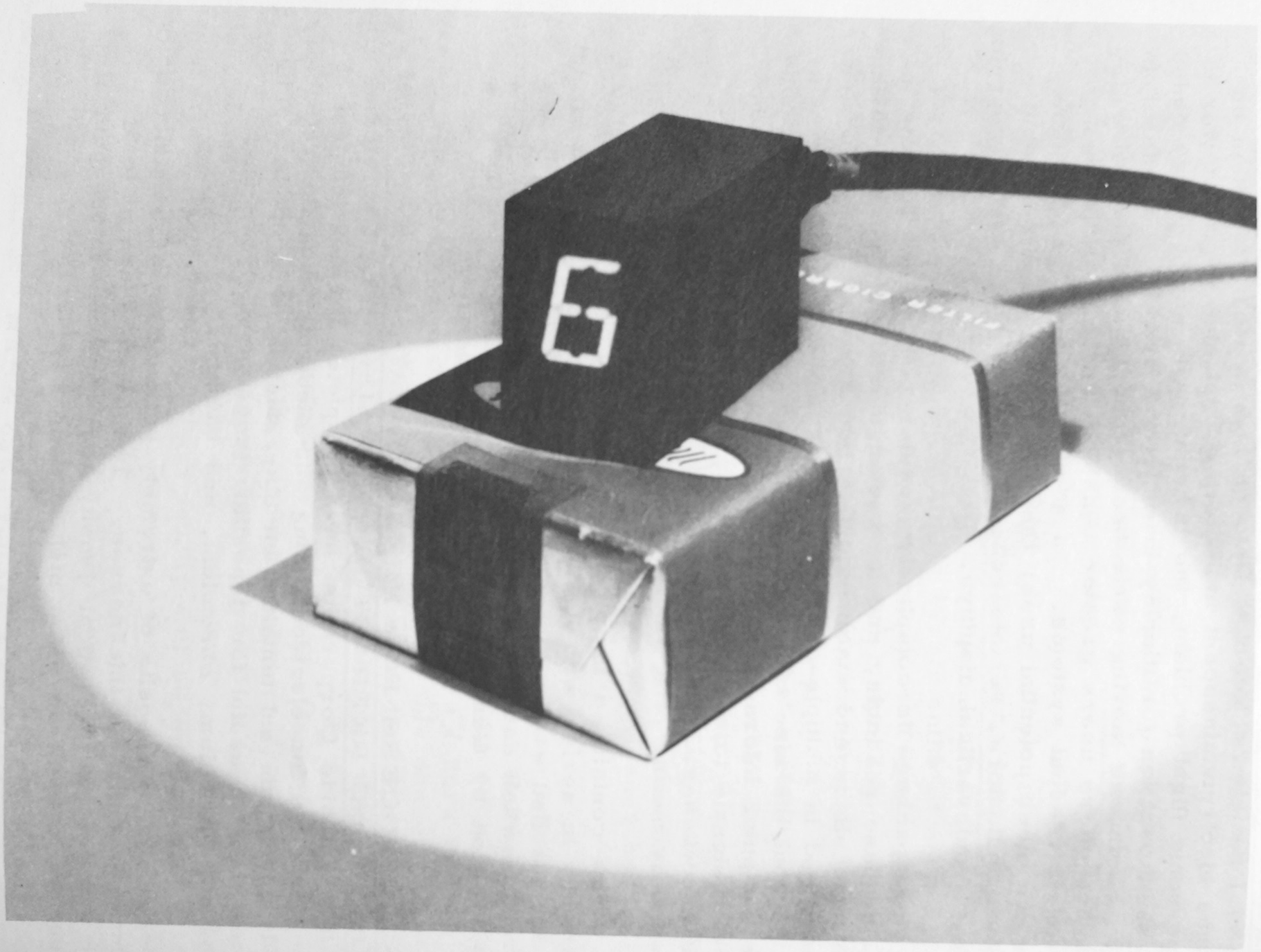

FIG. 1

Electroclad, 99.8% Theoretical density
Extremely Pure.

source: Union Carbide Corp
See Space Tech. Dept. Disc
June 3, 1963
Marshall SFC

TABLE 1

PHYSICAL PROPERTIES OF REFRACTORY METALS

Metal	Melting Point °C(°F)	Density g/cc	Thermal Conductivity-cal/sec. cm. °C	Thermal Expansion-μin./in. °C	Specific Heat-cal/g°C
Tungsten	3400(6152)	19.3	0.399	4.45	0.034
Tantalum	2996(5425)	16.6	0.130	6.5	0.036
Molybdenum	2622(4752)	10.2	0.349	5.45	0.065
Columbium	2415(4379)	8.57	0.125	7.1	0.065
Hafnium	2130(3866)	13.09	0.053	6.2	0.035
Vanadium	1900(3452)	6.11	0.074	8.3	0.120
Zirconium	1830(3326)	6.5	0.21	5.7	0.066
Chromium	1550(2822)	7.14	0.16	5.0	0.107

Electrocladding has been done on a variety of substrates, including steel, stainless steel, copper, beryllium-copper, graphite, nickel, and various Hastelloys.

Electroclad composites exhibit a remarkable integrity and freedom from pinholes. Impervious claddings have been made on copper substrates (Fig. 2) with only 0.001 mm (40 μin.) of tantalum electrocladding. However, an electroclad thickness of 0.076 + 0.127 mm (3 to 5 mil) is recommended for extended service in severe environments, such as hot aqueous HC1. Thicker coatings [up to 6.3 mm(1/4 in.)] with an excellent surface have been prepared many times.

There is a good metallic bond between the electrocladding and the substrate. This bond reduces the temperature differential between the substrate and the clad, as well as reducing differential thermal stresses. This feature is important in applications such as heat transfer apparatus, rocket nozzles, or in storage tanks (Fig. 3).

Cost comparisons with presently available mechanical lining methods show a decided advantage for the electrocladding process. The savings become greater as the intricacy of the parts to be electroclad increases. (Source: Data supplied by Union Carbide Corporation)

TRANSTAGE ENGINES FOR TITAN III COMPLETED.

A set of "battleship" propellant tanks for testing the Titan III's Transtage engines has been developed by Martin Company.

The 4400-kg (9700-lb) test tanks are called battleship tanks because they have extra thickness and strength to withstand the exhaustive test program (Fig. 4).

Dubbed as a "workhorse" booster for a wide range of manned and unmanned missions, Titan III consists of a strengthened Titan II core vehicle, two strap-on solid propellant engines that provide lift-off thrust, a control module, and transtage.

The transtage engine burns storable liquid propellants. In ground tests of the engine, the "battleship" tanks take the place of the stage's own tanks and feed fuel and oxidizer into the combustion chamber.

FIG. 2

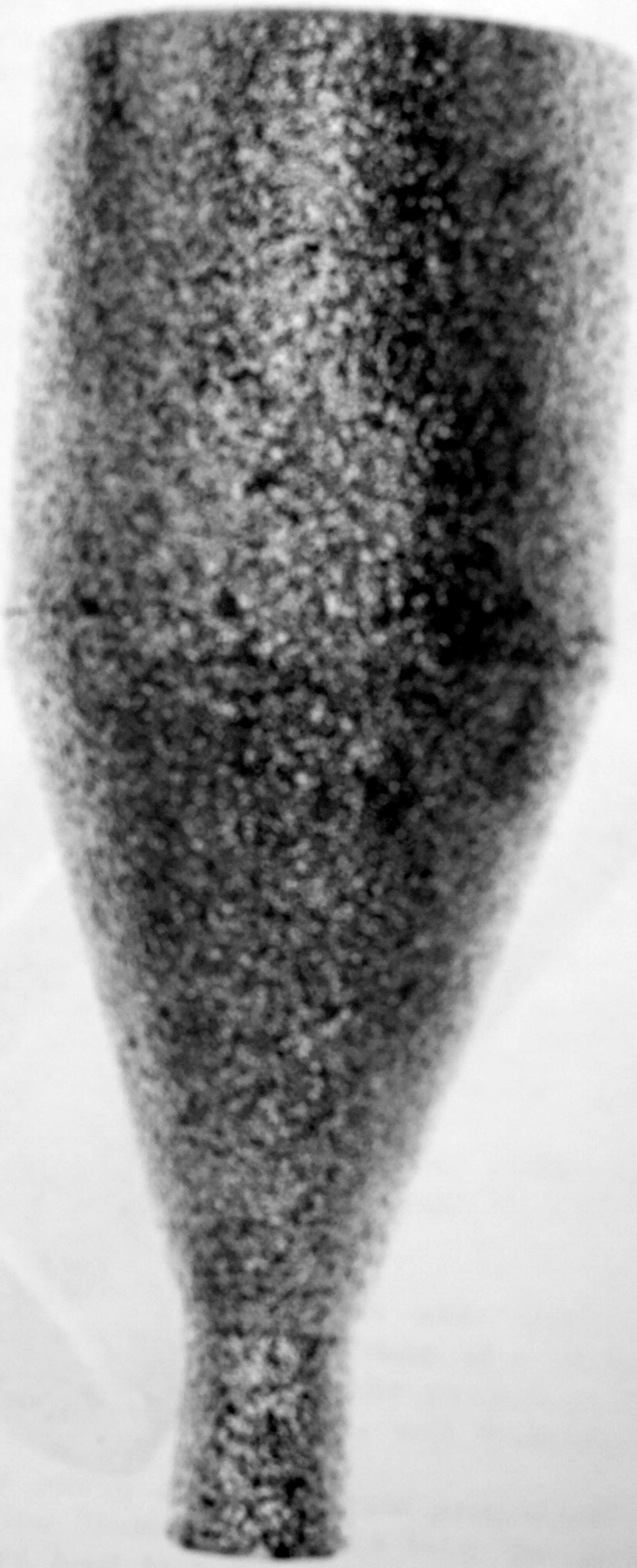

FIG. 3

Transtage develops 7000 kg (16,000 lb) of thrust and has the capability of multi-restarts in space. It gets the name from its ability to transfer payloads from one trajectory or orbit to another in the manner of a railroad switch engine--thus the nickname "switch engine in space." (Source: Data supplied by Martin Company)

COMPUTER LINE DEVELOPED. Development of a line of fast-access, rotating memory-storage devices has been announced by General Precision, Inc. The new random-access storage units include three magnetic-drum and ten magnetic-disc models. Drum-storage capacity is up to 4,100,000 bits and disc-storage capacity has a maximum of 7,680,000 bits (Fig. 5).

A desk-sized computer, used in more than 400 installations, utilizes a magnetic memory drum, while a suitcase-sized digital computer contains a 28-cm (11-in.) magnetic disc that stores 4096 words on a single side.

The Series L100 discs use one side for storage, while the L200 discs use both sides. Flying read/record heads are fitted to both. Sizes of the discs range from 10 to 60 cm (4 to 24 in.) in diam. They are driven by induction motors through preloaded, permanently lubricated bearing assemblies. A read/record head is used for each track, eliminating the need for head movement.

A special feature of the discs is a long-wearing coating of nickel cobalt that is plated over the aluminum base. This smooth, hard recording surface is not appreciably affected by multiple start-and-stop operations. It has outstanding magnetic performance characteristics. When the disc rotates, the flying heads float over the surface on a very thin cushion of air, automatically compensating for any variations caused by temperature or other factors.

The L500 series of magnetic drums ranges in capacity from 512,000 to 4,100,000 bits. Each of the three models is available in two types of different lengths to give a further choice in storage capacity.

All models feature an integral air circulation system; high-precision, lifetime-lubricated bearing assemblies; a unique read-write head design; and an integral induction motor drive.

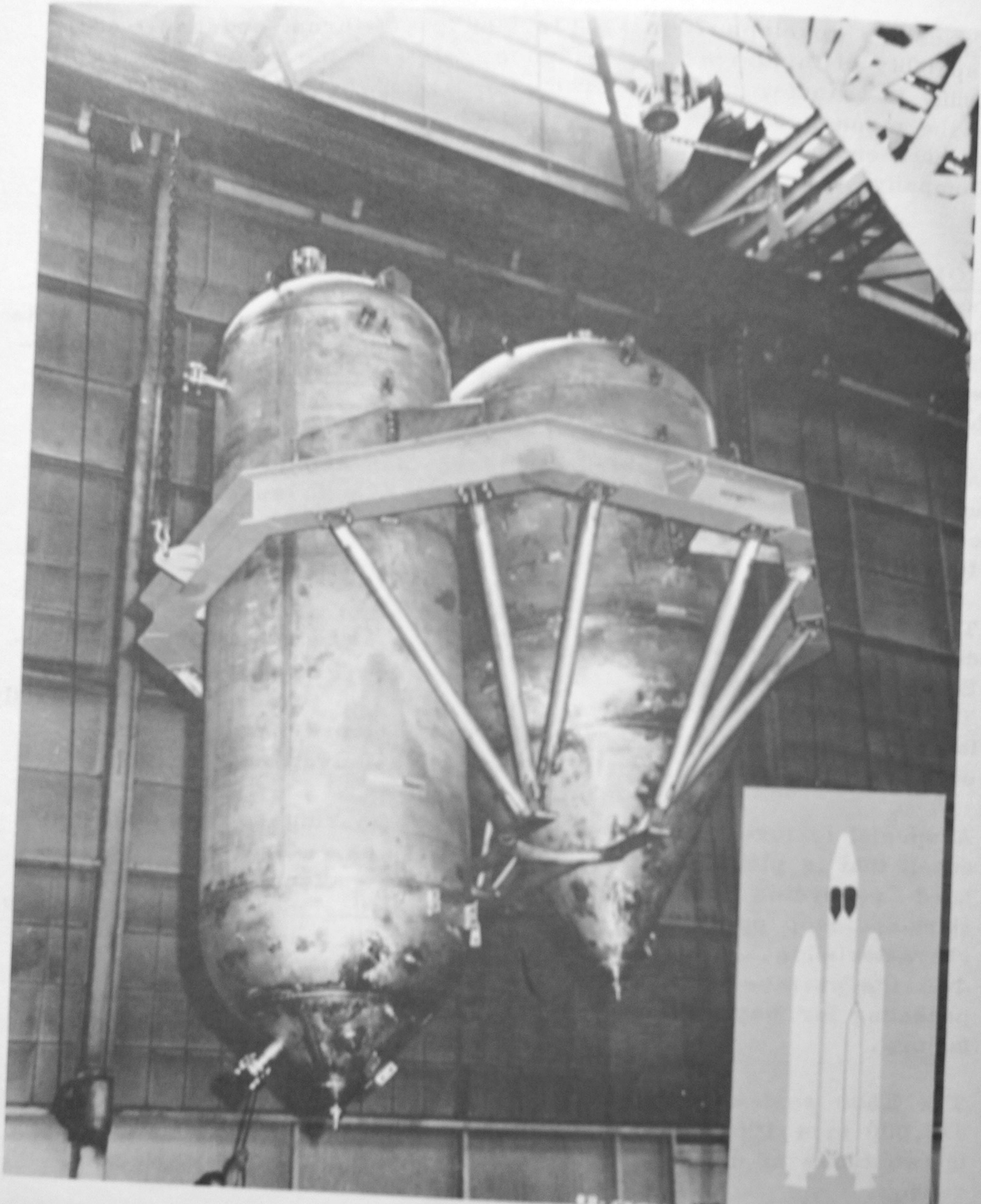

FIG. 4

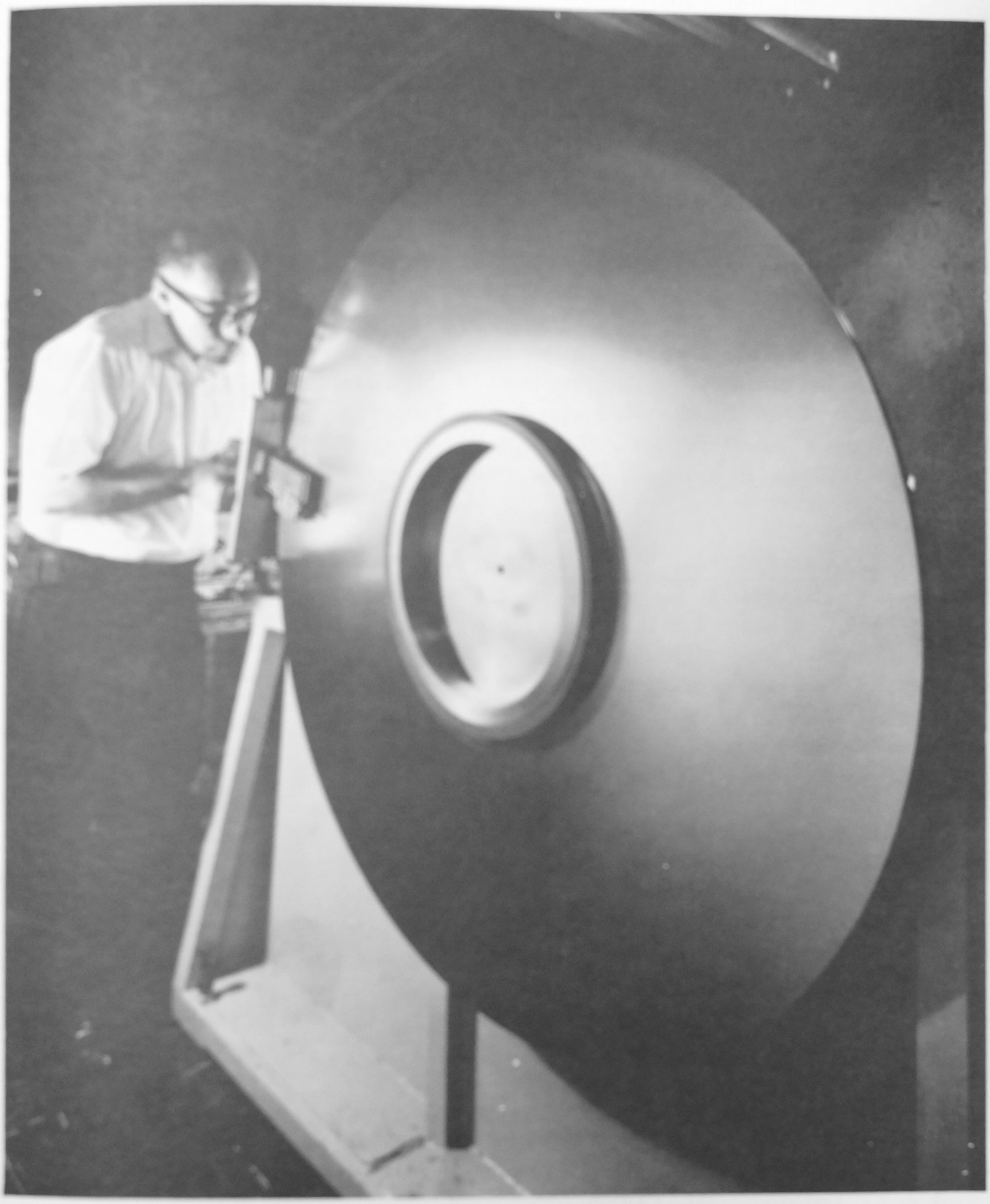

FIG. 5

The effect of the specially designed air circulation system is to allow drum operation at temperatures as high as 60.6°C (140°F). Further protection against high temperature, vibration, and shock is provided by careful selection of materials and design proportions to compensate for extreme environmental conditions.

Read/record heads (Fig. 6) are dimensionally stable throughout the operating temperature range and are positively clamped to eliminate creep. Precision dial indicators assure accurate head settings.

Simple and reliable bearing assemblies are grease-lubricated for life, which is planned to be 10 years of continuous operation at 3600 rpm. The drums are driven directly by induction motors, so that the motor shaft is also the upper shaft of the drum assembly. (Source: Data supplied by General Precision, Inc.)

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 DDC 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. DEVELOPMENT AND TESTING OF TUNGSTEN EMITTERS FOR ION PROPULSION SYSTEMS, J. M. Gerken et al. AD 292 257
2. DEVELOPMENT OF SEALED SILVER OXIDE-ZINC SECONDARY BATTERIES, J. J. Lander and J. A. Keralla. AD 291 646
3. CRYOGENIC MATERIALS DATA HANDBOOK, SUPPLEMENT NO. 4, F. R. Schwartzberg, R. D. Keys, and S. H. Osgood. PB 171 809-4
4. PROGRAM OF TESTING NONMETALLIC MATERIALS AT CRYOGENIC TEMPERATURES. AD 294 772
5. HYDRODYNAMIC THEORY OF FRONTOGENESIS, V. I. Gubin. 61-11469
6. PHYSICAL PROCESSES IN STELLAR INTERIORS, D. A. Frank-Kamenetskii. 63-11175

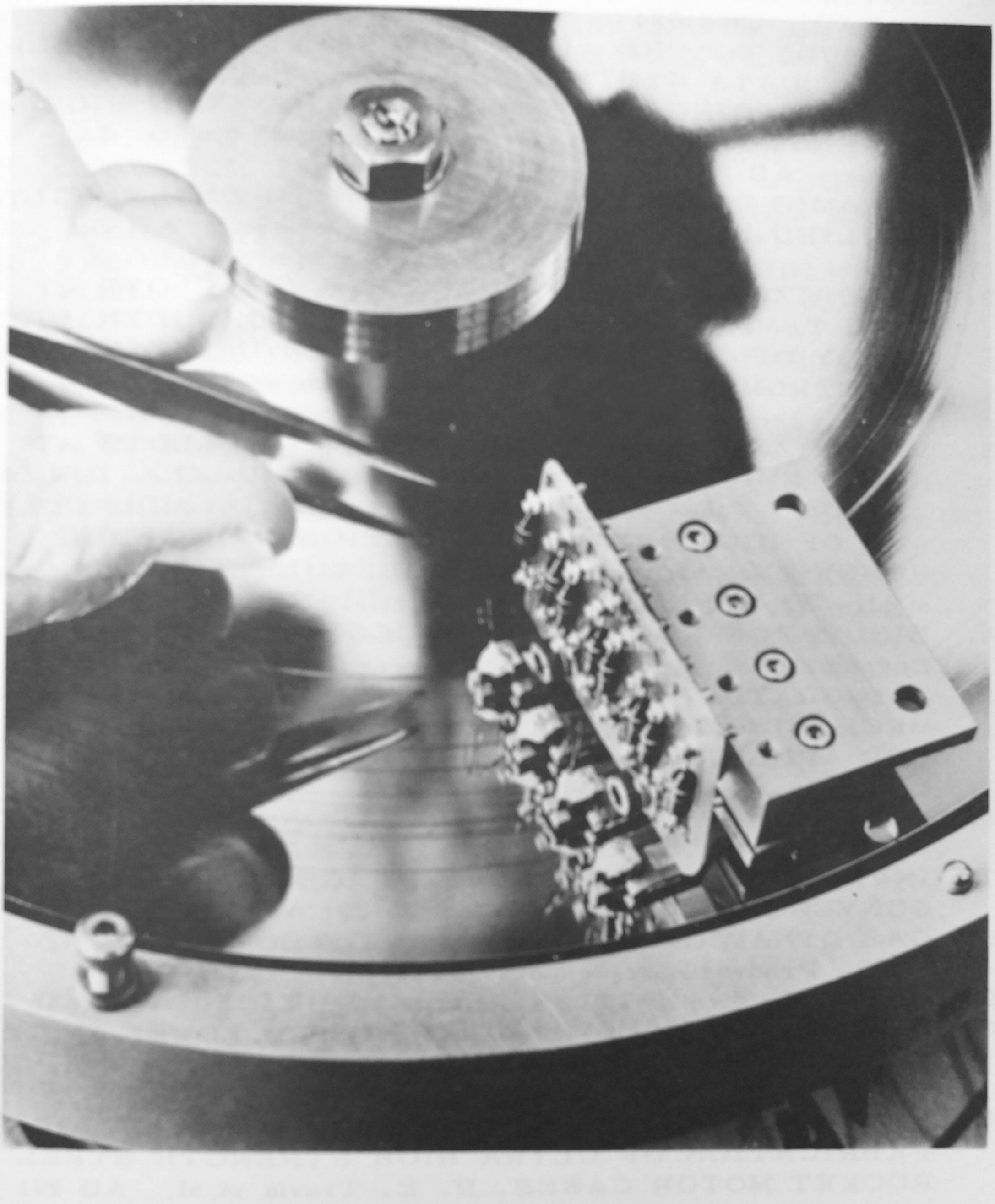

FIG. 6

8. SOVIET REPORTS ON METEOR OBSERVATION BY RADAR. 63-21724
9. A STUDY OF THE AIR FORCE MAINTENANCE TECHNICAL DATA SYSTEM, J. E. Losee et al. AD 288 636
10. STRAIN AGING AND DELAYED FAILURE IN HIGH-STRENGTH STEELS, E. A. Steigerwald and G. L. Hanna. AD 294 396
11. DYNAMIC RESPONSE OF SHELLS TO EXTERNALLY-APPLIED DYNAMIC LOADS, J. W. Leech. AD 294 384
12. VAPORIZATION OF COMPOUNDS AND ALLOYS AT HIGH TEMPERATURE, PART VII, THERMODYNAMIC STUDY OF TIN AND LEAD SULFIDE USING A MASS SPECTROMETER, R. Colin and J. Drowart. AD 277 906
13. VAPORIZATION OF COMPOUNDS AND ALLOYS AT HIGH TEMPERATURES, PART IX, CORRELATION OF DISSOCIATION ENERGIES OF GASEOUS MOLECULES AND OF HEATS OF VAPORIZATION OF SOLIDS: HOMONUCLEAR DIATOMIC MOLECULES, G. Verhaegen et al. AD 278 830
14. DISCHARGE EFFECTS IN A CESIUM DIODE, J. L. Coggins. AD 284 678
15. INTEGRATION OF ENERGY STORAGE AND DISCHARGE MECHANISMS IN BULK SILICON AND GERMANIUM FOR APPLICATION TO NEURISTOR LINES, D. R. Chambers. AD 293 854
16. POWER CONVERSION BY ELECTRON CONVECTION, S. R. Hoh and W. L. Harries. AD 291 683
17. INVESTIGATION OF CLOSE-SPACED THERMIONIC CONVERTER, D. K. Coles. AD 291 677
18. GAS DYNAMICS AND PHYSICS OF COMBUSTION, A. S. Predvoditelev, editor. 62-11030
19. OPTICAL TRANSITION PROBABILITIES. 61-11437
20. A STUDY OF WELD HEAT-AFFECTED ZONES IN THE TITANIUM-6A1-6V-2Sn ALLOY, R. E. Lewis and K. C. Wu. AD 291 400
21. EVALUATION OF ELECTRON BEAM WELDING FOR FABRICATION OF ULTRA HIGH STRENGTH STEEL ROCKET MOTOR CASES, R. E. Travis et al. AD 291 403
22. OPTIMUM LOW-ACCELERATION TRAJECTORIES FOR INTERPLANETARY TRANSFERS, A. V. Zimmerman et al. N63-11613

23. A STUDY OF ABORT FROM A MANNED LUNAR LANDING AND RETURN TO RENDEZVOUS IN A 50-MILE ORBIT, J. A. White. N63-10904

24. ANALOG STUDY OF DESCENTS FROM LUNAR ORBIT, J. N. Sivo. N63-11615

25. RESEARCH AND DEVELOPMENT OF A LIQUID-GAS CONTACTOR FOR PHOTOSYNTHETIC GAS EXCHANGERS, H. Wallman et al. AD 290 349

26. THEORETICAL BASIS FOR THE PRINCIPLE OF SINGLE-CELLED ALGAE CULTIVATION, I. V. Smirnov. 63-21454

27. PROBLEMS OF SPACE BIOLOGY, N. M. Sisakyan and V. I. Yazovskiy, editors. 63-21437

28. THERMO-STRUCTURAL ANALYSIS MANUAL, VOLUME I, H. Switzky, M. J. Forray and M. Newman. AD 286 908

29. THERMO-STRUCTURAL ANALYSIS MANUAL, VOLUME II. AD 290 593

30. RESISTANCE OF ADHESIVE-BONDED METAL LAP JOINTS TO ENVIRONMENTAL EXPOSURE, W. Z. Olson, H. W. Eickner and R. M. Lulling. AD 291 663

31. FUNDAMENTALS OF DIFFUSIONAL BONDING, VII, L. S. Castelman, H. A. Froot and L. Seigle. SEP 260