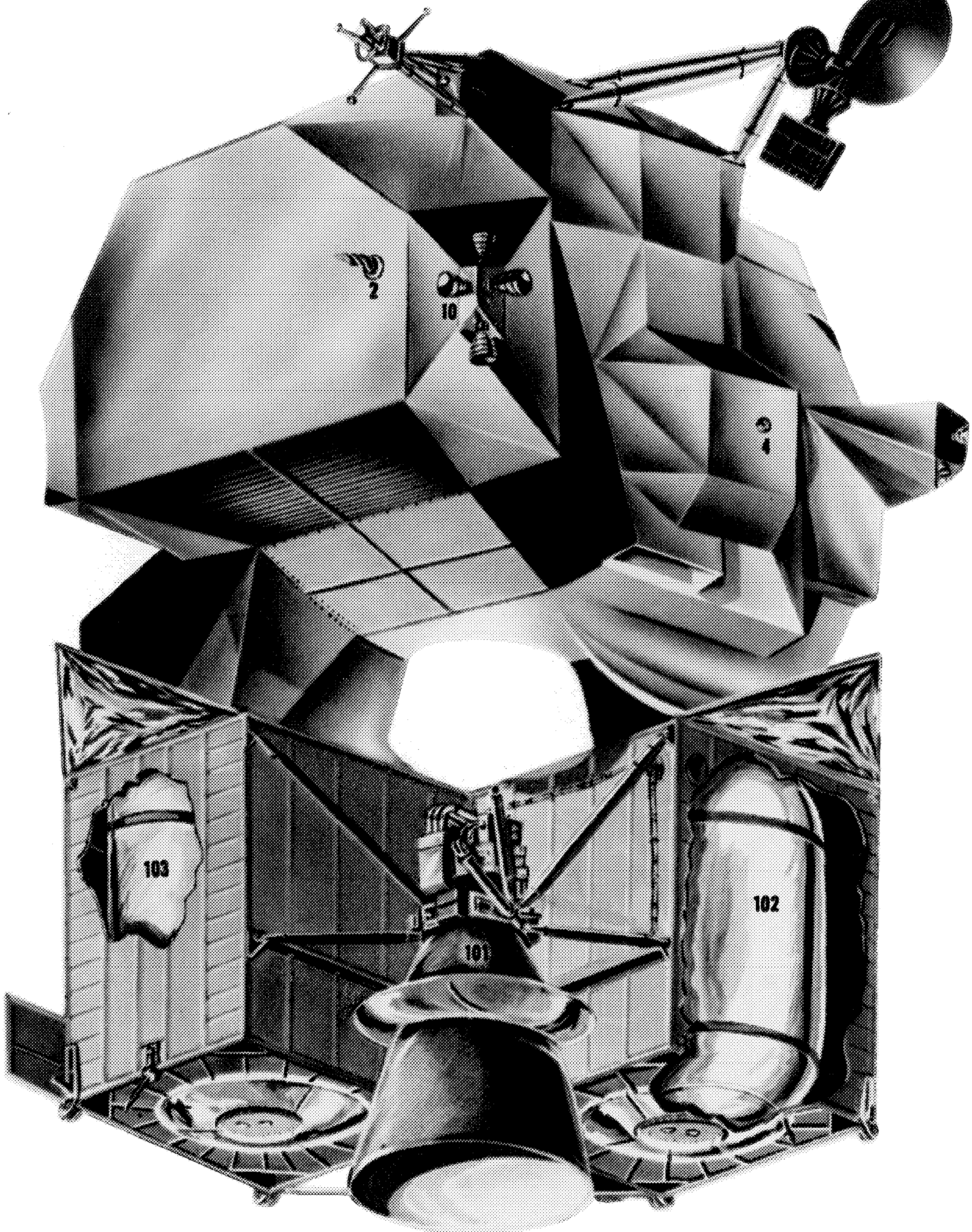

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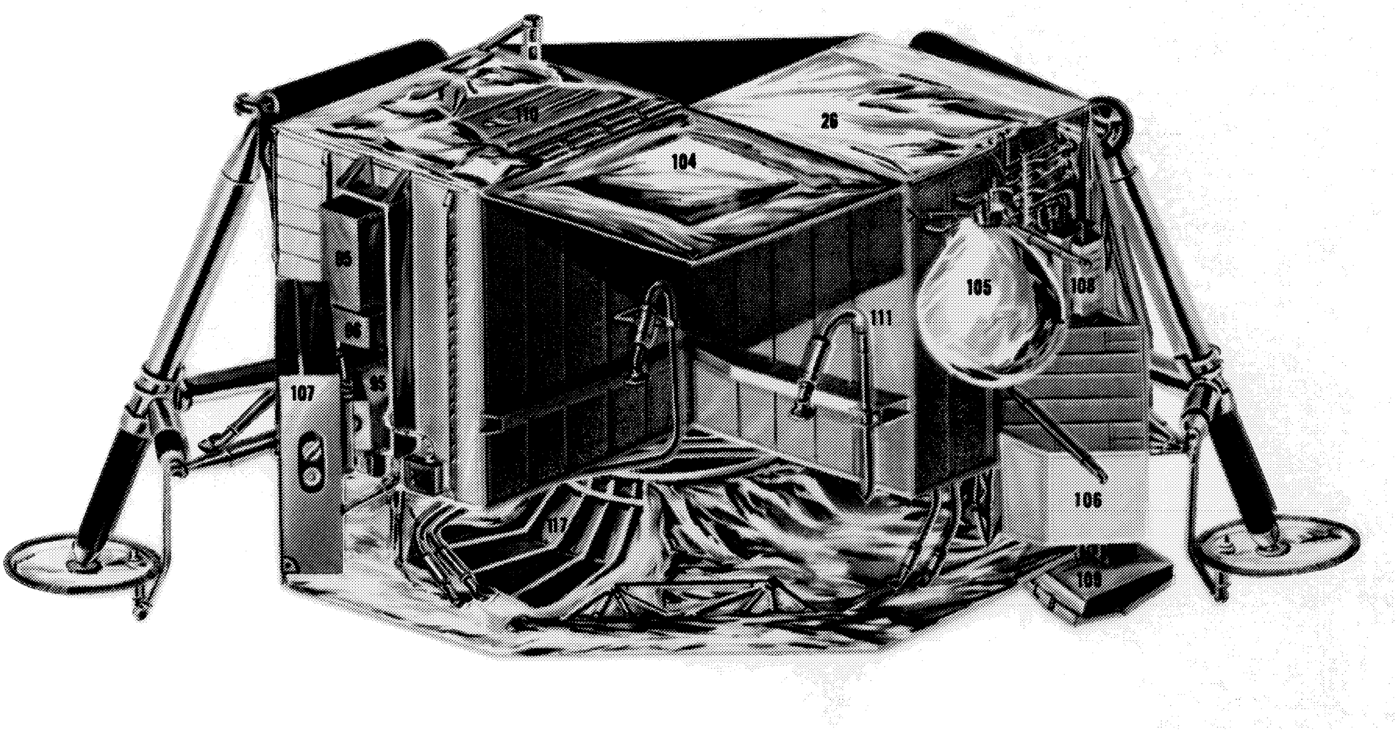

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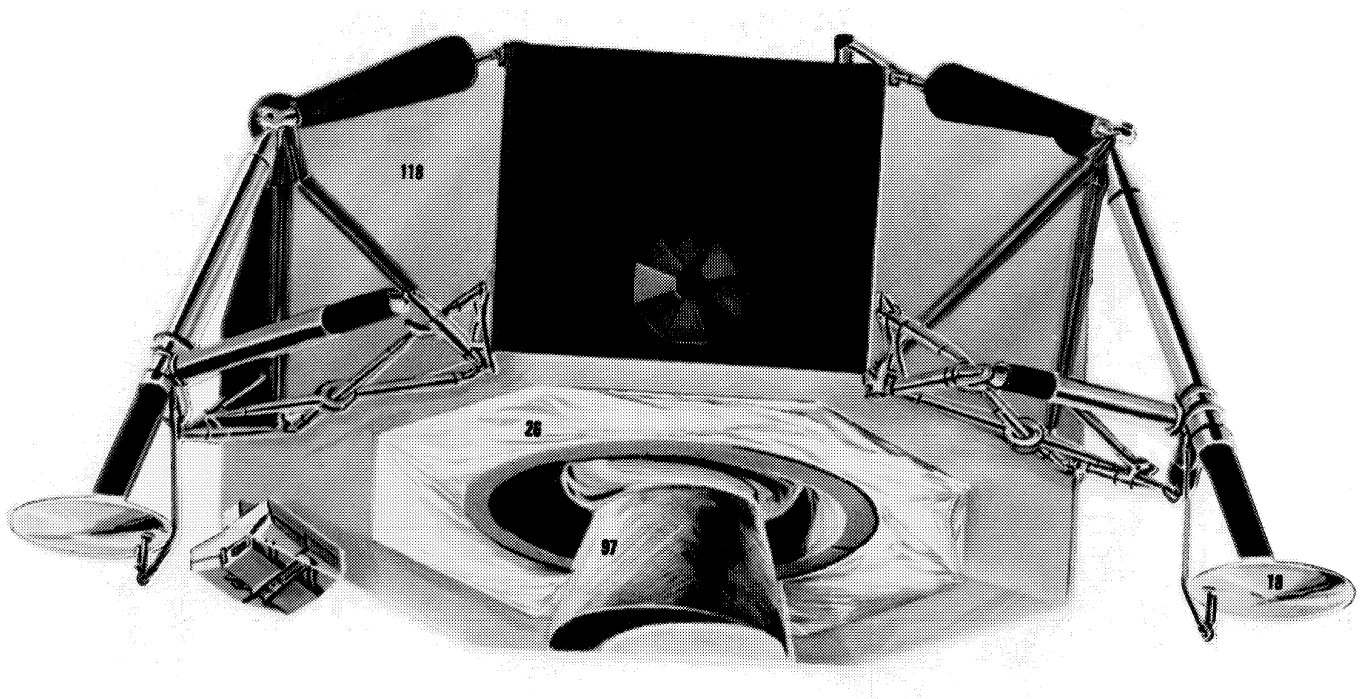

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LEGEND

1. Rendezvous Radar
2. S-Band In-Flight Antenna
3. Tracking Light
4. Docking Light
5. Alignment Telescope
6. EVA Rail
7. Docking Window
8. Docking Target
9. VHF In-Flight Antenna
10. RCS Thrusters
11. Ingress/Egress Platform & Rails
12. MESA "O" Ring Release
13. Upper Outrigger Venting Shield
14. Ingress/Egress Ladder
15. Primary Shock-Absorber Strut
16. Secondary Shock-Absorber Strut
17. Deployment Truss & Down-Lock Mechanism
18. Landing Pad
19. S-Band Erectable Antenna (Lunar Surface)
20. Radioisotope Thermal Generator
21. Docking Light (Port Side)
22. Forward-Vision Window
23. LM/CM Docking Hatch
24. Outrigger Strut
25. Insulation Vent
26. Thermal Insulation Blankets
27. Lunar Surface Sensing Probe
28. Insulation Support Frame
29. Interstage Connection Points (4)
30. Ascent Fuel Tank
31. Reaction-Control Oxidizer
32. Reaction-Control Fuel
33. Helium Pressurization Unit
34. Reaction-Control Helium
35. Water Tank
36. Relay Box
37. Abort Sensor
38. Inertial Measurement Unit (IMU)
39. Ingress/Egress Hatch
40. Landing Point Designator
41. Oxidizer Service Panel
42. Ascent Engine Cover
43. Alignment Optical Telescope
44. Upper Hatch
45. Commander's Main Flight Panel
46. LM Pilot's Main Flight Panel
47. Commander's EV Visors (Stowed)
48. Commander's Circuit Breaker Panel & Side Console
49. PLSS (Stowed)
50. Commander's Support & Restraint Reel
51. Commander's Armrest & Thrust Control
52. Main Panel/Cabin Floodlights (2)
53. LM Pilot's Armrest (Stowed)
54. LM Pilot's Support & Restraint Reel
55. Anti-Bacterial Filter Stowage
56. Cabin Relief & Dump Valve
57. Docking Drogue (Removable for Access)
58. Suit Circuit Assembly
59. Water Control Module
60. Cabin Air Recirculation Fan
61. LiOH Canister
62. LM Pilot's EV Visor (Stowed)
63. LM Pilot's Restraint Reel
64. Crew Equipment Storage
65. LM Pilot's Console & Circuit Breaker Panel
66. Oxygen Umbilical Hoses
67. Ascent Engine (3,500 lb Thrust in Vacuum)
68. Coupling Data Unit
69. Guidance Computer & Cold Plate
70. Power Servo Assembly
71. Ascent Oxidizer Tank
72. Descent/Ascent Section Explosive Attachment
73. Interrupt Connector Assembly & Wiring
74. Aft Equipment Bay
75. Gaseous Oxygen Tank
76. Helium Tank
77. Helium Pressurization Control Modules
78. Thrust Chamber Isolation Valves
79. Electronic Replaceable Assembly Rack
80. Batteries
81. Inverter
82. Electrical Control Assembly
83. Abort Electronics Assembly
84. Attitude & Translation Control Assy
85. Rendezvous Radar Electronic Assembly
86. Signal Conditioning Electronics Replaceable Assy No. 1
87. Pulse Code Modulation & Timing Equip. Assy
88. Signal Conditioning Electronics Replaceable Assy No. 2
89. Caution & Warning Electronics Assembly
90. S-Band Transceivers
91. S-Band Power Amplifier & Diplexer
92. Signal Processor
93. VHF Transceivers & Diplexer
94. Descent Structure
95. Batteries
96. Electrical Control Assembly
97. Descent Engine Skirt
98. S-Band Steerable Antenna
99. Electronics Package
100. Landing Gear Chock Mount
101. Descent Engine Throttleable (10,000 lb Approx Thrust)
102. Descent Oxidizer Tank (Fore & Aft)
103. Descent Fuel Tank (Port & Starboard)
104. Ascent Engine Blast Deflector
105. Water Tank
106. Scientific Equipment Boxes (2)
107. Specimen Return Container Assembly (MESA)
108. Landing Radar Electronics
109. Landing Radar
110. Fuel & Electrical Line Runs
111. Fuel Lines To Descent Engine
112. Fuel Lines (Descent Engine)
113. Supercritical Helium Tank
114. Ambient Helium Tank
115. Oxygen Tank
116. Scientific Equipment Power Outlets
117. Descent Stage Skirt Structure
118. Thermal & Micrometeoroid Shield

ABBREVIATIONS USED IN LEGEND

EVA: Extravehicular Activity
VHF: Very High Frequency
MESA: Modularized Equipment Stowage Assembly
RCS: Reaction Control Subsystem
LM/CM: Lunar Module/Command Module
PLSS: Portable Life Support System

BIOGRAPHIES

NAME: Llewellyn J. Evans, President
Grumman Aircraft Engineering Corporation, Bethpage, New York

BIRTHPLACE AND DATE: Born August 2, 1920, Unsankinko, Korea

EDUCATION: Graduate of the University of California (1942). Received a degree in Law from Harvard Law School in 1947.

MARITAL STATUS: Married to the former Georgene Hubbard of Seattle, Washington. They have a son, Llewellyn, Jr., a student at Cornell Law School, Ithaca, New York.

ORGANIZATIONS: Member of the American Bar and Federal Bar Associations, and the Harvard Law School Association.

MILITARY SERVICE: United States Army Air Corps from 1943 to 1945. Was Group and Squadron staff flight engineer. Was among the first crew members assigned to the B-29 bomber. Earned the Distinguished Flying Cross and Air Medal with five Oak Leaf Clusters.

BACKGROUND: Mr. Evans was a member of Sigma Alpha Epsilon, was active in competitive tennis and public speaking. After receiving his Harvard law degree in 1947, Mr. Evans was Assistant Counsel with the Department of the Navy, Washington, D. C. During this period he was admitted to the Bars of the United States District Court for the District of Columbia, the United States Court of Appeals, the United States Court of Claims, and the New York State Bar.

Mr. Evans joined Grumman in 1951 and served as Associate General Counsel until 1958 when he was appointed General Counsel. In 1960 he was appointed Vice President of Grumman, and in 1963 was appointed Senior Vice President. He became President and a member of the Board of Directors of Grumman Aircraft Engineering Corporation in May of 1966.

In March 1969 Mr. Evans received the NASA Public Service Award "for his outstanding contribution as a key leader of the Government/Industry Team which made possible the exceptional success of Apollo 9, the first manned flight of the Lunar Module".

He and his family reside in Brookville, New York, and maintain a farm in Warrenton, Virginia.

NAME: Joseph G. Gavin, Jr., Vice-President, Space Programs
Grumman Aircraft Engineering Corporation, Bethpage, New York

BIRTHPLACE AND DATE: Born September 18, 1920, Somerville, Massachusetts

EDUCATION: Graduate of Massachusetts Institute of Technology (1942). Received a S. B., S. M. in Aeronautical Engineering.

MARITAL STATUS: Married to the former Dorothy Dunklee of Brattleboro, Vermont. They have two sons, Joseph G. Gavin III, a graduate student at Columbia University, New York and Donald Lewis Gavin, a student at Wesleyan University, Connecticut. A daughter, Tay Gavin Erickson, is a student at Mt. Holyoke College, Massachusetts.

ORGANIZATIONS: Member of Educational Council, Massachusetts Institute of Technology and American Institute of Aeronautics and Astronautics.

MILITARY SERVICE: United States Navy from 1942 to 1946. Was an Engineering Officer.

BACKGROUND: Mr. Gavin was in the Honors Group of his graduating class at MIT. After his discharge from the Navy, he began his career at Grumman as a design engineer. From the Preliminary Design group Mr. Gavin was assigned as Project Engineer on the F9F-6 in 1950 and in 1952 as Project Engineer on the F11F Program. In 1956 he was assigned as Chief Experimental Project Engineer until 1957 when he was made Chief Missile and Space Engineer. In 1962 Mr. Gavin was promoted to Vice-President, Director of LM Program and in 1968 assumed the responsibility for all Grumman's space programs. In 1968 he received the Man-of-the-Year Award from Aerospace Educational Council, Inc. Mr. Gavin has served as President of the Harborfields Central School District #6 Board of Education.

He and his family reside in Huntington, New York.

NAME: Dr. Ralph H. Tripp, LM Program Director
Grumman Aircraft Engineering Corporation, Bethpage, New York

BIRTHPLACE AND DATE: Born Denton, Montana, March 11, 1915

EDUCATION: Received his BA from Drake University in 1937, and his MS and PhD in Applied Mathematics and Theoretical and Applied Mechanics in 1942 from Iowa State College.

MARITAL STATUS: Married the former LaVone Semingson. They have three daughters, Virginia, Haillie, and Roberta.

ORGANIZATIONS: Member of Instrument Society of America (President, 1961), Associate fellow of AIAA, Member of AAAS, National Space Club, American Management Association.

BACKGROUND: Dr. Tripp was a teacher at Iowa State College until he received his PhD in 1942. He then joined Grumman working in the Structures group in charge of vibration and flutter. In 1948 he became the head of the Structural Research Group. Later that year he formed the Research Department and became the Department Head. In 1949 he became the head of the Instrumentation Department. In 1958 he became the Assistant Director of Flight Test. He was appointed Director of the Orbiting Astronomical Observatory (OAO) in 1962. He directed the OAO Program until March 1968 at which time he joined the LM Program.

He and his family reside in Cold Spring Harbor, New York.

NAME: Thomas J. Kelly, LM Assistant Program Director – Engineering
Grumman Aircraft Engineering Corporation, Bethpage, New York

BIRTHPLACE AND DATE: Born June 14, 1929, Brooklyn, New York

EDUCATION: Bachelor Mechanical Engineering, Cornell University (1951); Master of Science, Mechanical Engineering, Columbia University (1956); Graduate study at Ohio State University and Polytechnic Institute of Brooklyn.

MARITAL STATUS: Married to the former Joan Tantum. They have six children.

ORGANIZATIONS: Member of AIAA (American Institute of Aeronautics and Astronautics), American Society of Mechanical Engineers (ASME). Active in AIAA affairs.

MILITARY SERVICE: Served as 1st Lt. in United States Air Force as Performance Engineer from June 1956 to April 1958.

BACKGROUND: Mr. Kelly is a member of Tau Beta Pi, Pi Tau Sigma, Quill and Dagger (all honorary societies).

Thomas J. Kelly has been involved in the Apollo Program at Grumman since its inception in 1960 in the form of manned spacecraft feasibility studies. He directed numerous company-sponsored studies prior to the Apollo Spacecraft proposal and was Project Engineer for the Apollo Spacecraft effort. Subsequently, he was Preliminary Design Engineer on the LM pre-proposal studies and the proposal to NASA. Since the award of the LM contract to Grumman, he has served as Project Engineer, Engineering Manager and Vehicle Test Manager for the LM Program and in his current capacity as Assistant Program Director – Engineering, he is responsible for all spacecraft engineering activity on the LM.

Prior to his involvement with the Apollo program, he was a propulsion engineer with Grumman on the Rigel missile (1951-53) and F11F aircraft programs (1953-56), and with Lockheed in space propulsion system development (1957-58).

He and his family reside in Huntington, New York.

A BRIEF HISTORY OF GRUMMAN AIRCRAFT ENGINEERING CORPORATION

Grumman has come a long way since it opened shop in a rented garage in 1930. Its six founders and 15 employees, within a year, fulfilled their first government contract: delivery of two amphibious aircraft pontoons. Today, with more than 35,000 employees in 35 Long Island plants and 25 field locations, the Corporation is involved in research, development, and production programs that encompass spacecraft, aircraft, support equipment, land vehicles, surface vessels, and submersibles.

The story of Grumman military aircraft begins in 1933 with the development of the FF-1 (a Navy biplane fighter) and proceeds to the Navy's *Intruders*, the Army's *Mohawks*, and the current Navy F-14A.

As part of the current space effort, Grumman designed and is constructing the Lunar Module (LM), the moon-landing vehicle in the NASA Apollo program.

The Corporation produced the *Denison* hydrofoil boat for the U.S. Maritime Administration, the *Dolphin* hydrofoil for commercial service, and the *PG(H) Flagstaff*, a military hydrofoil. For undersea research, a Grumman/Piccard research submersible, the *Ben Franklin*, is being prepared for its initial Gulf Stream Drift Mission.

In commercial aviation, Grumman is producing the *Ag-Cat* for crop dusting and spraying, and the highly successful turboprop executive aircraft, *Gulfstream I*, and the new and faster fan-jet version, *Gulfstream II*.

Finally, in seemingly less exotic efforts, Grumman Allied Industries is producing truck bodies, aluminum canoes, and fiberglass boats.

But this takes us ahead of the Grumman story.

Early in its existence, the Corporation developed a reputation for excellence in design and manufacture of aircraft, qualities that came to the forefront during the Second World War. Not only did Grumman build and deliver more than 17,000 combat planes during that period, but it won five Navy "E" production awards, received a Presidential Medal of Merit, and established an unequalled military production record (more than 600 *Hellcats* in just one month from a single plant). Grumman *Hellcats, Wildcats,* and *Avengers* accounted for about two-thirds of the enemy aircraft destroyed in the Pacific Theater.

Grumman also has an admirable record in the commercial field. Beginning in 1936 with the appearance of the amphibious *Goose* and through the present-day success of the *Gulfstream II* – a twin-jet corporate transport – Grumman's commercial craft have established a worldwide reputation for service and durability.

APOLLO NEWS REFERENCE

The coming of the space age has produced the greatest continuing period of expansion at Grumman since World War II. Its present growth program has established Long Island as one of the prime technological sources for support of the United States in space.

In 1960, the National Aeronautics and Space Administration (NASA) awarded Grumman its first aerospace contract for development of the Orbiting Astronomical Observatory (OAO).

The most far-reaching aerospace contract was awarded in 1962, when NASA selected Grumman to develop the LM. The LM will land two American astronauts on the surface of the moon before the end of this year. Recently Grumman received a contract for LM-A, the control station for the Apollo Telescope Mount (ATM) to be used as part of NASA's Saturn I Workshop.

The Corporation is also conducting NASA-sponsored advanced research programs to investigate future adaptations of the LM, as well as a vehicle to traverse the lunar surface.

The Grumman Aircraft Engineering Corporation provides a wide variety of products for Army, Navy, Marine, NASA, and commercial activities. The Corporation played a major role establishing Long Island as the cradle of aviation; its continuing, advanced research and development programs in the aerospace field enhance that reputation.

A BRIEF HISTORY OF THE APOLLO LUNAR MODULE

It has been nearly eight years since Grumman Aircraft Engineering Corporation undertook the responsibility of designing, developing, and manufacturing the Apollo Lunar Module for the National Aeronautics and Space Administration.

In 1958, after many years as a producer of aircraft for the United States Navy, Grumman began studies on manned space flight programs. The Corporation submitted a spacecraft proposal for Project Mercury, but, primarily because of prior Navy aircraft production commitments, the bid was unsuccessful.

In early 1960, Grumman submitted a preliminary study on Project Apollo. At that time, the Earth Orbit Rendezvous (EOR) theory for a lunar landing was most prevalent. When NASA held a competition, Grumman and International Telephone and Telegraph presented results of their combined studies. They were unsuccessful in this bid for the project.

By 1961, Grumman, convinced they had the ability to build dependable spacecraft, submitted the results of in-house studies to NASA. In October of that year, NASA held a competition for Apollo hardware. Again, Grumman, this time in conjunction with General Electric, was unsuccessful.

In mid-1962, thoroughly convinced that Lunar Orbital Rendezvous (LOR) was the best method to effect a lunar landing, Grumman launched a feasibility study on LOR. NASA then asked for proposals involving use of the LOR concept and the Lunar Excursion Module. Grumman submitted its proposal in September 1962, with RCA as principal subcontractor. NASA Administrator James E. Webb, now retired, emphasized at the time that only since July had NASA committed itself to "lunar orbit rendezvous" using the advanced Saturn booster. More than a million man-hours had gone into studies of how to get men to the moon and back.

On November 7, 1962, NASA issued the following news release:

> "Grumman Aircraft Engineering Corporation, New York, today was selected to build Project Apollo Lunar Excursion Module – a spacecraft in which Americans will land on the moon and return to a moon orbiting mother craft for the journey back to earth".

By November 18, 1962, a team of Grumman engineers was in Houston working with NASA, even though the contract still was being negotiated.

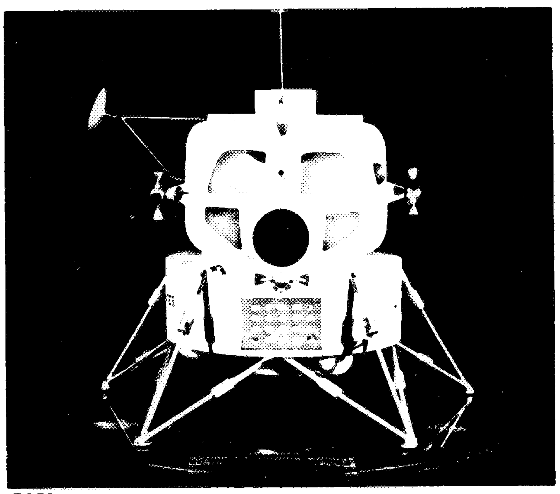
Items listed in the news release included:

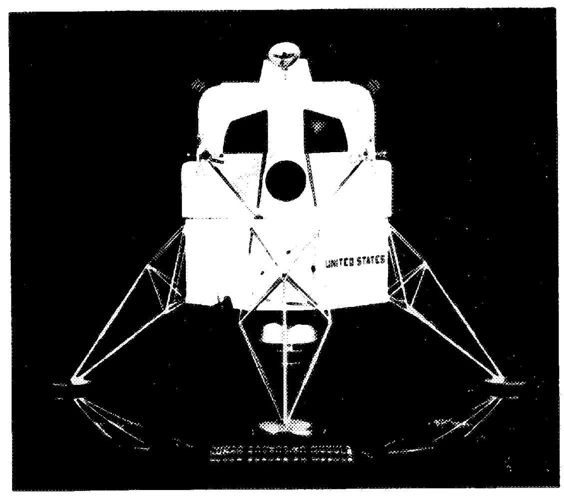
- A three-stage Saturn with first-stage thrust of 7.5 million pounds
- A 5-ton Command Module (now 6½ tons)
- A 25-ton Service Module (now 27½ tons)
- A 12-ton Lunar Excursion Module (now 16 tons)

The NASA release went on to say, "LEM will look something like the cab of a two-man helicopter, measuring 10 feet in diameter and standing about 15 feet tall on its skid-type legs". (It now measures 31 feet, legs extended, and stands 23 feet tall.)

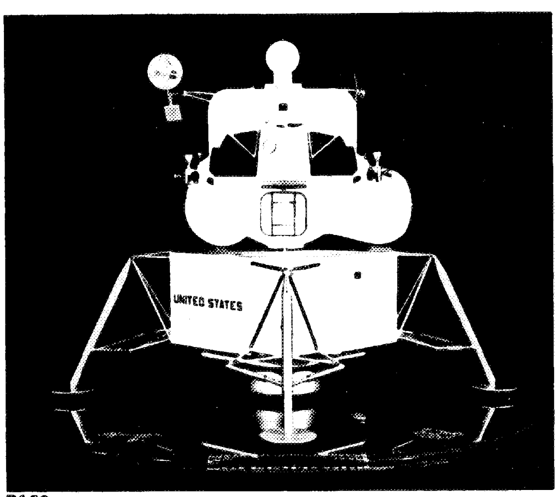
Many facets of the module have changed from the initial drawings and proposals made in 1960, even its name. NASA dropped the "E" (for "Excursion") in LEM in 1967.

Today, the $1.61 billion cost incentive contract calls for Grumman to design, develop, and manufacture 15 Lunar Module (LM) flight vehicles, 10 Lunar Module Test Articles (LTA's), and two simulators. More than 5,000 people are employed by Grumman on the Apollo Program at Bethpage, New York; White Sands, New Mexico; Cape Kennedy, Florida; and Houston, Texas.

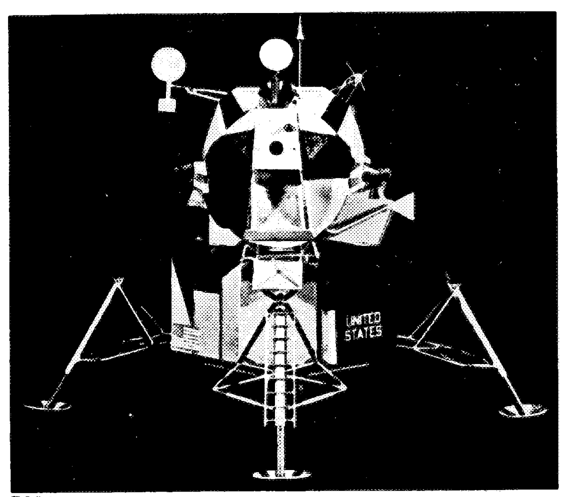

R151 *1962*



R152 *1963*



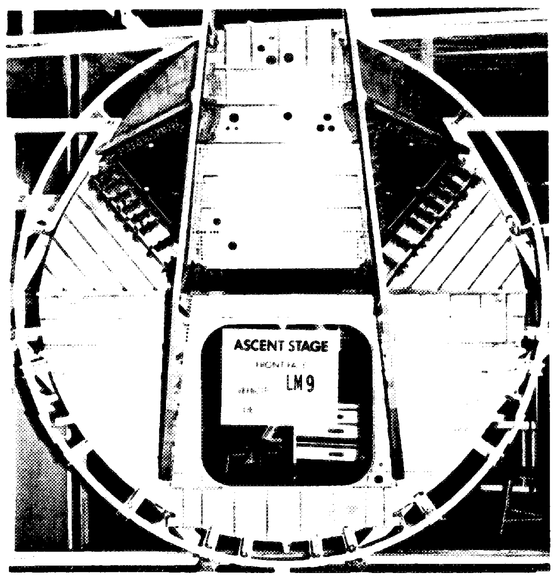
R153 *1965*



R154 *1969*

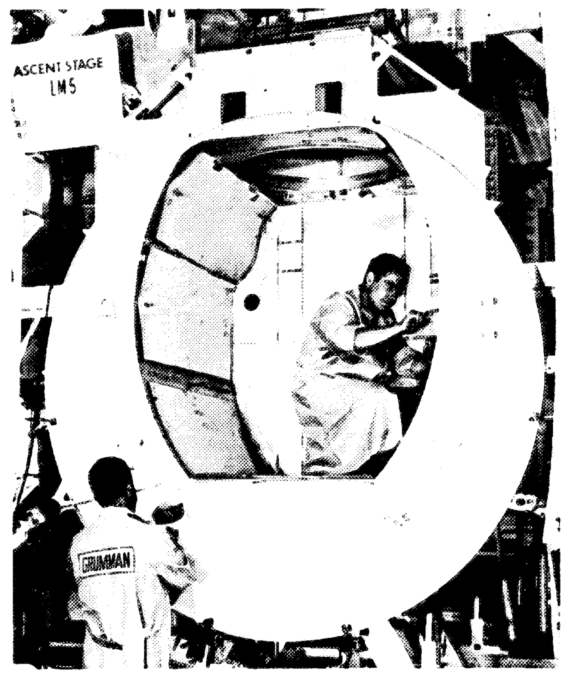
LM MANUFACTURING

The ascent stage of the Apollo Lunar Module (LM) is the control center and manned portion of the space vehicle. Its three main sections are the crew compartment, midsection, and aft equipment bay and tank section. The crew compartment and midsection make up the cabin. The ascent stage structure consists of the following subassemblies: front face, cabin skin, midsection, and aft equipment bay. The cabin skin subassembly is fabricated from formed chem-milled skin panels that are welded and mechanically fastened.



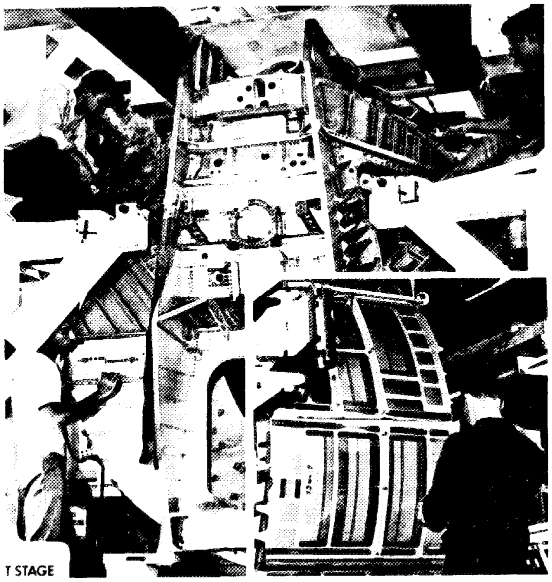
R-122

The front face of the ascent stage is fabricated from chem-milled skin panels that are welded and mechanically fastened. Sealing the mechanical joints, trimming the forward face contour, and adding formed longerons and stringers complete the operations for this assembly.



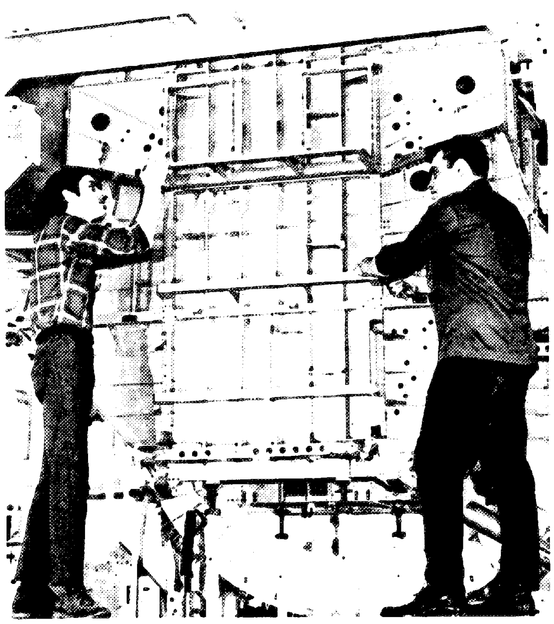
R-123

The midsection consists of two machined bulkheads, an upper deck tunnel weldment, a lower engine deck weldment, and chem-milled skins.



R-124

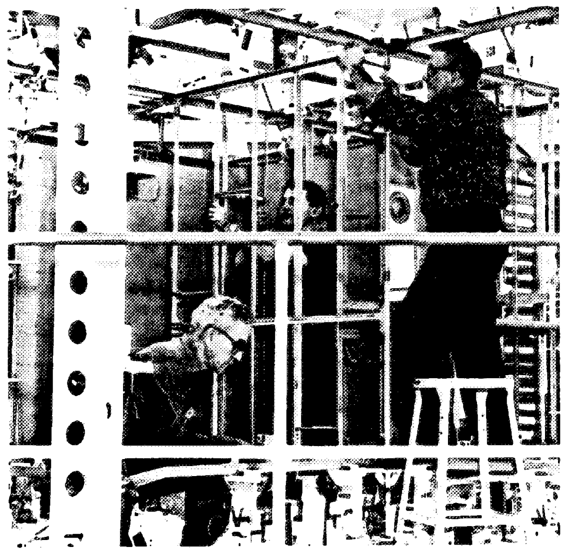
The front face assembly and cabin skin subassembly are mechanically joined with the midsection and are sealed to form the cabin pressure shell of the ascent stage.



R-125

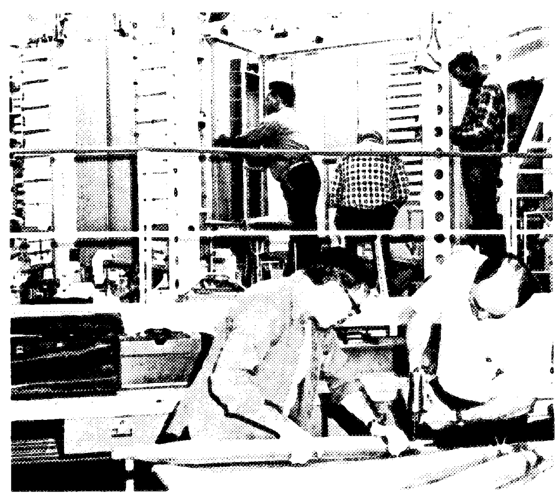
Cold rails, chem-milled beams, struts, and machined fittings comprise the major structural components in the aft equipment bay.

The descent stage is the unmanned portion of the LM. It consists primarily of machined parts and chem-milled panel/stiffener assemblies that are mechanically fastened. Compartments formed by the structural arrangement house the descent engine, and propellant, helium, oxygen, and water tanks.



R-126

Fabrication of the descent stage begins with the joining of the machined "picture frames" and the chem-milled panel/stiffener assemblies to form the engine compartment.



R-127

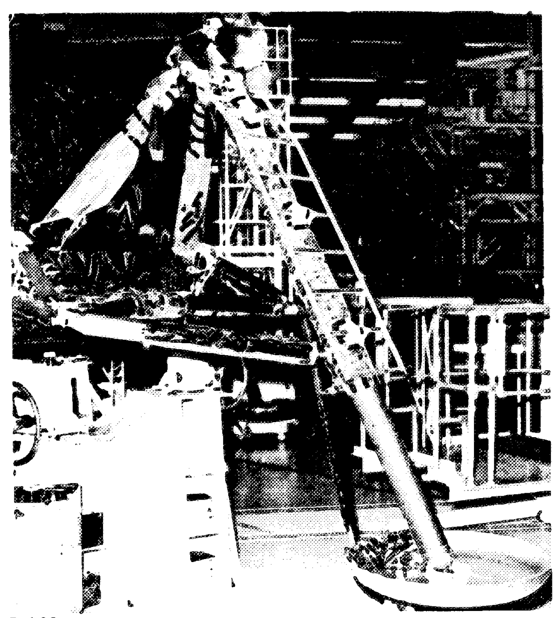
After the outrigger bulkhead assemblies are attached to the engine compartment with machined cap strips, the eight remaining panel/stiffener assemblies are added.

The cantilever-type landing gear is attached externally to the descent stage and folds inward to fit within the shroud of the Saturn V aerodynamic shell. The landing gear consists of four sets of legs connected to outriggers that extend from the ends of the descent stage structural beams.

R-128

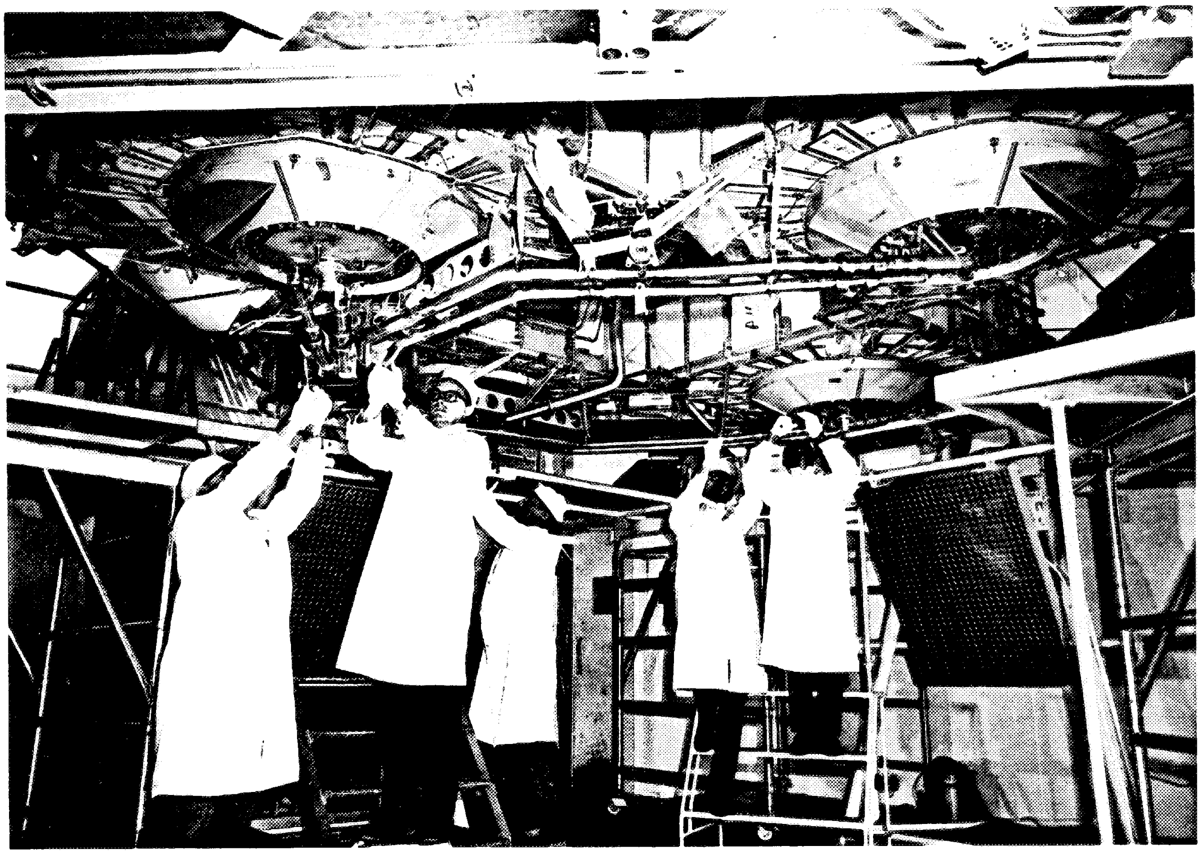
With the addition of the upper and lower machined decks and the machined interstage fittings, the completed descent stage structure is moved to the clean room facility.

Each landing gear consists of a primary strut and foot pad, two secondary struts, an uplock assembly, two deployment and downlock mechanisms, a truss assembly, and a lunar-surface sensing probe. A ladder is affixed to the forward leg assembly. The struts are machined aluminum with machined fittings mechanically attached at the ends.



R-129

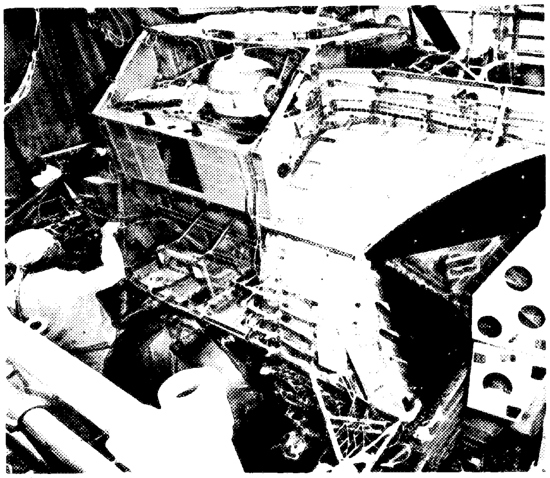
The Descent Propulsion Section consists of two fuel and two oxidizer tanks centered about a deep-throttling ablative rocket engine which has restart capabilities.



R-130

After the descent stage has been moved to the clean room facility, interconnecting gas and liquid balance lines for like tanks are installed.

The Ascent Propulsion Section uses a fixed, constant-thrust rocket engine. The section includes the associated ambient helium pressurization and propellant supply components.

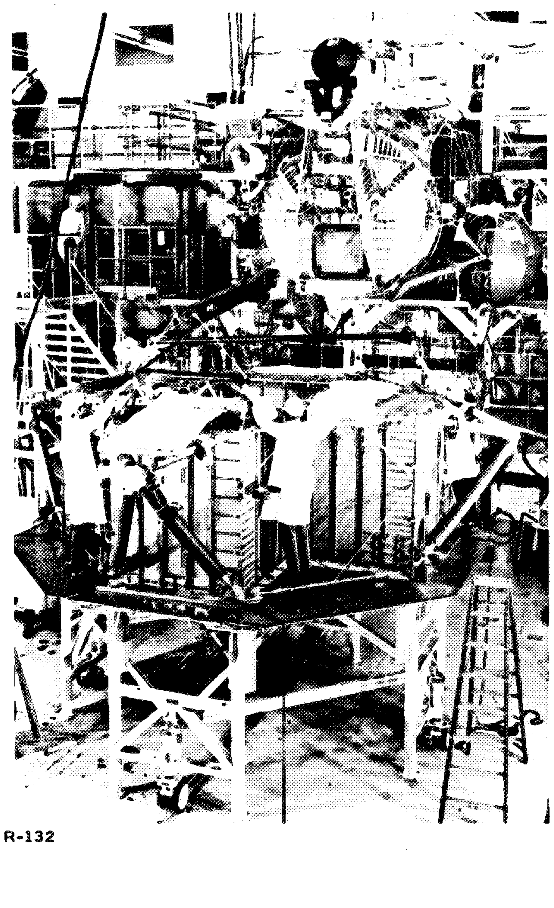


R-131

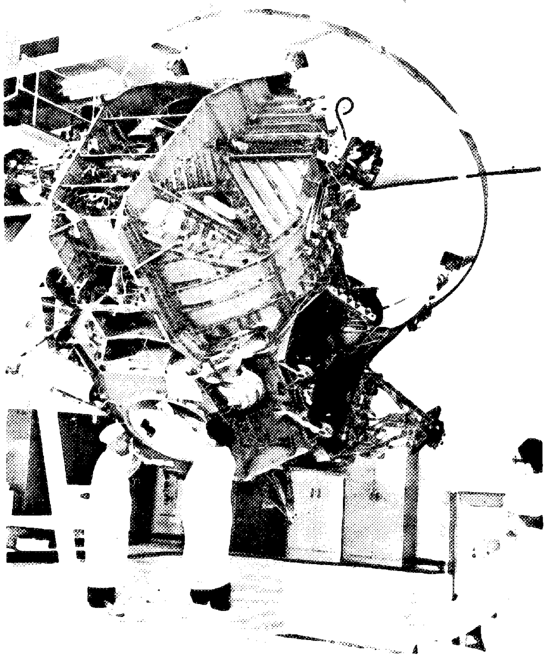
With the installation of the various electrical and electronics components and associated wiring, the two stages of the LM are tested and checked out separately.

Two main propellant tanks are used; one for fuel, the other for oxidizer. The tanks are installed on either side of the ascent stage structure.

The ascent and descent stages are then mated and further checks are made on the entire spacecraft.



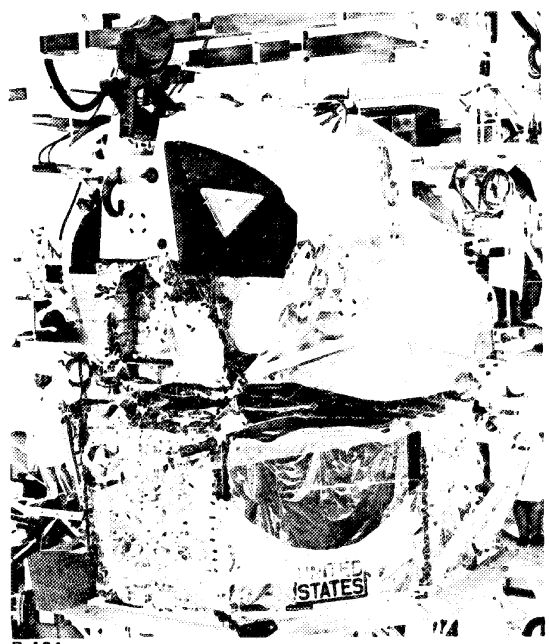
R-132



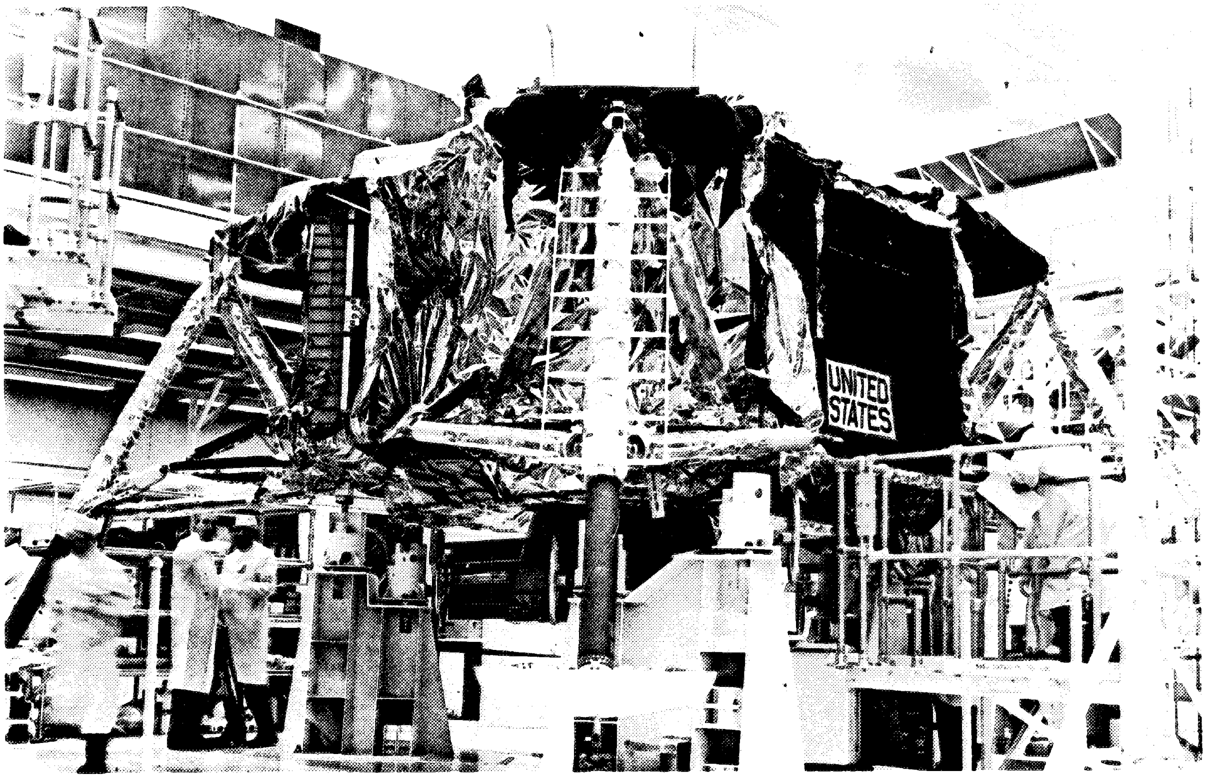
R-133

Although strict cleanliness procedures are followed while the LM is under construction and test, one last clean and rotate check is made. Loose material overlooked by the quality control teams will be dislodged and removed during this process.

When all components of the LM subsystems have been verified, the installation of thermal blankets and micrometeoroid shielding begins. The spacecraft is now ready for Final Engineering and Acceptance Testing.

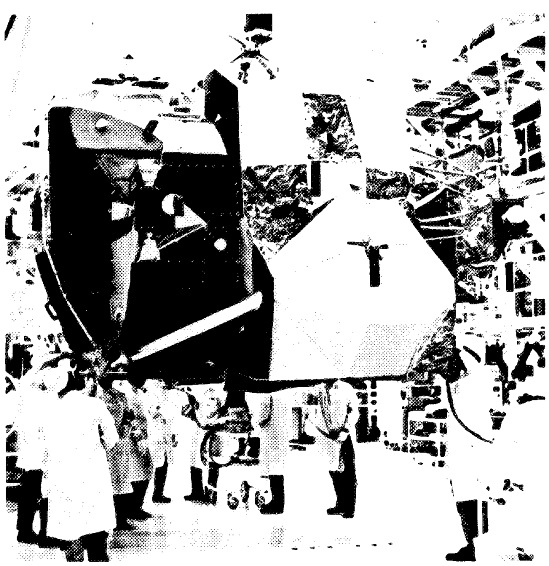


R-134



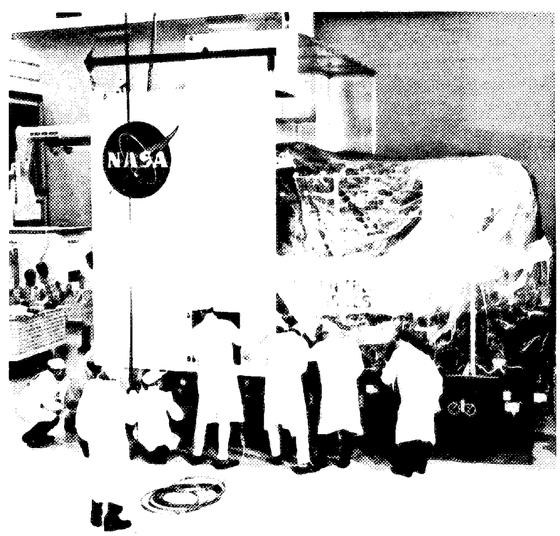
R-135

Prior to shipment, the stages of the Lunar Module are separated and a landing gear deployment check is made. The landing gear is then removed prior to the LM being put into a protective container.

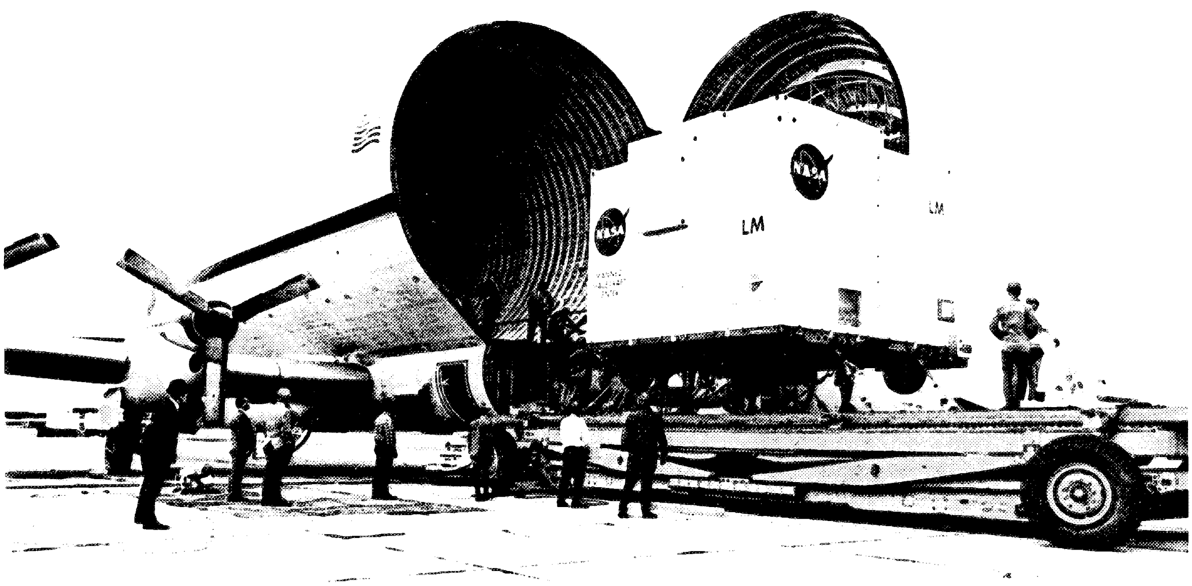


R-136

The Lunar Module ascent stage is then prepared for shipment. Technicians verify that all components are properly secured.



The stages are put into protective containers. When the entire stage has been encased, dry nitrogen is pumped into the container and maintained at positive pressure during the flight to NASA Kennedy Space Center.



R-138

The separately packaged Lunar Module stages are placed aboard the Super Guppy aircraft for the flight to NASA Kennedy Space Center.