APOLLO 11

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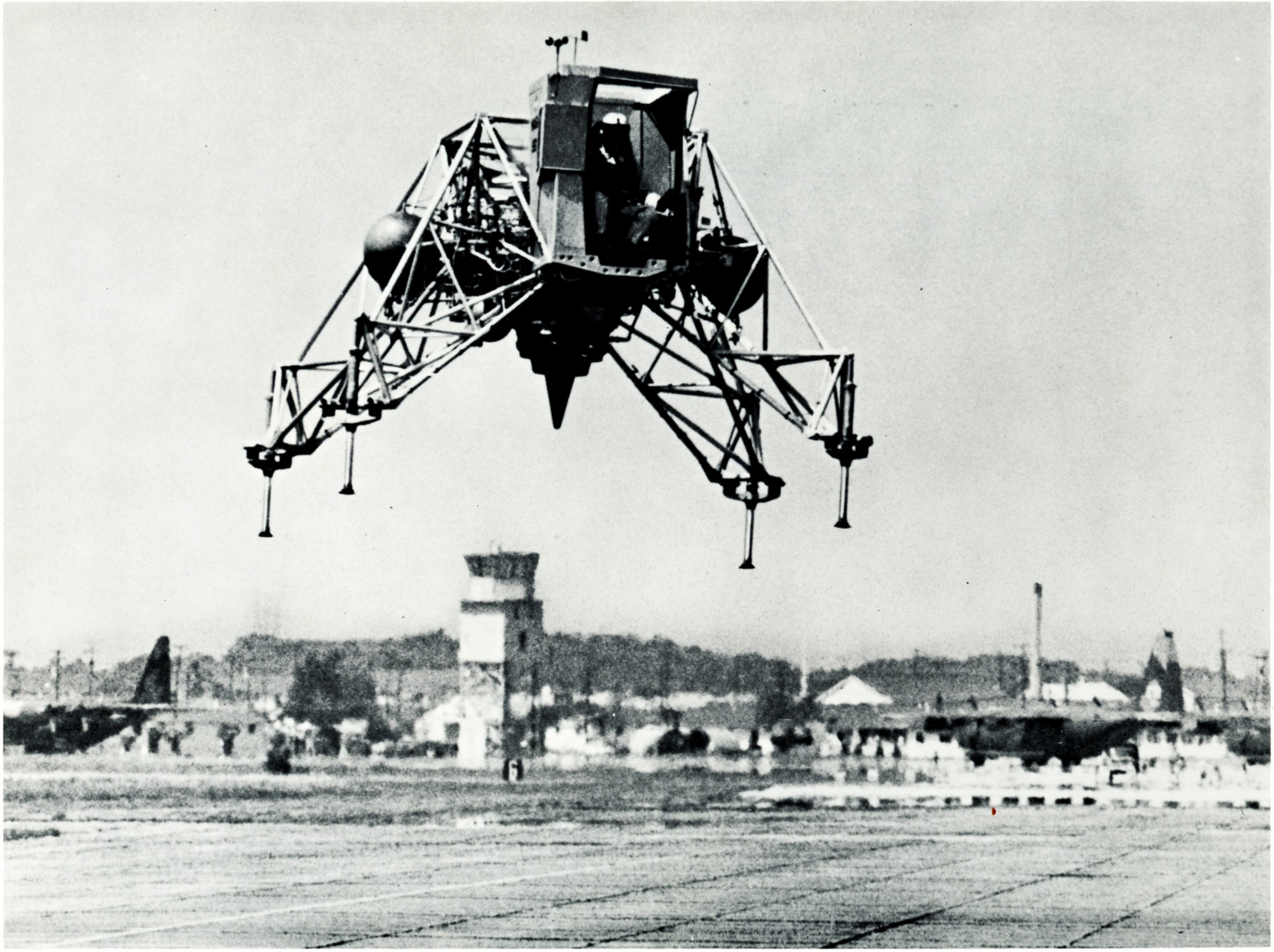
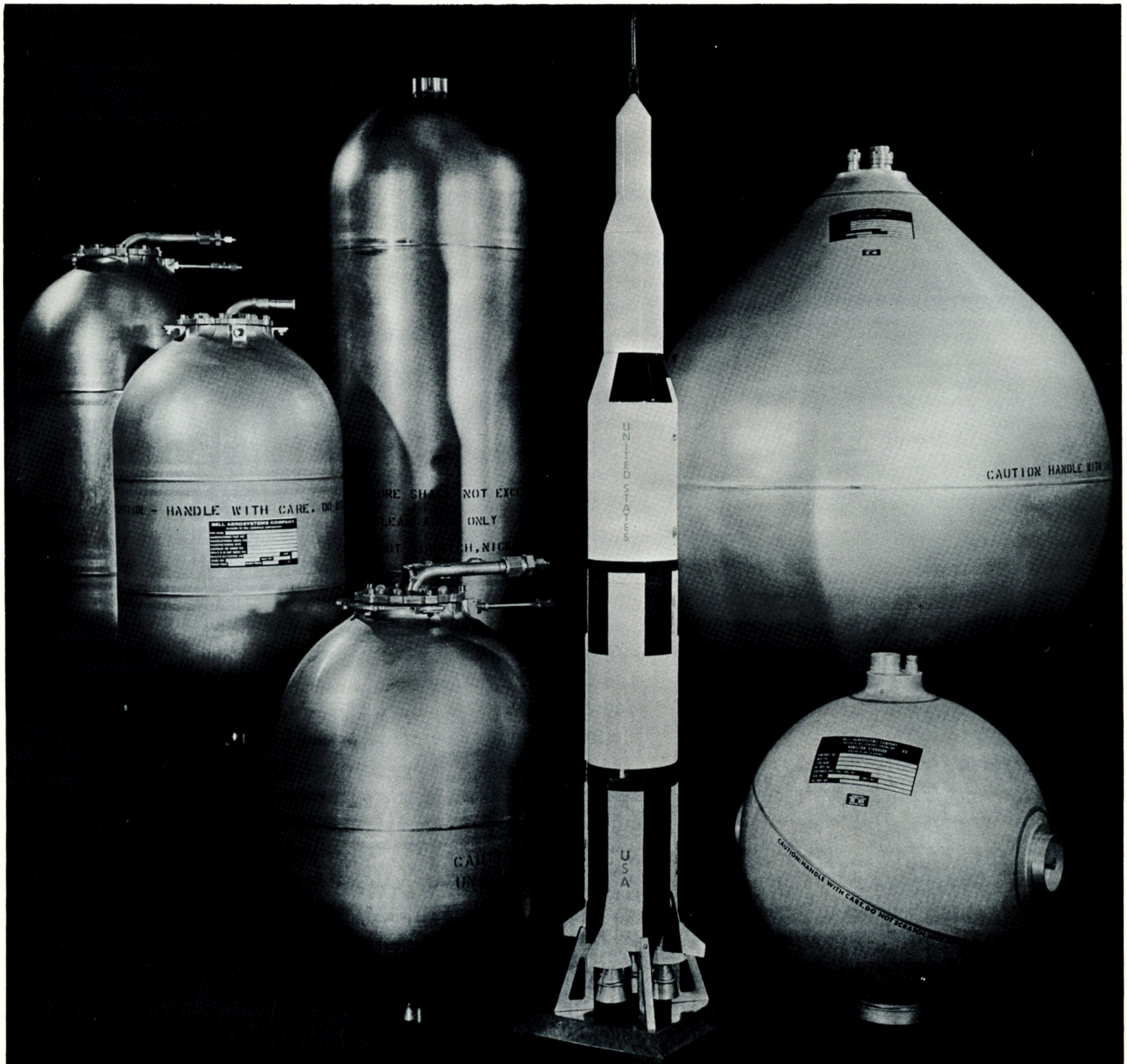
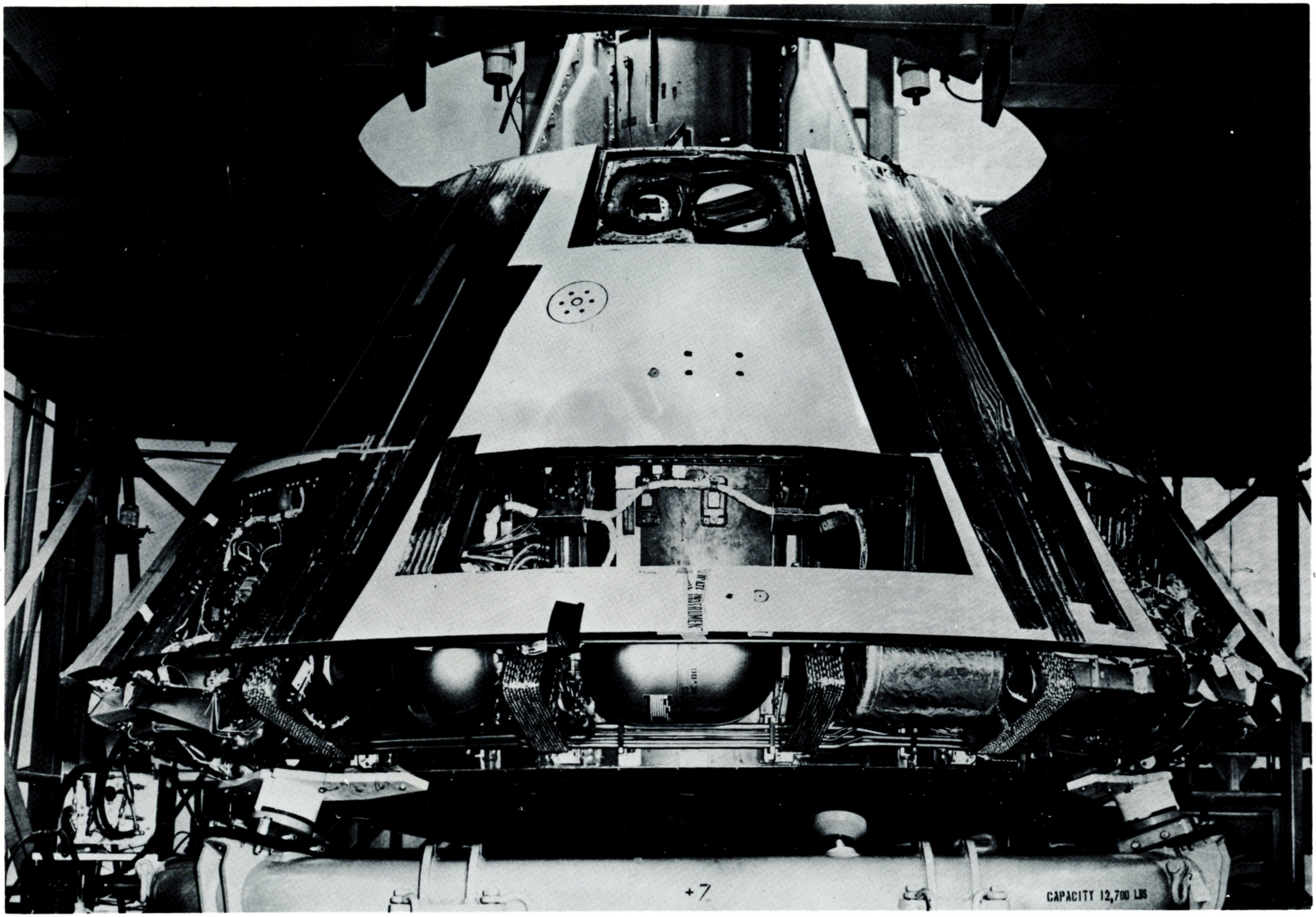


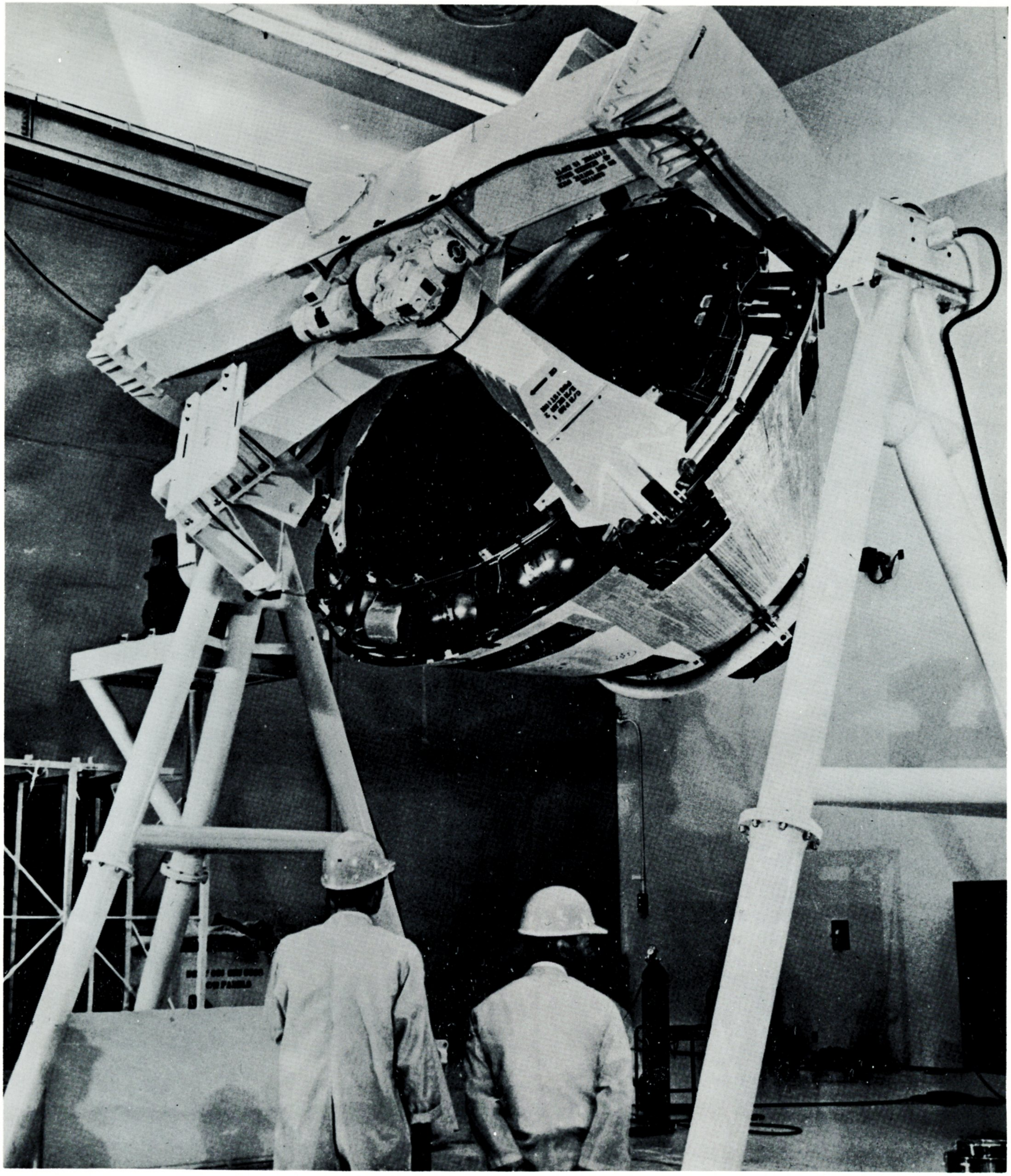
ASTRONAUT NEIL ARMSTRONG, commander of Apollo 11, practices techniques of a lunar approach and landing in the Lunar Landing Training Vehicle (LLTV) at Ellington Air Force Base near Houston, Texas. Armstrong, who completed a series of seven LLTV flights on June 16, said: "I'm very pleased with the way it flies... I think it does an excellent job of actually capturing the handling characteristics of the Lunar Module in the landing maneuver." The LLTV was designed and built by Textron's Bell Aerosystems Company at Buffalo, New York. (Photo No. 306524-3)



Surrounding a four-foot-high model of the Apollo/Saturn V launch vehicle are a few of the various sizes and shapes of positive expulsion tanks provided by Textron's Bell Aerosystems Company of Buffalo, N.Y. To the right of the model are the two configurations of water tanks for the Lunar Module's environmental control system. Various propellant tanks for the Apollo Command, Service and Lunar Modules and Saturn S-IVB stage are to the left of the model. (Photo No. 218991)



Positive expulsion tanks, which contain the fuel and oxidizer for the reaction control system, are shown in the lower section of this Apollo Command Module in the clean room at North American Rockwell's Space Division, Downey, Calif. Textron's Bell Aerosystems Company of Buffalo, N.Y. supplies a total of 31 positive expulsion tanks for the Apollo Command, Service and Lunar modules and for the Saturn S-IVB stage. (Photo No. C-25621)



The four positive expulsion tanks which supply propellants to the reaction control system of the Apollo Command Module are visible in the lower portion of this spacecraft as it receives final tumbling test at North American Rockwell's Space Division, Downey, Calif. The tanks, which provide maximum utilization of the propellants on board the spacecraft under zero gravity conditions, are provided by Textron's Bell Aerosystems Company of Buffalo, N.Y. (Photo No. C-25620)

TYPICAL LUNAR LANDING SIMULATION WITH LUNAR LANDING TRAINING VEHICLE

To begin an actual lunar landing simulation, the pilot takes off and climbs for about two minutes to an altitude of 400 feet on the power of the main jet engine. As he approaches this altitude, he tilts the vehicle forward approximately five degrees in order to develop enough forward velocity to begin simulation. As this velocity is achieved, the vehicle is returned to near vertical position for the initial portion of the simulated lunar trajectory.

The two 500-pound lift rockets are fired to activate the weight and drag computer which begins controlling the jet thrust automatically to support five-sixths of the vehicle weight. The vehicle attitude and rocket thrust is varied to maintain the planned flight path. About 100 feet above the ground, the rocket thrust and pitch attitude are increased to reduce the rate of descent and forward velocity. As the forward velocity stops, the vehicle's attitude is reduced to vertical and final touchdown is controlled with small rocket thrust changes.

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7/11/69-34

FOR IMMEDIATE RELEASE

FROM: News Bureau
BELL AEROSYSTEMS COMPANY
A Textron Company
Buffalo, New York 14240
Phone: 716-297-1000

Rocket propellants for all Apollo 11 reaction control systems and water for the Lunar Module's environmental control system will be provided from 31 positive expulsion tanks designed, built and flight qualified by Textron's Bell Aerosystems Company of Buffalo, New York.

The precision-made Bell Aerosystems positive expulsion devices aboard moon-bound Apollo 11 include:

Two fuel and two oxidizer tanks in the Command Module.

Eight fuel and eight oxidizer tanks in the Service Module.

Two fuel and two oxidizer tanks in the Lunar Module.

Two fuel and two oxidizer tanks in the Saturn S-IVB Auxiliary Propulsion System.

Three water tanks for the Environmental Control System of the Lunar Module (one for the descent stage and two for the ascent stage).

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Positive expulsion devices are required in space vehicles because the liquids do not flow naturally toward the tank outlet as they would on earth. Instead, under the zero or less-than-earth gravity conditions of space flight, the fluids may float around in clumps, or bunch up at one end or cling to the tank's inner wall.

Therefore, liquids have to be squeezed out of the tanks, much the same as one would force toothpaste out of a tube.

Each Apollo propellant tank is a cylindrical shell made of titanium alloy. Inside each tank is a flexible Teflon bladder which contains the propellant. Running longitudinally through the center of the tank inside the flexible bladder is an aluminum tube--called a diffuser--which is perforated with hundreds of tiny holes smaller than a pinhead.

When the fuel or oxidizer is required, compressed helium gas is driven into the space between the outside of the bladder and the inner wall of the tank, squeezing the bladder. The propellant, in turn, is forced into the diffuser tube and to the reaction control thrusters.

The flow can be shut off at any time by closing the valve between the tank and the thruster. Because pressure from the helium gas continues on the outside of the bladder, the flow can be resumed instantly by reopening the valve.

The Bell water tanks will be used in the lunar-landing spacecraft to supply the water required for drinking and food preparation and for cooling the heat transfer section coolant during LM operations.

Water is stored in three separate tanks. The largest, located in the descent or lower section of the Lunar Module, holds 333 pounds of water. Two smaller tanks, carrying 42.5 pounds of water each, are located in the ascent stage. Each tank consists of an aluminum outer shell with a flexible bladder inside that holds the water. Nitrogen pressure between the bladder and shell forces the water out of the tanks to a regulating and distribution system.

Bell tanks in tests have repeatedly expelled up to 99 per cent of their contents. Cycle life of 50 expulsions also have been demonstrated.

Design and production of positive expulsion tanks has been a major effort at Bell Aerosystems since the company's entry into the rocket propulsion field some 18 years ago.

Since the advent of space exploration, Bell has made important contributions in the design of positive expulsion tanks for operation under zero and low gravity conditions.

Other programs which utilize Bell Aerosystems positive expulsion tanks include Lunar Orbiter, Centaur, Minuteman and Gemini and Mercury manned space missions.

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BELL AEROSYSTEMS COMPANY
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HOUSTON, TEXAS -- As the Apollo astronauts maneuver their Lunar Module (LM) the final few hundred feet to the first lunar landing, the command pilot will be relying on experience gained in a unique, space-age training vehicle being operated by the National Aeronautics and Space Administration's Manned Spacecraft Center.

Designated the Lunar Landing Training Vehicle (LLTV), the wingless trainer is a free-flying, highly-instrumented platform from which astronauts can conduct simulated moon landings on Earth.

Designed and built by Textron's Bell Aerosystems Company of Buffalo, N. Y., the LLTV is the only free-flying simulator of its type in the world. Astronaut Neil Armstrong, the Apollo 11 commander, practiced the critical final 400 feet of an actual lunar landing during training flights here last month.

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Before flying the LLTV, astronauts receive extensive training in helicopters, tethered flight simulators and ground-based laboratory simulators. However, to insure the pilot proficiency demanded by the lunar landing phase of the Apollo mission, LLTV training for LM commanders is desirable. Astronaut Edwin Aldrin is the LM pilot for Apollo 11. He and Astronaut Armstrong are scheduled to make the first lunar landing.

The LLTV resembles the Lunar Module in many ways. A major difference is that the LLTV incorporates a jet engine. This engine--a throttleable and automatically controlled 4,200-pound thrust turbofan--lifts five-sixths of the vehicle's weight. Mounted vertically in the LLTV, the engine is gimballed to maintain a vertical lift vector at all times. During attitude changes lift for the remaining one-sixth weight is furnished by two 500-pound thrust rocket engines which the astronaut uses to control his descent in much the same manner as he would use the LM descent engine in an actual lunar landing.

Sixteen smaller rockets clustered in fours around the LLTV are fired as needed to achieve attitude and directional control. These reaction control thrusters operate like those aboard the LM.

With this combination of propulsion systems, the LLTV can hover, fly horizontally, perform pitch and roll maneuvers and yaw a full 360 degrees.

In flight, the LLTV's responses to control inputs are similar to those of the Lunar Module.

Another subsystem measures aerodynamic forces, such as wind gusts, and automatically gimbals the turbofan lift engine to neutralize these forces on the vehicle during flight.

Physically, the LLTV is structured much like the "spider-like" Lunar Module. The 11 foot 4 inch high trainer is supported by four slender truss legs. The LLTV's cockpit contains controls and instrument panels similar to those the LM commander will use during an actual lunar landing. The LLTV, however, accommodates only one pilot instead of the two that will be in the moon landing vehicle.

Of the three LLTVs delivered by Bell to NASA in late 1967, one completed 12 flights before crashing December 8, 1968 during a checkout flight. Its NASA test pilot parachuted to safety.

Of the two remaining LLTVs, one is operational and the other is undergoing preliminary ground tests.

Since October 1968, the operational LLTV has completed more than 30 preliminary test flights, and has logged approximately two hours of total flight time. The longest flight to date has been approximately seven minutes.

Prior to the LLTV, Bell Aerosystems also developed a Lunar Landing Research Vehicle (LLRV) for NASA. It served primarily to establish the feasibility of the concept. Although configured much like the LLTV, the LLRV was not capable of simulating all the control and handling characteristics of the Lunar Module.

Bell built two LLRVs for NASA. One crashed during a test flight in May 1968. Its pilot, Astronaut Armstrong, parachuted to safety.

Subsequent investigations of both the LLRV and LLTV accidents by NASA officials revealed no systems malfunctions in either vehicle.

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BELL AEROSYSTEMS COMPANY AND APOLLO 11

For Textron's Bell Aerosystems Company of Buffalo, New York, Apollo 11 represents a major test for all five aspects of the company's role in the lunar landing mission.

A variety of Apollo-oriented assignments have earned Bell equipment and technology roles extending from lift-off to splashdown.

In addition to the Lunar Landing Training Vehicle (LLTV) and the development of Lunar Module (LM) Ascent Engine, Bell's role includes a family of zero-gravity propellant and water tanks, a series of computer structural analyses and the Lunar Module Rendezvous Simulator.

As the astronauts maneuver their LM the final few hundred feet to their historic landing, they will be relying on experience gained in a unique, wingless trainer developed by Bell for the National Aeronautics and Space Administration's Manned Spacecraft Center.

Designated the LLTV, it is the only free-flying simulator of its type in the world.

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Apollo 11 Commander Neil Armstrong utilized it to practice the critical last 400 feet of an actual lunar landing during training flights at Ellington Air Force Base, Texas, last month.

Propelling the astronauts in the LM ascent stage from the moon's surface will be a 3,500-pound thrust rocket engine that Bell designed and helped develop. The Ascent Engine is particularly vital to the success of Apollo 11 for it must function properly the first time because, unlike many of LM's other subsystems, there is no back-up ascent propulsion system.

A valve redundancy design provides this critical powerplant with an ultra-high level of reliability.

Capable of multiple restarts and a total burn time of approximately 10 minutes, the Ascent Engine was first fired in space during the Apollo 5 mission in 1968. It also registered successful firings on the other two missions in which it was involved--Apollo 9 and 10.

At one time, more than 700 Bell Aerosystems' employes were directly involved in the Ascent Engine development program.

As a result of an accelerated design modification program completed in October 1968, Bell engineers directed a significant weight reduction program. They were able to reduce the engine's thrust chamber weight by some 33 pounds.

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Undertaken in conjunction with an overall effort to meet reduced LM weight specifications, Bell's success was due largely to the company's ability to extrapolate data from its other rocket propulsion systems research and development programs.

The injector, final assembly and test of the Ascent Engine are now provided by the North American Rockwell Rocketdyne Division.

As the Ascent Engine boosts the LM into lunar orbit for its rendezvous with the Apollo 11 Command Module, the astronauts will be utilizing experience acquired from another advanced Bell trainer--the Lunar Module Rendezvous Simulator (LMRS).

An earlier version of this simulator was used by NASA as an engineering tool and by Gemini astronauts to practice rendezvous and docking procedures.

Located at NASA's Manned Spacecraft Center, the LMRS electronically generates all the visual out-the-window sensations experienced by astronauts in the Lunar Module during an actual link-up with the Command Module above the moon.

The system employs a computer to constantly update its television display simultaneous with the control inputs generated by the operator in a laboratory LM simulator. With the LMRS, an operator has a full 360 degrees of flight freedom. He can view the command module and approach it from a distance of 10,000 feet.

Bell engineers will begin their Apollo 11 watch at liftoff, when their attention will be focused on the third stage of the gigantic Apollo space vehicle. They have scrutinized the structural integrity and stability of this section through the microscopic "eyes" of a specially-developed program.

The analyses were conducted in 1968 under two NASA contracts. Utilizing its General Purpose Structural Analysis Computer Program--one of the few in the world capable of performing such large-scale computations--Bell Aerosystems completed the complex task of simultaneously tracing and defining the thermal and mechanical stresses at some 5,000 key points throughout the intricate framework of the Apollo spacecraft Service Module, Lunar Module, and Command and Service Modules.

Under a companion contract, stability studies were conducted on the Apollo S-IVB forward skirt, Instrument Unit, Lunar Module Adapter and Command/Service Modules.

The analyses were designed to chart the internal load distributions to locate any potentially dangerous structural situations which may occur on this upper-most stage during the launch phase of a mission when vibrations and structural temperatures are at their maximum.

During their analyses, Bell reconstructed a mathematical model of the Apollo third stage within a computer and then subjected this model to all the thermal and mechanical load conditions of an actual lift-off.

Nine days after lift-off, Bell technology will perform its final function as the Apollo 11 astronauts align their spacecraft in the proper attitude for reentry into the earth's atmosphere. For this maneuver, four of Bell's 31 positive expulsion tanks aboard Apollo 11 will support the Command Module's reaction control system which the astronauts will use to control the attitude of their spacecraft during their 25,000-mile per hour return to earth.

In addition to supplying fuel and oxidizer to the Command, Service, and Lunar Module rocket-powered reaction control systems and the Saturn S-IVB's auxiliary propulsion system, Bell's positive expulsion tanks supply water for the Lunar Module's Environmental Control System.

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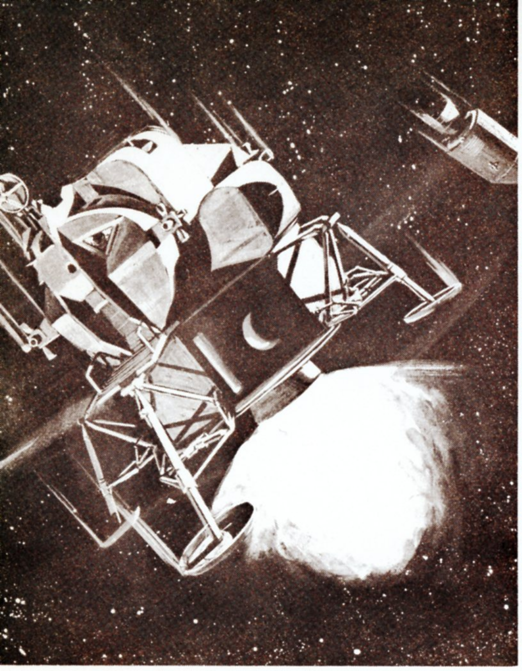

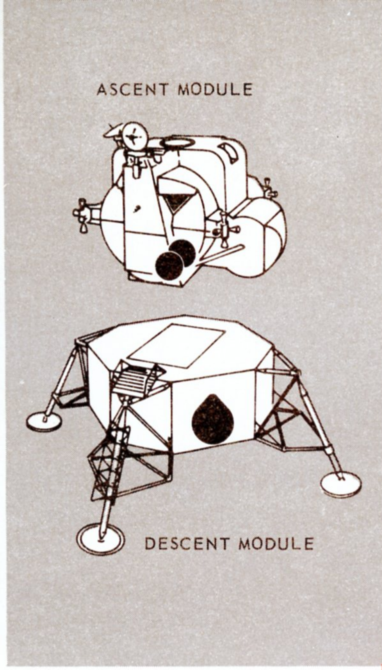

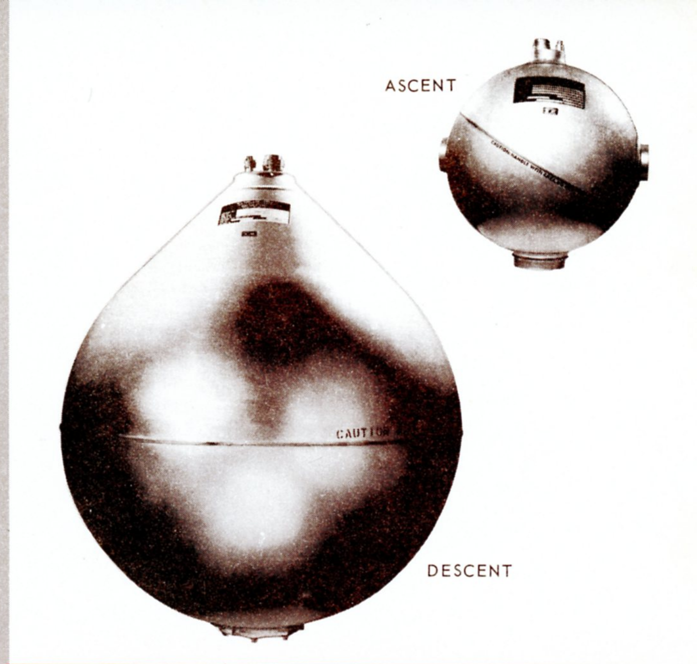

Apollo Lunar Module Water Tanks

Textron's Bell Aerosystems Company was selected by Hamilton Standard Division of United Aircraft Corporation to develop the positive expulsion water tanks for the environmental control system of Project Apollo's Lunar Module (LM). The LM is that portion of NASA's three-module, manned spacecraft which will land on the moon. Grumman Aircraft Engineering Corporation is prime contractor for the Lunar Module.

Bell tanks will be utilized in the lunar-landing spacecraft to supply water for the astronauts' consumption and for cooling the heat transfer section coolant of the LM during its descent flight to the lunar surface and ascent flight back to the orbiting Apollo spacecraft.

Positive expulsion systems are a necessity for space vehicles because liquids do not flow naturally toward a tank outlet as they would on earth. Instead, under the zero, or less than earth gravity conditions of space flight, the liquids tend to float in the tank, or cling to the tank walls.

The LM environmental control system water tankage for the ascent stage consists of two spherical, metal shell tanks containing a flexible, silicone rubber bladder and a perforated diffuser assembly, for positive expulsion of the water. The descent stage of the LM, used as the platform for liftoff, contains a conical, metal shell tank with the same positive expulsion water system.

When water is required, the pressurized gas collapses the bladder about the central perforated diffuser tube thereby forcing the water through the tube and out the outlet port of the tank. The bladder ensures delivery of the water to the environmental control system in all attitudes and gravitational fields.

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BUFFALO, NEW YORK
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SPECIFICATIONS

ASCENT WATER TANK

PRESSURANT	Nitrogen
DIMENSIONS	
Diameter	14.7 inches
OPERATING PRESSURE	54 psia
WALL THICKNESS	0.030 inches
WEIGHT	6.0 pounds
BLADDER MATERIAL	Silicone Rubber
CYCLE LIFE	50 Expulsions
EXPULSION EFFICIENCY	99%

DESCENT WATER TANK

PRESSURANT	Nitrogen
DIMENSIONS	
Length	32.5 inches
Diameter of Sphere	28.6 inches
OPERATING PRESSURE	54 psia
WALL THICKNESS	0.041 inch
WEIGHT	22.8 pounds
BLADDER MATERIAL	Silicone Rubber
CYCLE LIFE	50 Expulsions
EXPULSION EFFICIENCY	99%

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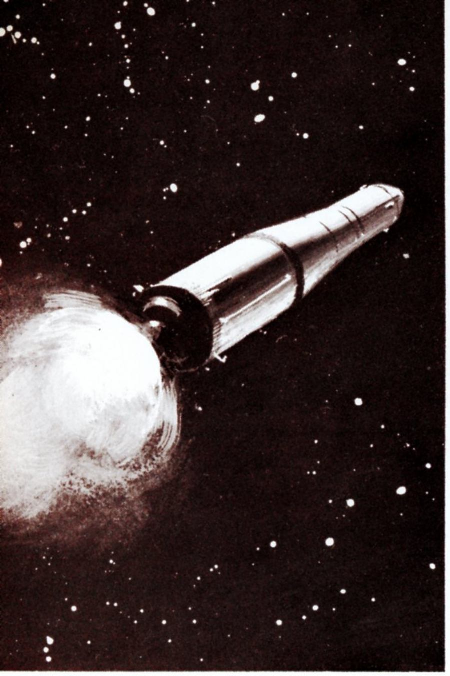 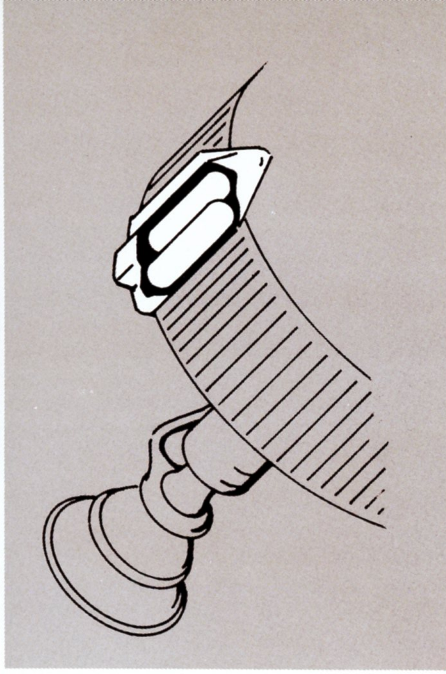 

Saturn S-IV B Tanks

Textron's Bell Aerosystems Company, the foremost developer of positive expulsion systems was selected to provide the positive expulsion propellant tanks for the auxiliary propulsion system of the Saturn S-IVB vehicle by Douglas Aircraft Company's Missile and Space Systems Division, principal contractor on the S-IVB vehicle for NASA's Marshall Space Flight Center. The Saturn S-IVB is the third stage of the three stage Saturn V launch vehicle which will propel the manned Apollo spacecraft to the moon.

The Bell positive expulsion tanks will supply propellants to the attitude and ullage control engines during powered flight, earth orbit, and translunar coast.

Positive expulsion systems are a necessity in space vehicles because liquid propellants do not flow naturally toward a tank outlet as they would on earth. Instead, under the zero, or less than earth gravity conditions of space flight, the propellants tend to float in the tank, or cling to the tank walls.

The S-IVB auxiliary propulsion system propellant tankage consists of two fuel and two oxidizer tanks. Each tank is a cylindrical metal shell containing a flexible Teflon bladder and a perforated diffuser assembly for positive expulsion of the propellants. A pressurization port is provided on the tank shell and a bladder bleed port is incorporated in the diffuser assembly.

When propellant is required, helium gas is forced into the tank assembly between the tank shell and bladder. The pressurizing gas displaces the propellant by collapsing the bladder about the central perforated diffuser tube, thereby forcing the propellant through the tube and out the discharge port of the tank. This system ensures delivery of propellants to the propulsion system in all attitudes and gravitational fields.

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SPECIFICATIONS

FUEL TANKS

PROPELLANT:	Monomethylhydrazine (MMH)
DIMENSIONS:	
Diameter	12.5 inches
Length	38.8 inches
WALL THICKNESS	0.029 inches
OPERATING PRESSURE	193-203 psia
WEIGHT	14.7 pounds
BLADDER MATERIAL	Teflon
CYCLE LIFE	20 Expulsions
EXPULSION EFFICIENCY	97 1/2%

OXIDIZER TANKS

PROPELLANT:	Nitrogen Tetroxide (N_2O_4)
DIMENSIONS:	
Diameter	12.5 inches
Length	38.8 inches
WALL THICKNESS	0.029
OPERATING PRESSURE	193-203 psia
WEIGHT	14.7 pounds
BLADDER MATERIAL	Teflon
CYCLE LIFE	20 Expulsions
EXPULSION EFFICIENCY	97 1/2%

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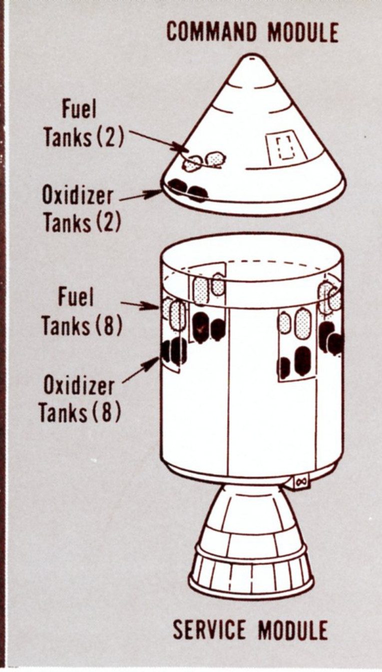

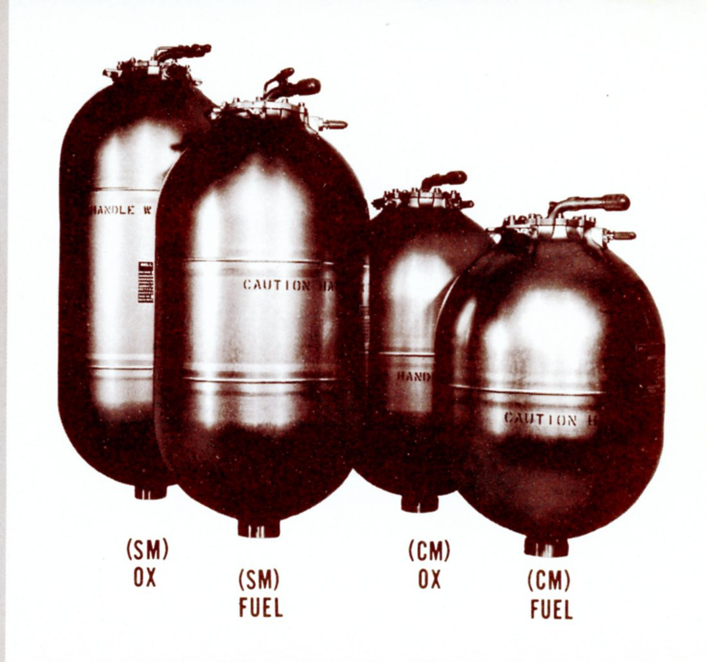

Apollo Command & Service Modules - Reaction Control Tanks

Textron's Bell Aerosystems Company, the foremost developer of positive expulsion systems, is providing the positive expulsion tankage for the Apollo spacecraft's reaction control system. Bell was selected to develop the tankage by North American Aviation's Space Division, principal contractor on the Apollo Command and Service Modules for NASA's Manned Spacecraft Center.

Bell tanks are utilized in the Command and Service Modules to supply the propellants to the reaction control rockets. These rocket thrust chambers are used for positioning, orientation, and stabilization of the spacecraft during the flight to and from the Moon, and during the reentry maneuvers.

The Command Module (CM) reaction control subsystem propellant tankage consists of two fuel and two oxidizer tanks; whereas the Service Module (SM) contains 8 fuel and 8 oxidizer tanks. Four fuel and four oxidizer tanks in the Service Module are of the Command Module configuration.

Each tank is a cylindrical metal shell containing a flexible Teflon bladder and a perforated diffuser assembly for positive expulsion of the propellant. A pressurization port is provided on the tank shell and a bladder bleed port is incorporated in the diffuser assembly.

When propellant is required, helium gas is forced into the tank assembly between the tank shell and bladder. The pressurizing gas displaces the propellant by collapsing the bladder about the central perforated diffuser tube, thereby forcing the propellant through the tube and out the discharge port of the tank. This system ensures delivery of propellants to the propulsion system in all attitudes and gravitational fields.

SPECIFICATIONS

COMMAND MODULE (CM) AND SERVICE MODULE (SM)

FUEL TANKS

PROPELLANT:	Monomethylhydrazine (MMH)
DIMENSIONS:	
SM Diameter	12.5 inches
SM Length	23.7 inches
CM Diameter	12.5 inches
CM Length	17.3 inches
WALL THICKNESS:	
SM	0.022 inch
CM	0.027 inch
OPERATING PRESSURE:	
SM	179 psia
CM	289 psia
WEIGHT:	
SM	7.9 pounds
CM	7.2 pounds

OXIDIZER TANKS

PROPELLANT:	Nitrogen Tetroxide (N_2O_4)
DIMENSIONS:	
SM Diameter	12.5 inches
SM Length	28.5 inches
CM Diameter	12.5 inches
CM Length	20.0 inches
WALL THICKNESS:	
SM	0.022 inch
CM	0.027 inch
OPERATING PRESSURE:	
SM	179 psia
CM	289 psia
WEIGHT:	
SM	8.7 pounds
CM	7.9 pounds

All tanks have Teflon bladders. 9-20 Expulsion cycles demonstrated; 91-5% to 99% expulsion efficiency demonstrated.

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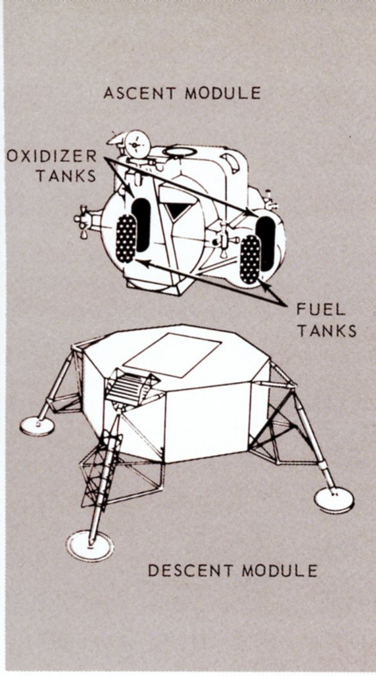

Apollo Lunar Module Propellant Tanks

The positive expulsion propellant tanks for the reaction control subsystem of Project Apollo's Lunar Module (LM), are designed, built and tested by Textron's Bell Aerosystems Company. Bell, the foremost builder of positive expulsion devices in the aerospace industry, was selected to develop the LM tankage by Grumman Aircraft Engineering Corporation, NASA's prime contractor for the LM spacecraft. The LM is the portion of the three-module Apollo spacecraft which will land on the moon.

Bell tanks will be utilized in the LM spacecraft to supply the propellants to the reaction control rockets. These rocket thrust chambers are used for positioning, orientation and stabilization of the LM during its descent flight to the lunar surface and ascent flight to the lunar orbiting Apollo spacecraft. The LM reaction control subsystem propellant tankage consists of two fuel and two oxidizer tanks. Each tank is a cylindrical metal shell containing a flexible Teflon bladder and a perforated diffuser assembly, for positive expulsion of the propellants. A pressurization port is provided on the tank shell and a bladder bleed port is incorporated in the diffuser assembly.

Positive expulsion systems are a necessity for space vehicles, because liquid propellants do not flow naturally toward a tank outlet as they would on earth. Instead, under the zero, or less than earth gravity conditions of space flight, the propellants tend to float in the tank, or cling to the tank walls. When propellant is required pressurized helium gas is forced into the tank assembly between the tank shell and bladder. The pressurizing gas displaces the propellant by collapsing the bladder about the central perforated diffuser tube, thereby forcing the propellant through the tube, and out the discharge port of the tank. This system ensures delivery of propellants to the propulsion system in all attitudes and gravitational fields.

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SPECIFICATIONS

FUEL TANKS

PROPELLANT	50/50 Blend Hydrazine and Unsymmetrical Dimethylhydrazine (N_2H_4/UDMH)
DIMENSIONS	
Diameter	12.5 inches
Length	32.2 inches
WALL THICKNESS	0.025 inch
OPERATING PRESSURE	200 psia
WEIGHT	10.5 pounds
BLADDER MATERIAL	Teflon
CYCLE LIFE	50 Expulsions
EXPULSION EFFICIENCY	99%

OXIDIZER TANKS

PROPELLANT	Nitrogen Tetroxide (N_2O_4)
DIMENSIONS	
Diameter	12.5 inches
Length	38.8 inches
WALL THICKNESS	0.030 inch
OPERATING PRESSURE	200 psia
WEIGHT	12.6 pounds
BLADDER MATERIAL	Teflon
CYCLE LIFE	50 Expulsions
EXPULSION EFFICIENCY	99%

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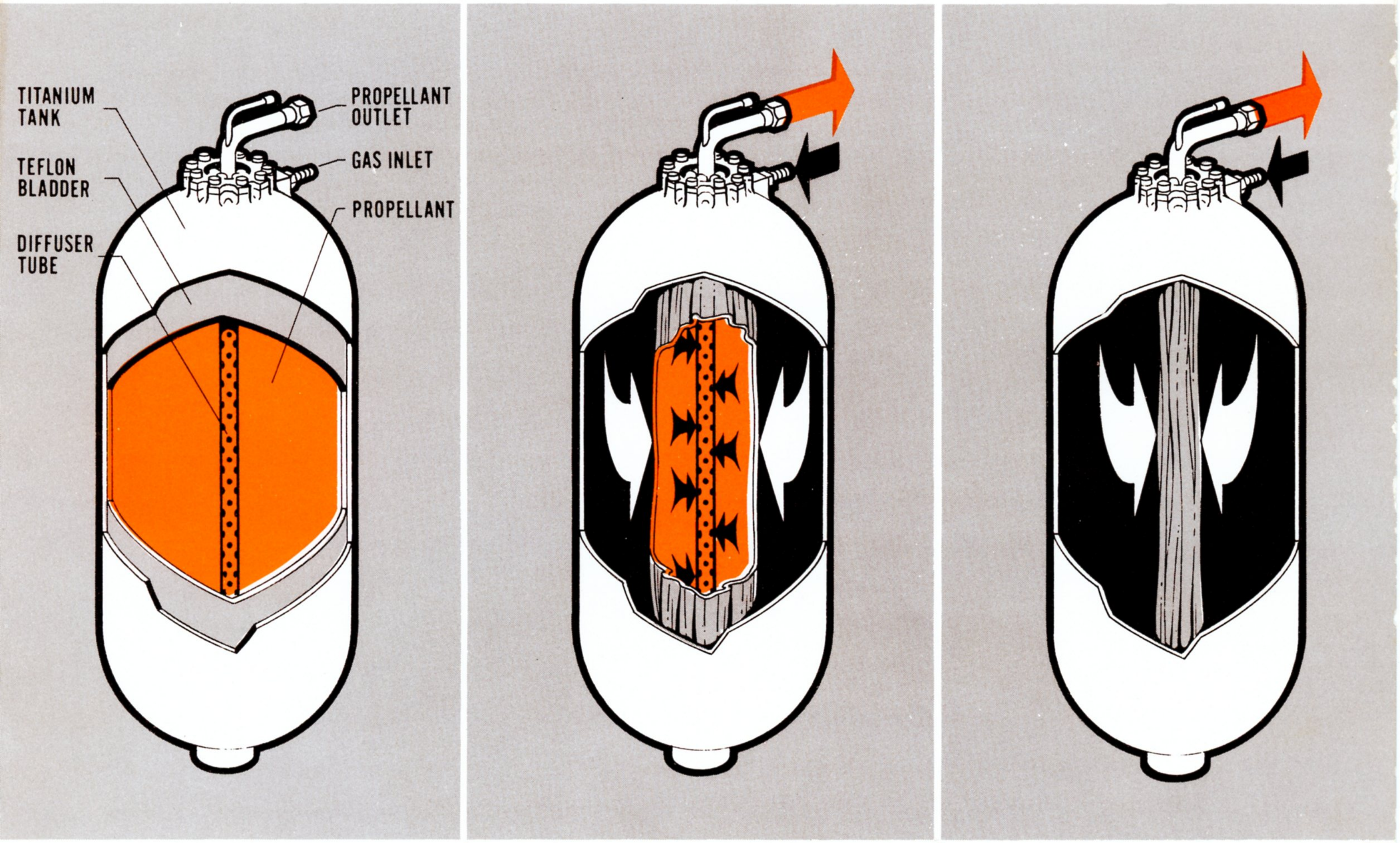
POSITIVE EXPULSION TANKS

In space, rocket propellants and other fluids must be forced or squeezed out of their containers. Under the zero gravity or less than earth-gravity conditions of space flight, liquids become very independent. Surface tension pulls them into drops. Inside a container that is partly empty, they may float around in clumps, bunch up at one end or cling to the tank walls. The mechanism developed to permit the withdrawal and maximum utilization of the tank contents is called a positive expulsion device.



A typical positive expulsion tank --- designed, built and flight qualified for the Apollo program by Textron's Bell Aerosystems Company --- consists of these major components: a titanium tank shell, a flexible Teflon bladder and a diffuser assembly. The bladder contains the liquid. Running longitudinally through the center of the tank and inside the bladder is the diffuser --- an aluminum tube which is perforated with hundreds of tiny holes smaller than a pin head.

When the liquid -- be it fuel or oxidizer -- is required, compressed helium gas (brown arrow) is forced into the space between the outside of the bladder and the inner wall of the tank, squeezing the bladder and its contents (white arrow). The propellant, in turn, is forced through the tiny holes of the diffuser assembly and from the tube (orange arrow) to the rocket thrusters.

The flow of propellant can be shut off at any time by closing a valve between the tank outlet and the rocket thruster. Because the bladder remains under pressure, propellant flow can be resumed instantly by reopening the valve. Bell Aerosystems' positive expulsion tanks have consistently delivered 99 percent of the liquid content from the tanks, thus enabling maximum use of the spacecraft's on-board propellants. Cycle life of 50 expulsions has been demonstrated.

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