NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROJECT GEMINI

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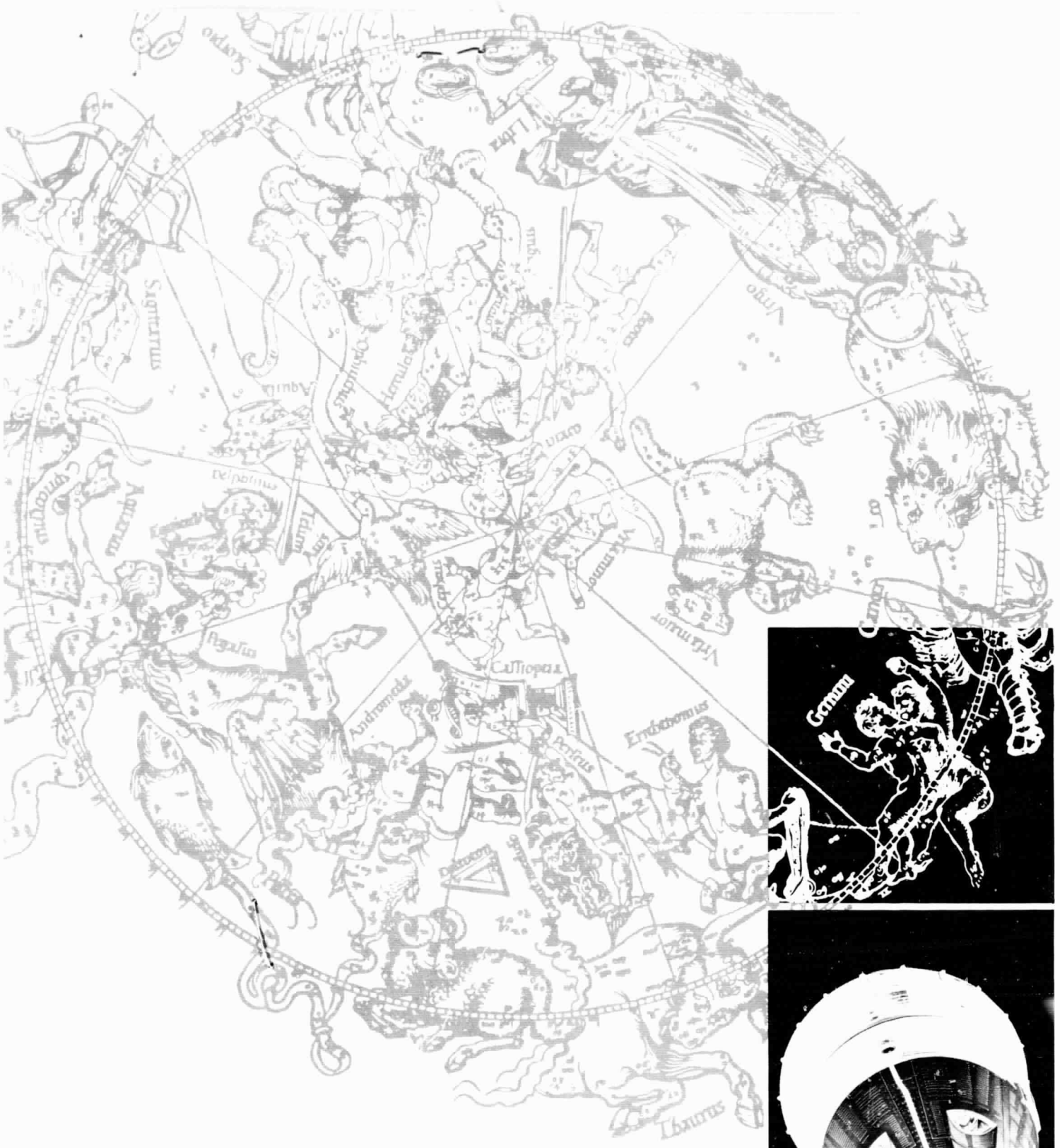
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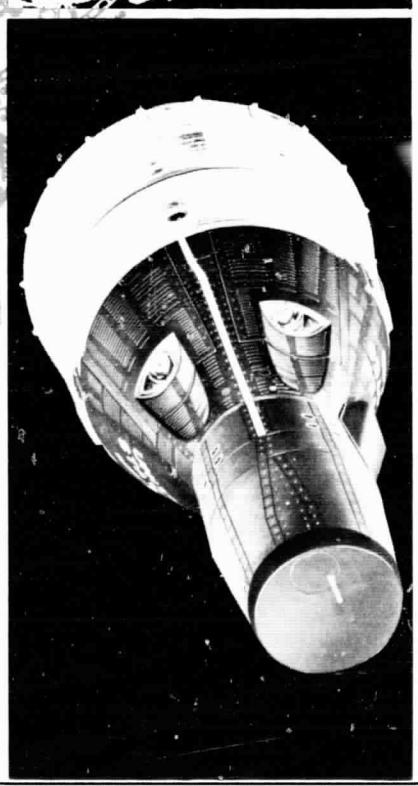
Gemini



PROJECT GEMINI

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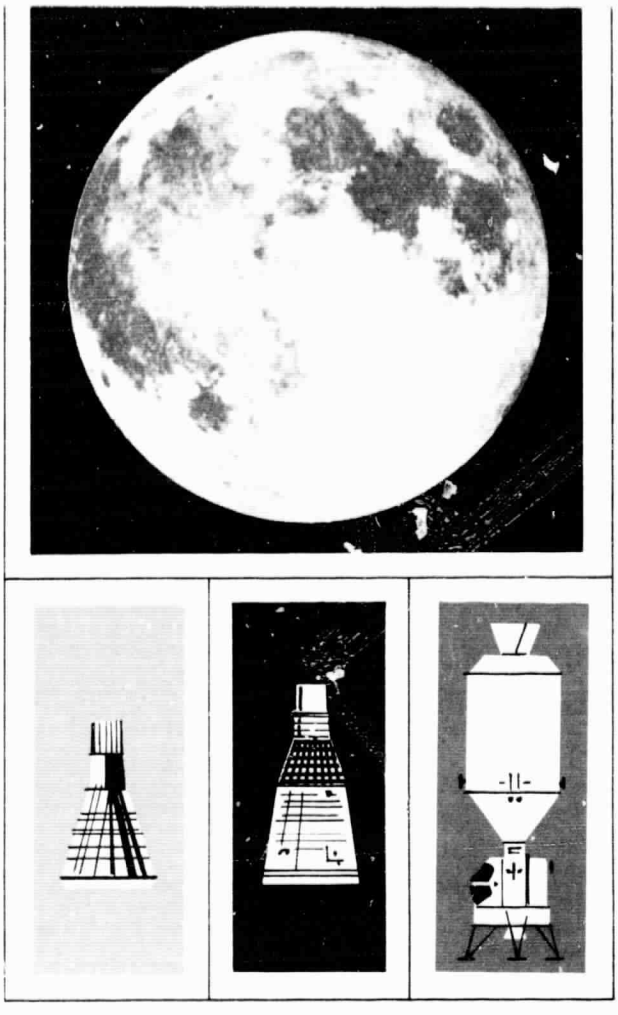


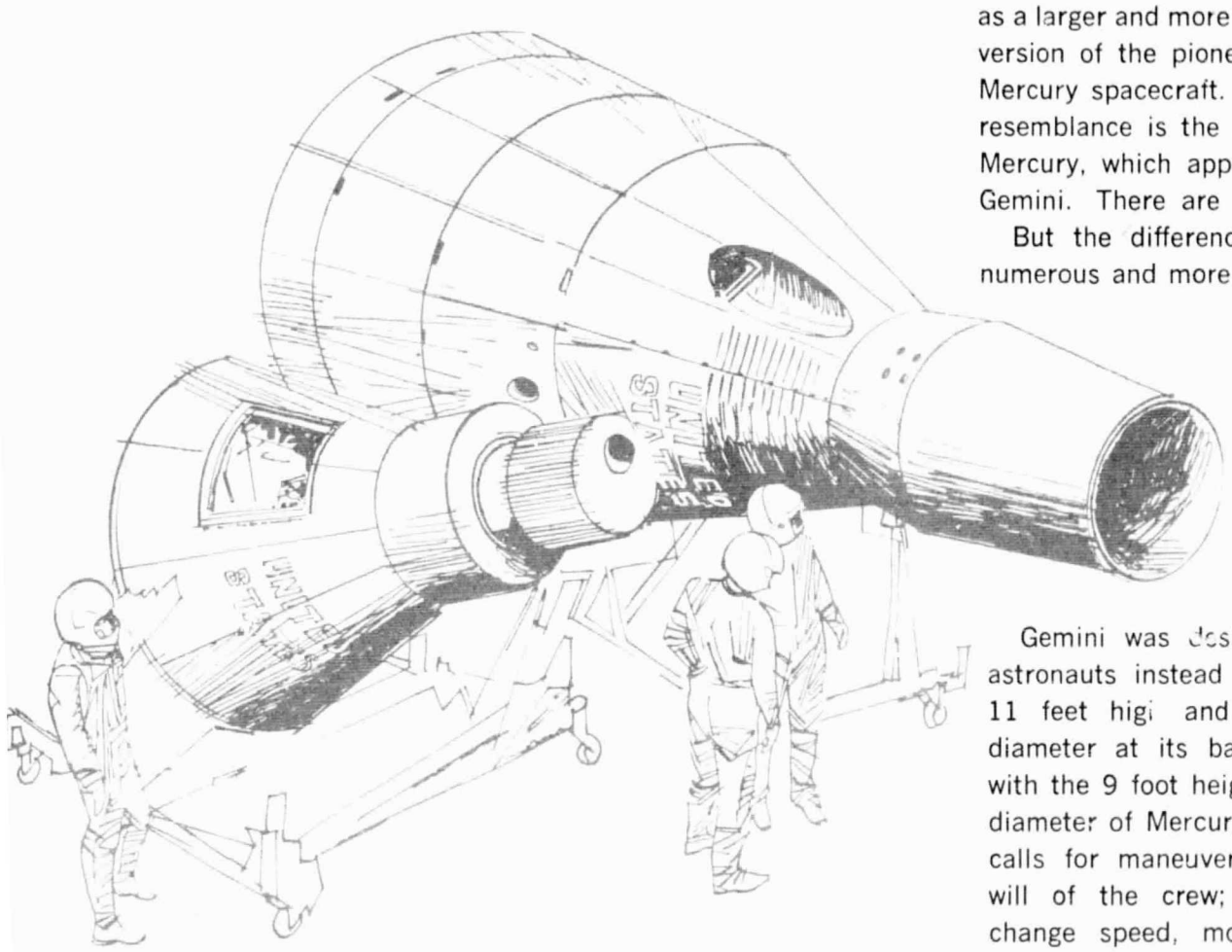
Introduction

A major goal of the U.S. manned space flight program is to put men on the moon during this decade, and bring them safely back to earth. In the process of achieving that goal, Project Gemini is Step Two. Step One was Project Mercury, in which U.S. astronauts first ventured into space and completed six flights ranging in length from fifteen minutes to thirty-four hours. Step Three is reserved for Project Apollo; its climax will be the lunar landing Project Gemini's vital intermediate mission is concerned with further development of spacecraft and launch vehicles, extension of the ground procedures for tracking, communication and control, and preparation of astronauts for operations of ever-increasing complexity and difficulty. Since it is flown by a crew of two astronauts, the project was named Gemini, for the stellar twins which have been in the sky since the beginning of time. Gemini is the third constellation in the zodiac, and is shown on pictorial sky maps as the twins Castor and Pollux, sitting together.

The Gemini Spacecraft

In the step by step process of the manned space flight program, the Gemini spacecraft was designed as a larger and more sophisticated version of the pioneering Project Mercury spacecraft. One obvious resemblance is the bell shape of Mercury, which appears again in Gemini. There are many others.

But the differences are more numerous and more important.



Gemini was designed for two astronauts instead of one. it is 11 feet high and 7½ feet in diameter at its base, compared with the 9 foot height and 6 foot diameter of Mercury. Its mission calls for maneuverability at the will of the crew; it can turn, change speed, move from one orbit to another. It has means to spot another spacecraft thousands of miles away and proceed to the position of that other spacecraft. (The term for this is rendezvous.) It can make contact with the other craft and make fast to it. (Docking.) It can furnish life support for its crew during a long duration flight such as two weeks or more, as compared with a day or so in space for Mercury. It is possible for one of the astronauts to step out of Gemini and maneuver

alongside. (Extravehicular activity.) Provision has been made for an extensive series of scientific experiments not specifically related to the operation of the spacecraft.

Structurally, the Gemini spacecraft consists of two major components: a reentry module and an adapter module.

The reentry module is the cone - plus - column - shaped unit which encloses the astronauts' compartment and provides life support. In it are control systems which enable the crew to approach and link up with another vehicle in space. As its name implies, it is the reentry module which returns to earth at the conclusion of the flight; it has gas jets (thrusters) to orient the spacecraft for descent to earth, and parachutes that open after the fiery entry into the atmosphere to stabilize and slow the descent.

In the adapter module, consisting of a retro section and an equipment section, is Gemini's orbit attitude and maneuvering system (OAMS), which provides the capability for such extensive maneuvering as changing of orbit. This module houses fuel cells, in which hydrogen and oxygen react and produce electricity to power the spacecraft systems. It houses the retrograde rocket system which is fired to reduce speed so that the spacecraft will fall back to earth. It also contains propellant tanks and supporting electronic equipment. The adapter module is shed in orbit as Gemini prepares for return to earth. First, the equipment section is left behind, exposing the retro section. Then, after the firing of the retrorockets, the retro section, too, is discarded, just before the entry into the atmosphere.

1 Two engineers approach the Gemini spacecraft prior to its test in a space simulation chamber. The chamber simulates temperature and vacuum conditions encountered in space.

Heat-absorbing material is poured into the Fiberglass honeycomb to form the spacecraft heat shield. The heat shield absorbs and dissipates heat generated on the craft's blunt surface during its entry into the atmosphere when the craft is returning to earth.

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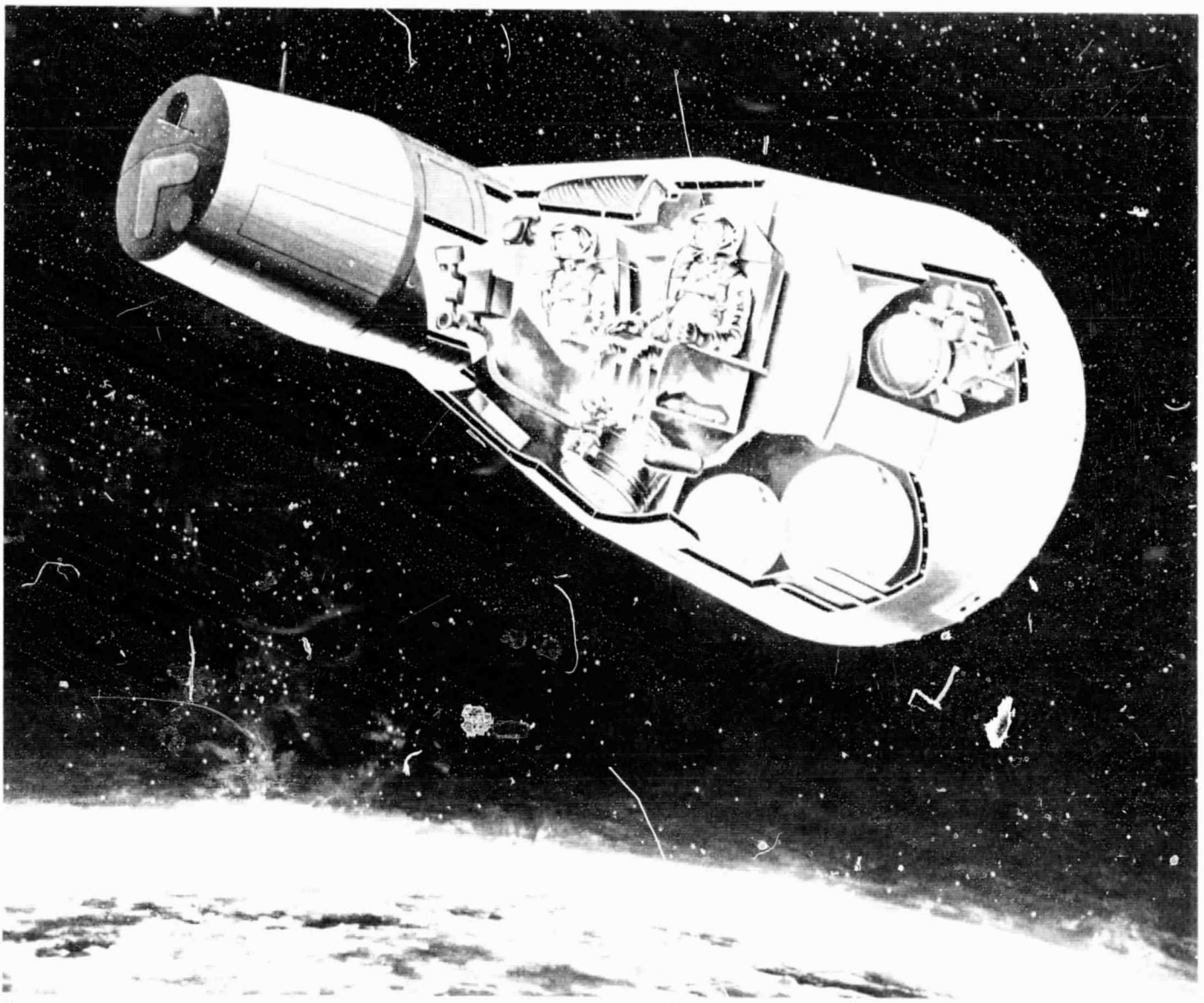
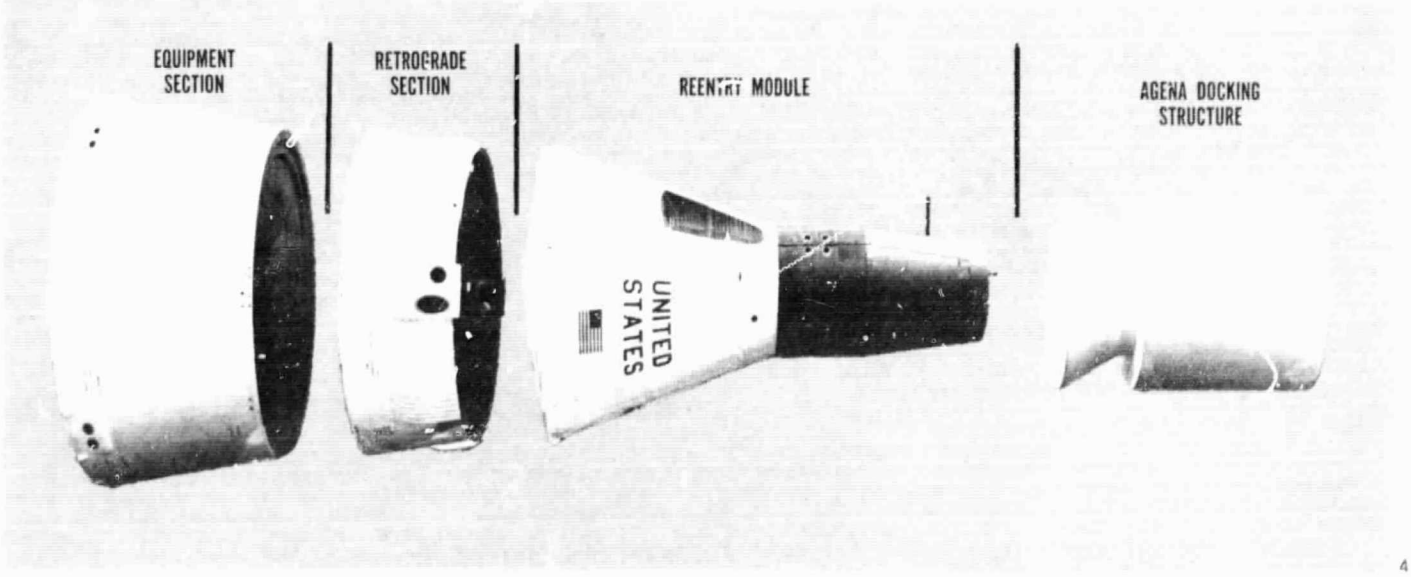
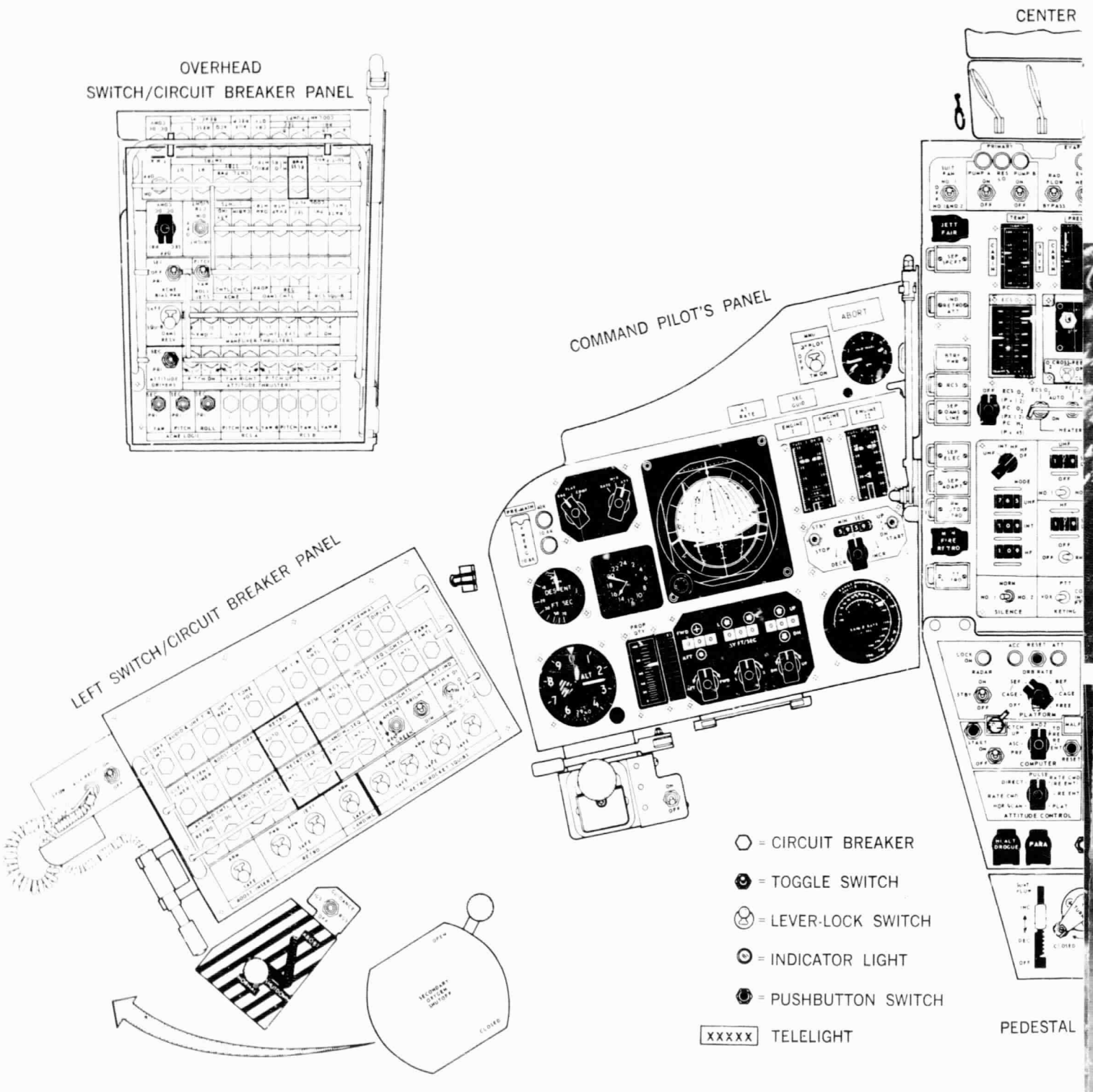


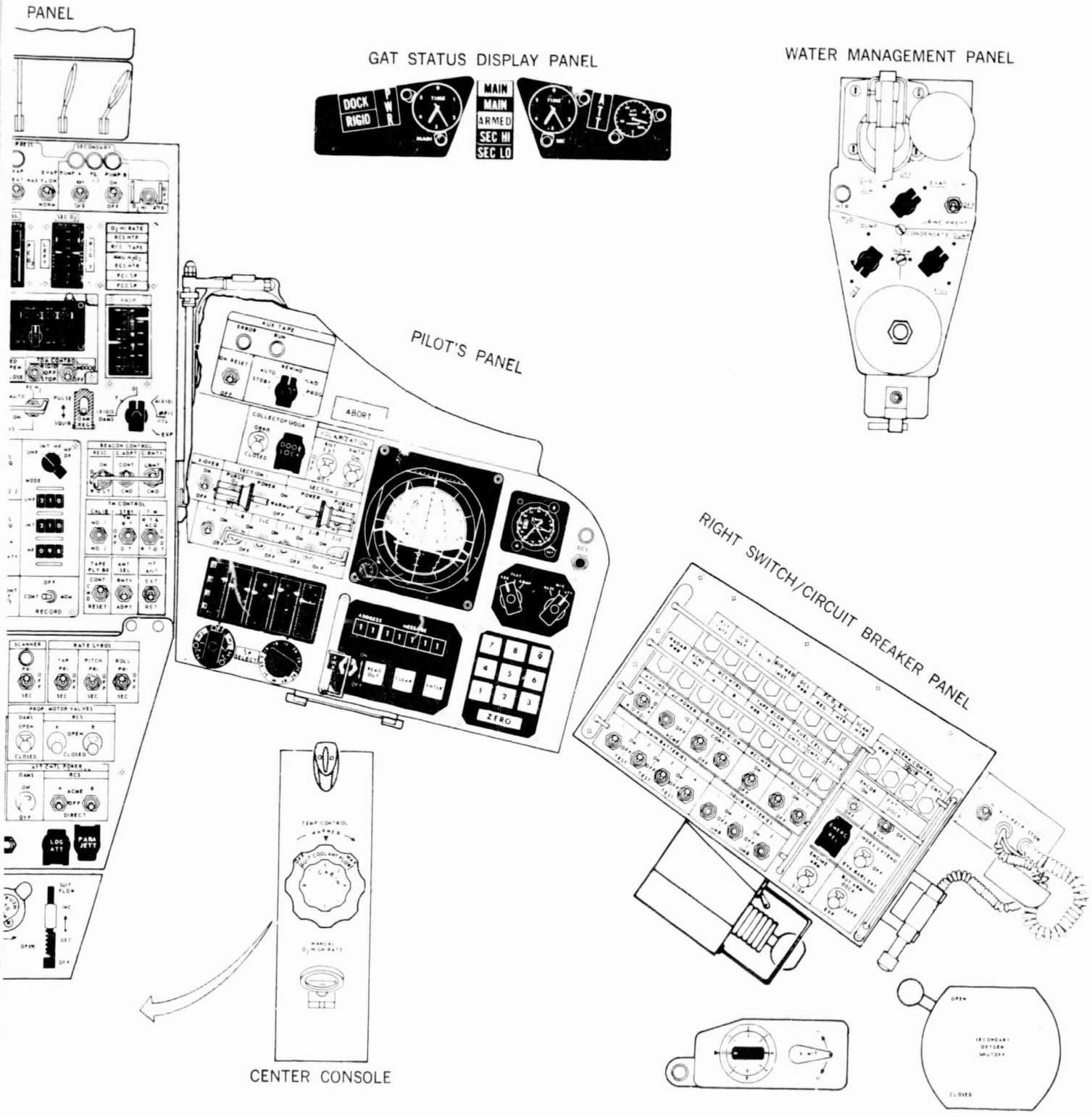
Cutaway view of Gemini's environmental control and reactant supply systems. The environmental control system supplies oxygen and maintains pressure and temperature to enable astronauts to live in space. The reactant system supplies hydrogen and oxygen to the fuel cells which produce electricity to run spacecraft equipment.



GEMINI INSTRUMENT PANEL



CREW DISPLAYS, CONTROLS, AND INSTRUMENTS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6

MENU FOR GEMINI

The Gemini menu ranges from cereals, orange juice and toast to meats, eggs, fish, and fruit salad. For each day, it provides about 2500 calories per person, plus other essentials of nutrition.

Food must be prepared so that it can be consumed by astronauts who are weightless, in an environment where everything is weightless, including the food itself. Solid foods are dehydrated and packed in bite-sized portions, in tubes, or as concentrates enclosed in plastic bags in which water may be added with a water gun. Three meals for each astronaut weigh no more than a pound, on earth.

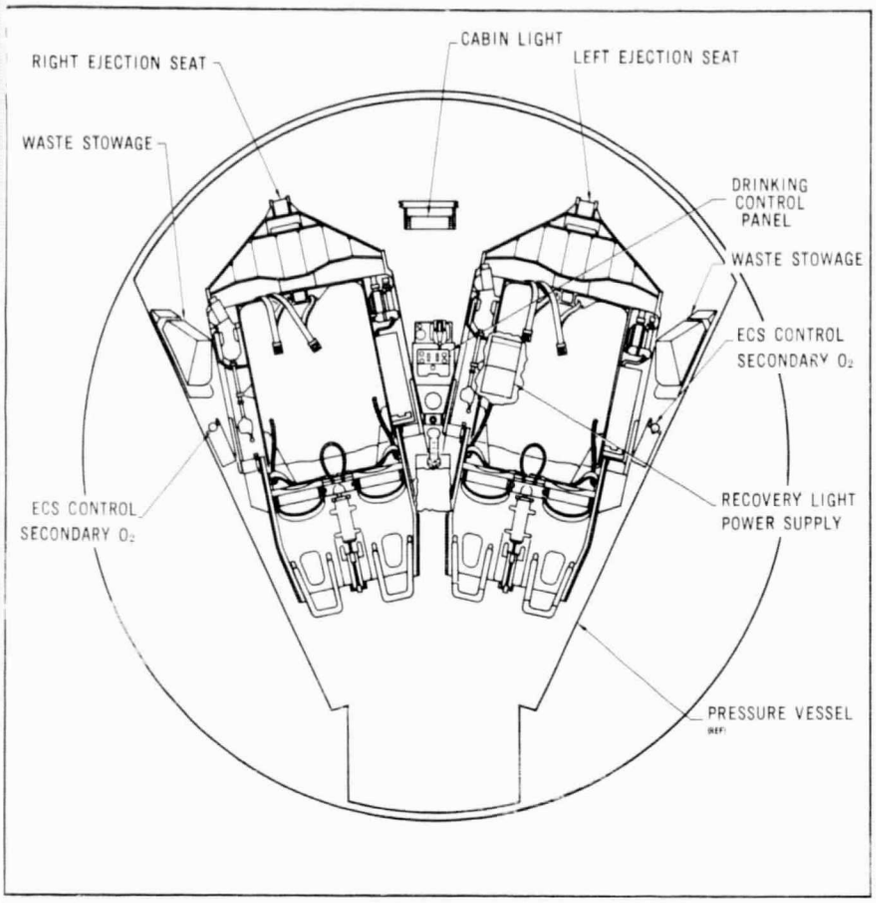
The astronauts are careful to prevent food particles or water droplets from escaping. In a condition of weightlessness, such particles would drift in the cabin, and could result in problems with sensitive equipment.

7

Typical dehydrated or freeze-dried food products prepared for astronauts' meals during space flight. Shown (l. to r., top to bottom) are strawberries, sandwiches, bread substitute, cocoa beverage, pea soup, potato salad, chicken with gravy, and grape juice.

8

NASA and McDonnell engineers perform a simulated seat ejection from Gemini spacecraft mock-up.



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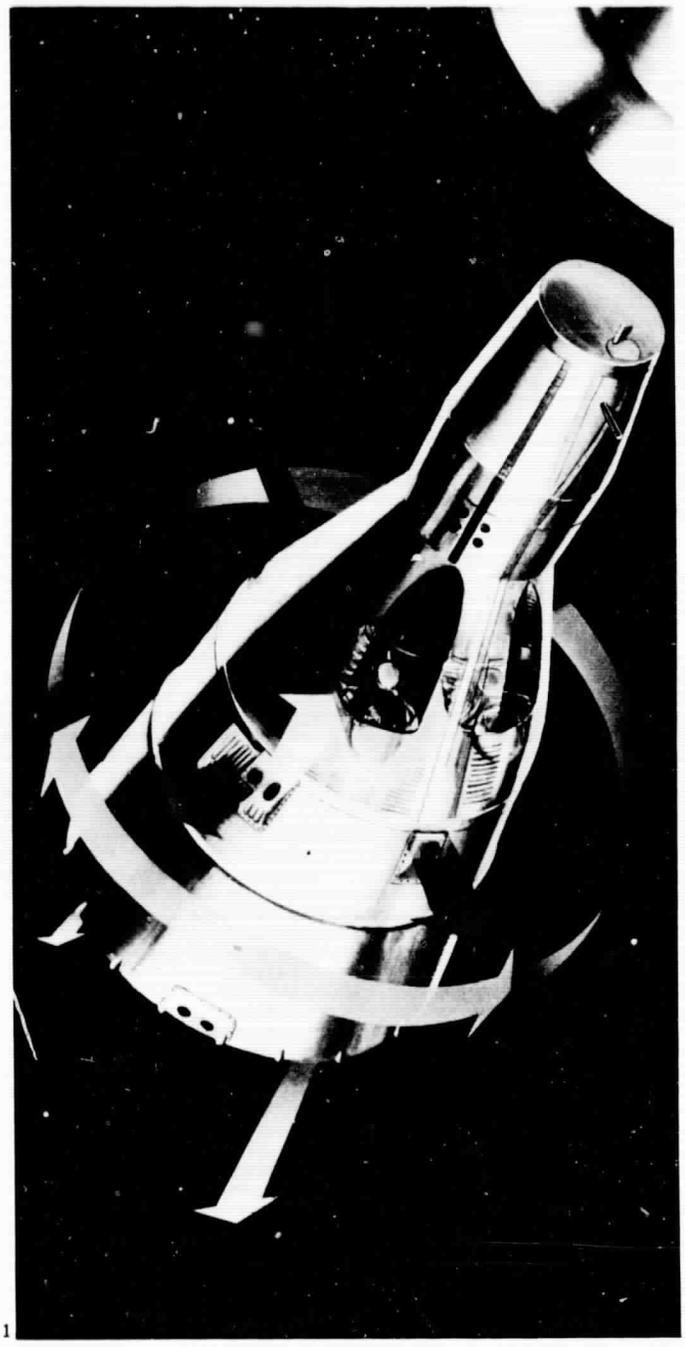
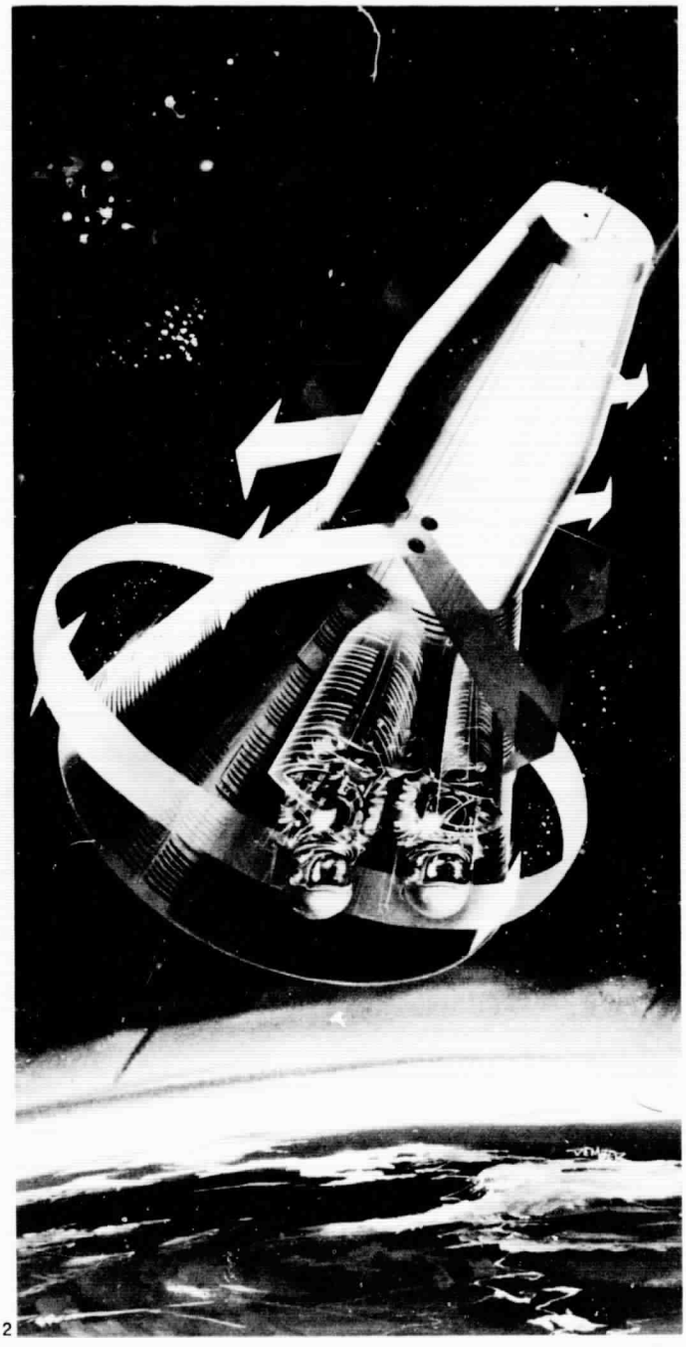
Astronaut stations in Gemini spacecraft.

10

Gemini spacecraft environmental control system test.



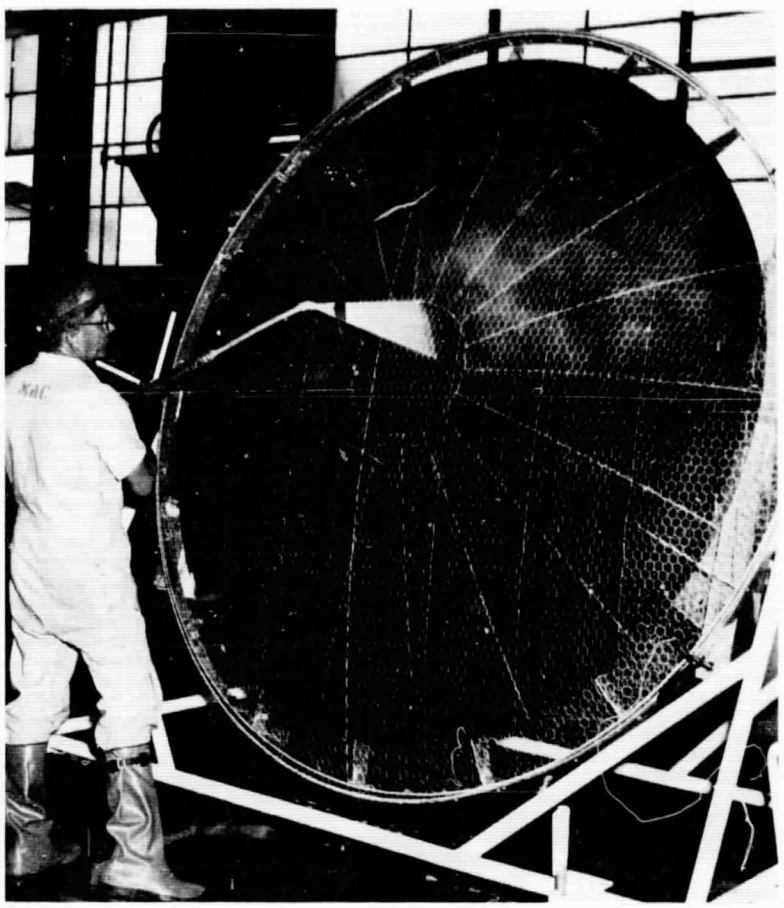
11 Artist's conception of Gemini spacecraft. The arrows indicate spacecraft movements made possible by its thrusters.



12 Artist depicts Gemini during reentry. Arrows show how craft's orientation can be controlled during reentry. Adapter module has been jettisoned in orbit during preparations for reentry.

13

Technician works on Gemini's inertial reference unit. The unit provides information during flight on Gemini's position relative to the earth's surface.



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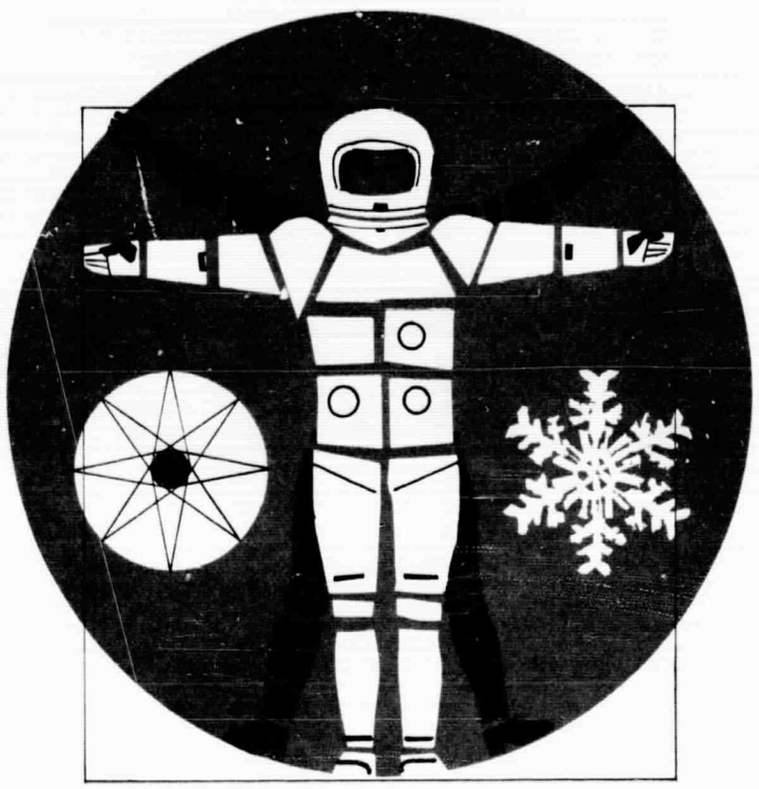
Workman sprays a heat-resistant compound on the Gemini spacecraft heat shield at McDonnell Aircraft, St. Louis.

The Gemini Space Suits



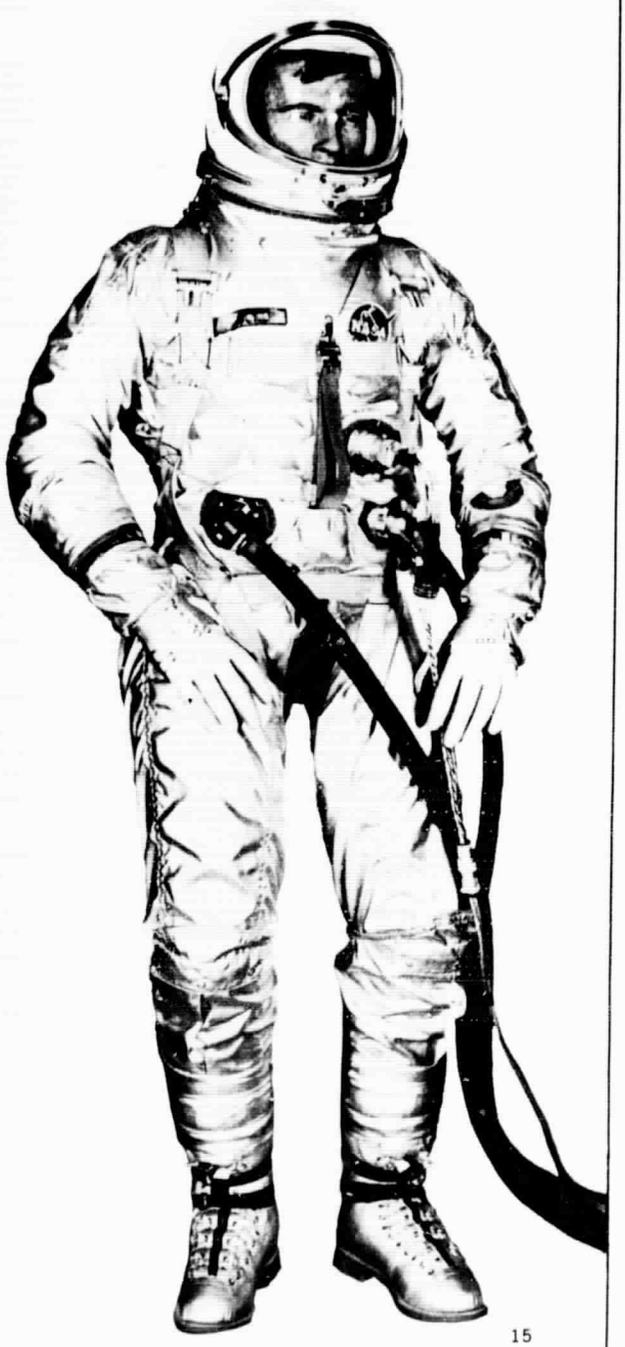
A new pressure suit was developed for the Gemini program, to provide more freedom of movement. The suit is connected with the cabin environmental control system which provides a 100 percent oxygen supply, pressurization and humidity control, and facilities for removing unpleasant odors. The suits have individual regulators so that each astronaut can select the flow of oxygen he desires.

Oxygen enters the suit just below the chest and is routed directly to the face area, the arm areas, the leg areas, then out an exhaust line to be purified for reuse.

For "walking in space," in which an astronaut leaves the cabin to maneuver alongside, a special EVA (for Extravehicular Activity) suit was designed.

The EVA suits have extra layers of tough plastic and other equipment. They provide pressure to protect the astronauts in the space vacuum. They resist radiation and meteoroid punctures. They furnish oxygen for breathing and keep the astronauts from becoming too hot or too cold. They provide protection against the intense glare of the sun. They allow freedom to bend bodies, arms, legs, and fingers.

For use during EVA, the astronauts carry such accessories as extra oxygen tanks, self-contained



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Astronaut demonstrates Gemini space suit.

16

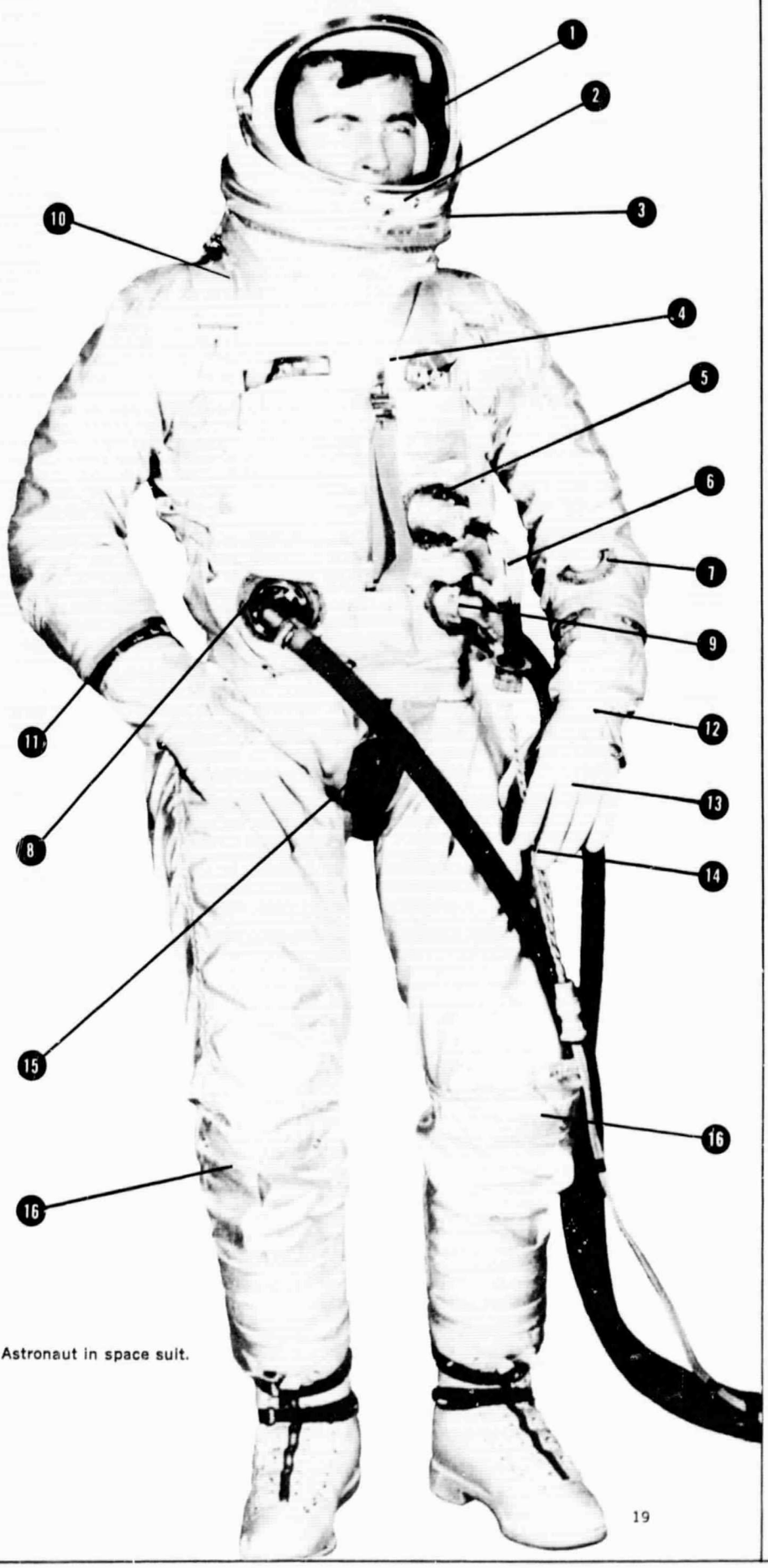
Back view of space suit shown at left.

rocket or jet power units for propelling themselves, special tools for tasks they are to perform in space, and, as a precaution, tethers connecting them with their spacecraft. The tether is part of an umbilical line for communication, and for oxygen supply from the spacecraft's reservoir.

The relatively lightweight suits for use inside of the spacecraft provide maximum protection, comfort, ease of movement, and facility in putting on and taking off. For additional comfort, Gemini astronauts can remove their suits during part of their mission and depend on the spacecraft's earth-like system.

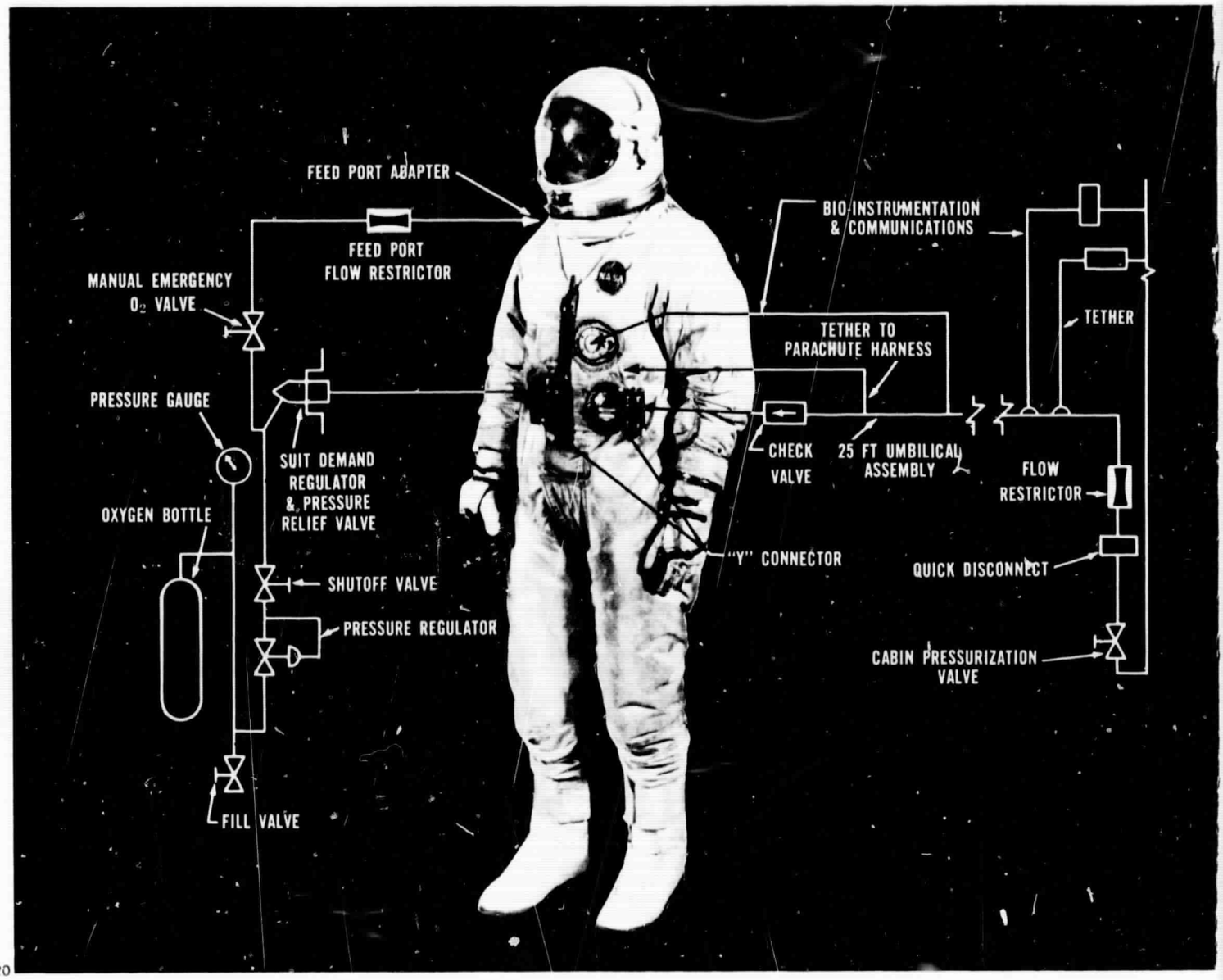
17 A NASA technician examines the helmet of a Gemini extra-vehicular activity space suit like that used by Astronaut Edward H. White during his "walk in space." The helmet has two additional external visors over the inner one.

18 A technician checks the 25-foot umbilical cable that carried oxygen from the Gemini spacecraft to Astronaut White. The cable also contains electric wires for radio communications and a 23½ foot tether that could withstand a thousand pounds of pull.

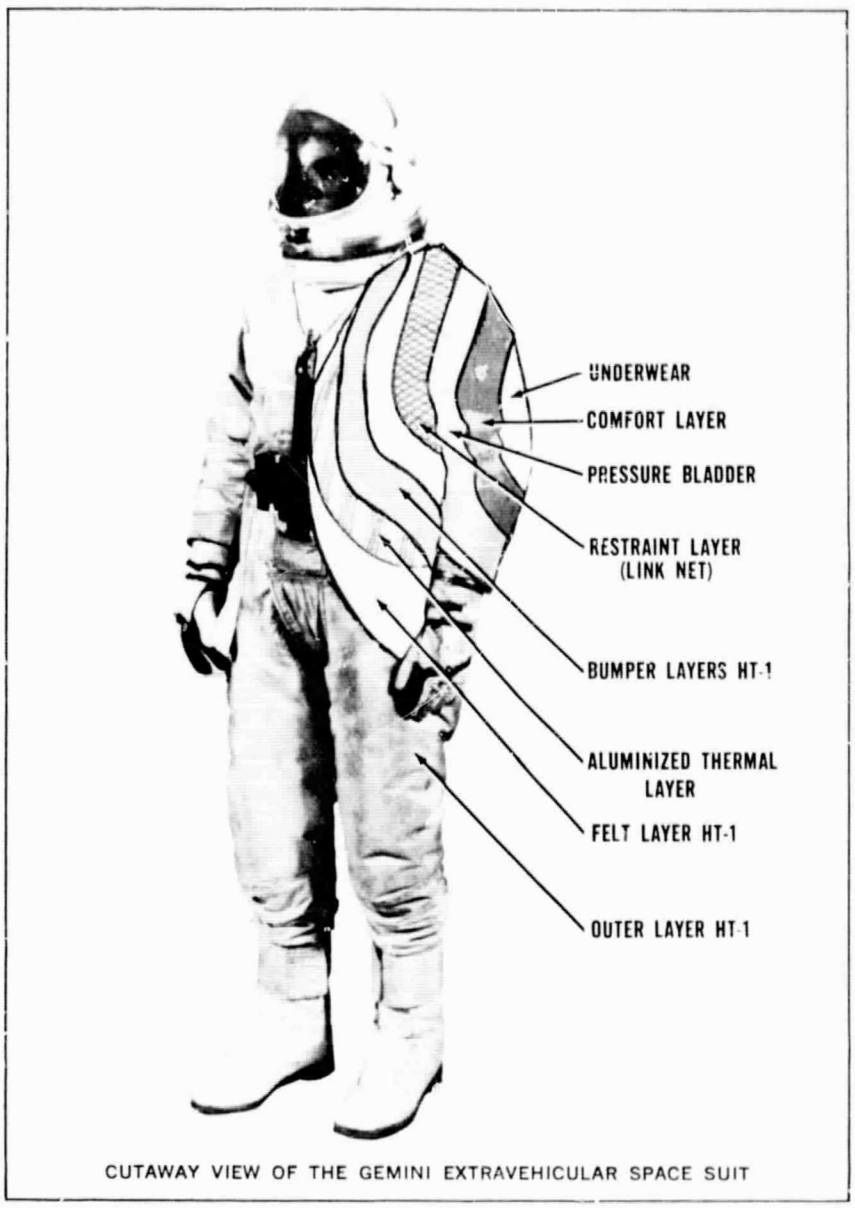


Astronaut in space suit.

1. Face visor
2. Feeding port
3. Rotatable neck ring
4. Helmet tie-down assembly
5. Biomedical and communications connector
6. Biomedical and communications cable
7. Suit pressure gauge
8. Oxygen outlet port (connected to hose)
9. Oxygen inlet port (connected to oxygen line)
10. Parachute harness
11. Rotatable wrist rings
12. Battery for fingertip lights
13. Gloves
14. Fingertip lights
15. Dorsal zipper
16. Leg pockets



COMPONENTS OF THE GEMINI EXTRAVEHICULAR SPACE SUIT



CUTAWAY VIEW OF THE GEMINI EXTRAVEHICULAR SPACE SUIT

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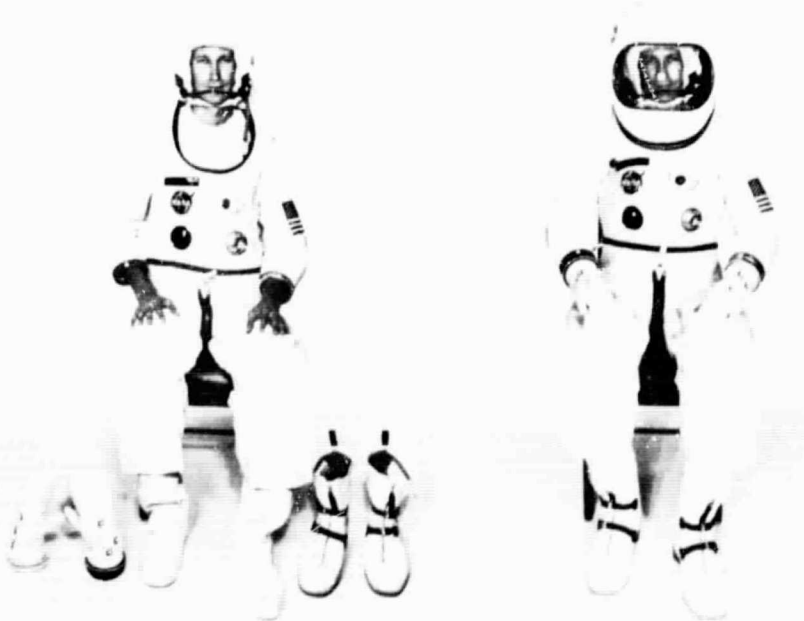

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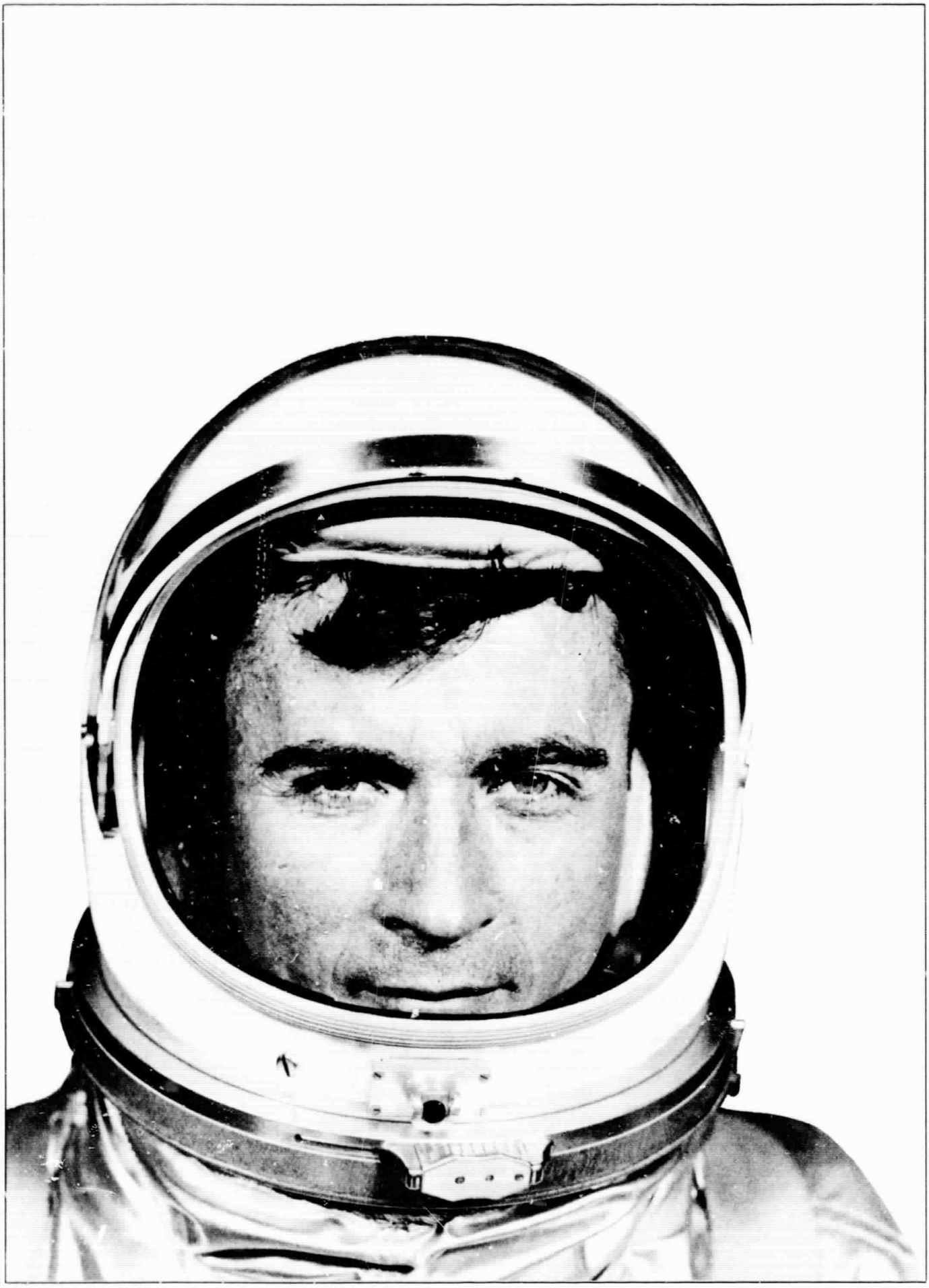
Lightweight Gemini space suit (unpressurized l.—pressurized r.) like those worn by Gemini Astronauts Borman and Lovell during their Gemini 7 flight.



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The Astronauts

Astronauts for Gemini flights are assigned from the group which began with seven jet pilots selected for Project Mercury in 1959, and which was augmented by the appointment of additional pilots in September 1962 and in October 1963. Also in the astronaut group are five scientist-astronauts chosen in June 1965, to train as highly specialized crewmen for Project Apollo, and additional pilots appointed in April 1966.

Most of the astronauts are officers of military air services; some are civilians.

In the first three groups, all were highly skilled jet pilots before they entered the program, and their individual skills include exceptional qualifications in such specialties as test flying and engineering.

They are based at NASA's Manned Spacecraft Center, Houston, Texas, but their training missions take them anywhere in the world to use special facilities or to take advantage of special situations which will contribute to the advancement of their knowledge and skills.

Aircraft are available to them to maintain their proficiency as jet pilots, and they frequently fly these aircraft when they have training missions at the Kennedy Space Center or other NASA installation, or at a contractor's base of operations.

The astronauts are put through a rigorous course of class, laboratory, and field training. They learn the complexities not only of their spacecraft but also of launch vehicles and ground facilities. They learn such classroom subjects as upper atmosphere physics, geology, astronomy, navigation, com-

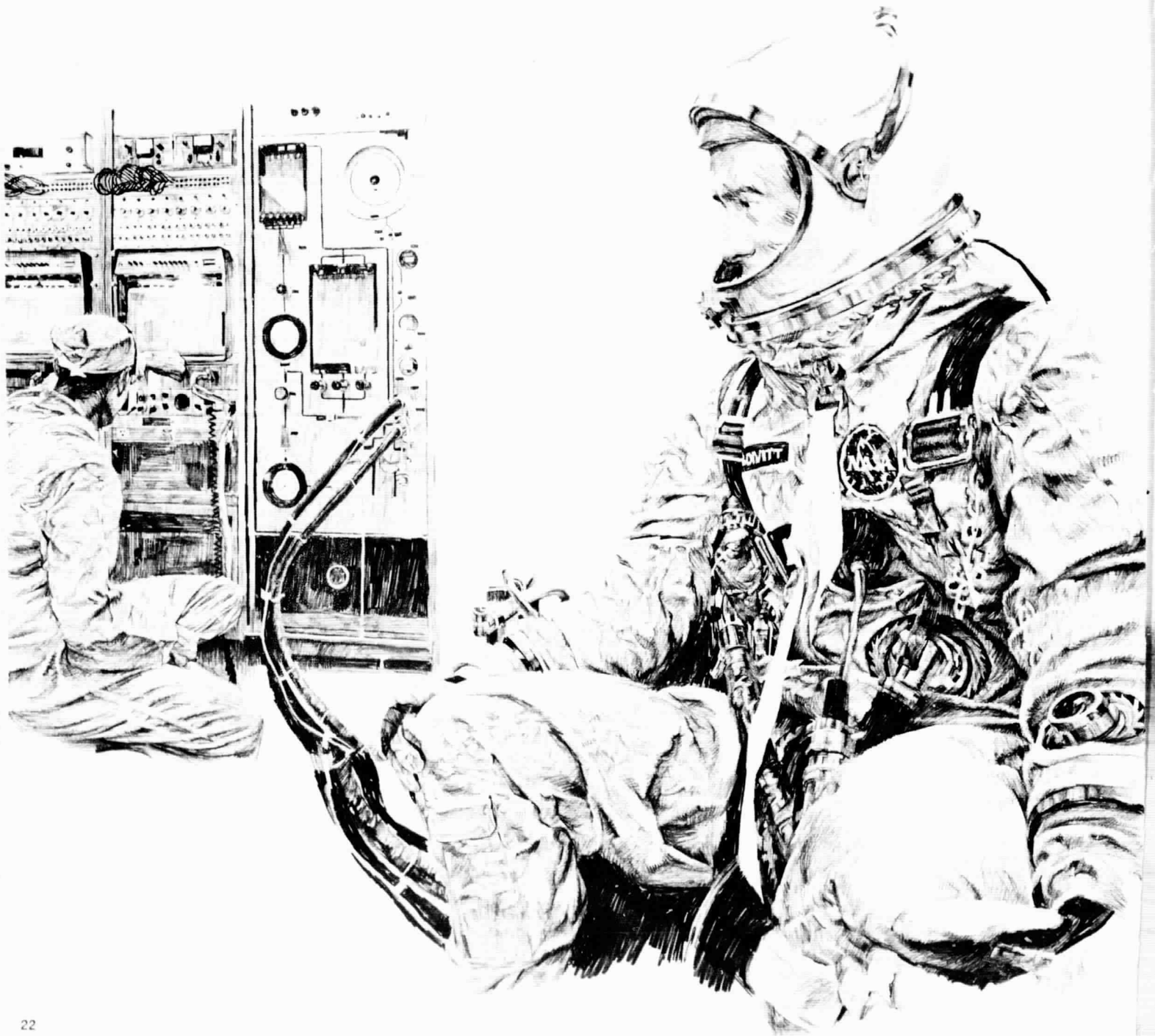
puter technology, space medicine, meteorology, communications, and the guidance, propulsion, and aerodynamics of spacecraft.

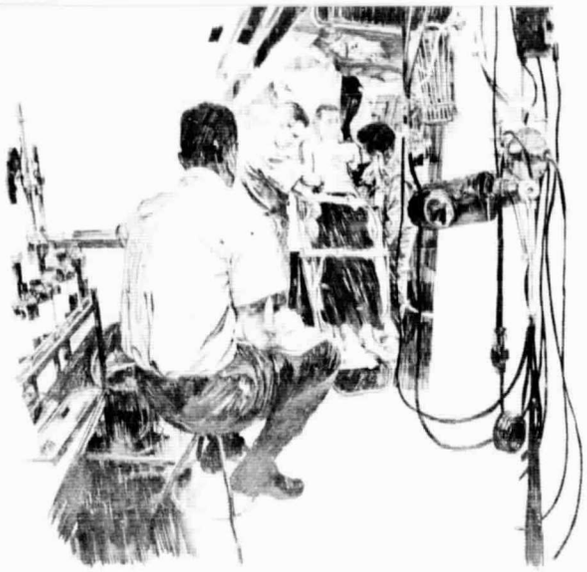
In giant centrifuges, they experience forces as high as 16 g (gravity) which has the effect of making a 180 pound man appear to weigh nearly 1½ tons. They experience weightlessness; this is accomplished in an airplane flown in a "parabolic arc" (first a dive to increase speed, then an unpowered arc up, over and down).

They learn how to conduct complex scientific and engineering experiments during space missions. They are trained in desert, jungle, and water survival routines.

They use simulators to "fly" the Gemini spacecraft, accomplishing every maneuver that will later be flown in space, including the complete operation of rendezvous and docking. The simulator sessions include both routine operations and maneuvers which might be necessitated by emergencies.

The validity of this training was demonstrated in the space mission of Gemini 8, when a thruster fired out of control. With the aid of ground control, the astronauts diagnosed their problem to an extent sufficient to permit recovery, and then cut their mission short and landed in one of the contingency areas.





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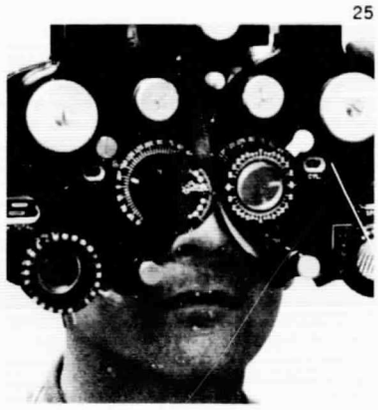

Scenes from the astronauts' physical examinations that precede every Gemini flight.

Astronaut studies a rock sample during geology instruction.

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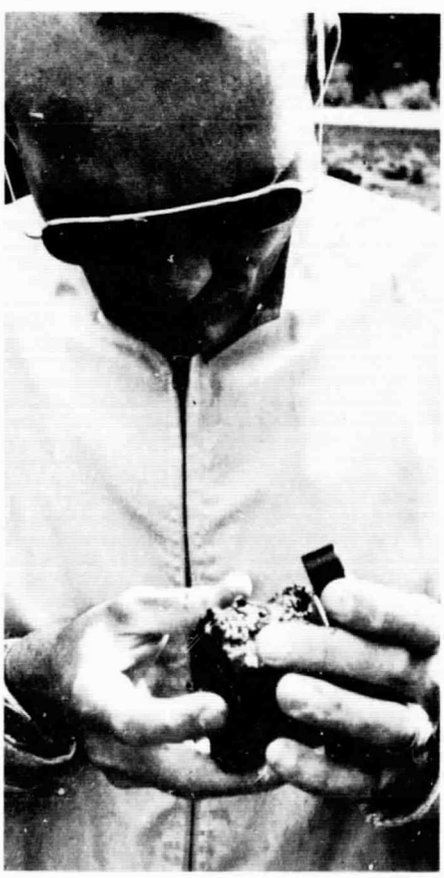

Astronauts McDivitt and White use a celestial globe to study the location of constellations they will see during their Gemini 4 flight.

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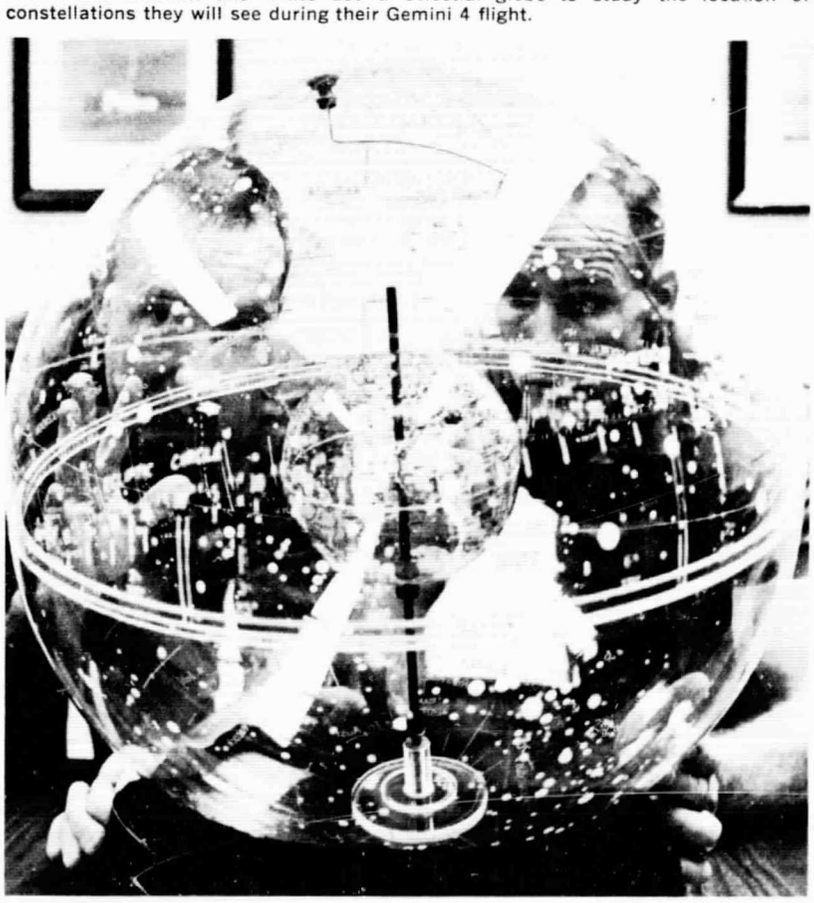
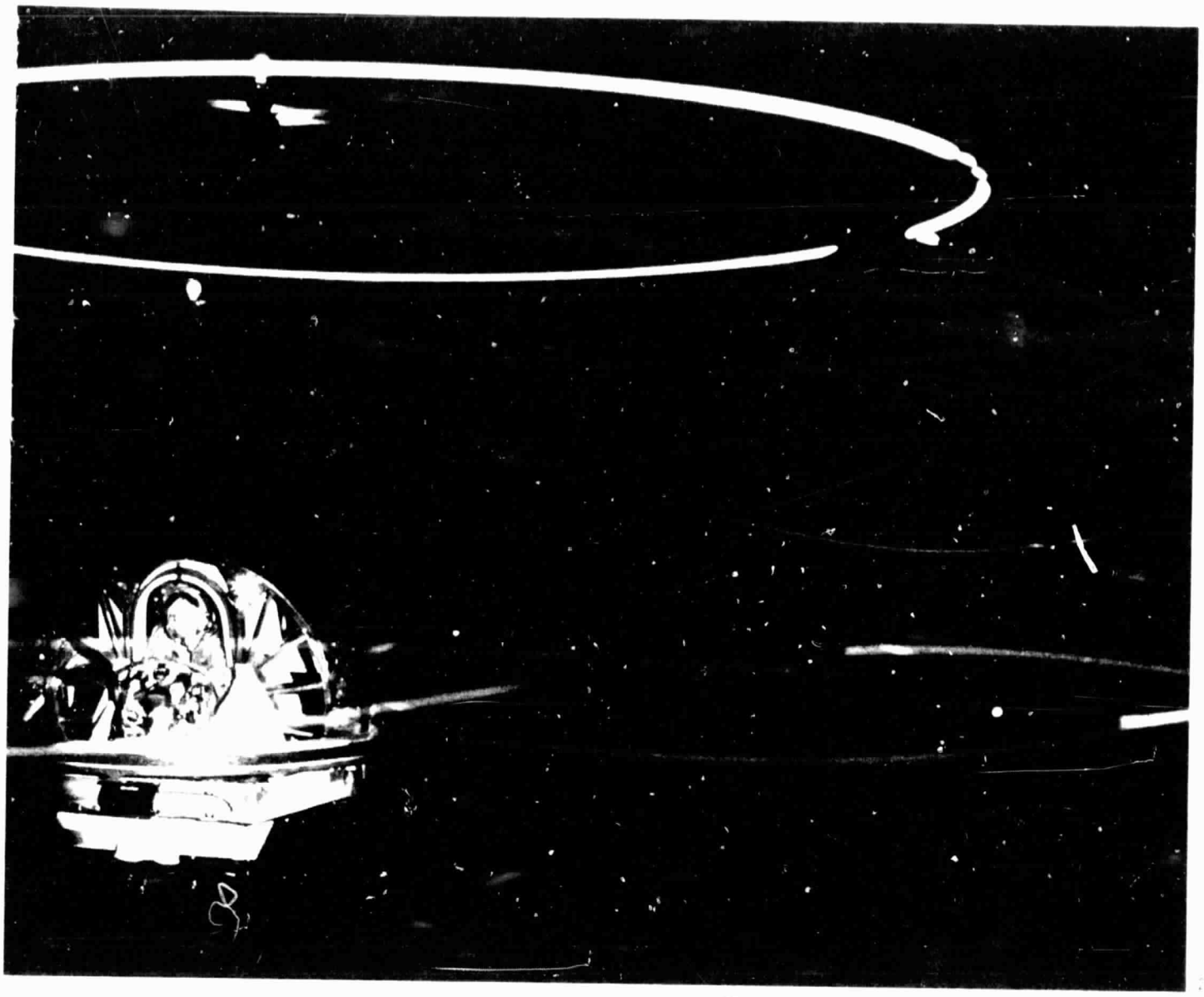


28 The Gemini rendezvous docking simulator used to develop orbital docking techniques.



29

Time exposure of a Gemini training device in action. The bands of light trace its movements

An aircraft flown through a parabolic arc—up, over and down—provides astronauts with a brief period of weightlessness when gravity is temporarily neutralized

30

31 Astronaut James Lovell hits the water with a splash during a simulated landing. He is riding the "Dillbert Dunker," a Naval training device at Pensacola, Florida.

32 Astronaut John W. Young leaves Gemini spacecraft during water egress training. Astronaut Virgil I. Grissom is already in the water.

33

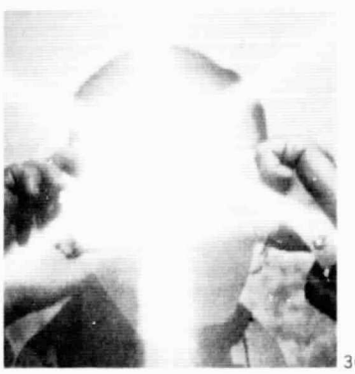
Astronauts undergo an endurance test along a snow-covered mountain trail.

34

A native guide shows four astronauts attending the Tropical Survival School in the Panama Canal Zone how to turn a bamboo stalk into a container for catching and storing rain water.

35

Astronauts join one-man life rafts together to form larger unit, as part of jungle survival training.



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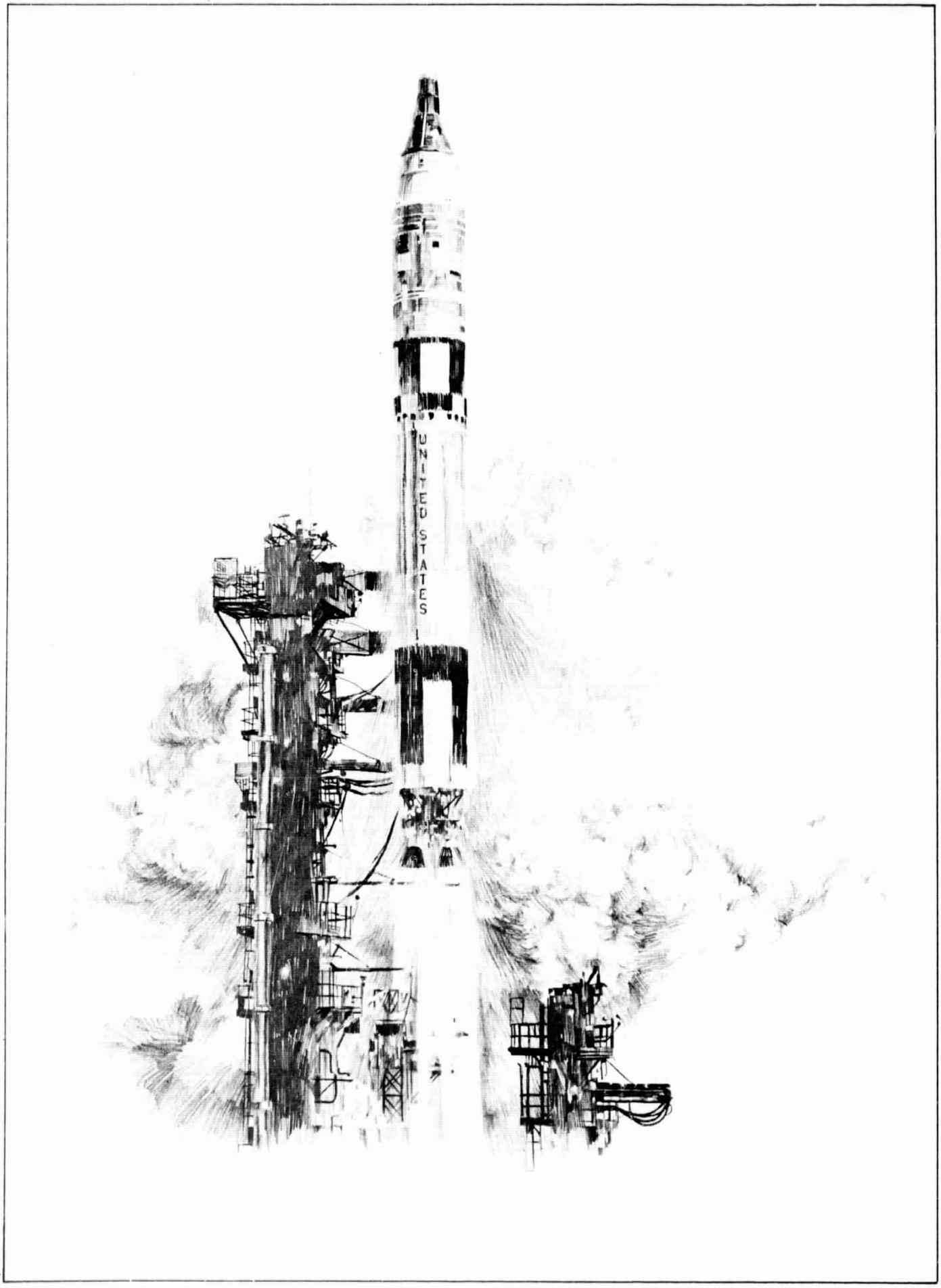
Astronaut uses a mirror to signal by reflecting sun's rays.



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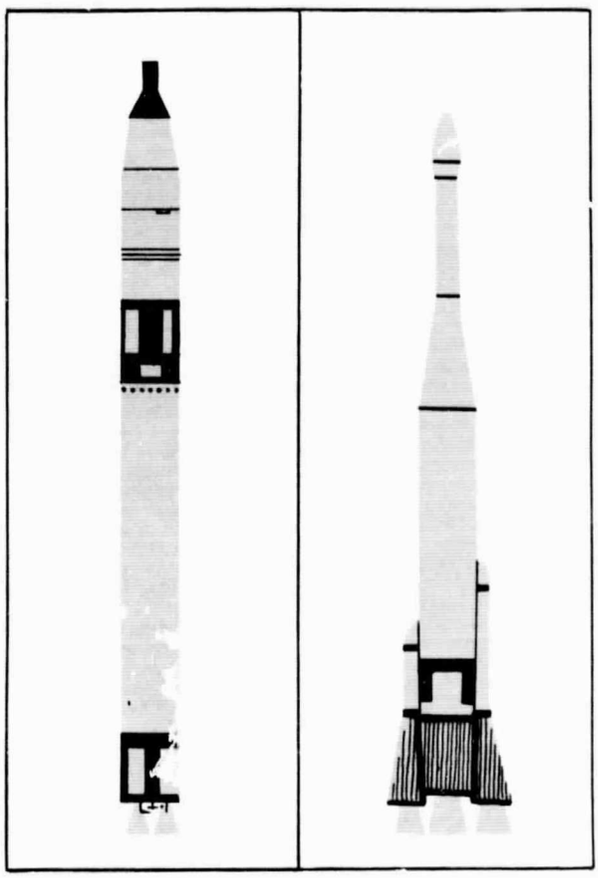
The Project Gemini Launch Vehicles



The Gemini-Titan at moment of blastoff. The Gemini Launch Vehicle (GLV), a modified Titan II, is a two-stage, liquid-fueled launch vehicle. The overall assembly, GLV and Gemini, is 109 feet tall and has a maximum diameter of 10 feet.

The two launch vehicles for Project Gemini are Gemini-Titan and Atlas-Agena.

The Titan part of Gemini-Titan consists of a modified version of the military Titan II. It is the rocket-powered vehicle which launches the Gemini spacecraft into orbit.

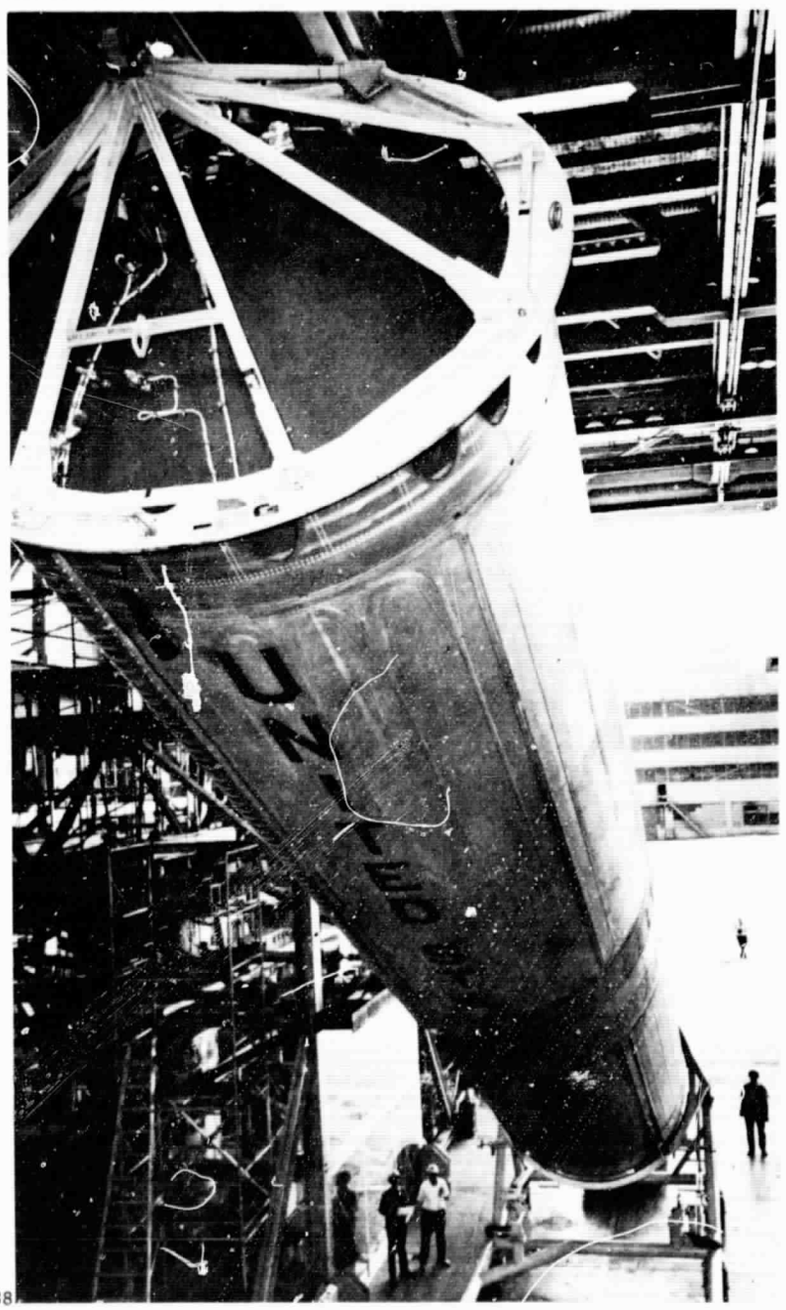
Atlas-Agena places its Agena upper stage into orbit as a target for Gemini rendezvous and docking experiments.

Gemini-Titan is 90 feet long without the Gemini spacecraft. Its two first-stage engines produce 430,000 pounds of thrust. Its second-stage engine, which is ignited in space provides 100,000 pounds of thrust. It can orbit a satellite weighing more than 8000 pounds.

The main and two auxiliary engines of the 66-foot long Atlas provide a total thrust of about 388,000 pounds. The single engine of the 26-foot long Agena can generate about 16,000 pounds of thrust. The Agena engine can be stopped and restarted many times. When the Gemini astronauts link up with Agena, they can operate its powerful rocket engine from their control panel to maneuver Gemini/Agena as a single spacecraft.

Atlas is an uprated version of the vehicle that placed the Mercury spacecraft into orbit.

First stage of the launch vehicle is set up in the vertical test cell at the Baltimore Division of the Martin Company.



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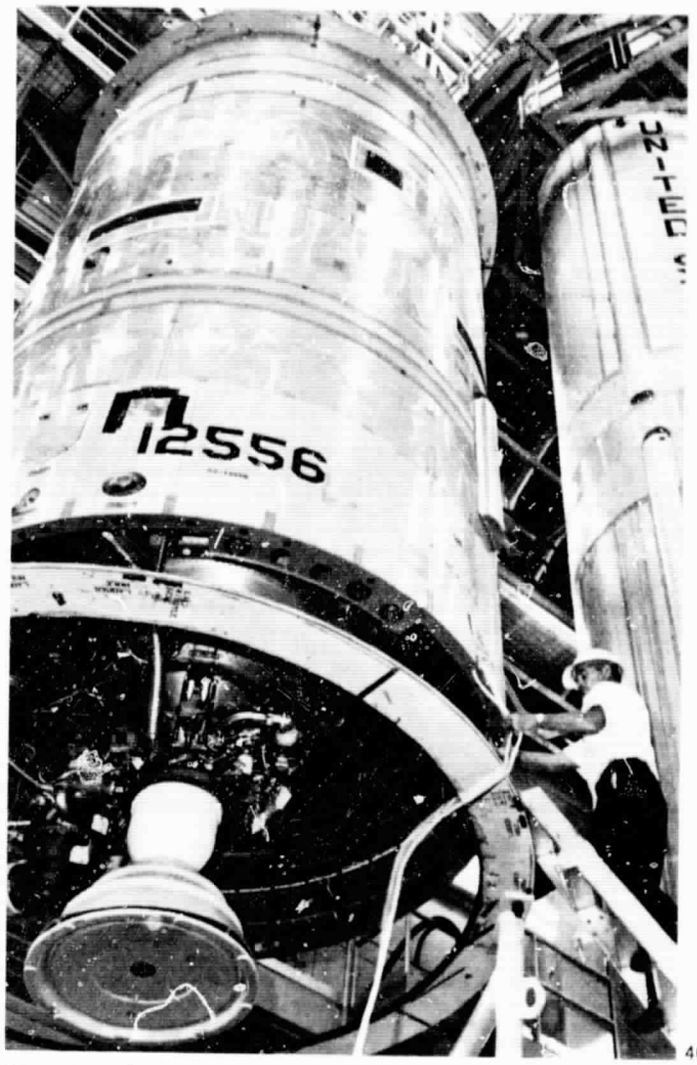

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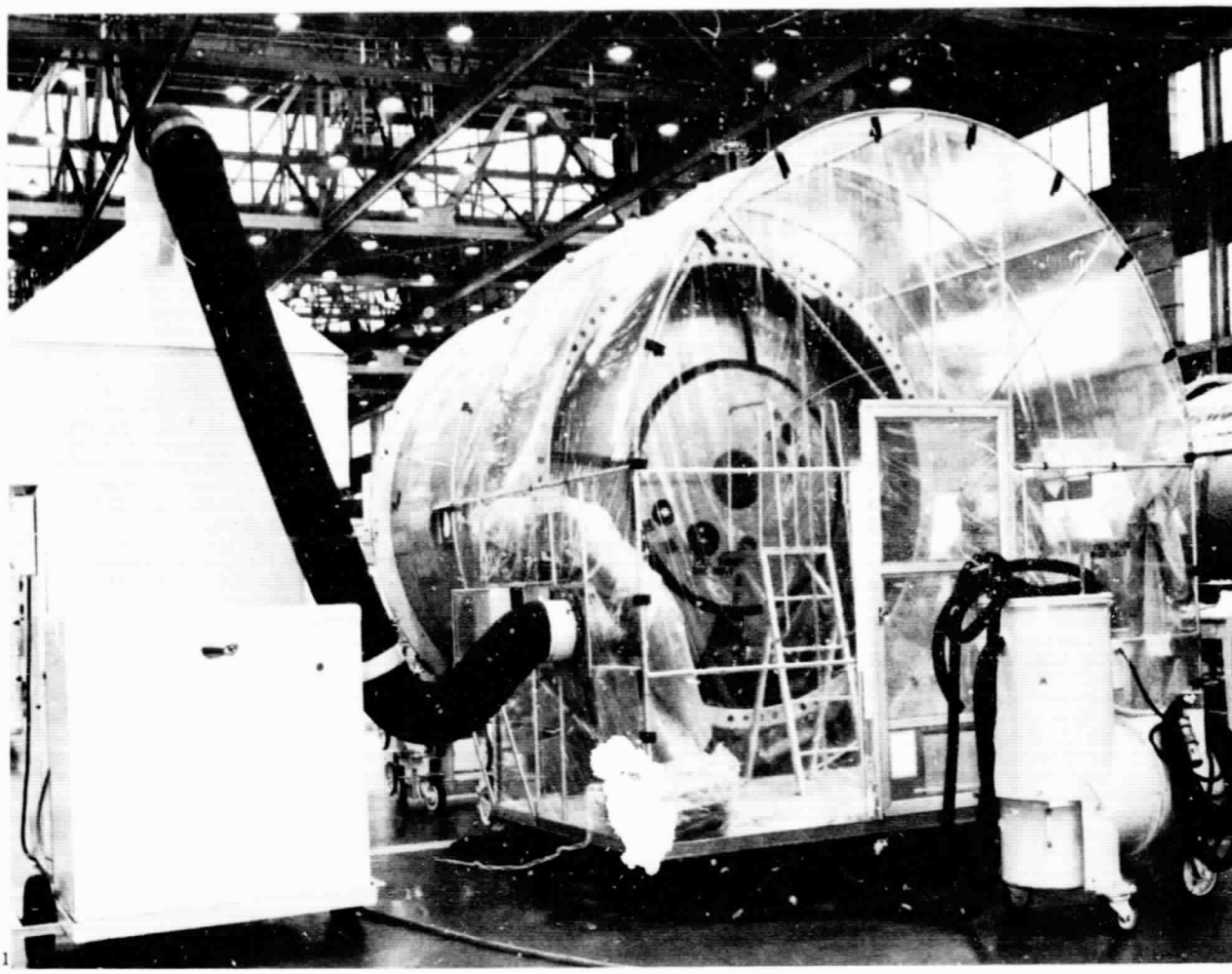
Stage two of the GLV is fitted into a swivel fixture prior to nesting with the first stage in the vertical test cell.

The Gemini Launch Vehicle stands in the vertical test cell before work platforms are lowered.



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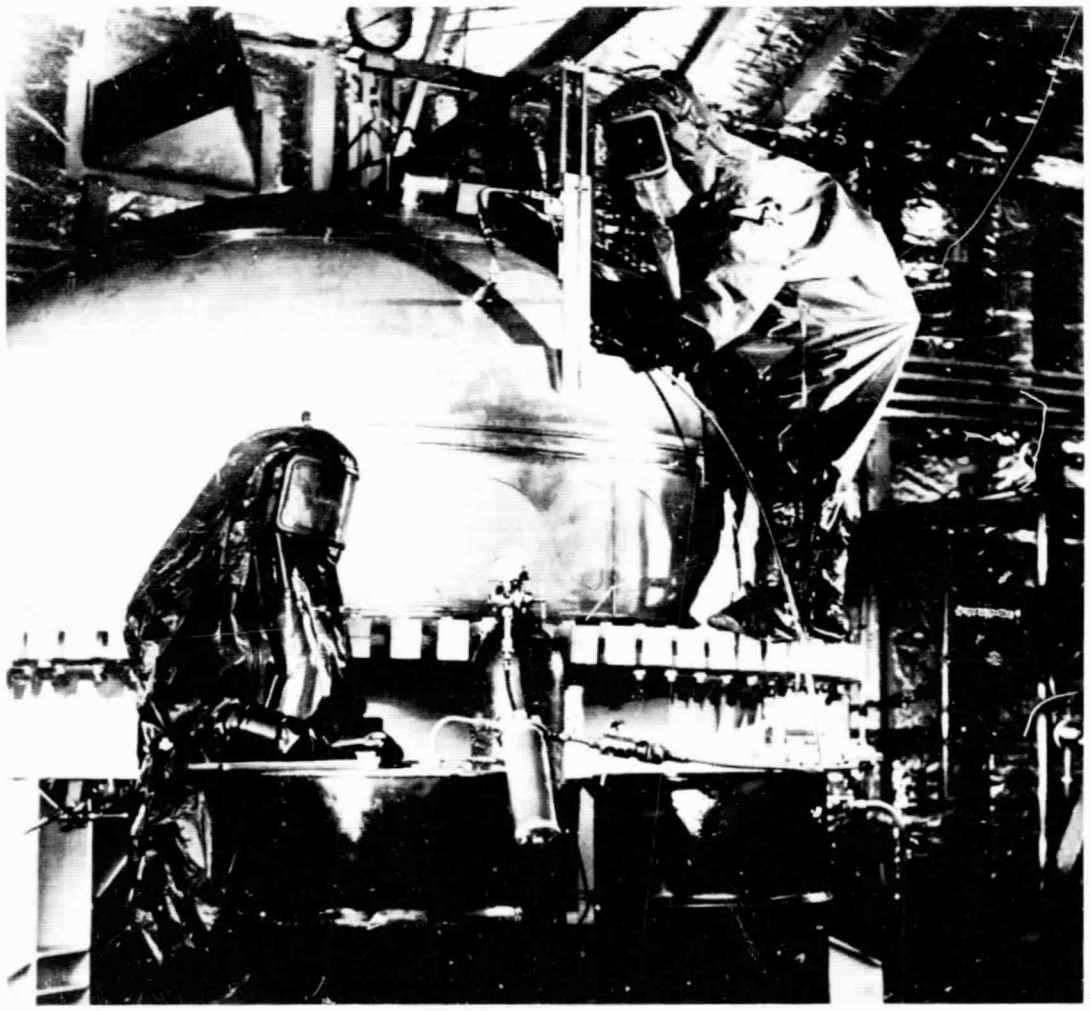
Second stage GLV fuel tank, in dust-free plastic igloo, is vacuum cleaned prior to its final assembly with other components of the launch vehicle.

42

Technician assembles a component of the Malfunction Detection System (MDS) of the GLV.



43

Workmen clad in protective suiting spray special materials on the top dome of the first stage section of the launch vehicle. This coating protects the dome against fire from the second stage engines when they ignite. The second stage ignites in flight and propels itself and the Gemini spacecraft to orbital velocity (about 17,500 m.p.h.).

44 Workmen cover the two stages of a GLV with canvas, preparing for airlift to Cape Kennedy, Florida.

45 The "Pregnant Guppy," a modified Boeing Stratocruiser which separates into two sections for loading. It can airlift one GLV stage at a time.

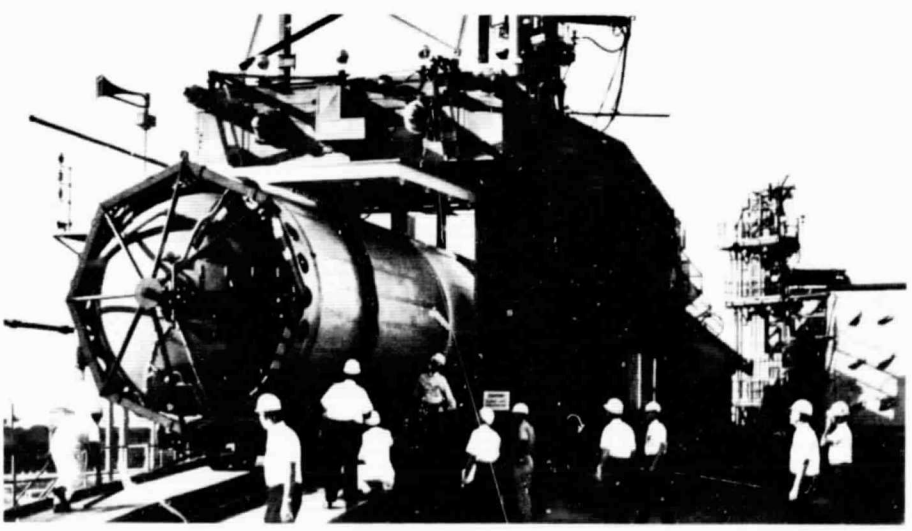
16 A first stage is loaded aboard the "Pregnant Guppy" for air shipment to Cape Kennedy.

47

After loading, the two parts of the "Pregnant Guppy" are gradually brought together.

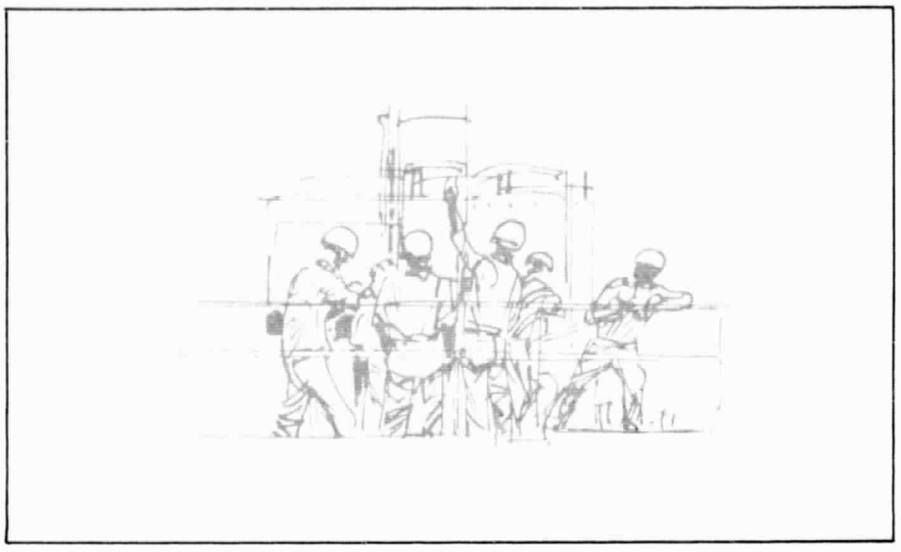
48

An Air Force C–133B cargo plane can carry both stages of the Gemini Launch Vehicle.

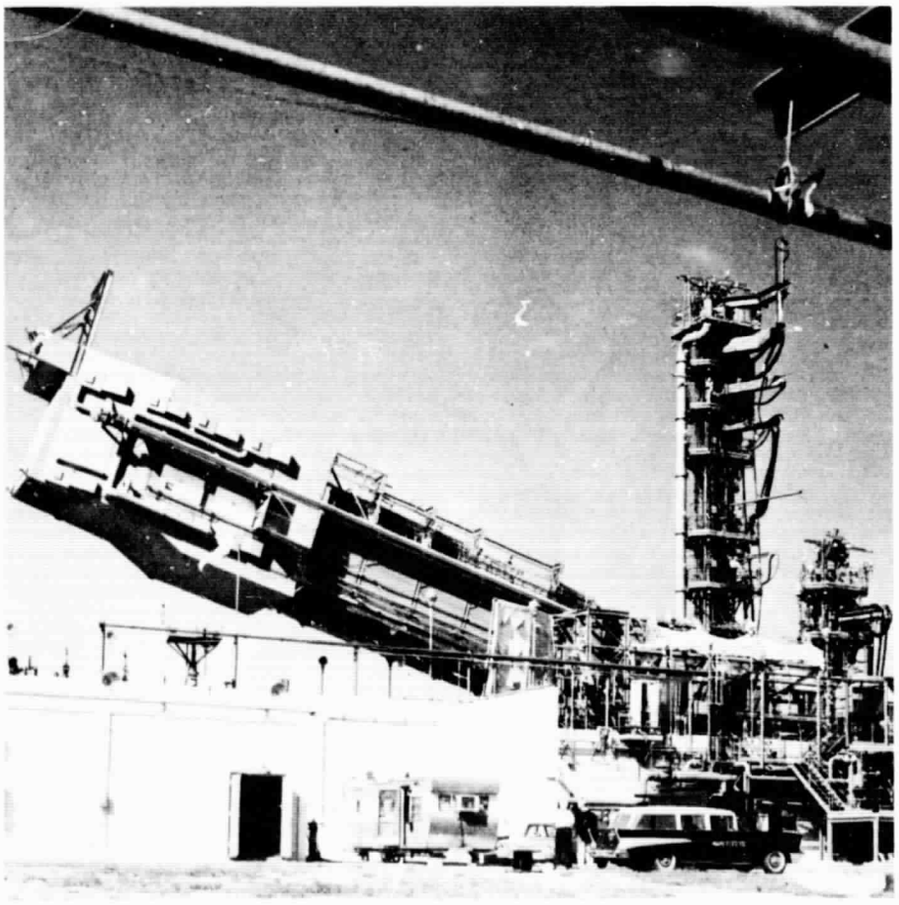


49

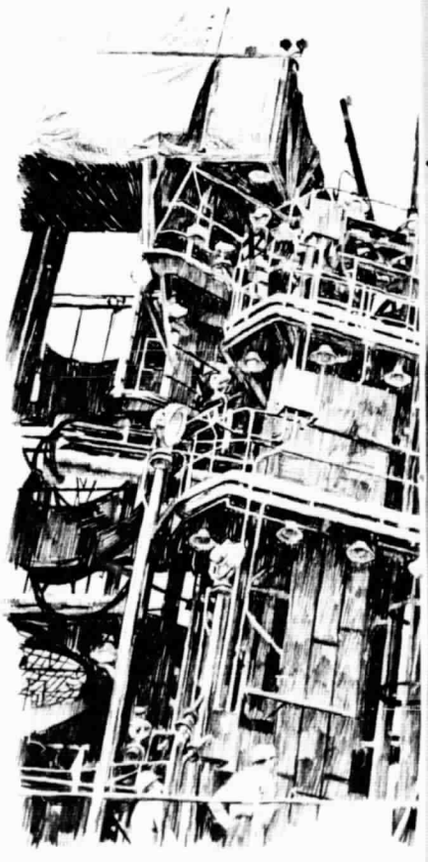
The first stage is positioned horizontally on the erector at Pad 19, Cape Kennedy.

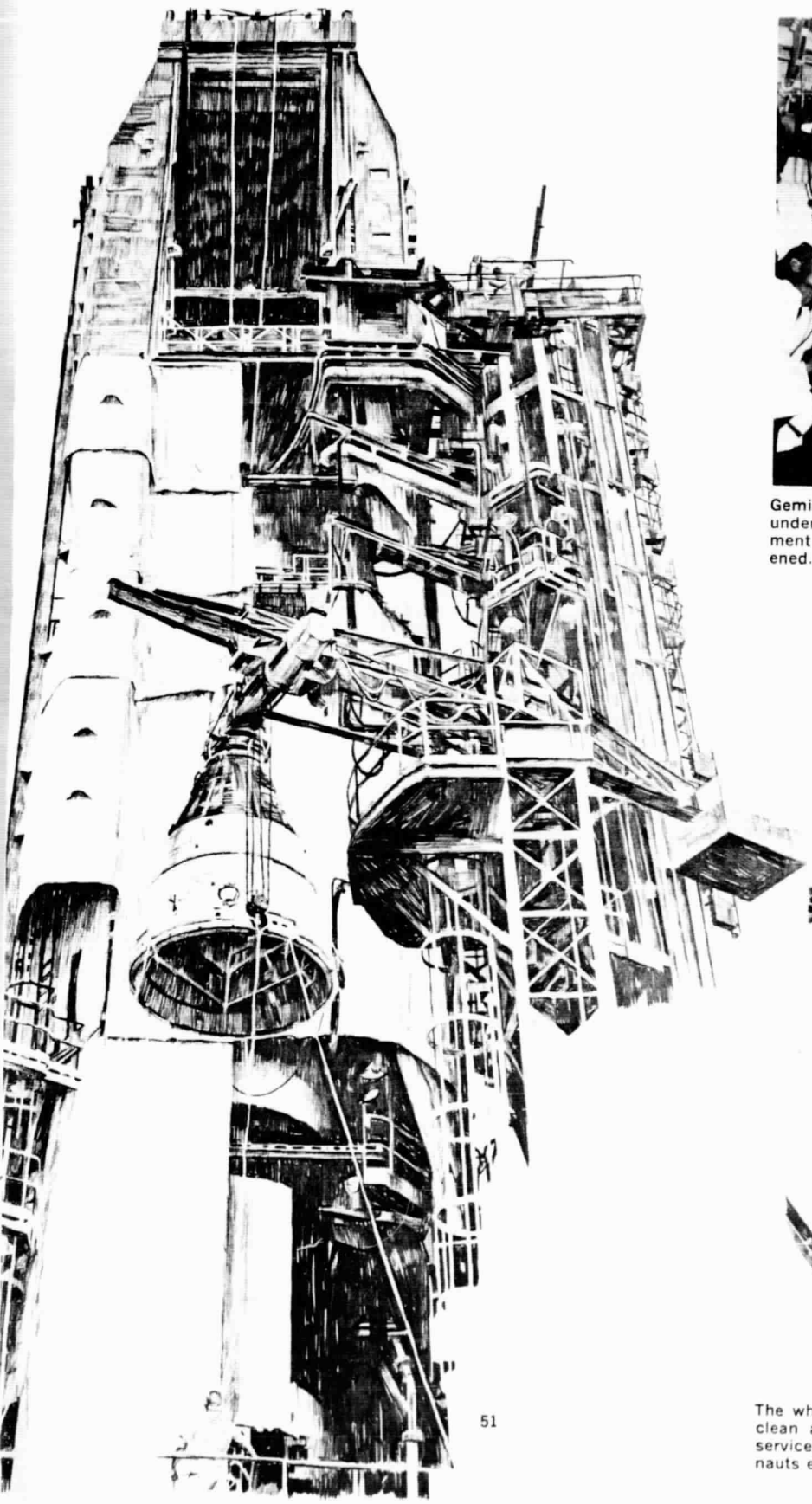


The Gemini spacecraft is raised by crane to the top of the launch vehicle at Pad 19, Cape Kennedy. The assembly is swung through the open door of the white room (at top), then lowered and bolted to the top of the second stage.



50 The GLV first stage being erected on Pad 19 at Cape Kennedy. After the first stage has been positioned on the erector gantry, the erector slowly rises to a vertical position. When the first stage is mated with the second stage and the Gemini spacecraft, the total weight is 150 tons. This launch vehicle erector is the only one of its type at Cape Kennedy.





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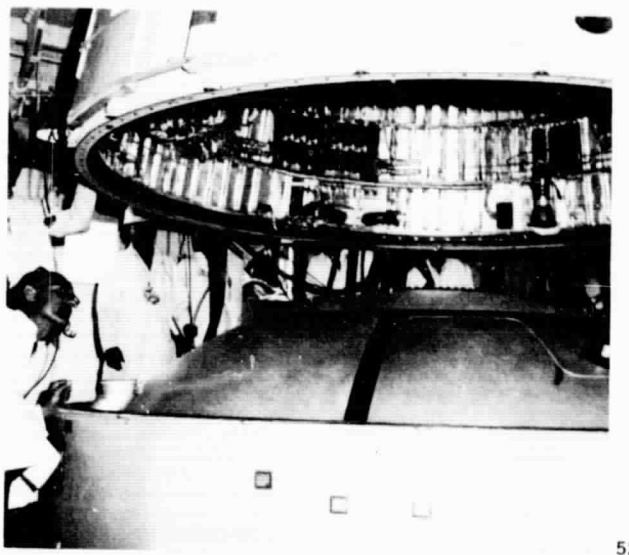
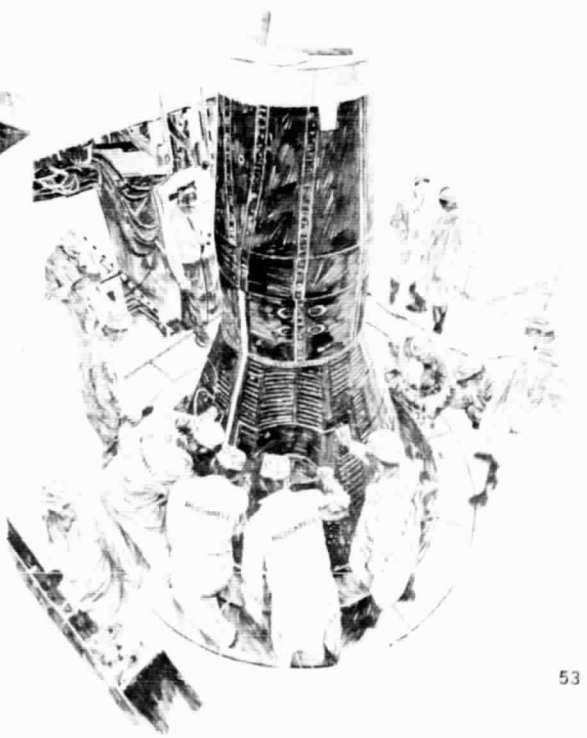


52

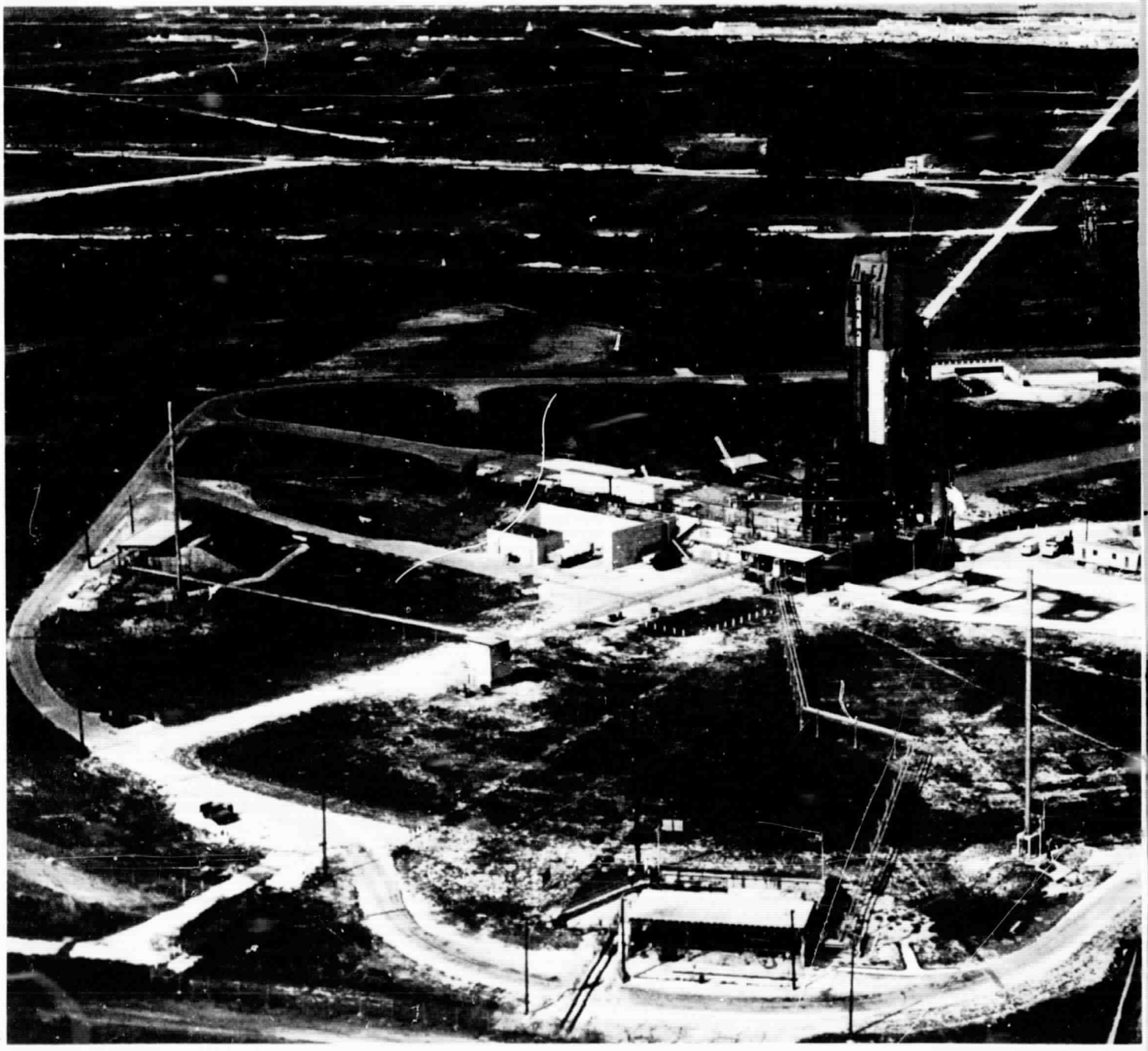
Gemini spacecraft being mated with the launch vehicle under the supervision of McDonnell engineers. After alignment is achieved, 20 5/16-inch bolts are inserted and tightened.



53

The white room. This is an environmentally controlled, superclean area at the top of the launch vehicle erector used to service the spacecraft. It is through this area that astronauts enter the spacecraft prior to flight.

Air view of Complex (Pad) 19 at Cape Kennedy.



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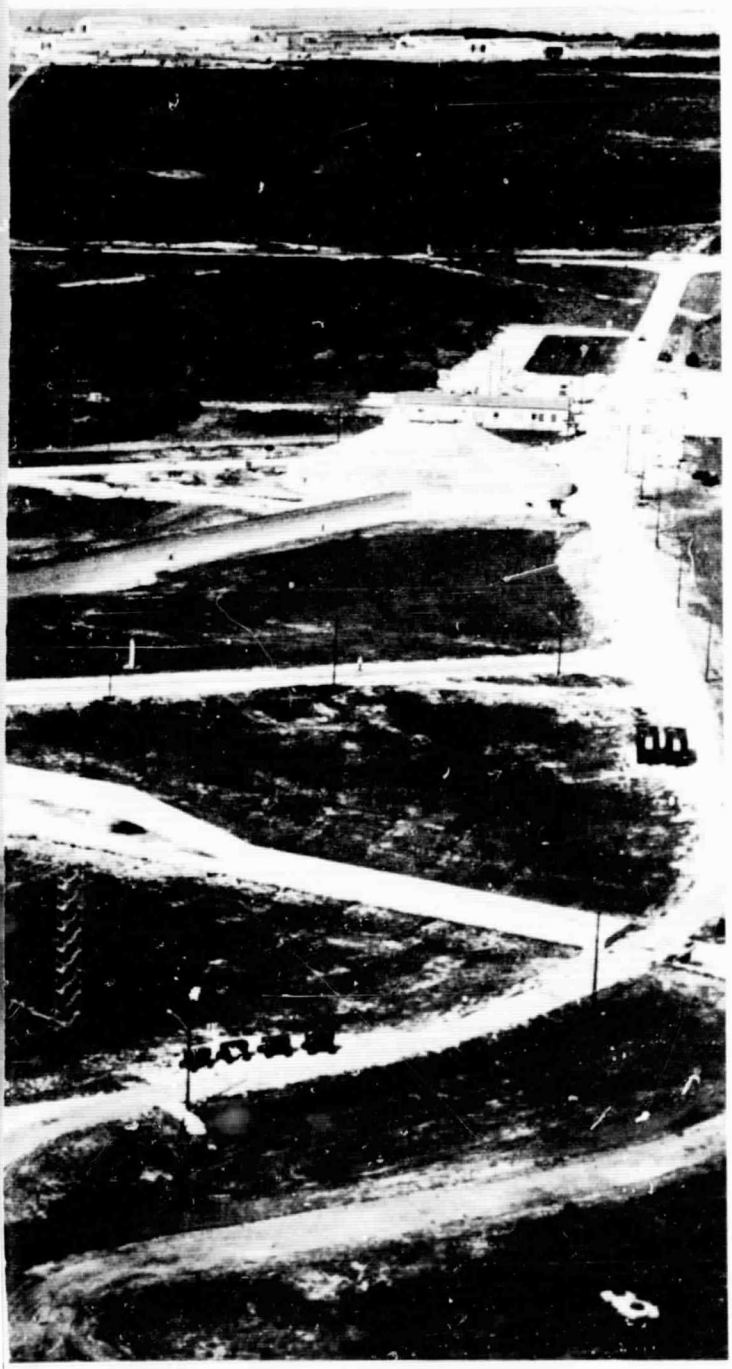
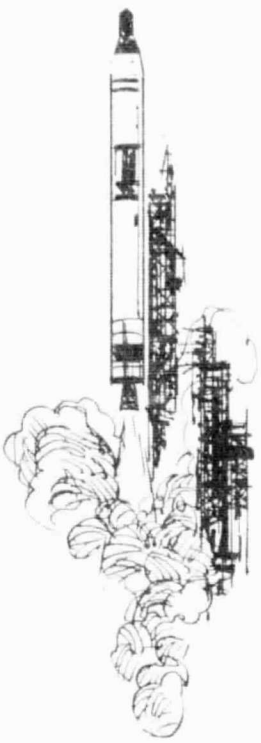
The Gemini Missions





Gemini missions into space have demonstrated that man can:

- Maneuver his craft in space.
- Leave his craft and do useful work in space.
- Rendezvous and dock with another vehicle in space.
- Function effectively during prolonged space flight of at least two weeks and return to earth in good physical condition.
- Control his spacecraft during its descent from orbit and land it within a selected area.

These are long steps across the frontiers of the unknown. But Gemini has done even more. Experiments conducted as part of Gemini flight missions have provided scientific, medical, and engineering data that add up to a tremendous increase in overall knowledge.

For example, oceanographers, meteorologists, and geographers are uncovering a wealth of information in photographs of the earth and its cloud cover that were taken from orbiting Gemini craft. Medical science is being advanced by study of data on the Gemini astronauts taken by instruments before, during, and after their flights.

RENDEZVOUS AND DOCKING

The technology for rendezvous and docking is vital not only for the manned lunar exploration program but also for other future space operations, including: Assembly and operation of manned orbiting space stations, satellite inspection and repair, refueling in space, assembly in orbit of the massive vehicles envisioned for manned interplanetary exploration, and, if ever required, the rescue of astronauts from disabled spacecraft.

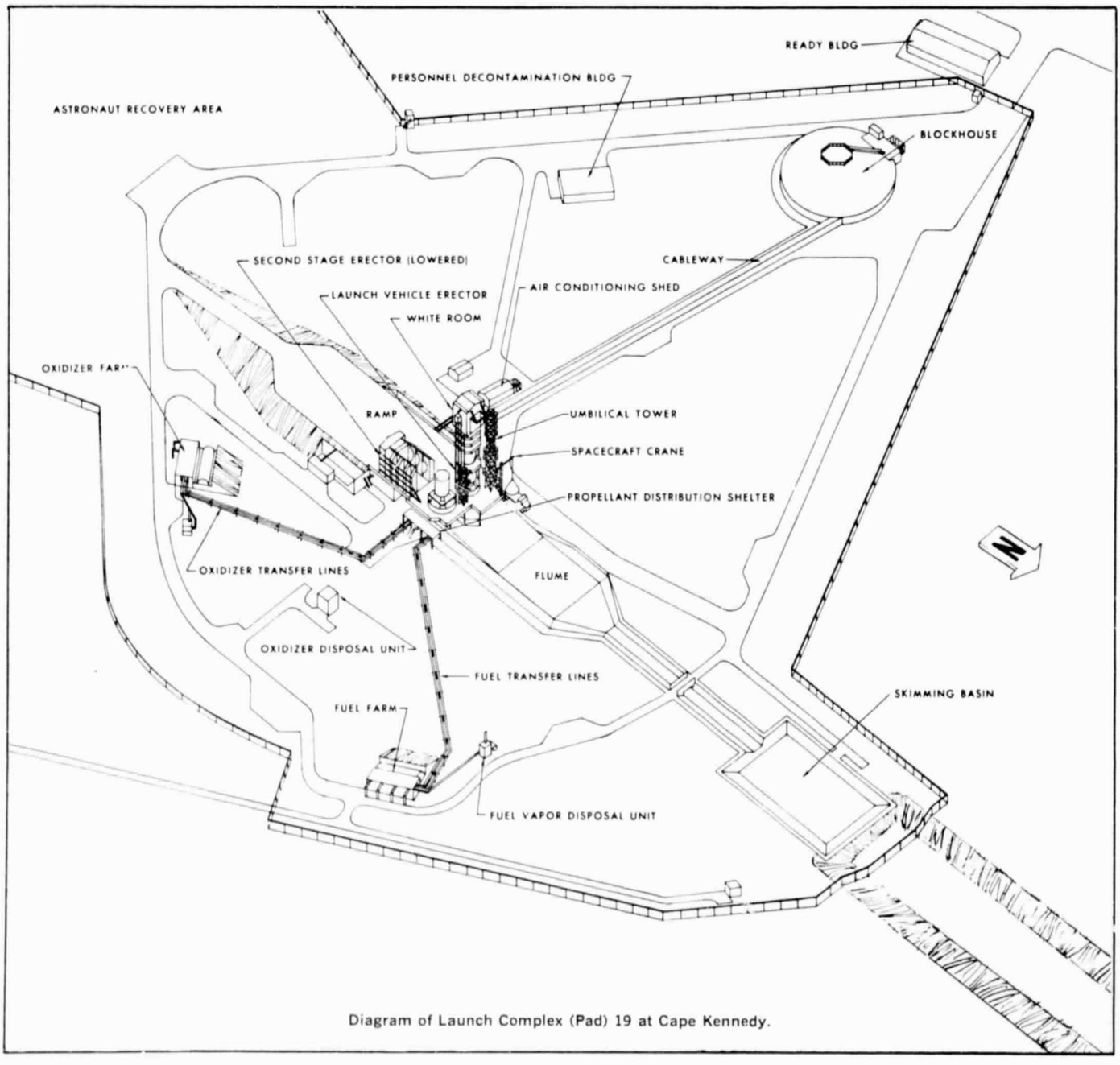
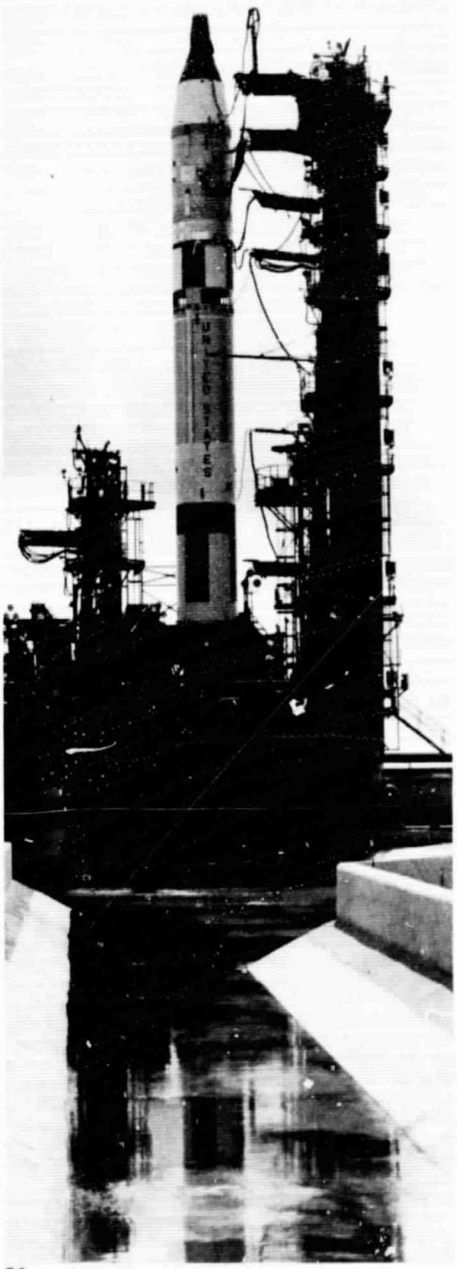


Diagram of Launch Complex (Pad) 19 at Cape Kennedy.

55

At bottom left, a Gemini-Titan stands ready for the countdown on Pad 19, Cape Kennedy. The middle photo shows the moment of lift-off. At right, the vehicle is in flight.



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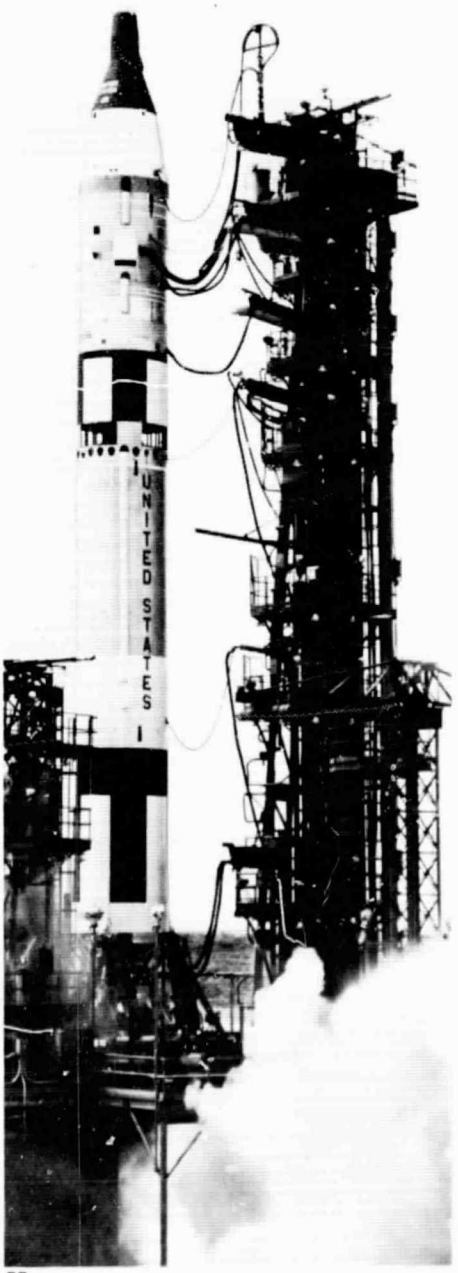

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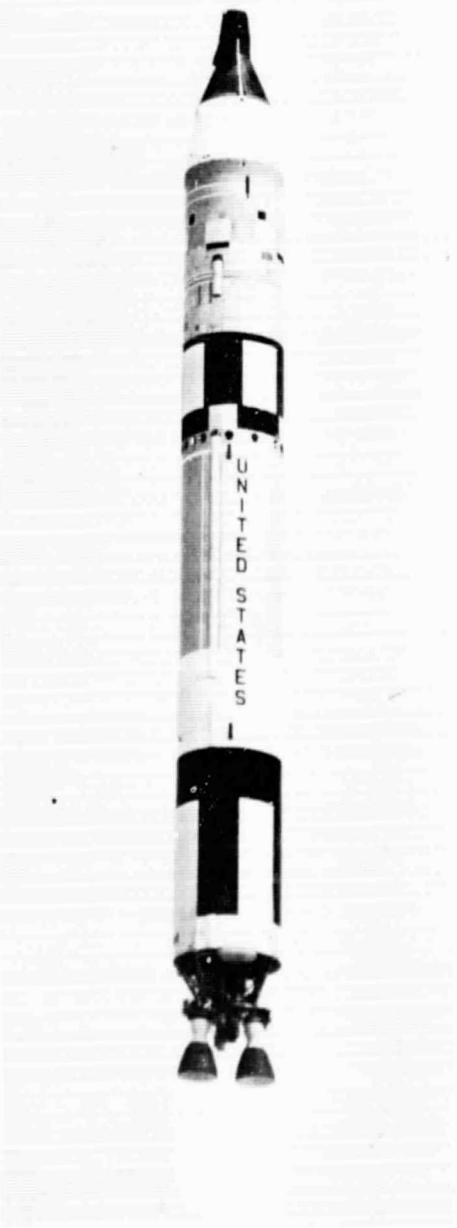

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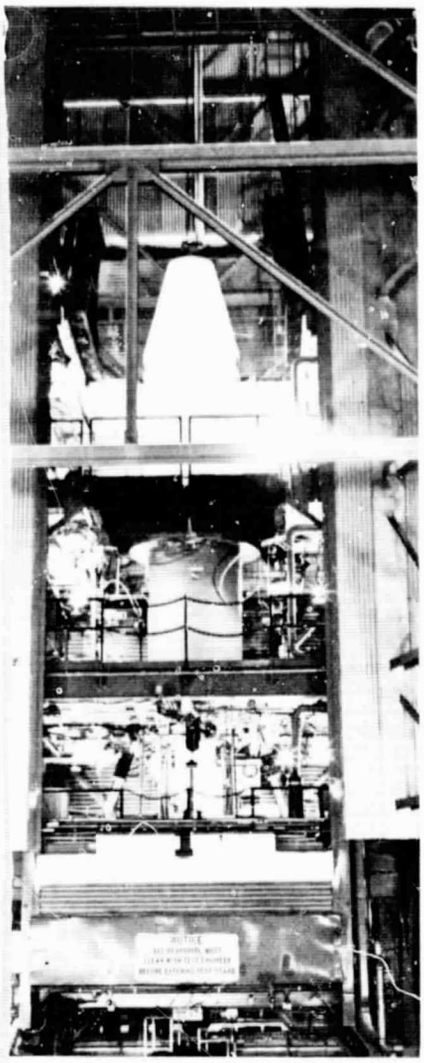


59

Agena ready for check-out by Lockheed technicians.

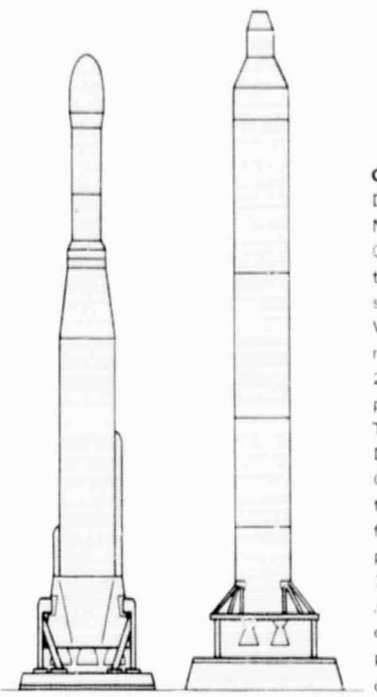
AGENA D
RENDEZVOUS TARGET

Developed by Lockheed Missiles & Space Company, originally for the Air Force. Used in many NASA and Air Force programs. Approximately 5 feet in diameter. Engine can be re-started while Agena is in orbit.

ATLAS

Developed by General Dynamics-Astronautics, originally for the Air Force. Used as a booster in a number of NASA and Air Force programs. Approximately 10 feet in diameter across tank section. Thrust: 367,000 pounds.

Combined height of Atlas-Agena is about 103 feet.



GEMINI SPACECRAFT

Developed for NASA by McDonnell Aircraft Corporation. Will carry two astronauts and supporting equipment. Weighs about twice as much as Mercury, is about 20 per cent larger with 50 per cent more volume.

TITAN II

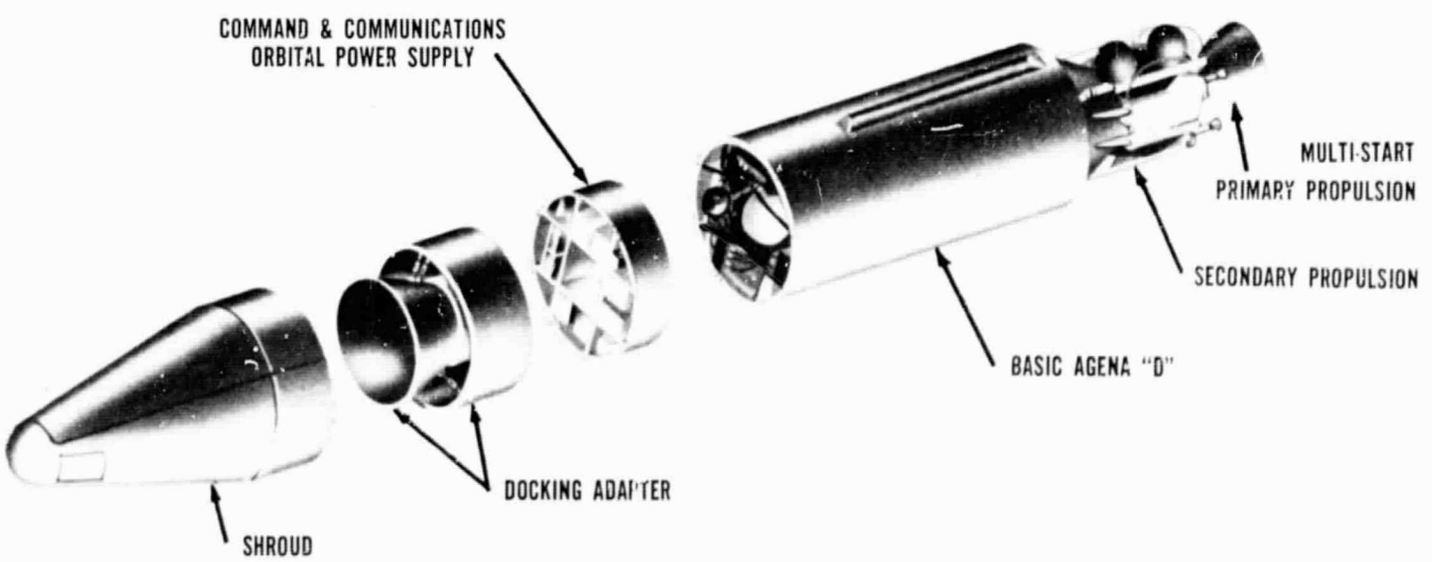
Developed by the Martin Company, originally for the Air Force. Thrust of first stage, 430,000 pounds; second stage, 100,000 pounds. Approximately 10 feet in diameter. Can place 6,000 pounds into low Earth orbit.

Combined height of Titan II-Gemini craft is about 110 feet.

60

GEMINI-AGENA TARGET VEHICLE

GEMINI-AGENA TARGET VEHICLE



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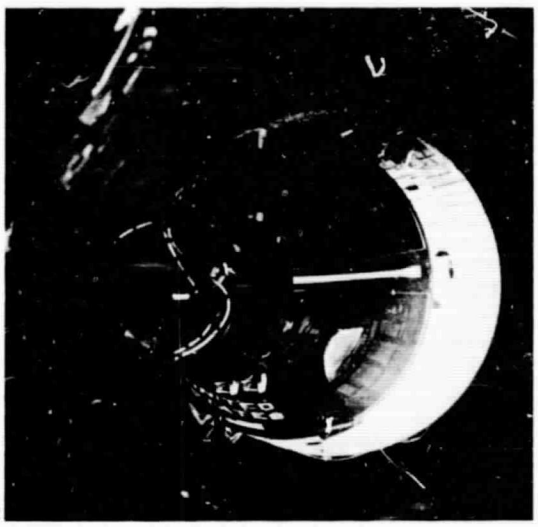

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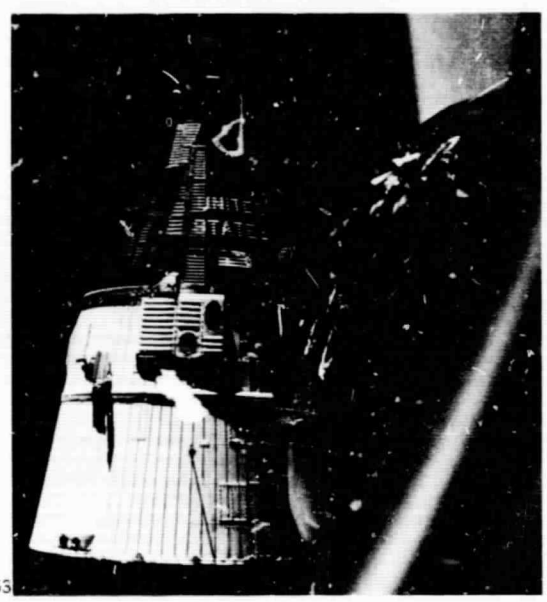

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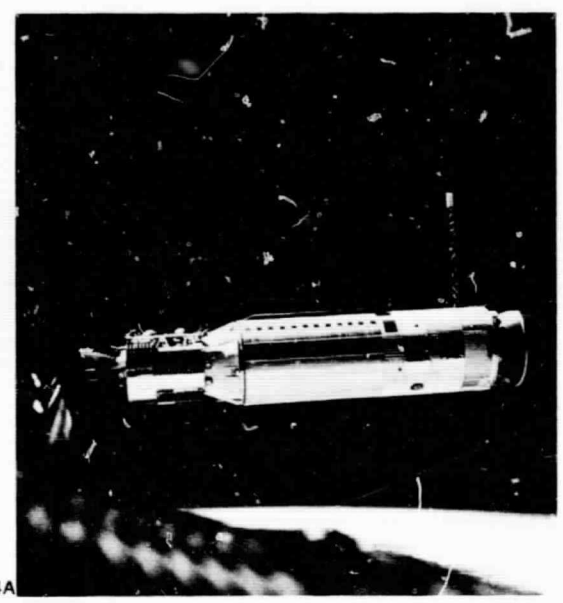
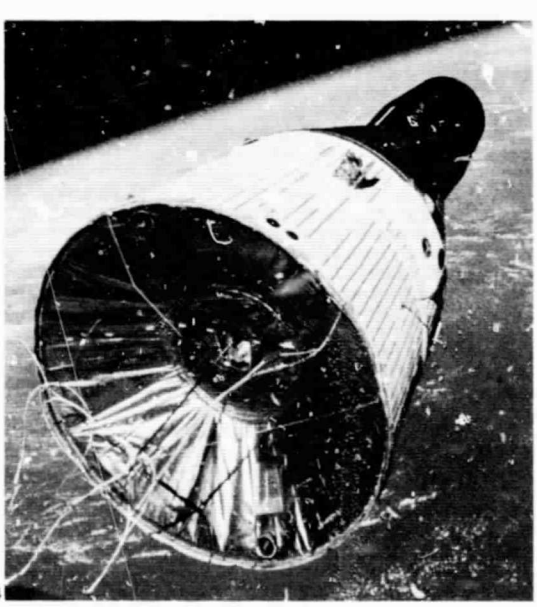
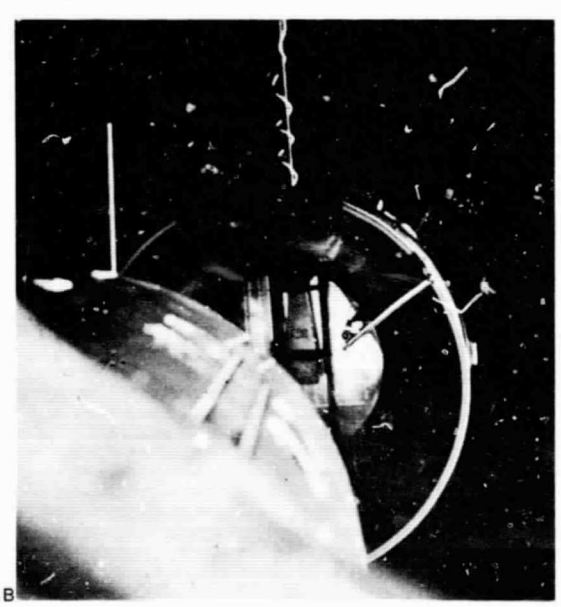


64A



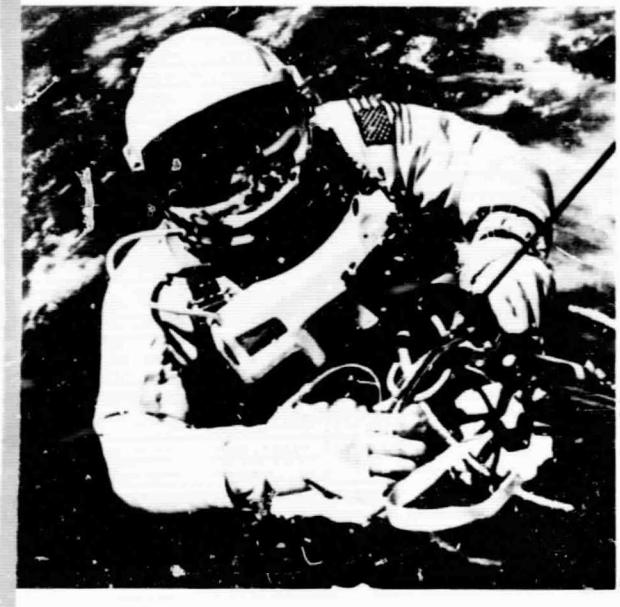
64

Front, side, and rear view of the Gemini 7 spacecraft taken from Gemini 6 (foreground) during their orbital rendezvous on December 15, 1965.



64B

Gemini 8 accomplishes docking by joining with the Agena target vehicle. Above, Agena from the window of Gemini 8. Below, Gemini 8 moves in for final stage of docking.



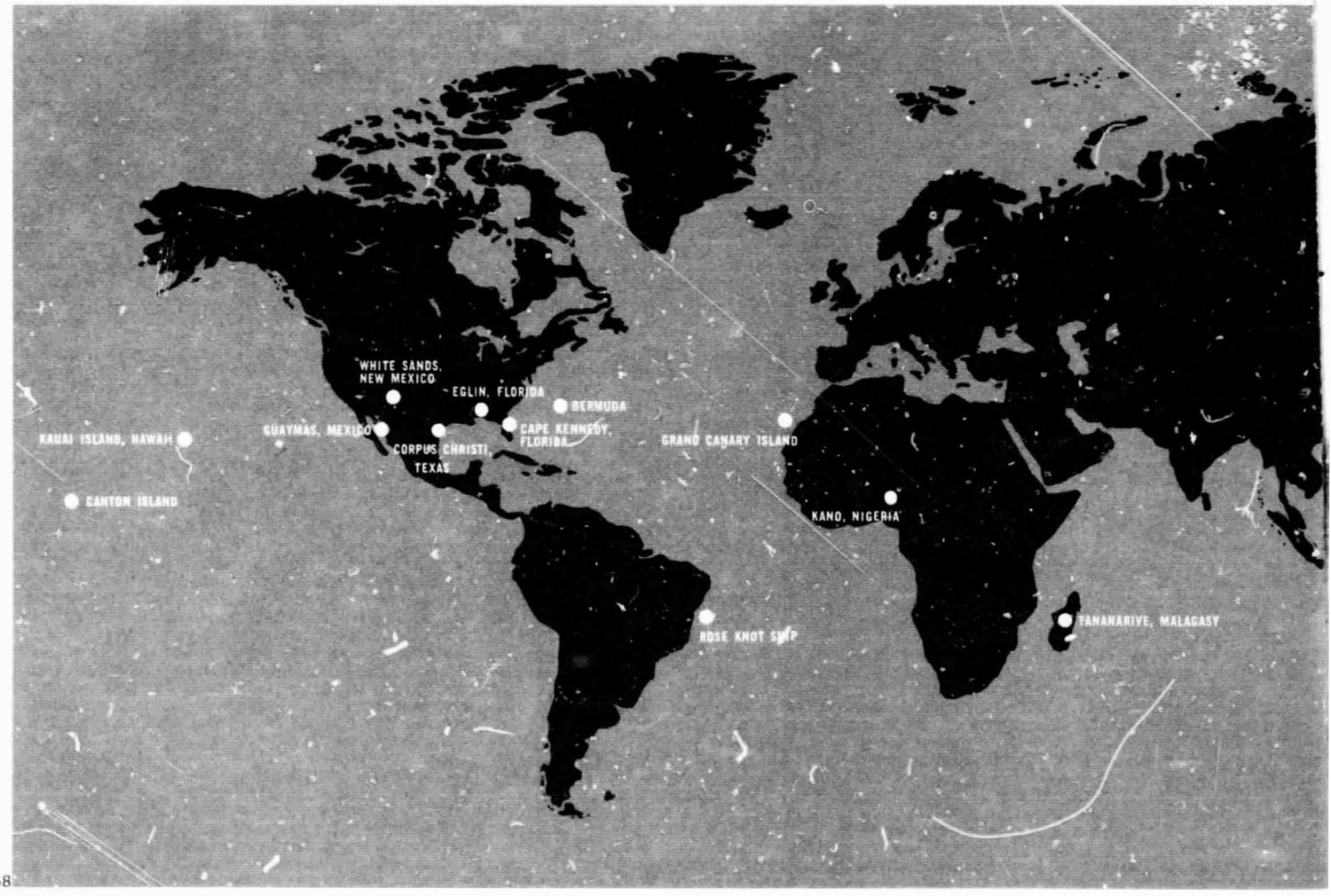
65

66

Astronaut White's "walk in space" during third revolution of the Gemini 4 flight.

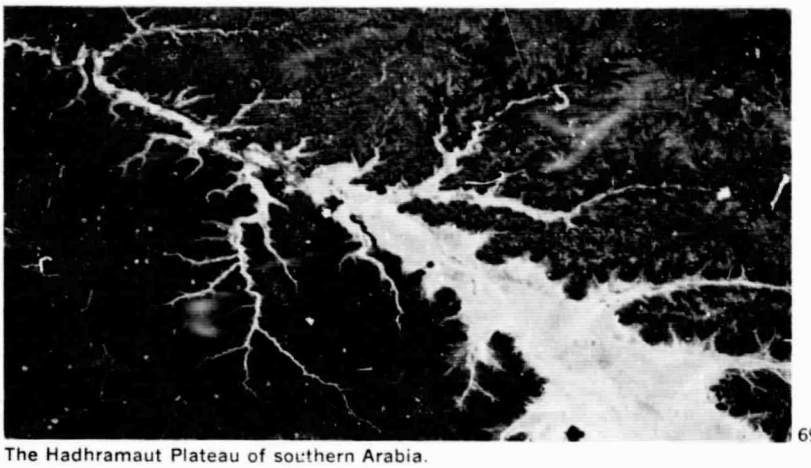
67 The Mission Operation Control Room in the Manned Spacecraft Center at Houston, Texas. The flight controllers are shown at their consoles during a Gemini space flight. Observers are looking through the windows of the viewing room.

Stations of the Gemini manned space flight support network.

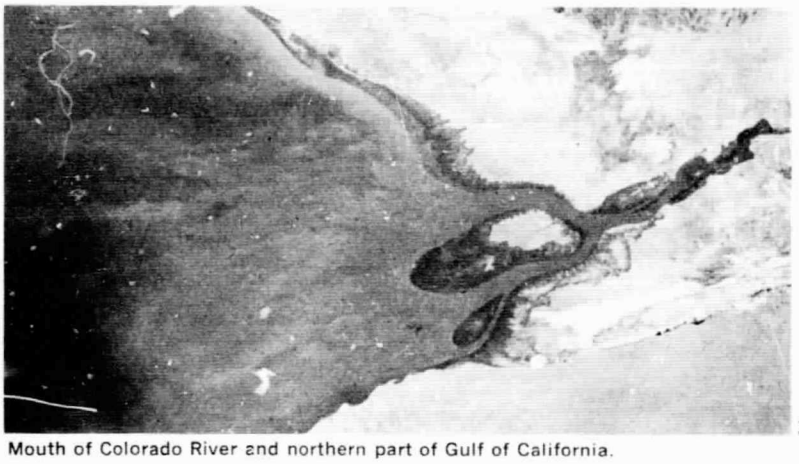


68

Photographs of the earth's surface were taken from Gemini spacecraft. Four of them are reproduced on this page.



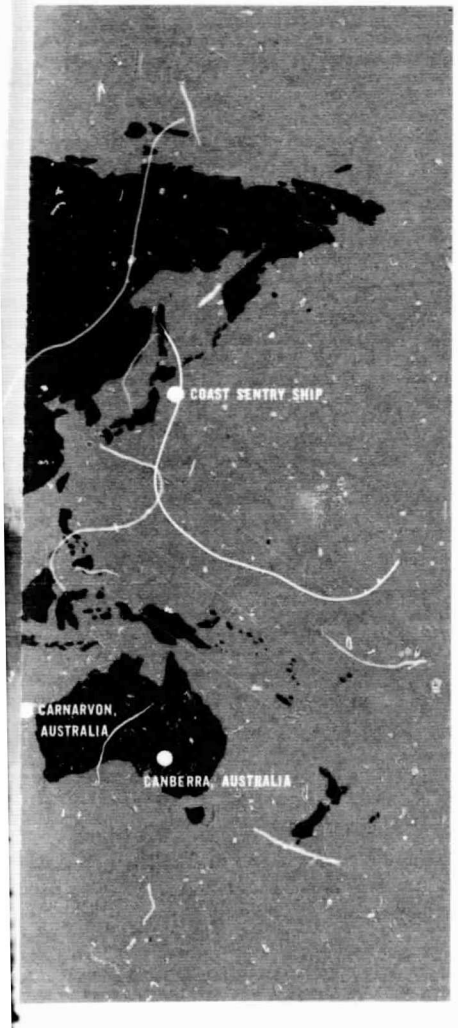
69 The Hadhramaut Plateau of southern Arabia.



70 Mouth of Colorado River and northern part of Gulf of California.

71 The Nile Valley in southern Egypt.

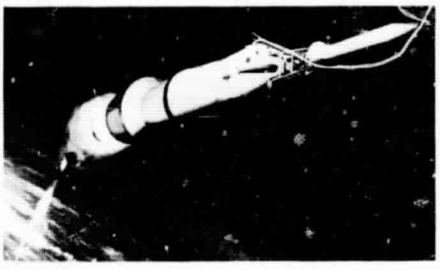
72 Strange Richat structures (concentric ridges) in northwest Africa.



73

Buoyed by its huge 85-foot diameter main parachute, the Gemini spacecraft drifts toward watery landing field in the Atlantic Ocean.

Next – Apollo and the Moon



Project Apollo is America's program for manned exploration of the moon. The Gemini missions have proved out much of the technology needed for Apollo and have brought conquest of the moon within reach.

When the Apollo astronauts head toward the moon, they will use operational and control techniques pioneered in Gemini. When they land on the moon, they will exit from their craft wearing suits and backpacks developed in Gemini. When they rocket their lunar ferry vehicle from the moon to rendezvous and dock with the Apollo parent craft that remained in lunar orbit, they will employ techniques proved in Gemini. And when they return to earth through the fiery heat and buffeting that accompany reentry into the atmosphere, they will utilize experience acquired in Gemini.

In the long range view, the new technology developed, tested, refined, and improved in Gemini paves the way not only for the lunar mission but also for other space missions to expand the frontiers of man's knowledge.

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