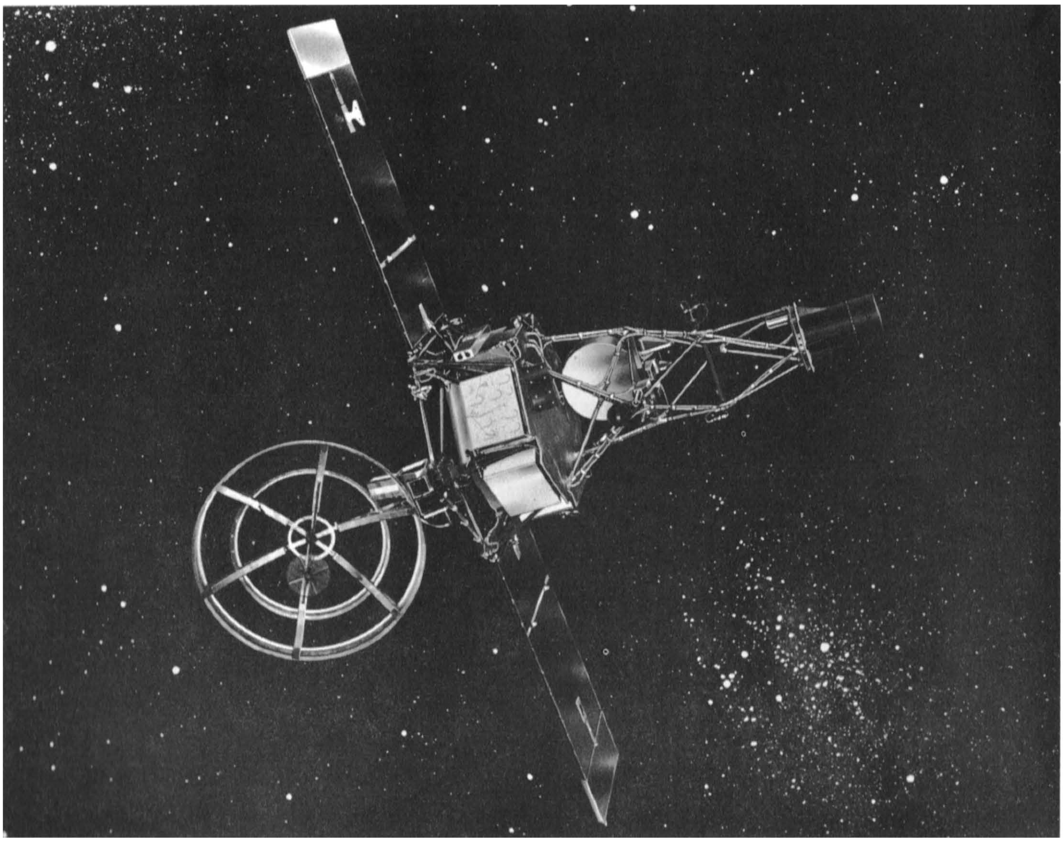
NASA FACTS (D-62)

An Educational Services Publication of the
National Aeronautics and Space Administration

MARINER



Mariner in space (artist's conception).

Ever since man first viewed Venus through a telescope, he has conjectured about the secrets behind its perpetual cloud layers. With the launch of a Mariner spacecraft on August 27, 1962, man took a great step forward toward learning about the earth's sister planet and perhaps answering a fundamental scientific question: Does life exist elsewhere than on earth?

Earth contact with Mariner as it passes in the vicinity of Venus will set a new record in long-distance communication, 36 million miles. The current record is 22.5 million miles established on June 26, 1960, with NASA's Pioneer V space probe. Pioneer V is still in solar orbit.

A successful Mariner flight will pass Venus at a distance of about 10,000 miles, giving mankind the first nearby observation of the mysterious planet. During the fly-by, Mariner's instruments will scrutinize Venus for signs of water vapor, oxygen, and other atmospheric constituents and attempt to ascertain the planet's surface temperature. It will also gather information on magnetic fields, radiation, and cosmic dust in the Venus space environment, and in interplanetary space between the earth and Venus. Moreover, Mariner will test basic elements of space technology required for advanced interplanetary missions of the future.

The information expected from Mariner can contribute significantly not only to scientific knowledge but also to planning for the day when man himself journeys to other planets.

Venus—Ocean or Dust Bowl?

VENUS—OCEAN OR DUST BOWL?

Although Venus is the earth's closest planetary neighbor, relatively little is known about it. Scientists agree that the planet's diameter is about 7,800 miles. This makes it, in size, almost the twin of the earth, which has a 7,926-mile diameter. Also known is that Venus revolves around the sun every 225 days; its average distance from the sun is 67.2 million miles; and the planet's mass—the amount of matter composing it—and gravitational field are similar to those of the earth.

Beyond these facts, information is fragmentary. This has led to divergent views on the character of the Venusian landscape. Imagined conditions range from a planet inundated by water to one that is dry and hot and whose lower atmosphere is laden with wind-driven dust because there is no rain to wash it down.

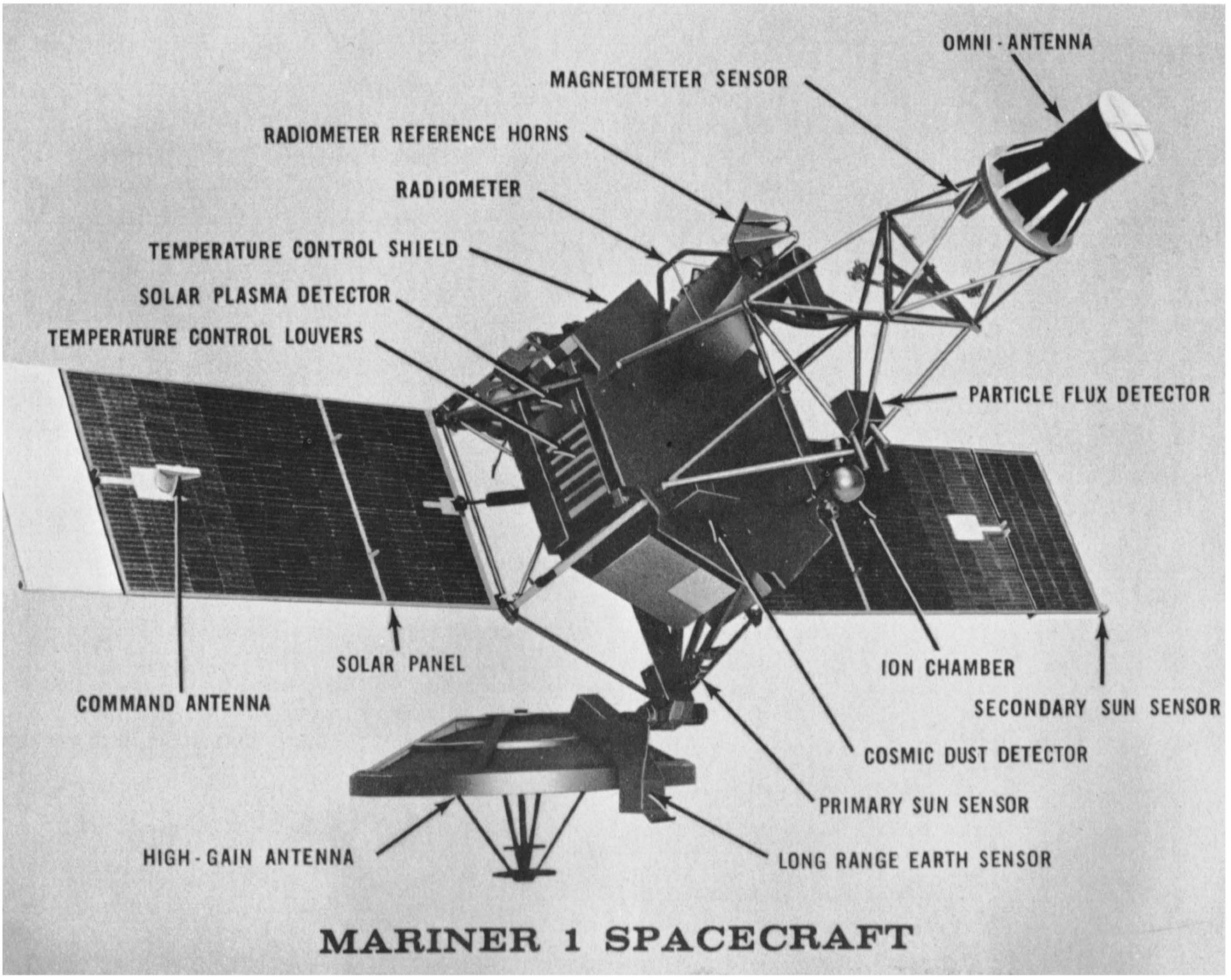
Our knowledge of Venus has been dependent on such techniques as analysis of radar echoes and sunlight reflection over a distance of more than 26 million miles. Scientists seriously debate the results of these experiments.

Microwave scanning of the planet indicates a near-surface temperature of about 615 degrees Fahrenheit. If this is true, then life such as that on earth could not survive on Venus. However, since these temperatures were taken from such a great distance, there is disagreement as to whether they are located on the surface or at higher altitudes. Infrared measurements indicate temperatures of 38 degrees below zero Fahrenheit somewhere in the atmosphere.

Spectographic observations, through which matter is identified by its absorption and emission of light, suggest that Venus' atmosphere is composed principally of carbon dioxide and nitrogen and contains negligible quantities of free oxygen and water vapor. This may indicate an absence of vegetation, at least of the types prevailing on earth. However, there is dissent as to how much water vapor and free oxygen the atmosphere contains.

Among puzzling visual features of Venus are the light and dark markings of its cloud mantle. There is speculation that these may be holes in the seemingly solid cloud blanket.

NASA launched Mariner during the Venus "launch window," a time interval when the positions of the earth and Venus are favorable to flight between the two planets. This period occurs once every 19 months. The next is due in 1964.



Mariner spacecraft with principal instrumentation indicated.

SCIENTIFIC EXPERIMENTS

Mariner's scientific experiments, designed to gather information on Venus and on interplanetary space between the earth and Venus, are under the direction of NASA's Jet Propulsion Laboratory, Pasadena, Calif. In the following paragraphs, organizations collaborating with NASA in a particular Mariner experiment are indicated in parentheses after the experiment description.

1. MICROWAVE RADIOMETER—to provide information on the surface temperature of Venus and to report the existence of water vapor in the atmosphere above a minimal concentration. The experiment will also attempt to determine whether the high temperature readings received from Venus are due to a dense ionosphere, thereby testing a theory that a Venusian ionosphere, thousands of times denser than earth's, gives the impression that the planet is hot. (Harvard University, Cambridge, Mass.; Massachusetts Institute of Technology, Cambridge; and Army Ordnance Missile Command, Huntsville, Ala.)

2. INFRARED RADIOMETER—to be aligned with the microwave radiometer thereby providing composite measurements relative to the temperatures and atmosphere of Venus. Data from the infrared radiometer will also help determine whether the light and dark markings in Venus' clouds are breaks in the cover and, if so, how much of the planet's heat escapes from them. (University of California, Berkeley, Calif.)

Man has called Venus his morning and evening "star." After the sun and moon, Venus is the most brilliant object in his sky. This is because of its proximity to sun and earth and its reflective cloud layer.

3. MAGNETOMETER—to measure strength and direction of interplanetary and Venusian magnetic fields. Existence of a Venus magnetic field would suggest a surrounding radiation region similar to earth's and such events as auroras and magnetic storms on Venus. A widely accepted theory is that a planet's magnetic field originates from fluid motion in its interior. If this is true, then the existence of a Venusian magnetic field would indicate that the planet has a molten core. Mariner will correlate its measurements of interplanetary magnetic fields with measurements near earth and with solar events to increase understanding of their relationships. In addition to its scientific value, knowledge of magnetic fields can contribute to design of communication systems for linking spacecraft and earth over interplanetary distance.

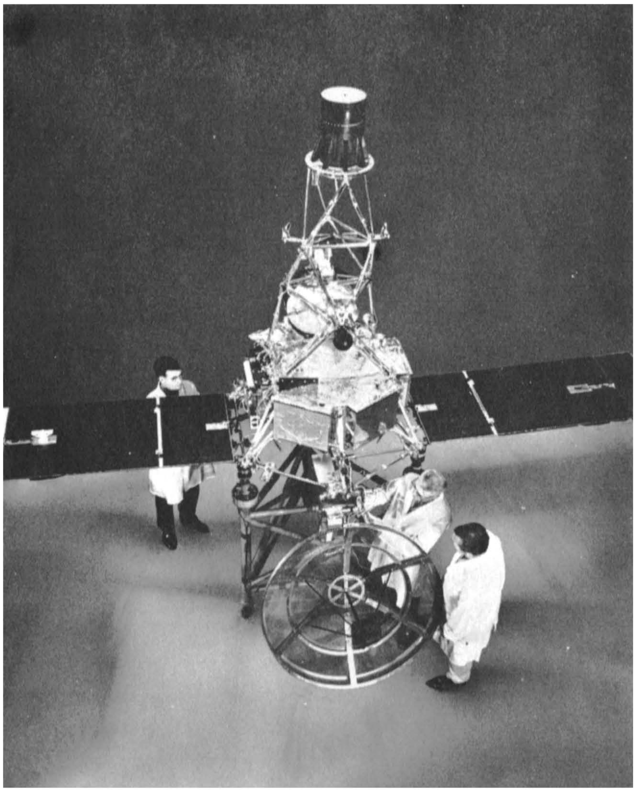
4. IONIZATION CHAMBER AND GEIGER-MUELLER TUBES—to measure the number and intensities of energetic particles in interplanetary space and near Venus. Representing much of the high-energy radiation in space, the particles are primarily cosmic rays which are made up of protons, alpha particles, nuclei of atoms heavier than hydrogen and helium, and electrons, another constituent of the atom. This experiment is vital to planning the safety of personnel on interplanetary flights. Moreover, a significant advance will have been made when the complicated interrelationship of these particles with each other and with magnetic fields is fully understood. For example, a decrease in the quantity and intensities of cosmic rays detected by Mariner as it moves closer to the sun would indicate that the sun's magnetic field is deflecting from the solar system cosmic rays originating in the interstellar space. (California Institute of Technology, Los Angeles, Calif.; State University of Iowa, Iowa City, Iowa.)

5. SOLAR PLASMA DETECTOR—to measure the concentration, flow, and intensities of charged particles (chiefly protons of the hydrogen atom) that continually stream from the sun. Relatively little is known about this steady outrushing of hot gas which is termed both the solar plasma and the solar wind, but its existence is widely accepted. This experiment will be correlated with magnetometer data to increase knowledge about the interaction of the solar wind with magnetic fields throughout the solar system.

Mankind's first Venus probe, launched by the Soviet Union on February 12, 1961, provided no scientific information because its radios went dead. Soviet trackers said the probe passed within 62,000 miles of Venus. Three other Soviet Venus probes were reported to have failed to leave their parking orbits.

6. COSMIC DUST DETECTOR—to measure the rate of flow, velocities, and direction of microscopic dust particles in interplanetary space and near Venus. Satellites and sounding rockets are studying cosmic dust near earth; Mariner will be the first to study them beyond earth's space environment. Scientific interest in cosmic dust is concerned with their origin—whether they are leftovers of a great cloud of dust and gas from which the solar system may have been formed or whether they originated outside the solar system. These clues could help solve the riddle of the solar system's birth and evolution. Data from this experiment would also contribute to determining the potential danger to manned spacecraft of these microscopic dust particles and to design of spacecraft structures that can cope with the danger.

On May 10, 1961, NASA's giant radio telescope facility at Goldstone, Calif. completed a two-month experiment during which radar signals were bounced off Venus. Data indicated that Venus rotated about once every 225 days, which is the length of the Venusian year. This means that Venus always keeps the same side facing the sun.



Technicians check Mariner spacecraft.

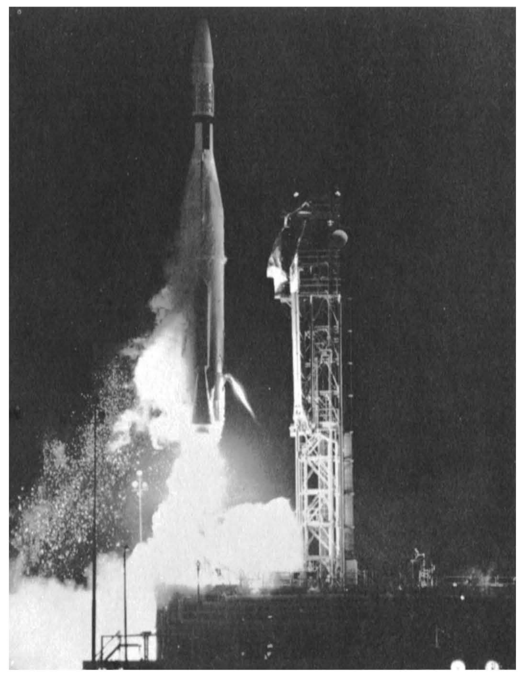
SPACECRAFT DESCRIPTION

At launch, Mariner is 5 feet in diameter at its base and 9 feet 11 inches high; cruise position 16.5 feet across and 11 feet 11 inches high. The spacecraft weights 446 pounds. The scientific experiments weigh 40 pounds; and structure, power supply, propulsion, communication, electronics, and other support equipment make up the remainder.

In space, Mariner must keep its solar cells facing the sun to create electric power for its instrumentation and its high gain antenna pointed toward earth for communication. This is accomplished through a complex system of sun and earth sensors, gyroscopes, and nitrogen gas jets, which keep Mariner in proper attitude.

The solar panels—27 square feet of surface holding 9,800 solar cells—convert sunlight to electricity. They can furnish a minimum of 148 and a maximum of 222 watts. Power not used by the instruments is stored by a rechargeable silver zinc storage battery with a 1,000-watt-hour capacity. The battery goes into action during peak power demands upon the spacecraft and during correction of Mariner's path in space when the solar panels temporarily are turned from the sun. It also sunplies electricity from launch of the probe to deployment of solar panels.

Other major equipment on Mariner is an omni-antenna which is employed for communication when the high gain antenna is not fixed on earth, other radio equipment, temperature controls, a 50-pound-thrust mid-course correction rocket system, and associated electronics.

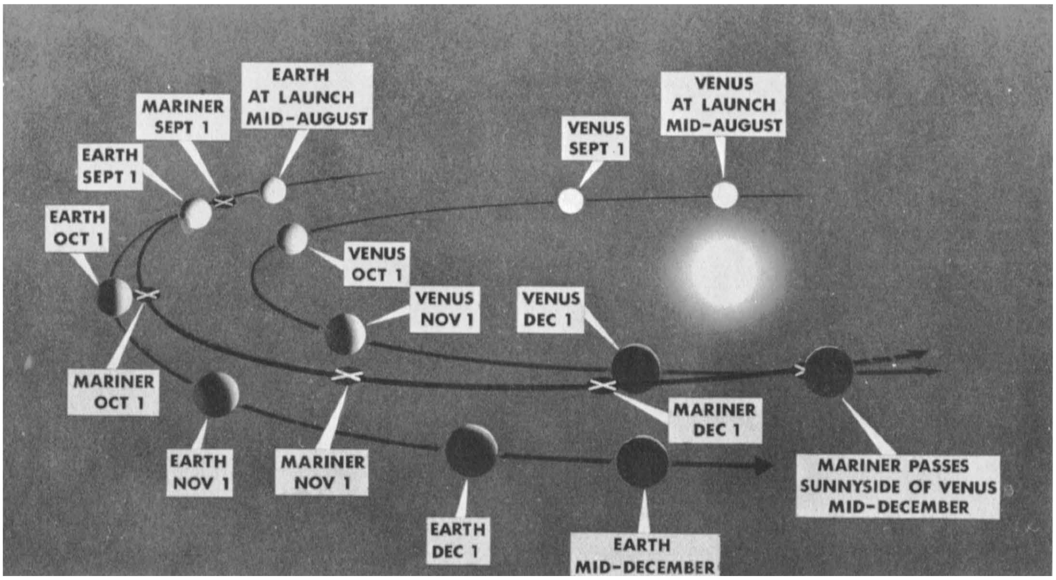


Atlas-Agena B starts Mariner on journey to Venus.

FROM EARTH TO VENUS

Imagine attempting to hit a fast-flying clay pigeon from a spinning merry-go-round, using a rifle fastened to the merry-go-round. An even more difficult situation confronted the mathematicians who had to figure out how to reach Venus from the earth.

In aiming Mariner, they had to consider, among other things: the speeds of earth and Venus around the sun; the spin of the earth; the movement of the sun; the pressure of sunlight; and the gravitational forces of the earth, sun, Venus, and Jupiter.



Mariner's path to Venus.

The Mariner flight plan is as follows:

A two-stage Atlas-Agena B launch vehicle starts Mariner on its flight. Shortly after Atlas separation, Agena B propels Mariner to orbital velocity (about 18,000 miles per hour) and then coasts with Mariner in a parking orbit about 115 miles above the earth.

Restarted at the optimum point for a Venus trajectory, Agena B accelerates Mariner to about 25,500 miles per hour, approximately 1,000 miles per hour more than needed to escape the earth's gravity. Following the second Agena cutoff, Agena and Mariner separate.

Around three days after launch, Mariner is nearly 600,000 miles from the earth and is essentially free of the earth's gravity. Its speed relative to the earth is down to approximately 6,870 miles per hour because of the earth's gravity pull.

The second Agena burn is timed so that Mariner's movement relative to the earth at 6,870 m.p.h. is opposite to the earth's direction around the sun. Thus, Mariner at first falls behind the earth as they race around the sun.

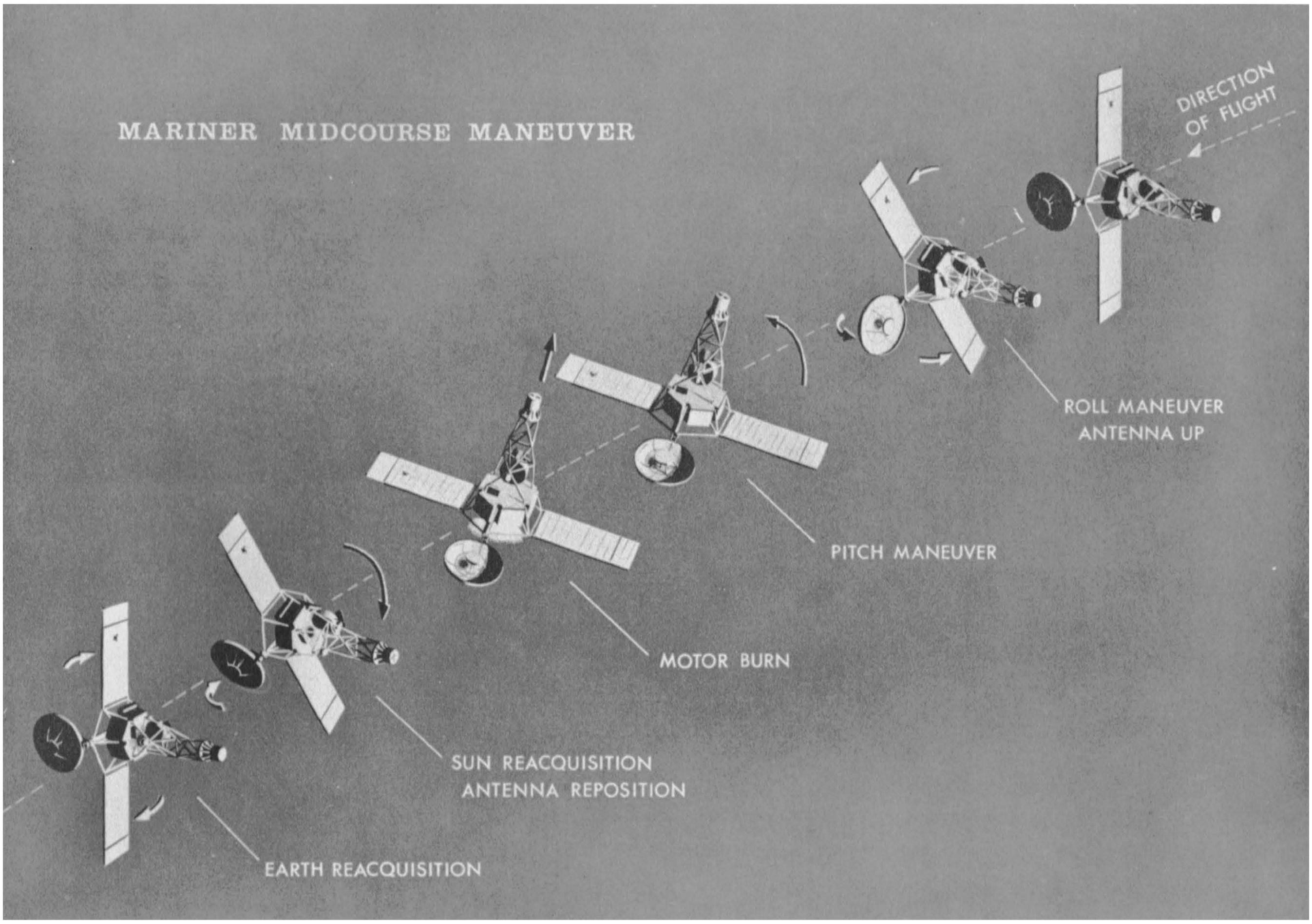
The earth's speed of about 66,000 miles per hour relative to the sun is sufficient to keep it in a near-circular orbit. Mariner's speed, almost 7,000 miles less than the earth's, is too slow to offset the sun's gravity. As a result, Mariner is drawn inward toward the sun. The combination of inward and circular motions puts Mariner into an elliptic orbit that intersects the orbit of Venus.

As Mariner falls toward the sun, its speed is increased by solar gravity. It overtakes and passes the earth and advances on Venus. Further augmented by Venus' gravity pull, the probe's speed climbs to more than 91,000 miles per hour as Mariner passes Venus on the planet's sunlit side. The average speed of Venus around the sun is 78,300 miles per hour.

If Mariner were to hit Venus, it would provide only a few minutes of close-up observation. Instead, Mariner is intended to fly by Venus at a distance of about 10,000 miles, yielding about 30 minutes of planetary data.

The planetary experiment is carried out when Venus and the earth are about 36 million miles apart instead of at their closest approach, 26.3 million miles. When the planets are nearest each other, Venus is between the earth and sun, and solar radiation could cause radio interference.

Mariner's mission is officially completed when it passes Venus. The mission will take approximately 110 days during which Mariner will travel about 180 million miles. Mariner is expected to continue to orbit the sun, joining five other



Mariner trajectory correction upon radio command from earth. High-gain antenna is moved up to avoid blast from mid-course correction rockets; rockets are fired; high-gain antenna realigned with earth and solar panels again locked on sun.

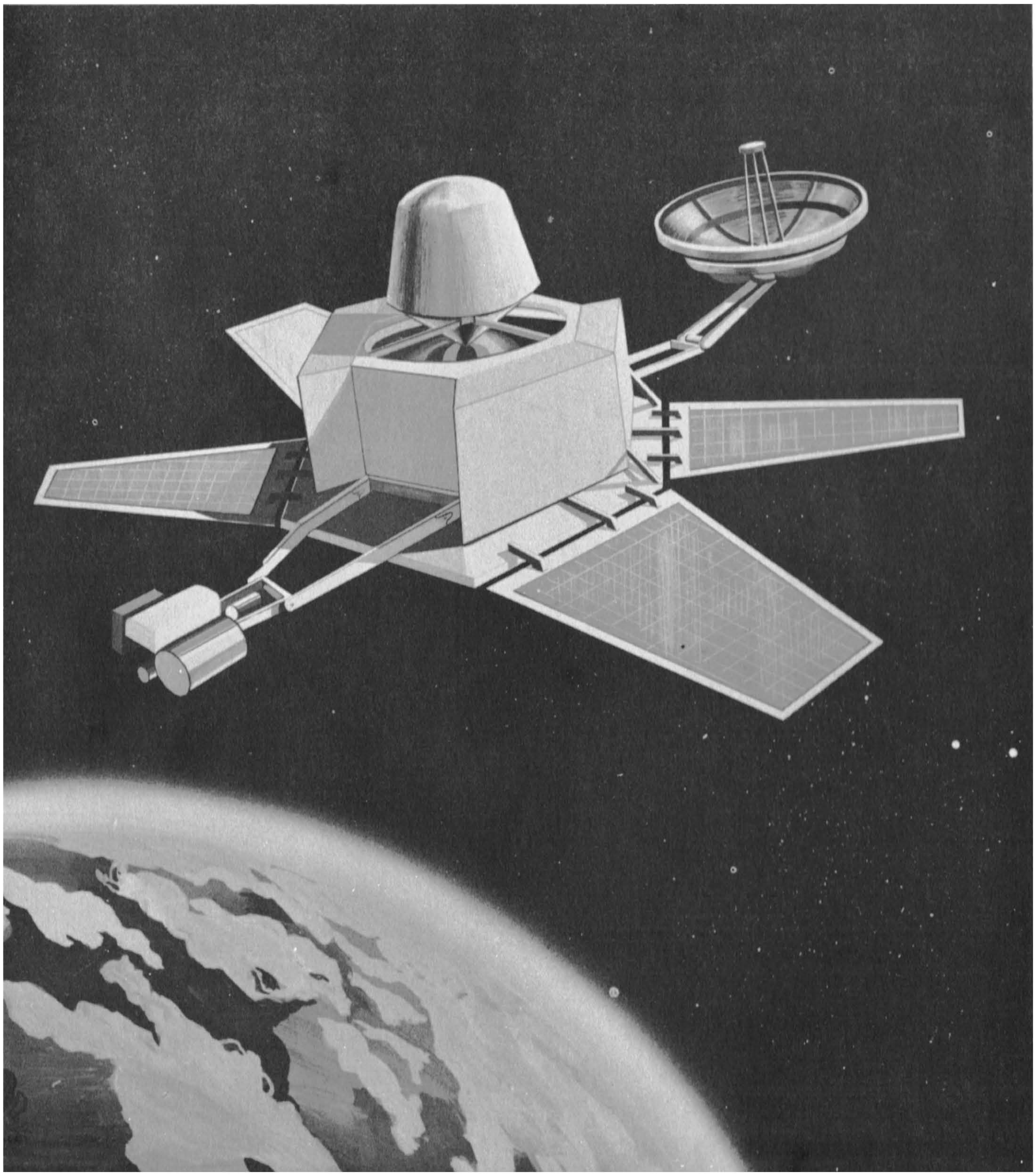
man-made planetoids: Lunik I, Pioneers IV and V, a Soviet Venus probe whose radio died before it could supply useful information, and Ranger III.

MID-COURSE MANEUVER

On September 4, Mariner executed perfectly ground radio commands for a complex mid-course maneuver, a scheduled event in the Mariner mission. The maneuver altered Mariner's trajectory from the initial path which would have carried the craft no closer than approximately 230,000 miles from Venus to one which passes within 10,000 miles of the planet. The correction, carried out when Mariner was about 1.5 million miles from earth, represents the greatest known range at which man has modified a spacecraft's course.

The maneuver comprised a sequence of three actions: (1) lengthwise roll of about 9.3 degrees; (2) pitch of about 139.9 degrees, turning Mariner almost completely around; (3) and rocket firing of about 29 seconds. Because the craft had swung around, its rocket decelerated it slightly relative to the earth.

Before the mid-course maneuver could be accomplished, the craft had to be stabilized or positioned on two axes. The first, achieved by locking the solar panels on the sun, occurred shortly after launch. The second, accomplished by aiming the high-gain antenna at the earth, was scheduled for about seven days after launch when Mariner was more than a million miles away. This time lapse was necessary because the earth sensor employed to align the antenna is so sensitive it would not have operated properly if used earlier.



Advanced Mariner, designed to fly by either Venus or Mars and rocket an instrumented package to the planet's surface.

ADVANCED MARINER

NASA is developing a series of Advanced Mariners for launches to the vicinities of Mars and Venus beginning in 1964. These craft will be three times heavier, carry more equipment, and be able to make more refined observations than the Mariner now on its way to Venus.

While flying by Mars or Venus, Advanced Mariner scans the planet with television cameras and radiometers, among other apparatus. It rockets an instrument package to the planetary surface to search for signs of life.

Advanced Mariner will be launched by Atlas-Centaur, now under development.

NASA FACTS format is designed for bulletin-board display uncut, or for 8 x 10½ looseleaf notebook insertion when cut along dotted lines and folded along solid lines. For notebook ring insertion, punch at solid dots in the margins.

NASA FACTS will be mailed only to addressees who request it from: Office of Educational Programs and Services, NASA, 400 Maryland Avenue, S.W., Washington 25, D.C.

★ U.S. GOVERNMENT PRINTING OFFICE 1962 OF—658955

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C.—Price 15 cents per copy; $11.25 per 100