First of 12 probes . . .

Mariner I Poised for Venus Shot

Program aimed at interplanetary exploration will extend through 1965; six experiments on first flight

THE U.S. BEGINS its first serious interplanetary exploration program with the scheduled launch of the *Mariner I* spacecraft.

Prime purpose of the first flight—slated for no earlier than July 21—is to fly within 10,000 miles of Venus and make infrared and microwave measurements of the planet's temperature and surface.

It will be the first of 12 launches planned in the *Mariner* program to obtain data about Venus and Mars.

The second *Mariner* launch is scheduled for early August. Two launches were scheduled this year, NASA said, because of the difficult nature of the mission.

This is primarily attributable to the long life of the flight, extending up to 140 days. The spacecraft will also be subjected to prolonged variations in temperature and unknown amounts of interplanetary radiation.

Two more flights toward Venus will be made in 1964. In 1964 and 1965, eight flights using a heavier advanced *Mariner* spacecraft will be made to the vicinity of Mars and Venus. It is probable that the later spacecraft will contain a capsule which will be injected into the atmosphere of both planets.

If successful, *Mariner I* will provide the first detailed information on Venus's atmosphere and surface temperature.

Data about both will go a long way toward establishing whether life on that planet is possible.

Six other experiments will be carried on the flight:

—An infrared radiometer experiment to provide information on the distribution of thermal energy in the planet's atmosphere.

—A magnetometer experiment to determine the three mutually perpendicular components of the magnetic field between Earth and Venus.

—A charged-particle experiment to detect the distribution, variations and energies of electrically charged particles in space and in the vicinity of Venus.

—An ionization chamber to detect the rate at which charged particles lose energy.

—A plasma experiment to obtain information on the extent, variations in, and mechanism of the solar corona.

—A micrometeorite experiment to measure the density of cosmic dust particles in interplanetary space and in the vicinity of Venus.

• **Configuration**—*Mariner I* weighs 446 lbs. and, in the launch position, is 5 ft. in diameter at the base and 9 ft., 11 in. high. In the cruise position, with solar panels and high-gain antenna extended, it is 16.5 ft. across in span and 11 ft., 11 in. high.

The hexagon framework base houses a liquid-fuel rocket motor, for trajectory correction, and six modules containing the attitude control system, electronic circuitry for the scientific experiments, power supply, battery and charger, data encoder and command subsystem, digital computer and sequencer, and radio transmitter and receiver. Sun sensors and attitude-control jets are mounted on the exterior of the base hexagon.

A tubular superstructure extends upward from the base hexagon. Scientific experiments are attached to this framework. An omnidirectional antenna is mounted at the peak of the superstructure. A parabolic, high-gain antenna is hinge-mounted below the base hexagon. Two solar panels are also hinged to the base hexagon. They fold up alongside the spacecraft during launch, parking orbit and injection and are folded down, like butterfly wings, when the craft is in space. A command antenna for receiving transmissions from Earth is mounted on one of the panels.

The solar panels contain 9800 solar cells in 27 square feet of area. They will collect energy from the Sun and convert it into electrical power at a minimum of 148 watts and a maximum of 222 watts.

• **Power supply**—Prior to deployment of the solar panels, power will be supplied by a 33.3-lb. silver-zinc rechargeable battery wtih a capacity of 1000 watt hours. The recharge capability is used to meet the long-term power requirements of the Venus mission. The battery will supply power directly for switching and sharing peak-loads with the solar panels; it also will provide power during trajectory correction when the panels will not be directed at the sun.

The power subsystem will convert electricity from the solar panels and battery to 50 volt, 2400 pps; 26 volt, 400 cps, and 25.8 to 33.3 volt d-c.

Two-way communication aboard the *Mariner* is supplied by the receiver/transmitter, two transmitting antennas—the omnidirectional and high-gain antenna, and the command antenna for receiving instructions from earth. Transmitting power will be 3 watts.

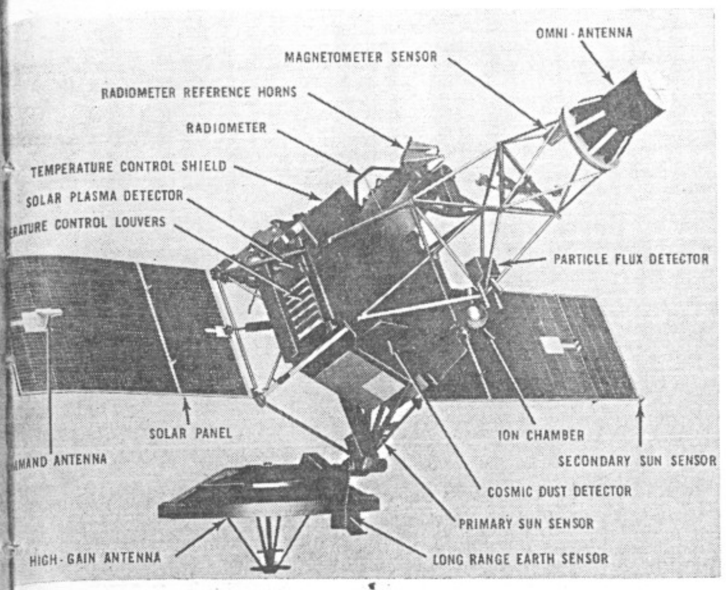
Stabilization of the spacecraft for yaw, pitch and roll is provided by 10 cold-gas jets, mounted in four locations, fed by two titanium bottles containing 4.3 lbs. of nitrogen gas pressurized to 3500 psi. The jets are linked by logic circuitry to three gyros in the attitude-control sub-system, to the Earth sensor on the parabolic antenna and to six Sun sensors mounted on the spacecraft frame and on the back of the two solar panels.

The four primary Sun sensors are mounted on four of the six legs of the hexagon, and the two secondary sensors on the backs of the solar panels. These are light-sensitive diodes which inform the attitude control system—gas jets and gyros—when they see the Sun. The attitude-control system responds to these signals by turning the spacecraft and pointing the longitudinal or roll axis toward the Sun. Torquing of the spacecraft for these maneuvers is provided by the cold-gas jets fed by the nitrogen gas regulated to 15 psi. There is calculated to be enough nitrogen to operate the gas jets to maintain attitude control for a minimum of 200 days.

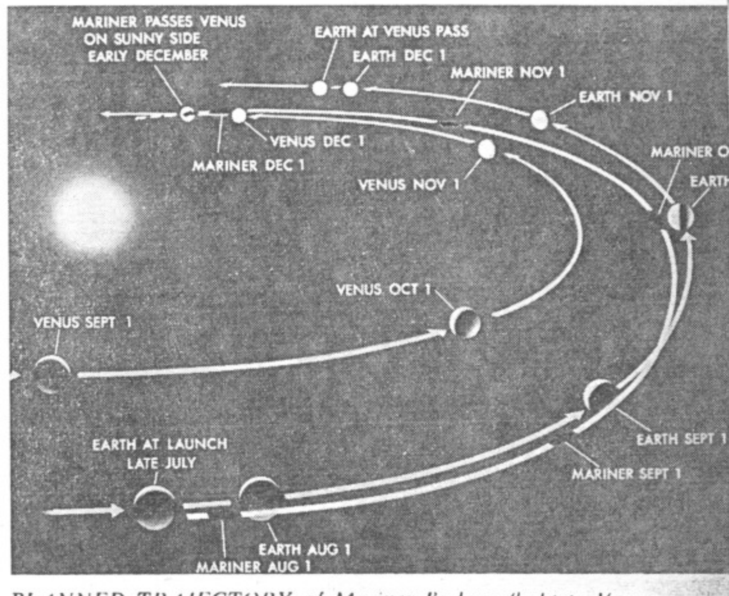
• **Venus fly-by mission** — Launch vehicle for the first *Mariner* shot is the *Atlas-Agena B*. It will launch the spacecraft to an Earth-orbit altitude of 150 miles.

Five minutes after launch the *Agena B* and *Mariner* separate from the *Atlas* booster.

The *Agena B* fires for the first time and burns for almost two and a half minutes to reach orbital speed of 17,450



MARINER I diagram shows interplanetary exploration gear.



PLANNED TRAJECTORY of Mariner I's long flight to Venus.

mph. After this burning time, *Agena B* shuts down and coasts in a parking orbit for more than 13 minutes until it reaches the optimum point in its orbit to fire for the second time.

The second *Agena B* burn injects the *Agena B* and *Mariner*, still as one unit, on an escape trajectory at a velocity of about 25,820 mph.

A little more than two minutes after second burn cutoff or injection, *Mariner* is separated from *Agena*, again by spring-loaded bolts. *Agena* then yaws 140-degrees in the local horizontal plane and performs a retro maneuver which reduces the *Agena* velocity and moves the *Agena* into a different trajectory.

Mariner now is on a trajectory that will take it fairly close to Venus. The omnidirectional antenna is working and radiating the radio transmitter's full three watts of power. Before and during launch, the transmitter had been kept at about 1.1 watts. This is required during the period the launch vehicle passes through a critical area between 150.000 and 250,000 ft., where a tendency exists for devices using high voltage to arc over and damage themselves; hence, the transmitter is kept at reduced power until this area is passed.

The sequence of events for *Mariner's* flight to Venus:

—The first command is issued by the CC&S 44 minutes after launch. Explosive pin pullers holding the solar panels and the radiometer in their launch position are detonated to allow the spring-loaded solar panels to open and assume their cruise position and free the radiometer to scan Venus as it passes by the spacecraft.

—At launch plus 60 minutes, the CC&S turns on the attitude control system and Sun acquisition will begin.

In order to conserve gas, the attitude control system permits a pointing error toward the Sun of one degree, or .5 degree on each side of dead-on. The mixing network in the attitude control system is calibrated to keep *Mariner* slowly swinging through this one degree of arc pointed at the Sun. The swing takes approximately 60 minutes. As *Mariner* nears the .5 degree limit on one side, the sensors signal the gas jets and they fire again. This process is repeated hourly through the effective life of *Mariner*.

—The Sun acquisition process is expected to take less than 30 minutes. When it is completed, the secondary Sun sensors on the backs of the solar panels are turned off to avoid having light from the Earth confuse them.

As soon as the solar panels are locked on the Sun, the power system will begin drawing electric power from the panels. The battery will now only supply power in the event of a peak demand that the panels cannot handle.

The next event initiated by the CC&S is the acquisition of Earth by the high-gain directional antenna. This does not occur, however, until 167 hours (seven days) after launch. The Earth sensor used to align the antenna is so sensitive that it would not operate properly if used earlier.

During Earth acquisition, the spacecraft maintains its lock on the Sun, but with its high-gain directional antenna pointed at a preset angle, it rolls on its long axis and starts to look for the Earth. It does this by means of the three-section, photo-multiplier-tube-operated Earth sensor mounted on and aligned with the high-gain antenna. During the roll, the Earth sensor will see the Earth and inform the gas jets. The jets will fire to keep the Earth in view of the sensor and thus lock onto the Earth.

The cruise mode will continue until time for the midcourse trajectory correction maneuver. After launch, most of the activity on the Venus Mission will be centered at the DSIF stations and at the Space Flight Operations Center at JPL.

• **Computer check**—Tracking data collected by the DSIF stations will be sent to JPL and fed into the 7090 computer system. The computer will compare the actual trajectory of the *Mariner* with the course required to yield a 10,000-mi. fly-by. If guidance errors before injection have put *Mariner* off the optimum trajectory, the computer will provide the figures to command the spacecraft to alter its trajectory.

After the midcourse maneuver has put *Mariner* on the desired trajectory, the spacecraft again goes through the sun and earth acquisition modes.

Mariner will continue in the cruise mode until planet encounter. During this period, tracking data from the three permanent DSIF stations will be sent to JPL where the 7090 computer system will refine the earlier calculations for planet encounter made at launch.

Ten hours before planet encounter, the CC&S will switch out the engineering data sources, leaving on the interplanetary science experiments. During the fly-by, only scientific data will be collected and transmitted.

The radiometer will begin a fast-search scan until Venus is sensed and then go into a slow scan. The planetary experiments will collect data on Venus for ½ hour as *Mariner* passes the planet.

The encounter mode of transmission —scientific data only—will continue for 56.7 hours. At the end of this period, CC&S will switch on the engineering data sources, and again in the cruise mode, both engineering and interplanetary scientific data will be transmitted.