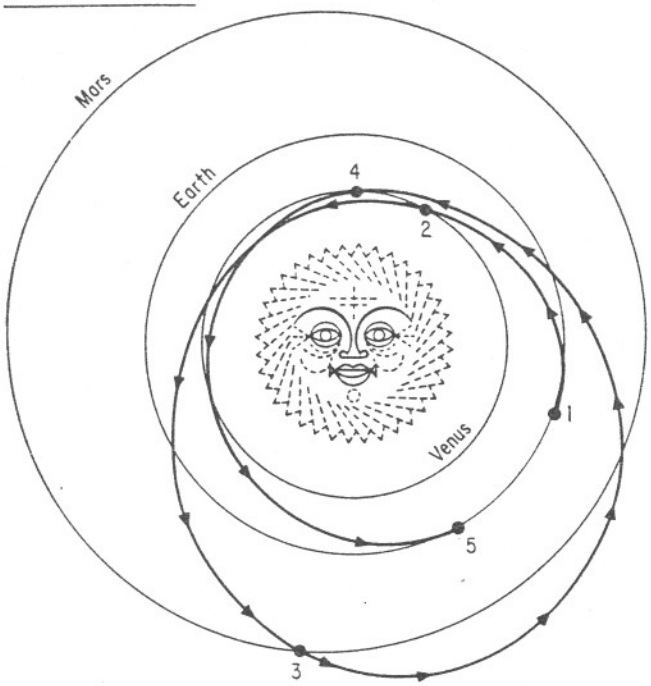
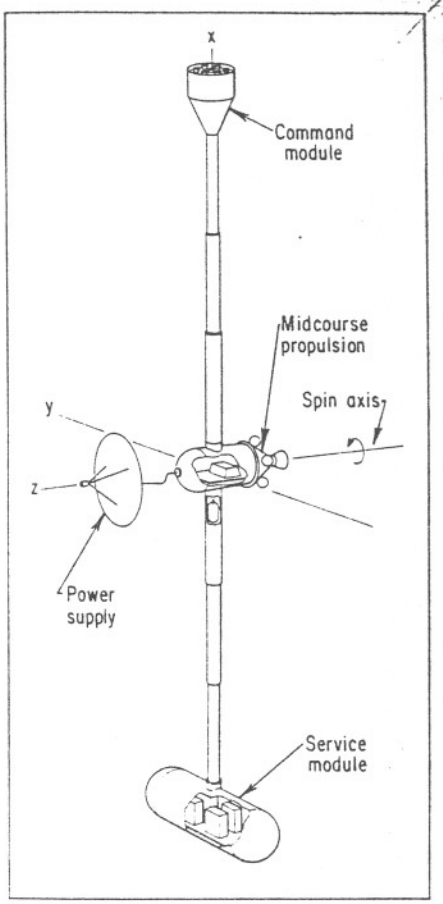


1. Leave Earth, Sept 6, 1970
2. Pass Venus, Nov. 20, 1970
3. Pass Mars, May 9, 1971
4. Pass Venus, March 4, 1972
5. Return Earth, July 22, 1972



Three-Man Crew in a Centrifuge Spacecraft:

Multiplanet Flyby Deemed Feasible by '70

SUNNYVALE, CALIF.—Three men in a spacecraft could leave earth during 1970, fly by Venus, then round Mars before streaking for home. And if they're launched at just the right time, they could even bank around Venus for a second look on the homeward leg of their journey. So says Lockheed Missiles and Space Co., in a report recently completed for NASA's Marshall Space Flight Center.

Manned interplanetary roundtrips can be accomplished in the next decade without any scientific breakthroughs, the report continues. But considerable engineering development of components now used or planned would be a prerequisite.

Spokes Connect Sections

The proposed interplanetary-spacecraft design consists of three main sections:

- Hub, containing a solar-flare shelter, midcourse-propulsion system, and a power station.
- Command module of the Apollo type.
- Service module, serving as the living and recreation center and containing the primary life-support equipment.

Service and command modules connect to the centralized hub by means of rigid-spoke tunnels, the modules rotating around the hub to provide artificial gravity (weight of the two extremities is the same).

Command module houses the crew during the launch phase and also serves as the re-entry vehicle, braking furnished by either a retro-propulsion or drag-brake system. At launch, the spacecraft is folded into a compact assembly atop the booster, with the spokes retracted to fit within the height of the payload shroud. Walls of the service and command modules act as their own launch support structures, requiring no external support.

Three Men Optimum?

It was not assumed that three men make up an optimum crew, reported Ben P. Martin, Lockheed advanced-systems engineer, at the Manned Space Flight Meeting, Dallas. Rather, "the three-man mission was investigated in the interest of exploring use of Saturn-type boosters for the earliest possible flights."

A nuclear earth-escape propulsion system would decrease the weight which must be placed in earth orbit for a Venus flyby to within the capabilities of a single advanced Saturn. And, for a high-energy Mars trip, the increase in earth-orbit weight would be much less for nuclear than for chemical-propulsion systems. One such nuclear system which should be available is the modified Nerva engine, now being developed as part of the upcoming RIFT (Reactor-In-Flight-Test) program.

Jockeying Among the Planets

Many trajectories are available, Mr. Martin continued, depending on whether single or multiple flybys are desired. Following are several hypothetical missions, dates being dictated by minimum propulsion requirements and not representing actual plans:

- Mars and return. Launch Oct. 31, 1970, pass Mars Aug. 22, 1971, return to Earth June 2, 1972.
- Two-planet flyby. Launch Dec. 25, 1970, pass Mars Nov. 10, 1971, pass Venus June 7, 1972, return Aug. 21, 1972.
- Three-planet flyby. Launch Sept. 6, 1970, pass Venus Nov. 20, 1970, pass Mars May 9, 1971, pass Venus Mar. 4, 1972, return July 22, 1972.

Each type of interplanetary "grand tour" becomes possible once every 6.4 years, when planets and spacecraft trajectories can be properly aligned. However, mission requirements are never identical, due to the eccentricity of Mars' orbit.

Fourteen-Hour Workday

Crews making the interplanetary flybys would be on strict daily schedules, following timetables as exact as those of the spacecraft itself. At least one member would be on duty in the command console at all times, monitoring conditions and taking emergency or corrective actions as required. General pattern of the daily schedule calls for 10 hr on duty, 2 off, 4 on, and 8 off. The work during the 10-hr shift would be divided among command, maintenance, and experimentation.

Cold Heading Forms Tiny Beryllium-Copper Parts

BRIDGEPORT, CONN. — Hard-to-work beryllium-copper alloys can now be cold headed into small, high-strength components. Sizes range from those standard for cold-heading techniques all the way down to subminiatures for electronic gear. The smallest size parts that can be produced are not economically feasible by other manufacturing methods.

Because of difficulties in forming beryllium-copper alloys, small fasteners and parts requiring complex configurations have previously been machined. However, according to Harvey Hubbell Inc., developer of the technique, manufacturing costs for a typical cold-headed beryllium-copper part are 75 per cent lower than those produced by screw-machine methods, and the savings on more complicated cold-headed shapes, frequently encountered in electronic-gear components, are expected to be even greater.

At the present time, parts can be produced in two beryllium coppers, No. 10 and No. 25. Diameters can be varied from 0.020 to 0.375 in. and lengths from 0.062 to 6 in. A wide range of head shapes can be turned out, but because of the toughness of the alloy, fillet radii have to be kept generous.