FIRST STOP: JUPITER

By DON BANE

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The first ship sails in 1976, then there will be periodic sailings until 1979, when the "Grand Tour" comes to an end, not to be repeated for 179 years.

The grandest Grand Tour of all—to the five outer planets and the interstellar reaches of the Milky Way—is in the advanced-planning stage at the National Aeronautics and Space Administration.

NASA wants to take advantage of a rare alignment of the outer planets—it happens only once every 179 years—to explore Jupiter, Saturn, Uranus, Neptune and Pluto, all for the price of a single space probe.

Jupiter orbits the sun beyond Mars, at an average distance of 484 million miles, 5.2 times the distance of earth from the sun. One Jovian year (Jove was another name for Jupiter) equals almost 12 earth years.

Saturn, the ringed planet, revolves around the sun at a mean distance of 887 million miles, once in 29½ years.

Uranus, the first planet discovered by telescope, makes one trip around the sun in 84 earth years, at a mean distance of 1.78 billion miles.

Neptune, whose discovery was the result of mathematical work, takes 165 earth years to make one turn around the sun, at an average distance of 2.8 billion miles.

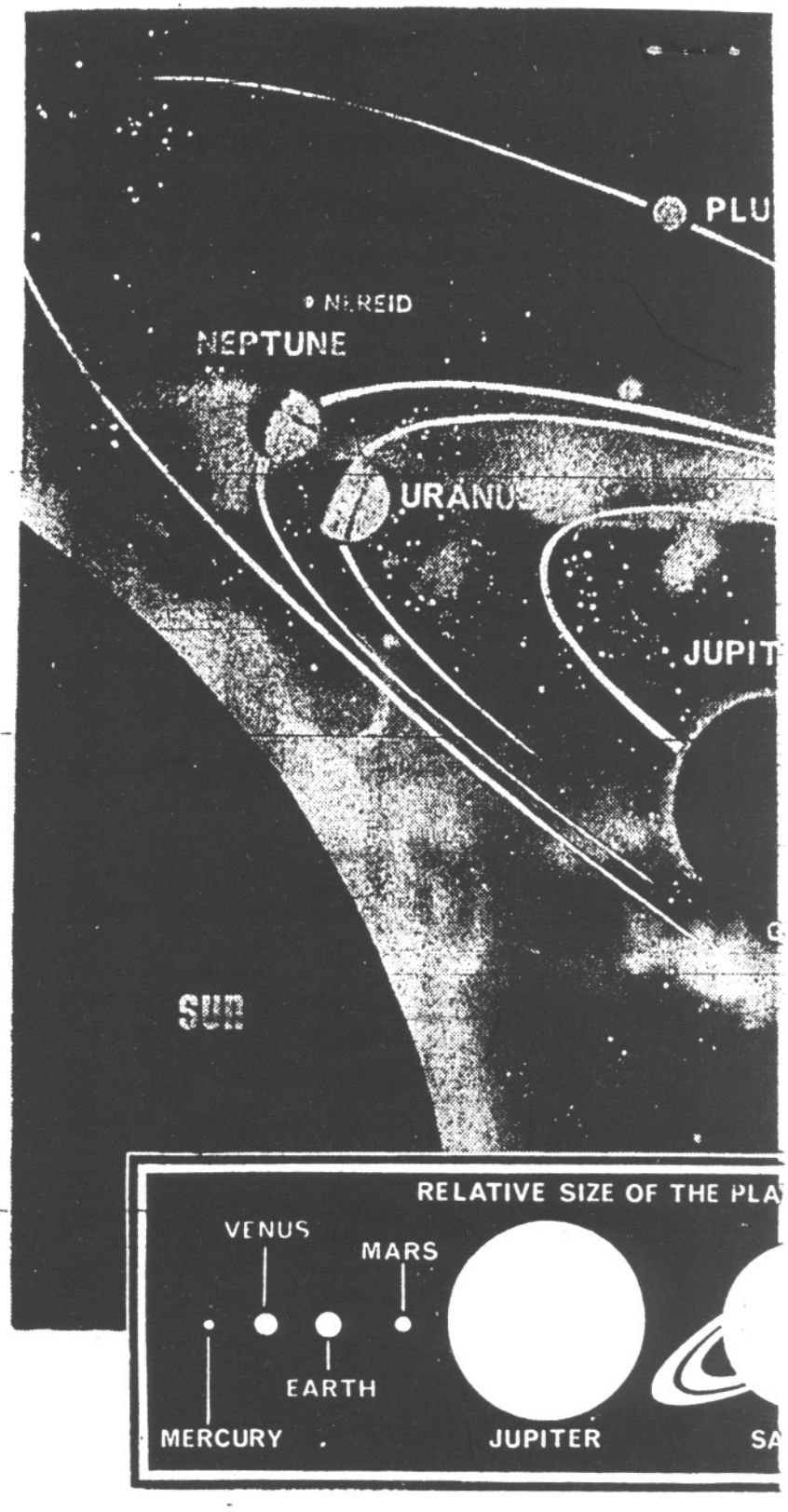
Pluto, the least known and understood of all the planets, completes one revolution in 248 years, at a mean distance of 3.67 billion miles.

And NASA is talking about getting all this for the price of a trip to Jupiter!

It can be done. In 1965, Dr. Homer Joe Stewart of Jet Propulsion Laboratory suggested a technique called gravity assist. Gravity assist makes use of one planet's gravitational field to boost the spacecraft on to the next planet.

As the spacecraft heads toward a predetermined point near the planet, the planet's gravitational field begins pulling it faster and faster. The spacecraft reaches such great speed as it passes the planet that it is swept away in a new direction a little like a jai alai player captures and hurls the pelota in the cesta (or basket).

It's a little like giving a rolling ball an extra kick as it pas-



Neptune. Thus, two missions could cover all the five outer planets.

The Jupiter-Saturn-Pluto flight would erase the problems of the close pass at Jupiter and possible collision with Saturn's rings. The spacecraft's trajectory would change just enough to allow safe passage.

And what sort of spacecraft would make such an incredible journey?

Basically it would be a second or third-generation Mariner-type machine, with changes for the specific requirements of the mission.

Solar power could not be used (the sun is a pretty poor heater at 3½ billion miles), so nuclear power would run the spacecraft. It would convert heat from the decay of a radioactive isotope into electricity.

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It's a little like giving a rolling ball an extra kick as it passes. The speed is increased and the direction changed, aiming the spacecraft at the next target.

Gravity assist would cut the flight time to a reasonable length, and would allow the spacecraft to be launched by one of America's less costly rocket combinations—the Titan-Centaur.

Without gravity assist, a direct mission to Pluto would require 41 years. And the spacecraft would have to be launched by a Saturn 5. With gravity assist, flight time to Pluto is cut to about eight years, solving one of the acute problems of a direct launch, the length of time a spacecraft can operate without literally falling apart from old age.

James E. Long of Jet Propulsion Laboratory's Advanced Studies Section has been in charge of most of the planning for the Grand Tour, and has written a number of detailed studies of the project.

There are, basically, three missions for NASA to pick from.

The first: Fly out beyond Mars, through the asteroid belt, past Jupiter, Saturn, Uranus and Neptune. Pluto would not be in the itinerary.

But this mission poses problems. First, the spacecraft would have to fly so close to Jupiter that it might be disabled by the big planet's radiation belts (similar to, but more intense than, the Van Allen radiation belts of earth).

Second, the rings of Saturn would literally get in the way, as the spacecraft would have to fly so close to them it might by clobbered by debris.

So NASA scientists have come up with a pair of missions. The first would fly past Jupiter and Saturn, head for Pluto and then escape the solar system for a look at interstellar space.

The second would fly past Jupiter, then on to Uranus and

tive isotope into electricity.

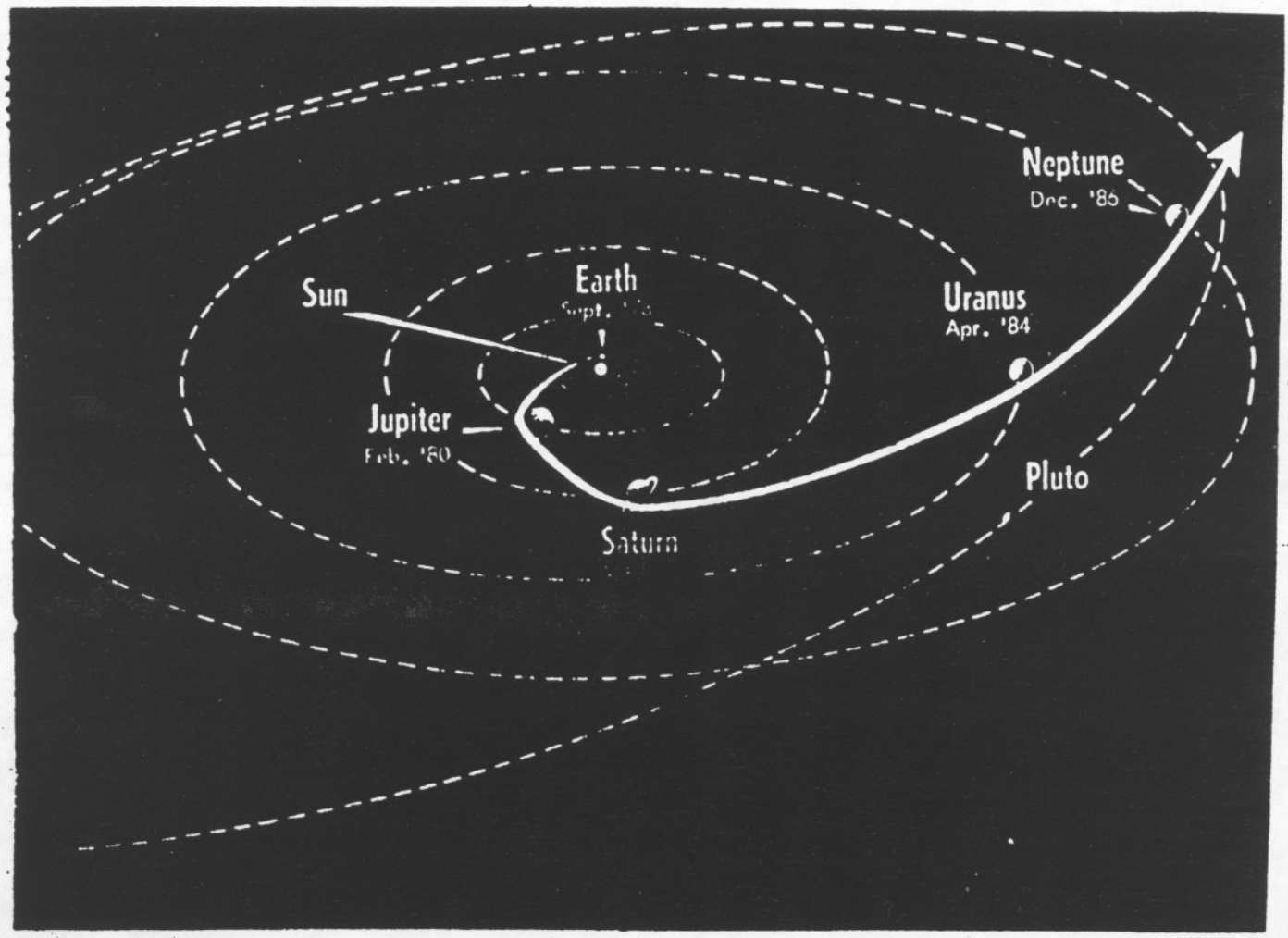
The scientific instruments to be carried aboard haven't been decided. But everyone who discusses it gets a glassy look in his eye and sighs, "Television, lots of television!" Such other

"No one knows what it (the spacecraft) will find out there, although no one is ruling out discovery of another planet."

experiments as surface temperatures, atmospheric composition, determination of mass and radio occultation, as used aboard the recent Mariner 6 and 7, are good guesses.

A computer would put the spacecraft through its paces, on radio commands from earth. Incidentally, when the spacecraft is near Pluto, a round-trip message from earth and back would require eight hours. One shift would send the command, and the reply from the spacecraft would be received after they had gone home and the next crew had taken over.

The spacecraft would be designed so that, in case of mal-



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