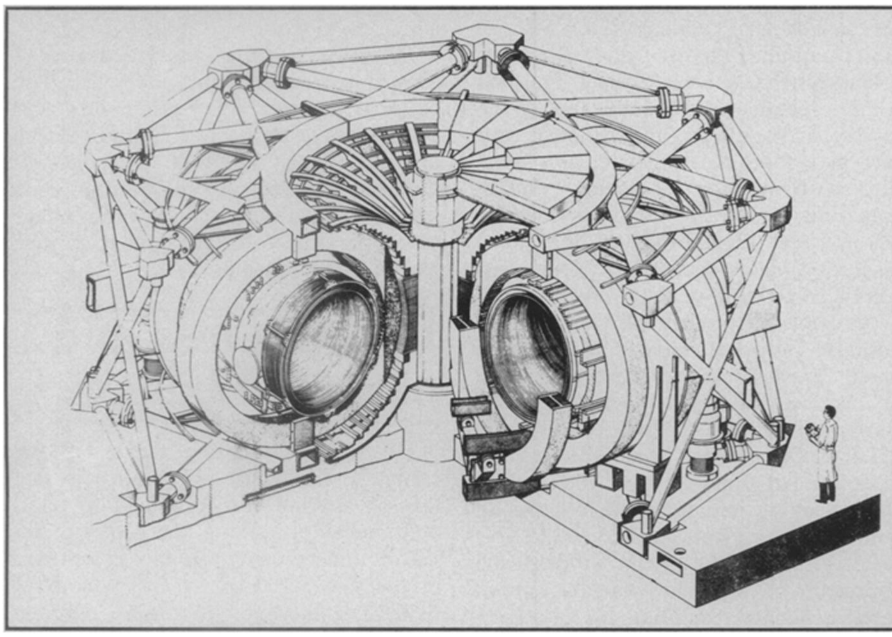
A torus with a one-two punch for fusion



Two-component torus: First device to make reactor-grade plasmas for fusion.

The three major criteria for achievement of controlled thermonuclear fusion are sufficient plasma temperature, density and confinement time. The 25-year history of the subject is largely a tale of successive efforts to increase one or more of those critical numbers toward the level required for a power-producing reactor.

Now a plan is made public for a device that could reach some of these reactor conditions. It is called the Two Component Torus (TCT), and, if authorized, could come on line by 1980. The proposal is still under internal review by the two interested institutions, the Princeton Plasma Physics Laboratory and the Westinghouse Electric Co. Whether it will gain approval there and be formally presented to the Government remains to be seen.

Plasma heating is one of the factors of prime interest now, and heartening progress is being made with such devices as the Adiabatic Toroidal Compressor at the Massachusetts Institute of Technology and the ORMAK at Oak Ridge National Laboratory. Temperatures of about 2,000 electron-volts are now reached; the usual theoretical rule indicates about 6,000 electron-volts would be necessary for a reactor-grade plasma. (Plasma physicists prefer to quote temperature as energy per particle since it is more meaningful for their work than degrees of an arbitrary scale.)

The heating method that seems promising, and the one that the TCT will use if it is built, combines the usual tokamak heating method with a second component, the injection of a neutral beam of gas. In the tokamak style, the plasma is confined in a toroidal or doughnut-shaped vessel, and a circular electric current is induced in it by a suitable magnetic field. Resistance to the current heats the plasma. The new plan involves then further increasing the temperature with the neutral beam. The energy it carries is converted to heat of the plasma by collision with the plasma.

Experiments along this line are showing desirable heating rates, and if progress continues with these and the still to come Princeton Large Torus, "then the tools will be in hand, not only for the generation of reactor-grade tokamak plasmas, but for the realization of actual energy break-even in [deuterium-tritium]," says the design report. (Break-even is getting as much energy out of the fusions in a plasma as is put in to heat and confine it.) There will be a need for a vessel to hold such a plasma. The designers of TCT intend to provide it.

The TCT would be big and expensive. With water-cooled magnets the radius of the doughnut would be 2.7 meters; with superconducting magnets (an option studied but not quite yet recommended) it would be 4.5 meters. The radius of the cross section of the actual plasma tube inside the doughnut could be 60, 95 or 130 centimeters depending on electric current and magnet choices. Cost is estimated at $215 million with allowance for inflation ($130 million to $155 million in 1974 dollars).

That is a lot of money for one device. Whether Congress would authorize it is open to question. Still, in a nation desperately looking for new energy sources, the urgency of pursuing approaches to controlled fusion seems plain. In the past members of Congress have shown a willingness to consider more money for fusion research than Republican administrations have been willing to ask for. □

Jupiter's new moon now almost certain

Jupiter's tentatively identified 13th moon (SN: 9/28/74, p. 195), discovered in September by California Institute of Technology astronomer Charles Kowal, now appears almost certain to be the real thing.

"It is highly unlikely that it is not a new satellite of Jupiter," says Kaare Aksnes of the Smithsonian Astrophysical Observatory. Because the object is so tiny and at such a great distance from earth, Kowal's initial observations, which covered a period of only three nights, were not enough to be certain that the object was indeed orbiting Jupiter rather than the sun, as would an asteroid or comet.

Following Kowal's sightings on Sept. 10, 11 and 12, using the 48-inch Schmidt telescope of the Hale Observatories atop Palomar Mountain, the object was sighted on Sept. 22 by Ray Weymann and Richard Cromwell of the University of Arizona, using a 90-inch instrument on Kitt Peak. Then, on Oct. 17 and 18, Kowal photographed it again from Palomar.

The overall time span of these observations is enough for at least 99 percent confidence that the object is a Jovian moon, says Aksnes, in which case it has covered about 40 degrees of its orbit during that time. If one assumes that the object is orbiting Jupiter, Aksnes says, the observations will fit with errors of less than 1.5 seconds of arc, which is below the resolving power of the telescopes. If a sun-circling orbit is assumed, on the other hand, the resulting errors are more than three times as large. Furthermore, Aksnes says, to fit the observations, a non-Jovian orbit such as that of a comet or asteroid would have to have an eccentricity of 1.19, which would make it so hyperbolic that it would not even be a closed orbit at all.

So far known only as J-XIII, the object appears to orbit the planet in the same direction as its rotation. At first it was thought to be traveling backwards (clockwise).

One possible orbit derived by Aksnes is inclined 24.95 degrees to the plane of the ecliptic, with the moon circling the planet every 282.0 days at a mean distance of 12.4 million kilometers and an eccentricity from 0.1 to 0.3. □