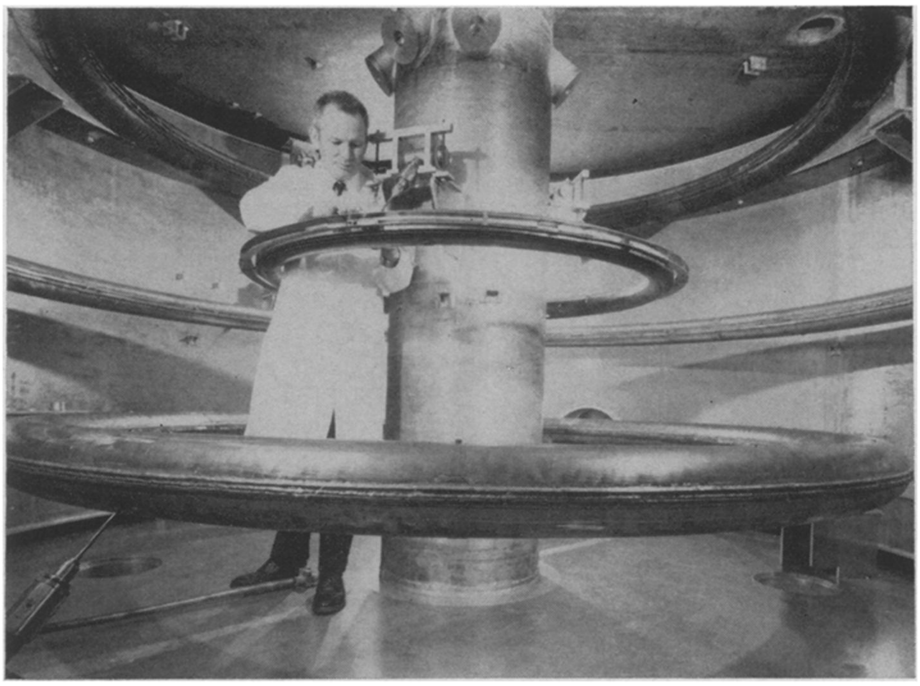

Gulf General Atomic

Electric current loops hold in the plasma in San Diego vacuum chamber.

FUSION

Confinement among the rings

Slowly the prospects have turned, and inch by inch scientists move toward a promised Niagara of power

Controlled thermonuclear fusion is the goal of a 20-year-old research program in various parts of the world. Since the first hydrogen bomb was exploded, the promise has existed that the energy that was there released explosively could be released in a controlled manner for power generation. The result would be fusion reactors that generate power from a cheap and abundant fuel, the heavy hydrogen in seawater.

The major frustration has been the researchers' inability to confine a plasma of ions and electrons, in which light nuclei would fuse into heavy ones, for a long enough time. To get enough fusions going to have a self-sustaining, power-producing reaction requires a plasma of about a million billion nuclei per cubic centimeter at a temperature of 100 million degrees K. to be confined for a tenth of a second.

Such a hot plasma would vaporize any container it touched, so the only way to confine it is to use a magnetic field to hold it in the middle of a vacuum chamber. But a plasma is an electrically conducting fluid and reacts back on the magnetic field producing counter pressures and instabilities by which it can quickly blow itself apart. Over the last two decades much hard work has gone into attempts to overcome the instabilities. Now it begins to seem success may be in sight.

The last year has seen new developments in plasma confinement come at an increasing pace, first from Germany and England (SN: 11/2, p. 439), then from the Soviet Union (SN: 5/26, p. 397; 9/27, p. 266) and now from the United States. Dr. Tihiro Ohkawa of Gulf General Atomic in San Diego, Calif., reported recently to a conference at Dubna in the U.S.S.R. that a plasma in a device he is working with had been held stably for 0.07 seconds. That is 10 times as long, he says, as any plasma has ever been held in a similar device.

The device Dr. Ohkawa uses in a vacuum tank 16 feet in diameter and 8 feet tall in which four concentric metal rings are suspended by thin metal support rods. Electric currents run in the rings, and they generate a magnetic field that increases with distance away from the plasma region. The increasing field tends to push the plasma back to its assigned region. The result is quite stable.

"People have been telling us for years that if we could eliminate the instabilities, we would get longtime confinement," says Dr. Bernard Eastlund of the Atomic Energy Commission. "This shows that when the instabilities are eliminated you get longtime confinement."

Russian efforts reported by academician Lev A. Artsimovich have held a plasma 70 times denser and about five times as hot in a device called Tokamak, but for only 0.02 seconds. Since progress toward fusion depends on the balance of the three characteristics as well as minimum requirements for all three, physicists tend to use the so-called Bohm diffusion time as a means of comparison. For each combination of density and temperature there is a particular Bohm time, and intercomparisons of confinements can be made by saying they are so many times the Bohm time. In these terms the Russian work is 100 times the Bohm time and the San Diego work about 300 times the Bohm time. The threshold of fusion is considered to be about 1,000 times the Bohm time, provided that the temperature and density are above the minimum levels.

Dr. Ohkawa's plasma is about a thousand times too thin and a hundred times too cool for controlled fusion, but a scale-up of his general idea looks possible. An actual fusion reactor, he says, could not tolerate the presence of the ring supports; therefore it became necessary to induce the plasma itself to carry the electric current.

It was not clear at the outset that the plasma could maintain the spatially separated currents as the rings had done; they might snap together to form a single current. But experimentation has shown that the currents will stay apart, and Dr. Ohkawa and his coworkers have built a pilot machine called Doublet in which the plasma does carry the currents.

The next step is to try to scale up Doublet to determine what the scaling laws are. If the scaling laws are what Dr. Ohkawa and his co-workers hope and believe, then, they say, it will be possible to go on to greater temperatures and densities and longer confinement.

Progress depends on funding, part of which comes from the AEC and part from Gulf General Atomic, and on how fast various stages of the work can be begun. Dr. Ohkawa and his coworkers hope that by the mid-1970's they will know whether it is possible to go on toward a fusion reactor on the plan of Doublet. *D.E.T.*