PHYSICS

H-Power Control Advances

Scientists are exploring the various possible ways of taming thermonuclear reactions in order to use hydrogen power for peaceful purposes.

➤ THREE NEW APPROACHES aimed at taming thermonuclear reactions for peaceful purposes were outlined to the American Physical Society meeting in Washington, D. C. They complement the so-called "pinch" method, which was reported at length in January, 1958. (See SNL, Feb. 1, p. 67.)

Immediate goal is to create a hot, fully ionized gas at a sufficiently high temperature and for a long enough period so that thermonuclear reactions will occur. Temperature of the hot gas, or plasma, must be approximately 100,000,000 degrees centigrade and the plasma must be isolated from the container walls for tenths of a second, or longer.

The business of igniting the plasma can be approached in a number of ways.

1. In the pinch method used at the Atomic Energy Commission's laboratories in Los Alamos, Berkeley and Livermore, tremendous currents are passed through the gas. The magnetic forces of the current itself throw the gas toward the center line of the tube. In other words, the current "pinches itself," with great increase in the density and temperature of the gas.

Straight tubes are often used in studying resulting effects but the main effort involves the use of doughnut-shaped tubes. There are many essential refinements to provide stability and long confinement.

2. In the mirror program proposed by Dr. R. F. Post of the University of California at Livermore, energetic ions (with accompanying electrons) are injected into a strong field provided by two large coils. At first, the ions run on spirals nearly at right angles to the field. Then the current in the big coils is increased. This squeezes the hot gas. In different designs, it is possible to squeeze the gas radially, and to push it together along the axis. It is also possible to push the gas from one chamber to another.

3. In the Princeton stellarators, a cold gas confined by a very strong magnetic field is used at the start. A small current is passed, and then a larger one is caused to flow by transformer action. This brings the gas to something more than 1,000,000 degrees centigrade. At that point this heating method is no longer satisfactory, because the electrical resistance of the gas has become too low. (A well-ionized gas may have an electrical resistance far less than that of a solid bar of copper occupying the same space.) Therefore, the next step is to shake the gas with very strong alternating magnetic fields. This heating process is called magnetic pumping.

Dr. Lyman Spitzer, director of Project Matterhorn and of Princeton University Observatory, showed that under these conditions the gas would drift toward the walls, and that this loss of gas could be largely avoided by bending the doughnut into a shape like a pretzel. Later, it was found good gas confinement could be achieved in a doughnut, by ingenious tailoring of the magnetic field. Both methods have been under study at Princeton.

4. The work reported from Oak Ridge National Laboratory is devoted to filling a confinement-space with super-hot ions; that is, ions which have an energy far superior to the ignition energy. It rests on some basic ideas worked out by Drs. E. D. Shipley, Lloyd P. Smith and Arthur E. Ruark, in 1952-53. An extremely hot plasma of low density has good confinement properties, and can be used to heat cooler ions that are added after the very hot plasma is formed. Loss of hot ions by trading of charges with the residual gas molecules in the vessel is a chief enemy in this method; it is also minimized when the ion-energy is very high, as others have shown.

Then Dr. John S. Luce, also of Oak Ridge, showed how the molecular ions can be trapped inside the confinement space. Dr. Herbert York, now director of the Defense Department's Advanced Research Projects Agency, is reported to have advanced the same idea independently.

Molecular ions are introduced and are dissociated. Each molecular ion breaks up into an atomic ion (a deuteron) and an atom of deuterium. The atoms escape, but the hot ions are caught on smaller orbits and circulate in the confining magnetic field. The whole matter hinges on efficient dissociation of the molecular ions. It is not enough to let them encounter molecules of the residual gas.

Dr. Luce supplied an essential step when he developed a high-vacuum, high-current arc on which the high energy molecular ions can be broken up with considerable efficiency. So far work on this method has been done with continuous injection into mirror coils fed with DC current. Hence the apparatus is called the DC Experiment, or DCX.

Science News Letter, May 17, 1958

EDUCATION

Old Mathematics Best; Date Called Unimportant

➤ SO-CALLED "modern mathematics" does not do as good a job in teaching as the old-fashioned kind that dates back 2,000 years to the days of Euclid, Prof. Morris Kline, director of the division of electromagnetic research at New York University's Institute of Mathematical Sciences, told the National Council of Teachers of Mathematics meeting in Cleveland.

"Up-to-dateness is totally irrelevant in mathematics," Prof. Kline said. "It has been built solidly since at least Greek times. . . . Older portions do not become antiquated or useless."

Prof. Kline attacked the "moderns" for replacing the older mathematics by such topics as symbolic logic, Boolean algebra, set theory, and some topics as groups and fields, topology, and postulational systems. Statistics is the one new field that should be introduced for those not entering specialized fields, he suggested.

We must, however, make drastic improvement in the way we have been teaching traditional subjects, Prof. Kline believes.

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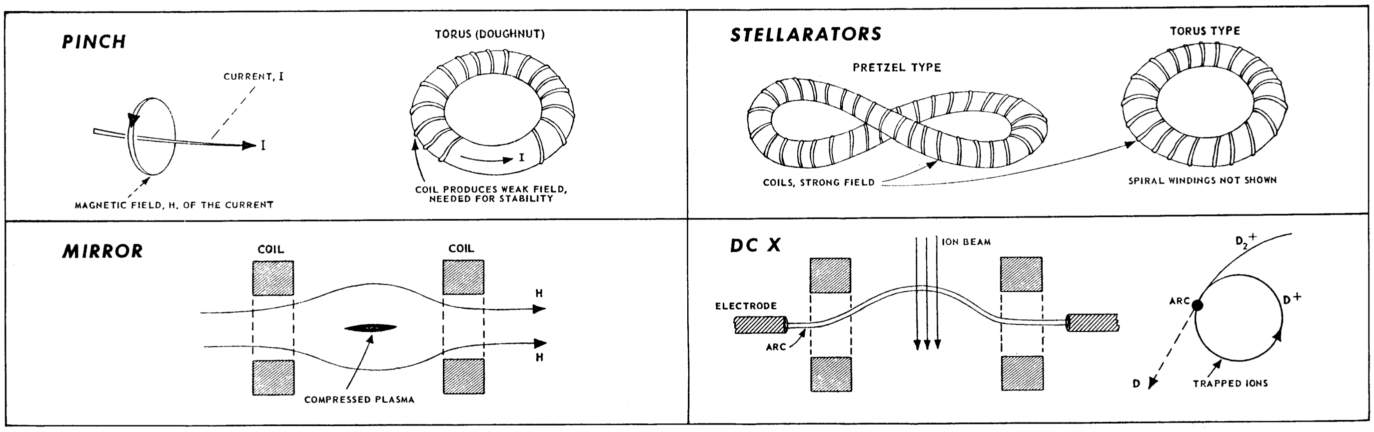

FOUR WAYS TO H-POWER—The drawings illustrate the four main methods for igniting plasma, essential to the use of H-power.