

New MHD energy system invented

As indicated by Dr. John Nuckolls' call for a national crash fusion program based on the higher quality of fusion energy, Lawrence Livermore National Laboratory, at which Dr. Nuckolls is Associate Director for Physics, has accelerated work on advanced fusion energy conversion techniques. The most recent development along these lines is an invention by Dr. B. Grant Logan of the Livermore Magnetic Fusion Division. Logan's invention could lead to substantial reductions in electricity cost for both future fusion reactors and existing types of power plants, such as fission reactors.

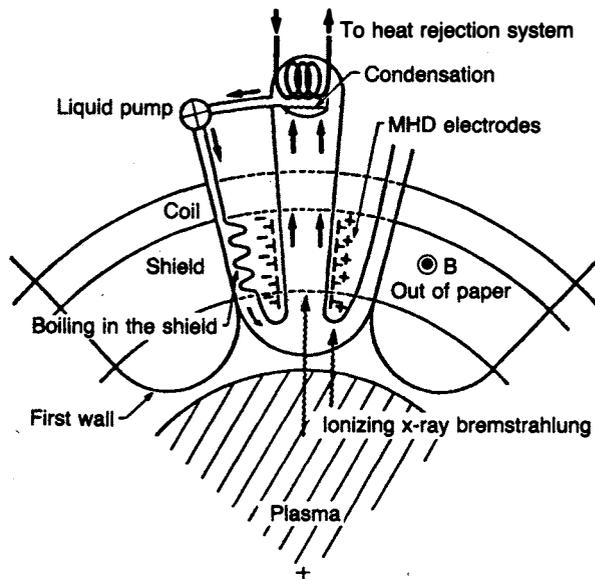
The Logan concept was disclosed first in a patent taken out under Department of Energy Contract No. W-7405-ENG-48. It consists of utilizing x-ray radiation produced by a fusion plasma to heat and ionize an electrically conducting vapor. The vapor is then passed through a MHD channel where its energy is converted to electricity. This removes the necessity for complex heat exchangers, rotating turbines, and electric generators. This great simplification of energy conversion promises to greatly reduce the total capital cost of power plants. The MHD conversion system also operates at a much higher efficiency than the conventional thermal turbine-generator technique.

MHD generators

Electric generators work on the principle that when a conductor, such as a piece of metal or an ionized plasma, passes through a magnetic field, an electric potential perpendicular to both the direction of motion of the conductor and the magnetic field is generated. Placing positive and negative electrodes across this potential will lead to the flow of electricity between them. In short, the MHD channel, consisting of a transverse magnetic field and electrodes, directly converts the kinetic motion of the conductor to an electrical current. Rotating turbines accomplish the same result, but must operate at lower temperatures and are therefore less efficient.

In fusion reactor studies through the 1970s, MHD generators have generally been limited to marginally economic topping cycles in which less than 10% of the thermal energy generated by the fusion plasma is converted to electricity. (More conventional thermal turbine-generator cycles would convert 30 to 40% of the output to electricity.) Dr. Logan's invention would convert over 30% of the fusion energy to electricity through the MHD cycle alone.

The Logan concept



As shown in the above figure, taken from Dr. Logan's patent, a fusion plasma is surrounded by the first wall of a vacuum chamber, a radiation shield, and finally a magnetic field coil. Neutrons from the fusion plasma penetrate the first wall and heat a liquid carried in pipes there. X-rays, in the form of fusion plasma *Bremstrahlung*, penetrate the first wall, which is made of a low atomic-number material. The x-rays further heat, vaporize, and ionize the liquid material. Microwaves generated by fusion plasma are allowed to pass through a ceramic window located in a small portion of the first wall. The microwaves preferentially heat the electrons in the ionized vapor. This prevents deionization of the vapor even though the average temperature falls below that needed for ionization. This partially ionized gas then passes through a magnetic field and MHD electrodes as it travels to a condensation chamber. The magnetic field is generated by the same coils as those used to contain the fusion plasma.

Logan has proposed a small experiment to test the basic concepts of this system. He believes that the ideas are applicable to both magnetic fusion and advanced fission reactors, like the high-temperature gas-cooled fission reactor.