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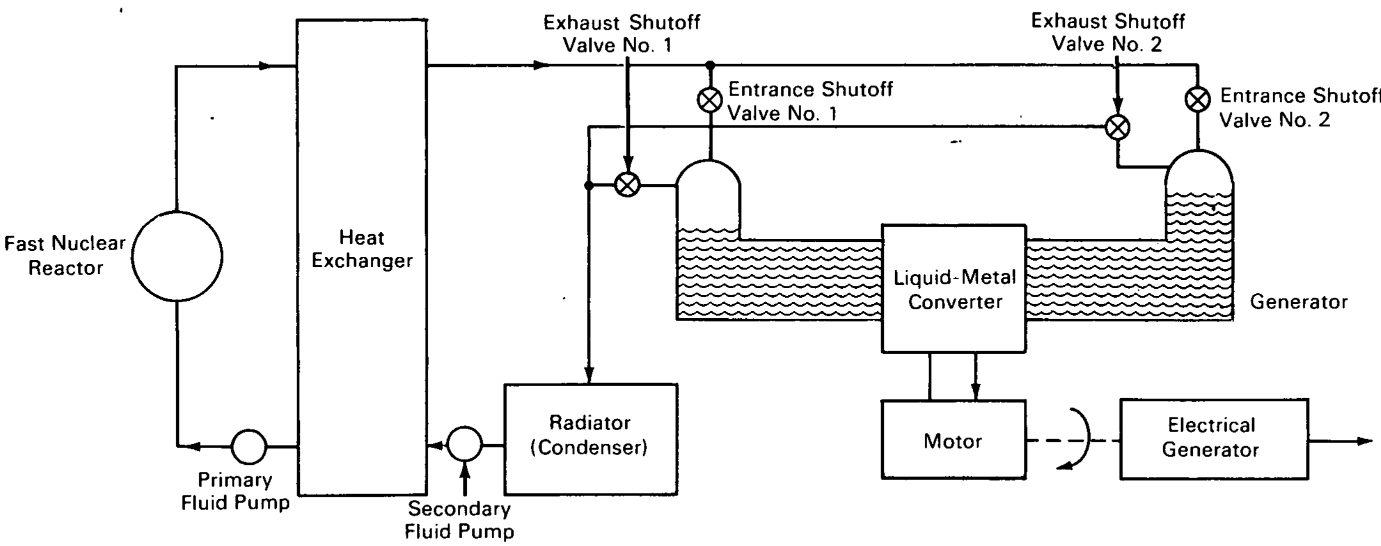
AEC-NASA TECH BRIEF

Liquid-Metal-Piston MHD Generator



Power Plant with Liquid-Metal-Piston MHD Generator

Problem:

To provide an MHD generator in which the working fluid is not thermally ionized. Such a generator is to be used with a nuclear source of heat.

In a typical MHD cycle, a working fluid is heated to a state of ionization and made to expand through a magnetic field thereby cutting the lines of force to generate electrical energy. However, if solid nuclear fuel is used, the available temperature is too low for thermal ionization of the working fluid.

Solution:

An MHD generator in which a slug or "piston" of liquid metal (such as liquid potassium) is used as the working fluid in a magnetic field. In this MHD generator, an expanding vapor of the metal is allowed to reciprocate the liquid-metal-piston through the magnetic field. The expansion energy is converted directly into electrical energy, instead of first to kinetic and then to electrical energy. Higher source pressures are possible, with consequent increases in cycle efficiencies. Since the generator electrodes "see" a reciprocating slug, the generator can deliver a low-voltage ac that can be easily transferred to a high voltage if desired.

How it's done:

A schematic arrangement incorporating the principle of the liquid-metal-piston MHD generator in a space power plant is shown in the figure. The power plant includes a fast nuclear reactor and an external heat exchanger. A pump circulates primary fluid between the reactor and heat exchanger. The secondary fluid, liquid potassium, is vaporized in the heat exchanger and transferred to the generator for expansion by way of the entrance shutoff valves. The

(continued overleaf)

potassium vapor is exhausted through the exhaust shutoff valves to the radiator (condenser) where the vapor is condensed to liquid. The secondary fluid pump circulates the liquid potassium back through the heat exchanger where it is again vaporized.

The generator, constructed of stainless steel, is partially filled with liquid potassium. The central portion of the generator is surrounded by a liquid-metal converter, which actually is a magnet to establish lines of force through the generator, and electrodes (not illustrated) integrally mounted in or on its walls for electrically contacting the liquid potassium within. The voltage output of the converter drives a motor which in turn drives an electrical generator to establish the desired voltage output of the system.

In actual operation, the liquid potassium is vaporized in the heat exchanger under a pressure established by the secondary fluid pump. Entrance shutoff valve no. 1 and exhaust shutoff valve no. 2 are opened simultaneously, so that the liquid potassium in the generator is pushed to the right. The liquid potassium develops an emf at right angles to the magnetic field established by the converter. The electrodes in the generator complete an electrical circuit, permitting the flow of electrical current which operates the motor. The potassium vapor remaining from the previous cycle and exhausting through exhaust shutoff valve no. 2, is at the lowest pressure of the system. It is cooled and liquefied in the radiator (condenser) and then pumped in liquid form back to the heat exchanger for vaporization once again. Entrance shutoff valve no. 1 and exhaust shutoff valve no. 2 are then closed and the second pair of corresponding valves are opened. The sequence of operation then repeats itself with the liquid potassium in the generator reversing in direction. Thus the liquid potassium reciprocates and a sinusoidal electrical output is delivered to the motor.

Notes:

1. Power utilities and heavy electrical industries may find this information of interest.
2. The innovation has been issued U.S. Patent No. 3,376,440.
3. Technical questions may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B69-10771

Source: J. P. Palmer of
Associated Universities, Inc.
Brookhaven National Laboratory
(ARG-10500)

Patent status:

Inquiries concerning rights for commercial use of this innovation may be made to:

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