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Channel-Wall Limitations in the Magnetohydrodynamic Induction Generator

The materials problems influencing the design and performance of the magnetohydrodynamic (MHD) induction generator have been discussed (*1*). A previous analysis of the machine is reviewed and extended to include electrically conducting channel walls and thermal insulation. The infinite-length machine is examined in detail, with both an approximate analysis to show the general behavior, and an exact solution to provide numerical data. An approximate analysis of one model of a finite-length generator is also presented.

The MHD generator system promises, because of its higher upper-temperature limit, to be more efficient than the present turbine systems for generating electricity, either alone or in combination with a steam system as a topping cycle; also it appears to be attractive for space and other special applications. This superiority of the MHD system has been demonstrated in various published analyses. However, the properties of its materials may reduce its performance; the importance of these properties was realized, and the analysis includes a detailed study of them and their effect on the generator's performance.

The MHD generator system analyzed uses an alkali metal as the working fluid at temperatures above 1,600°F in a condensing or Rankine cycle. The alkali metal is pumped through a channel by the vapor, the result being either a pure liquid or a liquid-vapor mixture as the working fluid in the generator. The channel is inside a magnetic core containing a polyphase winding that produces a traveling magnetic field in the fluid. The high-velocity fluid moves at a velocity greater than that of the traveling magnetic field, so that the fluid does work on the magnetic field and thereby generates electrical power.

The analysis formulates the design of the MHD generator. The requirements of the properties of the materials of both the electrically conducting refractory metal liner, in contact with the hot, high-velocity, alkali-metal working fluid, and the thermal insulation to protect the magnetic core are considered. The matter of these requirements versus the available properties is a vital factor in the ultimate efficient operation of an MHD power system.

The power flow between the field structure and the fluid is used for determination of the effect of the conducting wall (metal liner), with practical properties of the materials and dimensions of the machine. It is shown that the wall has to be very thin for acceptable performance by the generator and that this requirement raises severe structural problems. The effect of the thermal insulation is determined to be small.

Reference:

1. E. S. Pierson and W. D. Jackson, *ANL-7148* (Argonne National Laboratory, March 1966) (available from CFSTI, Springfield, Va. 22151, at $3.00—microfiche $0.65); W. D. Jackson and E. S. Pierson, in *Proc. I.A.E.E. Symp. Salzburg July 1966* (I.A.E.E., Vienna, Austria, 1966), vol. 2, pp. 889–902.

Notes:

1. Manufacturers of power generation and distribution equipment may be interested.

(continued overleaf)

2. Inquiries may be directed to:

Office of Industrial Cooperation
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
Reference: B69-10255

Source: (1) W. D. Jackson of
Massachusetts Institute of Technology
under contract to
Argonne National Laboratory
(2) E. S. Pierson
Reactor Engineering Division
(ARG-10128)

Patent status:

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

Mr. George H. Lee, Chief
Chicago Patent Group
U.S. Atomic Energy Commission
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439