1952

A Method for Harnessing the Gravitational Field of the Moon

Irwin Tessman
Sloane Physics Laboratory, Yale University, New Haven, Conn.
13 October 1952

SUMMARY

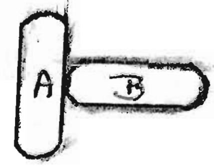
It is shown how the gravitational field of the moon can be used to create temperature changes in appropriate substances by the well known order-disorder adiabatic transition. It is proposed that the heat produced be usefully employed in operating a heat engine. The efficiency of such an engine is discussed.

An order-disorder adiabatic transition is generally known to be accompanied by a temperature change. In an adiabatic process the entropy is unchanged so that if the system is ordered in configuration space there must be a corresponding disordering in momentum space which is equivalent to an increase in terperature. The process is reversible. The phenomenon has beek widely utilized in such processes as the adiabatic expansion and compression of a volume of gas and the adiabatic demagnetization of a paramagnetic salt. In the latter case the molecules of the salt are lined up and consequently ordered by the magnetic field. If the salt is thermally isolated and the magnetid field turned off the temperature will drop. In a similar manner the force of gravity will contribute to the ordering of a substance, and if the force can be varied, temperature fluctuations will result and a heat engine could be run. This is the application I should like to suggest.

A convenient source of a strong fluctuating gravitational field must be found. There may be some unknown properties of gravity which might produce such a source in the future. For the present, use of the moon's field can be attempted. The tremendous work done in the raising of the tides is indicative of the effects due to the moon's gravitational field and to a lesser extent to the sun's field. That source of energy has been well known but is not easily harnessed. Its origin is in the variation of the direction of the moon's gravitational force relative to the earth as the earth rotates on its axis.

The heat engine I propose would utilize this same variation in the direction of the moon's gravitational field. We should probably have to use a non-isotropic substance so that when the gravitational force acts along one axis, the ordering process, say, is greatest. The increase in temperature due to the adiabatic ordering of the material provides the temperature difference necessary for the operation of the engine. When the earth rotates approximately 90 degrees the disordering process will be at a maximum, but since this would be performed non-adiabatically the final temperature of the substance would be that of the surroundings. As the earth continues to rotate the ordering process resumes and is performed adiabatically. If many substances are simultaneously used but inclined at various angles, each would be at a different stage of the process at any time and the engine could operate continuously.

For practical power output large scale operation would be necessary for it would appear that such an engine would be inefficient. The temperature difference obtainable may be very small, setting a low upper limit to the efficiency. A more efficient system would obtain if a two stage process yielding a larger temperature difference were used. Two substances, A. and B, with their axes perpendicular are placed in thermal contact as shown in the diagram. First A is ordered by the gravitational force, raising its temperature. But



since B is in thermal contact, its temperature is raised also. As the earth rotates B is finally ordered, but if the thermal contact has been broken it does not have to share the added heat with A. In this manner greater temperature differences and hence greater efficiencies are attained. This method can be extended to a multistage process. Adequate insulation must, of course, be devised. By the proper choice of materials a practical heat engine utilizing the gravitational field of the moon may be possible.