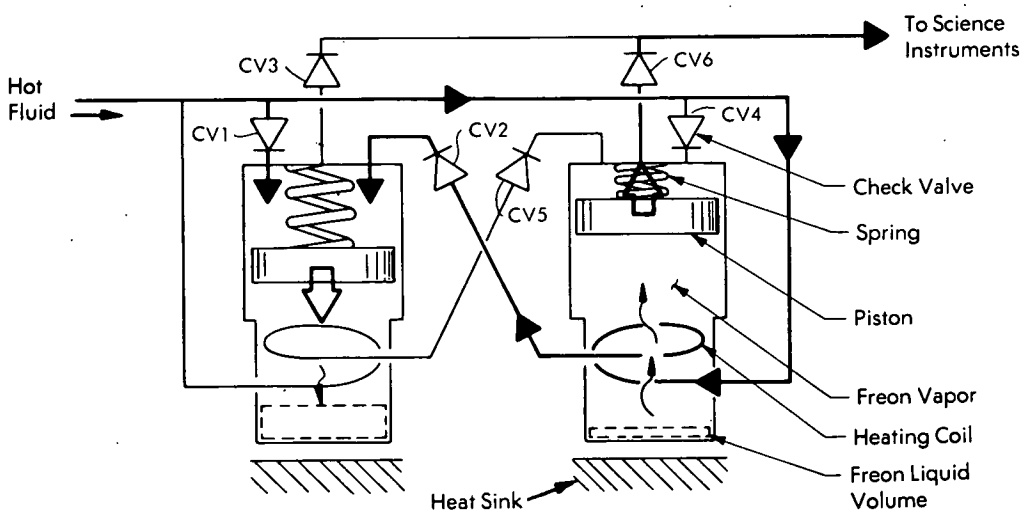
NASA TECH BRIEF

NASA Pasadena Office

Thermal-Powered Reciprocating Pump



The problem:

Science and flight instruments in spacecrafts must be kept warm during missions in deep space. Radioisotope thermal generators in spacecrafts produce an abundance of waste heat which is normally allowed to escape into space; it would be desirable to transport some of the waste heat by means of a heat exchange fluid to the cold instruments, but an electrical pumping system cannot be used because it would consume 10 watts of power. An alternative method for circulating the heat exchange fluid was required.

The solution:

A two-cylinder reciprocating pump which is powered by energy derived from the warm heat exchange fluid; reciprocating action in each of the cylinders occurs because of alternate vaporization of a working fluid by the heat exchange fluid and condensation by flow of the latent heat of vaporization to a heat sink.

How it's done:

The device consists of a pair of cylinders, each with a thermally nonconductive piston, a heat-exchange coil, and a heat sink surface. The cylinders are interconnected as indicated in the diagram, that is, the heat coil of one cylinder is connected to the intake of the other cylinder. In each cylinder, a working fluid (such as dichlorodifluoromethane) is trapped between the piston and the end of the cylinder which is in communication with a heat sink.

As indicated in the diagram, the left piston is moving downward; this occurs because the working fluid in the cylinder is condensing at the cold surfaces in contact with the cylinder. The downward motion of the left-hand piston draws hot heat exchange fluid

(continued overleaf)

from the supply line through the heating coil in the right-hand cylinder and causes vaporization of the working fluid in the cylinder. The expanding vapor of the working fluid raises the right-hand piston, thus forcing working fluid to flow to the scientific instruments.

When the left-hand piston reaches the bottom of its stroke, fluid flow in the heating coil of the right cylinder ceases and the working fluid vapor in the right-hand cylinder begins to condense because of the constant removal of energy at the cylinder surfaces in contact with the heat sink; as a result, the right-hand piston descends and hot heat exchange fluid is drawn through the heating coil of the left-hand cylinder, which leads to raising of the left-hand piston and forcing of heat exchange fluid to the scientific instruments. The cylinders operate in a manner in which the pump is a mechanical analog of an astable electronic flip-flop; in the diagram, mechanical check valves are denoted by the electronic diode symbol. The coil springs indicated in the diagram are merely symbolic representations of forces which are required to drive the pistons during the course of pump operation; however, springs may be utilized to adjust the operating temperature of the pump.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: TSP 72-10723

Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

NASA Patent Counsel
Mail Code 1
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103

Source: Eric E. Sabelman of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-11417)