NASA TECH BRIEF

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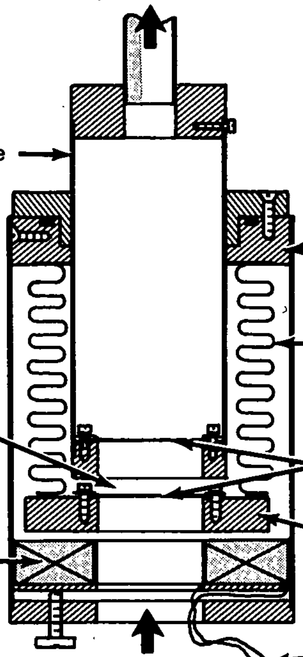
Simple Pump Maintains Liquid Helium Level in Cryostat



The problem:

To devise a pump that will maintain a precise level of liquid helium in a cryostat. The response of a pressurization system to circulate liquid helium from the supply Dewar vessel was found to be too slow to provide precise level control in the cryostat.

The solution:

A simple reciprocating pump incorporating a niobium solenoid armature that is maintained in a superconductive state by the liquid helium.

How it's done:

The pump, shown in cross section, is designed to operate when immersed in the liquid helium supply Dewar vessel, with the discharge end of the pump connected to the cryostat transfer line. A superconductive niobium ring, which serves as the solenoid armature, is suspended by a nickel bellows from a nonmagnetic stainless steel frame. A nylon valve disk is seated over the hole in the niobium ring. Above this piston assembly (comprised of the niobium ring, bellows, and nylon disk) is a rigid discharge tube

(continued overleaf)

containing a second nylon disk. A solenoid coil, made of superconductive niobium to minimize electrical losses and designed to be energized by a 60 cps source, is mounted below the piston assembly.

When the level of the liquid helium falls in the cryostat (as the result of evaporation losses), a liquid level sensor in the cryostat provides a signal to the 60 cps power source to energize the solenoid coil. The magnetic field generated by the solenoid coil repulses the superconductive niobium armature, thereby compressing the bellows and closing the lower valve disk. The liquid helium above this disk is consequentially pushed upward (opening the upper valve disk) and flows into the cryostat. When the coil is deenergized, the bellows relaxes, forcing the piston assembly downward against the liquid helium. This action causes the lower valve disk to open and admit liquid from the supply Dewar vessel into the pump chamber. The weight of the column of liquid in the discharge tube closes the upper valve disk, preventing reverse flow when the coil is deenergized.

The mass of the piston assembly and the spring constant of the bellows are selected to give mechanical resonance when the solenoid is energized. The mechanical resonating frequency is twice the 60 cps frequency applied to the solenoid, as the magnetic forces between the solenoid coil and the niobium armature are always repulsive regardless of the direction of the current. Therefore the pumping action is oscillatory at this resonating frequency during the periods when the solenoid coil is energized.

Notes:

1. A pump, 0.9 inch in diameter by 2 feet in length, provided a maximum flow rate of 10 liters per hour against a 2-meter head. The flow can be adjusted smoothly to any rate below the maximum by adjusting the current in the coil.
2. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B67-10039

Patent status:

No patent action is contemplated by NASA.

Source: T. A. Buchhold
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