



Improved Relief Valve Would Be Less Susceptible to Failure

Opening force and, hence, opening piston speed would be reduced.

Stennis Space Center, Mississippi

The balanced-piston relief valve with side vented reaction cavity has been proposed as an improved alternative to a conventional high-pressure, high-flow relief valve. As explained below, the proposed valve would be less susceptible to failure.

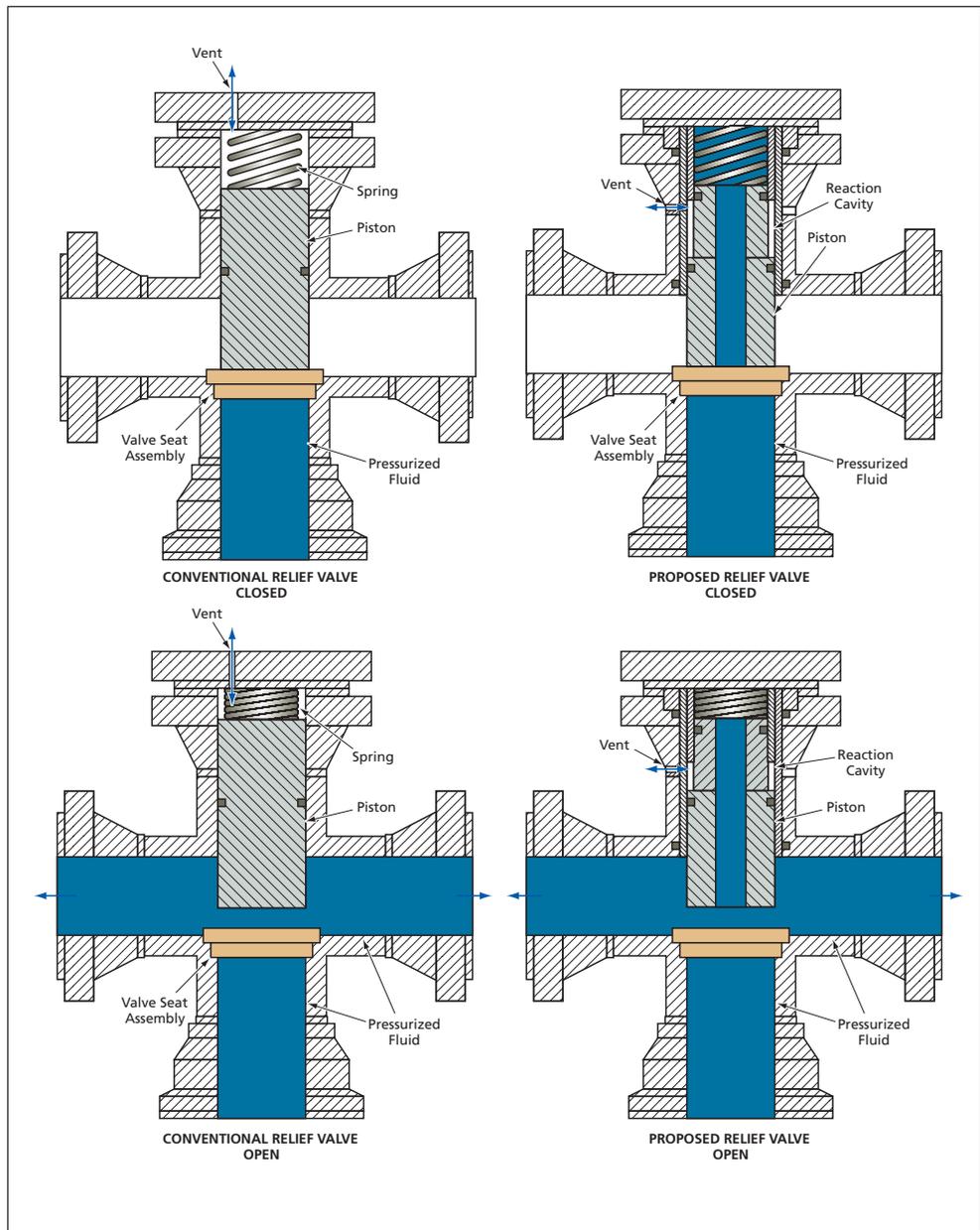
The left side of the figure shows a typical conventional high-pressure, high-flow relief valve, which contains a piston that is exposed to the upstream pressure across the full valve-seat diameter and is held against the valve seat and the upstream pressure by a large spring. In the event of an increase in upstream pressure to a level above the valve set point (the pressure above which the valve opens), the opening force on the piston can be so large that the piston becomes accelerated to a speed high enough that the ensuing hard impact of the piston within the valve housing results in failure of the valve.

For a given flow cross section, the proposal would significantly reduce the force, thereby reducing susceptibility to failure. A basic version of the proposed balanced-piston relief valve with side vented reaction cavity is depicted on the right side of the figure. The piston would contain a central hollow that would allow the pressurized fluid to flow into the spring cavity above the piston, so that the pressure in the fluid would act against both the upper and lower piston faces.

The outer diameter of the piston at the upper end would be somewhat less than the outer diameter of the piston at the lower end, the two diameters meeting at a shoulder on the side of the piston. A sleeve filling the annular space between the two diameters would surround the upper end of the piston. Therefore, the upper

piston face would be slightly smaller than the lower piston face, the difference between the areas of these faces being equal to the annular cross-sectional area of the sleeve or, equivalently, of the shoulder.

The reaction cavity (the annular side volume between the shoulder and the sleeve) would be vented to either the atmosphere or other source of reference pressure below the valve set point. As a result, the upward (opening) fluid pressure



In the **Proposed Relief Valve**, the net fluid-pressure opening force on the piston would be much less than in the conventional relief valve because the upward force of the fluid pressure on the bottom piston surface would be mostly counteracted by the downward force of the fluid pressure on the top piston surface.

force on the piston would exceed the downward (closing) fluid pressure force on the piston, the net upward fluid pressure force being equal to the annular area of the shoulder and the gauge pressure (absolute fluid pressure less atmospheric or other reference pressure). Because the annular shoulder area could be made less than the area of the lower piston face, the opening force could be tailored to a suit-

ably low value through design choice of the upper and lower piston diameters. (Of course, for a given valve set point, it would be necessary to choose a spring of correspondingly reduced stiffness.) The fluid in the spring cavity would present inertial impedance that would further reduce the opening acceleration of the piston. As an additional benefit, it may be possible to reseal the valve at a greater

fraction (perhaps as much as 100 percent) of the valve set point than that of a conventional relief valve.

This work was done by Bruce R. Farner of Stennis Space Center.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Intellectual Property Manager, Stennis Space Center, (228) 688-1929. Refer to SSC-00232-1.

Safety Modification of Cam-and-Groove Hose Coupling

Coupling halves cannot be separated while the hose is internally pressurized.

John F. Kennedy Space Center, Florida

A modification has been made in the mating halves of a cam-and-groove hose coupling to prevent rapid separation of the halves in the event that the cam levers are released while the fluid in the hose is pressurized. This modification can be duplicated on almost any commercially available cam-and-groove hose-coupling halves and does not interfere with most vendors' locks that prevent accidental actuation of the cam levers.

The need for this modification arises because commercial off-the-shelf cam-and-groove hose-coupling halves do not incorporate safety features to prevent separation in the pressurized state. Especially when the pressurized fluid is compressible (e.g., steam or compressed air), the separated halves can be propelled with considerable energy, causing personal injury and/or property damage. Therefore, one purpose served by the modification is to provide for venting to release compressive energy in a

contained and safe manner while preventing personal injury and/or property damage. Another purpose served by the modification, during the process of connecting the coupling halves, is to ensure that the coupling halves are properly aligned before the cam levers can be locked into position.

For the purpose of describing the modification, the coupling halves are denoted the receiving and mating halves, respectively. The modification includes the formation of two installation/removal slots and two safety pockets in the receiving coupling half. Each safety pocket is located at an angle of 45° from an installation/removal slot and provides both a "catch" to prevent accidental release and a landing for full installation. The mating coupling half has been modified to receive two shoulder bolts made of A286 stainless steel.

In use, if the mating coupling half is not rotated 1/8 turn relative to the re-

ceiving coupling half, then the cam levers cannot be rotated into position and locked to provide the required seal between the two coupling halves. The head of each shoulder bolt slides in one of the installation/removal slots and provides a stop if release is initiated accidentally while the fluid in the hose is pressurized. The safety pocket prevents rotation of the mating coupling half relative to the receiving coupling half while the fluid is pressurized, thereby also preventing sudden separation of the coupling halves. At the same time, the modifications allow the coupling halves to disengage slightly to allow venting of the pressurized fluid. Once pressure in the hose is sufficiently low, the coupling halves can be safely disconnected from each other.

This work was done by Paul Schwindt and Alan Littlefield of Kennedy Space Center. Further information is contained in a TSP (see page 1), KSC-12713

Using Composite Materials in a Cryogenic Pump

Shaft speed is increased and conductive leakage of heat is reduced.

John F. Kennedy Space Center, Florida

Several modifications have been made to the design and operation of an extended-shaft cryogenic pump to increase the efficiency of pumping. In general, the efficiency of pumping a cryogenic fluid is limited by thermal losses (the thermal energy that the pump adds to the fluid). The sources of the thermal losses are pump inefficiency and leakage (conduction) of heat through the pump structure. Most cryogenic pumping systems are required to operate at maximum efficiency because

the thermal energy added to the fluids by the pumps is removed by expensive downstream refrigeration equipment. It would be beneficial to reduce thermal losses to the point where the downstream refrigeration equipment would not be necessary.

A typical cryogenic pump includes a drive shaft and two main concentric static components (an outer pressure containment tube and an intermediate static support tube) made from stainless steel. In order to reduce the leakage of heat, the

shaft is made longer than would otherwise be needed. The efficiency of the pump could be increased most easily by increasing the speed of rotation of the shaft, but the speed must be kept below the lowest of the rotordynamic critical speeds. (In essence, the rotordynamic critical speeds are resonance frequencies at which the interaction of rotational dynamics and elasticity of the shaft and the rest of the rotor can cause the rotor to vibrate uncontrollably, possibly damaging the pump.)