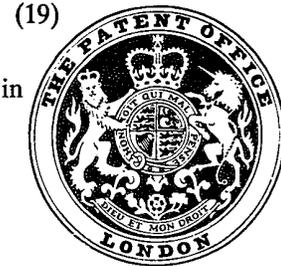


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(54) EXHAUST VALVES FOR EXPELLING A PRESSURIZED HIGH TEMPERATURE FLUID TO ATMOSPHERE

(71) We, THE BABCOCK & WILCOX COMPANY, a corporation organised and existing under the laws of the State of Delaware, United States of America, of 161 East 42nd Street, New York, N.Y. 10017, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to exhaust valves for expelling a pressurized high temperature fluid to atmosphere.

In the handling of high pressure fluids flowing in valves, it has been customary to utilize an orifice means or valve opening having a high velocity short throat section to attain energy losses or high pressure drops. If the fluid is in a liquid state and liable to flash, that is, vapourise or turn to a gaseous condition on the downstream side of the orifice means or valve opening, it may condense implosively and induce damaging shock waves, cause erosion, and the like. Also, as the velocity of the fluid in the valve exceeds the velocity of the fluid in the line, several disturbing reactions occur. The most serious problem is rapid erosion of a valve seat plug of the valve by direct impingement of the liquid and any foreign particles suspended therein. Additional erosion results from cavitation. Cavitation may be defined as the high speed implosion of vapour against parts of the valve.

In addition to the severe problems resulting from erosion, the increased velocity also causes the flow characteristics of the valve to become unpredictable and erratic. This occurs because the changes in velocity significantly affect the valve vena contracta vortexes and fluid enthalpies.

Other objectionable problems created by the high fluid velocity in the valve are severe noise generations, trim fatigue and possible

degradation of flowing fluid materials such as, for example, polymers.

The foregoing and other deficiencies were somewhat overcome by more recent devices which effect dissipation of energy of a flowing high pressure fluid by subdividing it into a plurality of passageways and labyrinths in which there are rapid changes of direction. Examples of such devices may be found in US Patents No. 3,514,074 and 3,513,864. These devices are formed as a series of cylindrically stacked members having inlets and outlets formed along concentric circular peripheries of each member with a labyrinth being formed therebetween. Where increased labyrinth outlet to inlet area ratios are required to provide a predetermined pressure drop through the device the circular outlet is appropriately increased by increasing the radius of each member to thereby increase the outlet area of the device. For high pressure drops the device becomes quite large and requires an increased amount of material and cost. Also, where a high temperature high pressure fluid is passed through such a device a significant temperature drop is encountered between the inlet and outlet due to the pressure drop through the device. This temperature differential may produce circumferential thermal stresses due to compressive forces on the high temperature inlet area and tensile stresses on the low temperature outlet area which may cause the members of the device to split and warp. When the members split or warp the labyrinth they form may be shortcircuited thereby impairing the effectiveness and operation of the device. The foregoing problems become especially acute in atmospheric venting situations.

Atmospheric venting is generally the noisiest of all control valve applications. The problem is difficult to treat because of the inherently higher pressure ratios, mass

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flow rates and the absence of the pipe wall as an attenuator. Fluid borne noise downstream of control valves is very high. If not treated or contained with the pipe, this noise can result in sound pressure levels of 150 to 170 dB three feet from the vent exit. Sound sources of this magnitude are hazardous to personnel and frequently result in complaints from local residents.

Mufflers and silencers can only attenuate fluid borne noise by 20 to 30 dB. Therefore, only partial success has been achieved with them in obtaining desired sound pressure levels. Furthermore, a typical path treatment system i.e., the muffler, lagging, support structure, etc., is very cumbersome and expensive. Often, the total cost of path treatment can exceed the valve cost many times over.

According to the present invention there is provided an exhaust valve for expelling a pressurized high temperature fluid to atmosphere, the valve comprising:

a series of elements having adjacent surfaces and joined to form a rigid structure; a multi-turn labyrinth formed between the adjacent surfaces of said elements to provide a pressure drop in fluid flowing therethrough;

a central aperture extending through said series of elements in a substantially perpendicular manner relative to the adjacent surfaces thereof and providing an inlet to said multi-turn labyrinth therealong;

outlet means formed along the external surface of said rigid structure to exhaust the fluid from said multi-turn labyrinth to the atmosphere; and

stress relief means formed in the external surface of said rigid structure to prevent splitting of said elements of said rigid structure due to a temperature difference between the high temperature fluid at the inlet and low temperature fluid at the outlet means.

The stress relief means may include a series of elongate cutouts formed in the adjoining surfaces of said elements and extending from the external surface of said rigid structure partially into the structure in directions substantially radially of the axis of said central aperture.

The cutouts may have formed along the surface thereof outlets for exhausting fluid from said multi-turn labyrinth to increase the outlet area of said rigid structure without increasing the size thereof. Such an arrangement provides a more compact structure requiring less material than the prior art devices having concentric circular inlet and outlet configurations wherein the outlet area is a function of the radius of the outlet configuration. Since this arrangement allows a larger outlet area to be formed than in the case of like elements not having the

cutouts and outlets, thermal stresses are significantly reduced by this feature also.

The invention will now be further described, by way of non-limitative example, with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal cross-section of an exhaust valve embodying the present invention;

Figure 2 is a perspective view of a disc stack of the valve of Figure 1; and

Figure 3 is a top view of one disc of the disc stack of Figure 2.

Referring now to the drawings, Figure 1 shows a steam exhaust valve assembly 10 for exhausting a predetermined amount of steam to the atmosphere 12 through a multi-turn labyrinth disc stack assembly 14.

Steam enters the valve assembly 10 through an inlet 16 and flows into a chamber 18 from which a predetermined amount of the stream is allowed to exhaust through the stack assembly 14 by a movable valve plug 20. The valve plug 20 is movable between a first position completely blocking the steam from entering the stack assembly 14 by completely blocking all the inlets 22 of the stack assembly 14 and a second position opening all the inlets 22 by moving up into a space 24 formed by a top casing 26 of the valve assembly 10. The plug 20 is moved by a connecting rod 28 connected to an actuator (not shown) which is responsive to system control signals in a well-known manner. To minimise the force that the actuator has to exert to move the plug 20 between positions, steam pressure is balanced across the plug 20 by providing a pair of passageways 30 extending longitudinally across the plug 20 for steam communication between the chamber 18 and the space 24.

The disc stack assembly 14 includes a series of individual discs 32 which are aligned with respect to the plug 20 and are clamped together by tension rods 34 between a bottom mounting plate 36 and a top mounting plate 38. A circumferential baffle 40 angularly extends from the bottom mounting plate 36 to encompass the stack assembly 14 and safely direct the steam exiting from outlets 42 of the stack assembly up into the atmosphere 12. The disc stack assembly 14 provides a multi-turn labyrinth for the steam as it travels from the inlets 22 to the outlets 42 by means of the discs 32, as will be disclosed later. The negotiation of these turns causes a significant pressure drop in the steam as well as a temperature decrease. To eliminate or at least minimise the above-mentioned thermal stress problem due to this temperature difference between the inlets 22 and the outlets 42, each disc 32 is formed to have a series of stress-relieving radial cutouts in the form of a series of elongate notches 80 which ter-

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minate in circular areas 82 (see Figures 2 and 3).

Referring further to Figures 2 and 3, in particular Figure 3, it will be seen that each disc 32 has a flat smooth solid bottom side (not visible in Figure 3) and an opposite side 70 on which a series of radially extending fence structures 84 are formed to raisedly extend up from the face 70. Each fence structure 84 has a series of spaced dividers 86 which overlap to define a multi-turn path for steam flow between adjacent fence structures 84. (For convenience, only some of the fence structures 84 and dividers occupying a sector of the disc 32 are shown in Figure 3). The turns are negotiated within the plane of the disc side 70. The notches 80 and the circular areas 82 have a wall 88 which prevents steam flow from exiting therethrough. However parts on all of the walls 88 could be easily omitted to provide an increased outlet area from the disc 32.

The discs 32 are stacked together to form the stack assembly 14 by placing the flat side of one disc 32 against the fence and divider 84, 86 side of the adjacent disc 32. The uppermost disc 32 may then be sealed by placing its fence structure 84 against either of the valve plates 36 and 38 shown in Figure 1 to provide a more compact steam exhaust valve assembly 10.

Attention is drawn to our co-pending Application No. 37263/76 from which the present Application was divided. (Serial No. 1561155).

WHAT WE CLAIM IS:-

1. An exhaust valve for expelling a pressurised high temperature fluid to atmosphere, the valve comprising:
 a series of elements having adjacent surfaces and joined to form a rigid structure;
 a multi-turn labyrinth formed between the adjacent surfaces of said elements to provide a pressure drop in fluid flowing therethrough;
 a central aperture extending through said series of elements in a substantially perpendicular manner relative to the adjacent surfaces thereof and providing an inlet to said multi-turn labyrinth therealong;
 outlet means formed along the external surface of said rigid structure to exhaust the fluid from said multi-turn labyrinth to the atmosphere; and
 stress relief means formed in the external surface of said rigid structure to prevent splitting of said elements of said rigid structure due to a temperature difference between the high temperature fluid at the inlet and low temperature fluid at the outlet means.

2. An exhaust valve according to claim 1, wherein said stress relief means includes a series of elongate cutouts formed in the adjoining surfaces of said elements and

extending from the external surface of said rigid structure partially into the structure in directions substantially radially of the axis of said central aperture.

3. An exhaust valve according to claim 2, wherein said cutouts have formed along the surface thereof outlets for exhausting fluid from said multi-turn labyrinth to increase the outlet area of said rigid structure without increasing the size thereof.

4. An exhaust valve according to claim 1, claim 2 or claim 3, including control means controllably extendable into said central aperture to thereby control the amount of fluid exhausted to the atmosphere.

5. An exhaust valve substantially as herein described with reference to the accompanying drawings.

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FIG. 1.

