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SPRING LOADED POP-ACTION SAFETY VALVES

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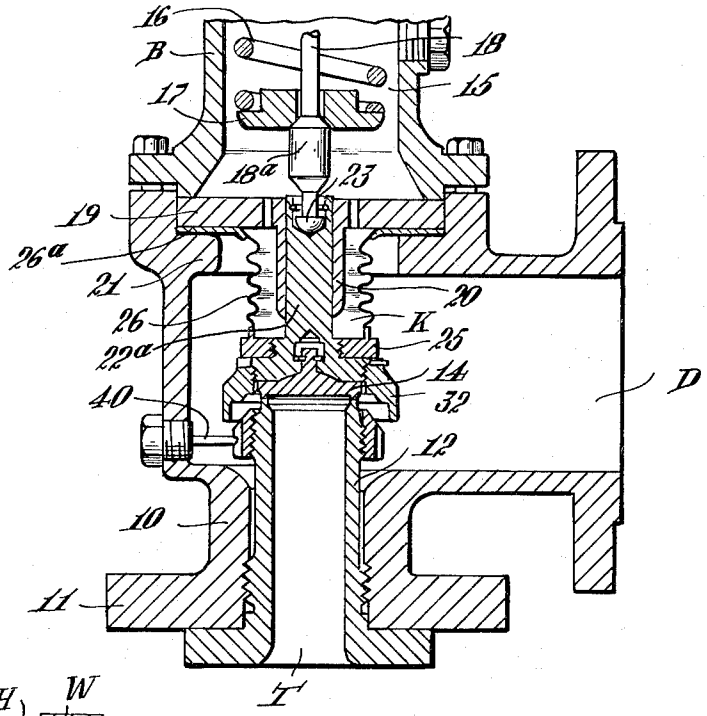


Fig. 1

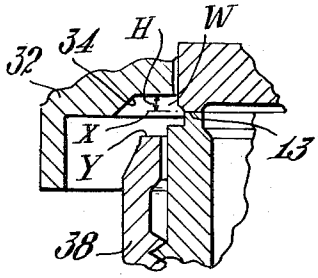


Fig. 3

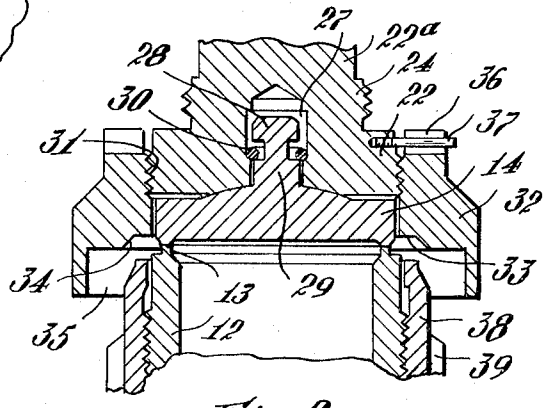


Fig. 2

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SPRING LOADED POP-ACTION SAFETY VALVES

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This invention pertains to spring loaded pop-action safety valves of the kind wherein a valve head is lifted from a seat in response to the accumulation of pressure beneath the valve head and wherein a blow-down ring, coaxial with the valve seat, is adjustable axially with reference to the plane of the valve seat thereby to determine the pressure at which the valve will close—the present invention relating more especially to a valve of that type wherein a valve holder, positioned above the valve seat, is guided to move toward and from the plane of the valve seat by a fixed guide, and wherein a valve head or disc, independent of the holder, is connected by a universal coupling to the valve holder so that it may rock in any direction. A valve of this general type is illustrated, by way of example in the patent to Gentzel, No. 2,021,773, November 19, 1935.

While the closure of a pop-action safety valve at a predetermined blow-down pressure is extremely important, it is also important that the valve pop or open sharply and to the desired lift without prolonged warn or simmer, but it is a known fact that where, in the usual type of construction, it is attempted simultaneously to adjust the valve for simmer (warn) and long blow-down the correction of one usually leads to accentuation of the fault in the other. Among the suggestions for the control of both blow-down and simmer, has been that of providing two or more concentric, relatively adjustable rings mounted on the nozzle tube whose upper end forms the valve seat, but this arrangement requires such nicety of adjustment that it cannot be regarded as providing a practical solution of the problem. Limited control of pop and blown-down has heretofore been attained by the use of a single adjustable ring mounted on the nozzle (whose upper end defines the valve seat) in combination with variously contoured surfaces and dimensions of the valve holder where the latter extends outwardly beyond the valve seat.

Thus, it has become customary to design the valve disc or the unitary valve holder (if the latter be employed) so as to provide a peripheral overhang or roof spaced above the plane of the valve seat whereby a "huddling" chamber, having a narrow discharge passage, is provided, so that the pressure fluid escaping over the valve seat develops an upward force against the overhang of the valve head or holder, thus effectively increasing the area against which the pressure fluid acts and so assuring prompt opening and high lift. In some prior instances, as disclosed in the patent to Raymond, No. 1,696,452, December 25, 1928, for example, the overhang has been so shaped as to direct the escaping fluid downwardly, thus developing kinetic force which further assists in lifting the valve head and maintaining it at the desired lift until the pressure has dropped to the blown-down point.

In such a valve, the exact height of the roof of the huddling chamber above the plane of the valve seat is an extremely important factor in determining the action of the valve; and in the design of such a valve, the characteristics of the particular fluid, which is to be controlled by the valve, must be taken into account in each instance, in calculating this sensitive dimension, as well as the range of pressures and/or temperatures of the fluid which will escape. Thus, the manufacturer of valves of this type has been confronted with the necessity of supplying valves in great variety in order to meet the demands of the user. For example, in attempting to supply the requirements of the trade, the following points of primary importance must be considered by the manufacturer:

(1) The variety of fluids, which may be of widely different physical properties, which must be handled, such as liquids, vapors, and gases;

(2) The pressure ranges which must be covered; for example, from 5 p.s.i. to 6,000 p.s.i. and higher, with widely varying expansion characteristics when the pressure fluid is released to atmospheric pressure or other fluid pressure at the discharge side of the valve;

(3) The temperature effect on the kinetic properties of the fluids which are released by the opening of the valve;

(4) The commercial tolerances obtainable in load ratings of springs which are ±5% of the specified rate;

(5) And other factors which are less prominent, but which have an influence on both simmer and blow-down, including seat width, alignment of valve parts, friction characteristics of the moving parts, seat finishes, etc.

Since the distance between the roof of the huddling chamber and the plane of the valve seat is initially the same as the distance between the roof of the huddling chamber and that surface of the valve head which contacts the seat, and since, in the use of a valve, that surface of the valve head which contacts the seat may become worn or eroded and must be dressed to insure non-leak contact, the initial careful dimensioning of the distance between the roof of the huddling chamber and the plane of the seat-contacting surface of the valve head is destroyed, thus requiring further machining to bring this very essential dimension back to what is proper for the particular circumstances for which the valve was initially designed. Since the seat-contacting surface of the valve head and the overhang portion which provides the huddling chamber are in most cases surfaces of the same piece of material, repeated reconditionings may so change the proportions of the parts that it becomes necessary to substitute an entirely new head for the original head. Thus, a further factor, which should be considered by the manufacturer, is that of so designing the parts as to make possible the ready adjustment of the height of the roof of the huddling chamber following the dressing of the valve disc.

In safety valves of the type to which the present invention relates and wherein the disc or head is connected to the holder by a universal joint (or equivalent coupling) thereby to permit the seat-contacting surface of the head or disc to make accurate contact with the seat—in spite of the fact that the upper part or holder is rigidly guided for rectilinear motion, further difficulties result in practical use, in particular with reference to the control of simmer, because of the fact that the head or disc may tilt and thus cause a variation or non-uniformity in the above-noted essential dimension, that is to say the distance between the roof of the huddling chamber and the plane of the valve seat.

Among the objects of the present invention is to provide a spring loaded pop safety valve in which the customary vertically adjustable blow-down ring is employed, and having provision for the use of the huddling chamber principle in the attainment of sharp lift without prolonged simmer, but wherein the height of the roof of the huddling chamber, relatively to the plane of the valve seat, may be easily and accurately adjusted by the manufacturer to meet the requirements of the individual user with reference to the character of the fluid with which the valve is to be used, and for the complete range of pressures and temperatures to be encountered during the use of the valve, thereby to insure acceptable limits of simmer and blow-down. Other objects and advantages of the

invention will be pointed out in the following more detailed description and with reference to the accompanying drawings wherein:

FIG. 1 is a fragmentary diametrical vertical section through the axis of the valve seat of a valve device embodying the present invention;

FIG. 2 is a fragmentary view to larger scale on the same plane as FIG. 1 showing the valve seat, the valve disc or head, and the valve holder in greater detail than in FIG. 1; and

FIG. 3 is a fragmentary radial section, to larger scale than FIG. 2, to facilitate the explanation of certain essential relationships between the parts.

In the attainment of the above objects, the valve holder is made to consist of two separate parts; namely a central part to which the valve head or disc is coupled in the manner above-described, and which is guided for accurate rectilinear motion toward and from the valve seat, and an annular skirt portion so connected to the central portion of the holder that it may be adjusted vertically relatively to the central portion, and which is so contoured as to provide the roof of the huddling chamber, and preferably also to change the direction of the escaping fluid so as to provide kinetic force to assist in lifting the valve head from the seat. Means is provided for locking this adjustable skirt portion in adjusted position, and preferably this locking means is so located within the valve body that it is not accessible from the exterior of the valve body, and is thus tamperproof. Moreover, the locking means, thus located, does not, by contact with any parts of the casing, introduce friction or interference with the normal operation of the combined holder and disc as the valve opens or closes.

Referring to the drawings, the numeral 10 designates the valve casing or body, of customary construction and material, having the base flange 11, by means of which it may be secured to the pressure container with which the valve is to be associated. A nozzle 12, having screw-threaded engagement with the valve body, defines the inlet fluid passage T whose delivery end is defined by the annular valve seat 13 at the upper end of the nozzle 12. The valve head or disc 14 has a finished annular surface at its underside which normally contacts the seat 13 leak-tight, and thus closes the passage T.

The valve also comprises the bonnet B which is secured in usual manner to the upper part of the body 10 by means of bolts, and which provides the spring-housing chamber 15 within which the loading spring 16 is arranged, the spring bearing at its lower end against the abutment member 17 which, in turn, rests upon a shoulder on the lower end portion 18*a* of the valve loading spindle 18. At its upper end, the spring bears against a fixed but adjustable abutment (not here shown) of conventional type. The floor of the chamber 15 is defined by a heavy plate 19, which is here shown as integral with a hollow cylindrical guide member 20 coaxial with the valve seat—the plate 19 being clamped between the lower end of the bonnet and a flange 21 forming a part of the valve body. The cylindrical stem 22*a* of a valve holder 22 is arranged to slide in the fixed guide 20, and this stem is connected, at its upper end, by a universal joint (indicated at 23) to the lower end of the spindle 18. The universal joint here shown is generally similar to that shown in the patent to Raymond, No. 1,696,452, December 25, 1928, wherein the lower end of the valve loading spindle is connected directly to the valve disc.

The invention as herein illustrated in its embodiment is a so-called bellows-type valve, such as disclosed in the patent to Briscoe et al., No. 2,264,656, December 2, 1941, and it is to be understood that the invention is equally useful in valves of other kinds.

As herein shown, by way of example, the stem 22*a* is externally screw-threaded at 24 (FIG. 2), for the reception of an internally screw-threaded annulus 25 (FIG. 1), to which the lower end of a metallic bellows 26 is secured leak-tight—the upper end of this bellows being welded to an annulus 26*a* which is clamped between the parts 21 and 19. The plate 19 has one or more openings connecting the interior chamber K of the bellows with the chamber 15. As here shown, the floor of the chamber K within the bellows is of a diameter exceeding the diameter of the valve seat 13. Were no bellows to be employed, the parts 25 and 26*a* would be omitted.

A chamber 27 (FIG. 2), in the lower end of the stem 22*a* of the valve holder, receives a head 28 at the upper end of a short stem 29 projecting upwardly from the valve head or disc 14, this head 28 being retained within the chamber 27 by a snap ring 30—thus providing a universal coupling or joint between the valve disc and the stem of the valve holder. Other forms of universal joint connection may be employed, if desired, for connecting the stem of the valve holder to the loading spindle and valve head, for example, such a connection as that shown in the patent to Corcoran, No. 2,151,501, March 21, 1939, by means of which the loading spindle is secured directly to the valve head, thus permitting the valve head or disc to rock or swivel relatively to the rigidly guided holder 22, thereby insuring accuracy of seating on the valve seat.

The lower part of the holder stem 22*a* is enlarged in diameter to form the valve holder 22, being here shown as of an external diameter somewhat exceeding the diameter of the valve seat, and this enlarged lower portion is externally screw-threaded at 31 for the reception of screw threads at the interior of the annular skirt 32, the latter thus being adjustable axially with reference to the holder 22. As shown in FIG. 2, the inner periphery of the skirt 32 and the undersurface of the holder define a circular chamber in which the valve disc 14 is located, this chamber being of such height and diameter as to permit the valve disc to rock or swivel relatively to the skirt.

The under surface of this skirt annulus 32 (outwardly of the disc-housing chamber) is contoured to provide the horizontal annular surface 33 which constitutes the roof of the huddling chamber. Desirably, although not necessarily, but as here shown, the under surface of the skirt is also provided with an outwardly and downwardly flaring surface 34, which acts to deflect the fluid escaping over the valve seat downwardly toward the discharge opening 35, thus creating a kinetic force which assists in lifting the valve from the seat.

The upper edge of the skirt 32 is provided with circumferentially spaced radial slots or notches 36 of a vertical depth exceeding the range of vertical adjustment of the skirt, and a pin 37, having screw-threaded engagement with a radial bore in the valve holder 22, may be arranged to engage any one of these notches, thus to hold the skirt 32 in adjusted position relatively to the holder 22.

The valve, as here shown, is provided with a conventional blow-down ring 38 having screw-threaded engagement with the exterior of the nozzle 12, and this ring 38 is provided with circumferentially spaced vertical ribs defining slots 39 into which a locking pin 40 (FIG. 1) may be projected thereby to hold the blow-down ring in adjusted position.

In FIG. 3 the character W indicates the huddling chamber whose horizontal roof is formed by the surface 33, and the broken line X indicates the horizontal plane of the seat surface. The dimension indicated by the character H is thus the carefully determined vertical height of the roof 33 of the huddling chamber above the plane of the valve seat. As above-noted, this dimension H is important in attaining the proper operation of the valve. The downwardly inclined surface 34, when used, also has a distinctly beneficial action in assuring optimum performance under varied conditions. Because the vertical position of the upper edge Y of the blow-down ring 38 is also importantly related to the plane of the valve seat 13, as well as to the dimension H, it is desirable that provision be made for easily main-

taining this relationship when adjusting the height of the skirt 32; and for this purpose, the pitch of the screw thread 31, which connects the skirt 32 to the holder 22, is preferably made the same as the pitch of the thread which connects the blow-down ring 38 to the nozzle 12, and for the same purpose, the number and spacing of the notches 36, at the upper edge of the skirt 32, is preferably the same as the number and spacing of the slots 39 at the outside of the blow-down ring.

Tests upon valves of small orifice area, embodying the present invention, conclusively show that by raising and lowering the skirt 34 relatively to the holder 22, the lifting force is varied and thus simmer and blow-down may be adjusted to the particular conditions of operation.

Thus by constructing the valve as above-described, it is possible to adjust it to suit various fluid characteristics, and to different pressures and/or temperatures; the seating surface of the valve head or disc may be dressed, by the removal of metal, and thereafter the skirt 32 may readily be adjusted relatively to the holder 22 so as to maintain unchanged the dimension H (FIG. 3) which as already noted is very important in controlling simmer, and without necessitating readjustment of the blow-down ring 38. The fact that the ideal dimension H can be retained after its proper adjustment has once been established, regardless of the number of reconditionings of the seating surface of the disc, provides maximum economy to the user. Moreover, the present arrangement makes it possible to maintain the dimension H after it has once been adjusted for the control of simmer, even though the valve head or disc 14 is so coupled to the stem 22 as to permit the disc or head to rock or swivel; whereas, if the skirt portion 32 of the valve were fixed relatively to the valve head or disc so as to partake of any rocking movement of the latter, it would be impossible to maintain the dimension H exactly, and said dimension might vary at various portions of the periphery of the valve.

By using the same pitch of thread for uniting the blow-down ring 38 to the nozzle 12 and for uniting the skirt 32 to the valve holder 22*a*, and by providing the same number of notches in the top of the skirt and in the periphery of the blow-down ring for engagement by the respective locking element, it is readily possible to maintain the relationship between the distance from the plane of the valve seat to the roof 33 of the huddling chamber and to the upper edge of the blow-down ring 38, respectively, when the proper relationship has once been determined, since any angular rotation of the skirt 32 for varying the dimension H may be matched by a corresponding rotation of the blow-down ring.

In valves in which a balancing bellows is employed, for example as disclosed in the co-pending application for Letters Patent, Serial No. 640,438, filed February 15, 1957, by Erling Klafstad for Balanced Bellows Valve, etc., upon which Patent No. 2,878,828 issued on March 24, 1958, it is sometimes found desirable for the better utilization of kinetic forces developed during flow conditions, to change the contour of the skirt portion of the valve; and by the arrangement herein disclosed, it becomes possible to make such a modification merely by exchanging one skirt portion 32 for another of the new contour without changing the valve head or holder—thus enhancing economy and interchangeability. Moreover, it becomes possible to make the skirt portion 32 of one material and the valve head or disc and the valve holder of other materials, if desired, which in some instances effects a substantial economy in cost of production; or, under some conditions, an improved durability or smoothness of operation. Moreover, because it is possible to remove the skirt portion from the valve holder and thus expose the entire periphery of the valve disc or head, it is no longer necessary to drill radial holes in the skirt portion (as is now done when the disc holder and skirt are unitary) in order to permit the entry of drift pins when it becomes necessary to remove the disc or head from the holder for machining or exchange.

While one desirable embodiment of the invention has herein been disclosed by way of example, it is to be understood that the invention is broadly inclusive of any and all modifications falling within the scope of the appended claims.

I claim:

1. In a spring loaded pop-safety valve of the kind which has a body provided with a discharge passage and comprising a fixed nozzle which defines an unobstructed inlet passage and whose upper edge forms the valve seat, a rigid fixed guide within the valve body whose lower end is spaced above the plane of the valve seat, a rigid valve holder comprising an integral elongate stem, coaxial with the valve seat, and having sliding engagement with said fixed guide as the holder moves toward and from the plane of the valve seat, a valve head or disc which normally makes leak-tight contact with the valve seat, a coupling so connecting the disc or head to the holder as to permit the disc or head to rock relatively to the holder, and an adjustable blow-down ring external to and coaxial with the nozzle and having screw-threaded engagement with the nozzle, the holder being of a maximum outside diameter approximating the external diameter of the nozzle, in combination, an annular skirt, independent of the holder, which has screw-threaded engagement with the periphery of the holder so that it may be adjusted axially, relatively to the latter, the undersurface of said skirt being contoured to provide an annular flat roof for a huddling chamber, said roof being always accurately parallel to the plane of the valve seat, and cooperating elements operative to retain said skirt in selected position of adjustment, at which when the disc is seated the roof of the huddling chamber is at a predetermined distance above the plane of the valve seat.

2. A safety valve according to claim 1, further characterized in that the screw threads which unite the skirt and blow-down ring to the holder and nozzle respectively, are of the same pitch, whereby rotation of the blow-down ring and the skirt through equal arcs, in the same direction, will shift the upper edge of the blow-down ring and the roof of the huddling chamber exactly the same amount axially, relatively to the plane of the valve seat.

3. In a spring-loaded pop safety valve of the kind which includes a body provided with a discharge passage and comprising a nozzle which defines an unobstructed fluid passage and whose upper end defines the valve seat, a single, axially adjustable blowdown ring coaxial with the nozzle and means whereby the ring may be adjusted vertically relatively to the nozzle, a vertically elongate, rigid, fixed guide within the valve body and whose lower end is spaced above the plane of the valve seat, a unitary valve holder comprising an elongate stem which slides in contact with said guide as the holder moves up and down, the lower part of the holder being of a diameter exceeding that of the stem and being of a maximum diameter approximating the diameter of the valve seat, a valve disc which normally makes leak-tight contact with the seat, and means so coupling the valve disc to the lower part of the holder as to permit universal rocking of the disc relatively to the holder, in combination, an annular skirt encircling that part of the holder which is of maximum diameter, the skirt being independent of the disc, but moving with the disc and holder toward and from the plane of the valve seat and to the same amount, the under surface of the skirt being contoured to provide a flat annular face constituting the roof of a huddling chamber, said annular face being always parallel to the plane of the valve seat; means so connecting the skirt to the holder that the skirt may be adjusted axially relatively to the holder, the inner periphery of the skirt and the under surface of the holder defining a chamber within which the upper portion, at least, of the disc is located, said chamber being of such

height and diameter as to permit the disc to rock freely relatively to the skirt, means operative to retain the skirt in selected position of adjustment relatively to the holder such that, whenever the holder is in disc-seating position, the roof of the huddling chamber will be at a predetermined selected distance from the plane of the valve seat—the under surface of the skirt, outwardly beyond the horizontal roof of the huddling chamber, comprising a portion which flares downwardly and outwardly.

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