Oct. 28, 1952 E. WOODWARD 2,615,465

SELF-CLEANING VALVE

Filed March 21, 1949 2 SHEETS—SHEET 1

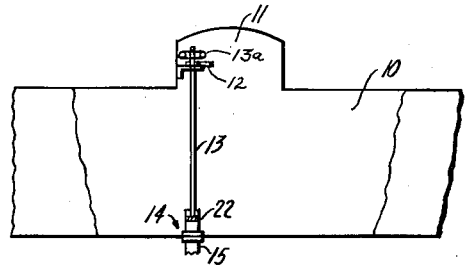


Fig.1

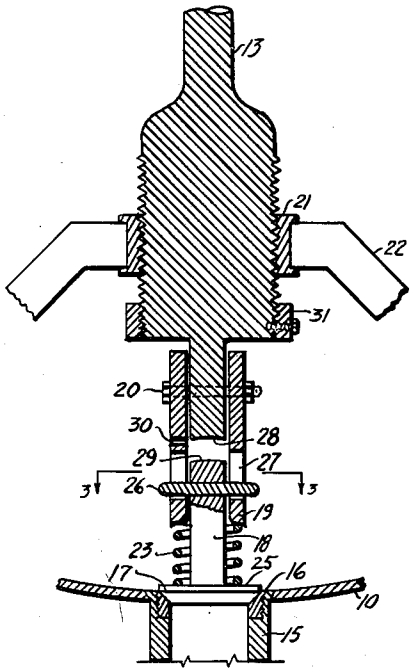


Fig.2



Fig.3

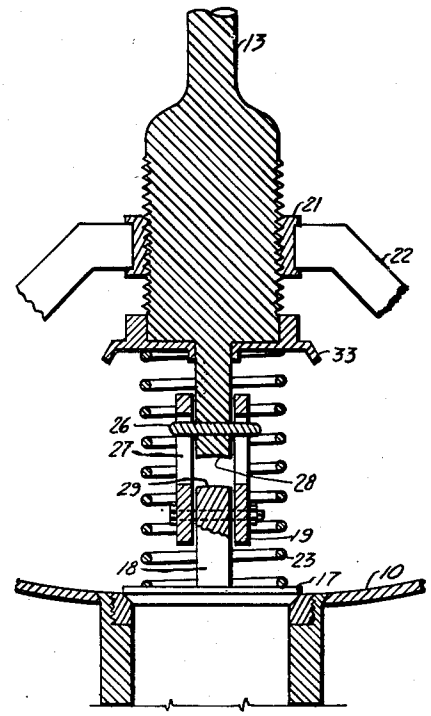


Fig.4

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SELF-CLEANING VALVE

Filed March 21, 1949 2 SHEETS—SHEET 2

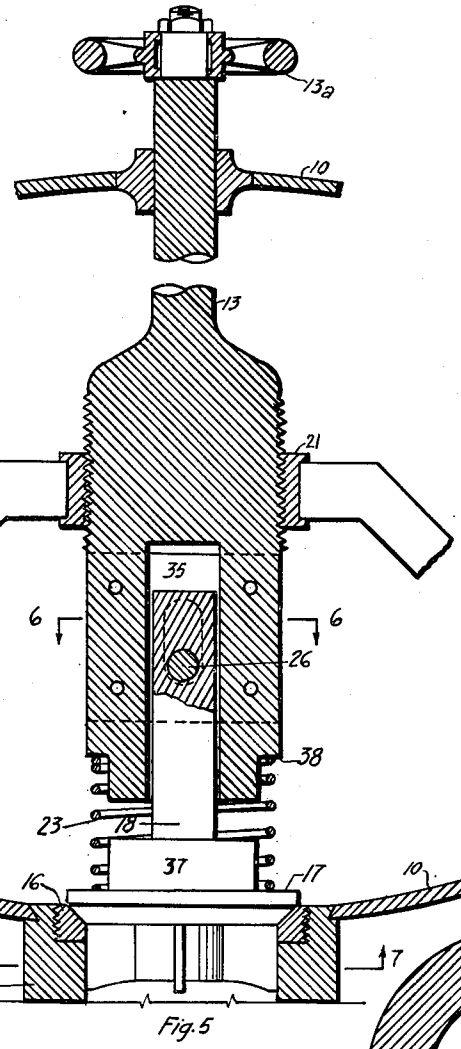


Fig. 5

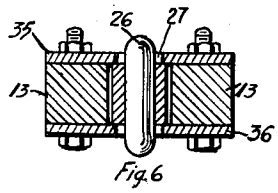


Fig. 6

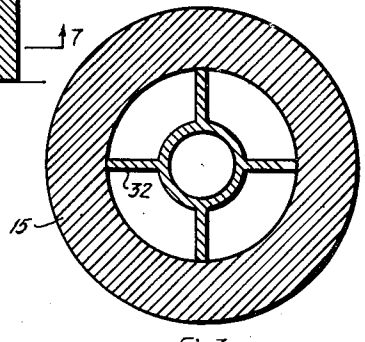


Fig. 7

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SELF-CLEANING VALVE

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6 Claims. (Cl. 137—243)

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This invention relates to outlet valves of the type used to control the discharge from tanks and the like, and is particularly concerned with an improved valve which is self-cleaning, and which may be operated to be partially self-grinding. Although not limited to use on tank cars, the valve is particularly designed for use as an outlet valve for railroad tank cars, such as are used for the shipment of petroleum and petroleum products.

For many years attempts have been made to improve tank car outlet valves to eliminate product losses and to avoid the extreme fire hazard caused by leaking valves when the cars are used to ship combustible liquids. While many improvements have been made to eliminate this leakage and stringent regulation have been imposed by the authorities with regard to leakage, the valves in use today do not meet the requirements for more than relatively short periods of time without continual and frequent servicing, and the designers of such valves appear not to have been aware of the main cause of leakage.

An occasional cause of leakage is lodgement of bolts, nuts and foreign objects between the valve and valve seat. These objects can be removed with but little trouble by means of a long pole and pick-up attachment. The main cause of leakage, responsible for probably 98% of the leakage, is accumulation of rust or scale from the tank car shell. Some of this scale lodges on the valve seat and when the valve closes it presses against the wet and brittle scale, crushing and impacting it into a small mound which sticks to the valve seat and prevents the valve from seating properly.

Such mounds of crushed scale can occasionally be flushed out but frequently they adhere tenaciously to the valve seating surfaces, and it is necessary to bear the expense and loss of time incident to sending the tank car empty to the shops for removal of scale and reconditioning of the valve. This occurs long before a tank car shell has sufficient loose scale to warrant steaming, scraping and cleaning.

It is, therefore, an object of this invention to provide an improved valve which is self-cleaning and which eliminates the scale from the valve seats on each opening and closing of the valve. While the valve is particularly useful when installed in a tank car having a shell made of ferrous metal, which is subject to scale or rust formation it is also suitable for other service, particularly in the handling of corrosive products or other products which may contain entrained solids causing severe wear on the valve seats.

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A further object is to provide a valve of the type described which is of such simple construction that the average mechanic can readily service it, and to provide a valve which is of rugged and inexpensive design, adapted for many different installations, whether large or small.

A further object is to provide a valve which eliminates the use of a locking device due to the fact that the valve member makes one or more revolutions on its seat after being seated, under spring pressure and the force of the fluid within the tank, before opening and closing.

Further objects are to provide a self-cleaning valve which is partially self-grinding; which tends to roll foreign objects out of the valve seats, pulverizes and allows washing out of scale which is the main cause of improper sealing; which is forced by its mechanism positively to its seat after pulverizing action, and which allows the controlling mechanism to be installed either in the bottom of the shell of the tank car or within the dome on top of the shell.

Briefly, the valve member according to the present invention is adapted to cooperate with a valve seat member having an annular, usually bevelled, seating surface faced toward the inside of the tank. The valve member is connected to the end of a valve stem which is mounted for reciprocating or axial motion and for rotary motion; the valve member is so connected as to have limited axial movement with respect to the valve stem and to rotate together with the valve stem and resilient means, such as a coil spring, which are arranged to urge the valve member away from the valve stem and toward the seat member. Abutment means on the valve member and on the valve stem are located to come into engagement to force the valve member positively against the seat member at the end of the axial movement of the valve stem, after the resilient means has been at least partially compressed. Outward movement of the valve member from the valve stem is limited by suitable means, such as a shoulder or lift pin, which serves also to lift the valve member from its seat after partial relaxation of the resilient means when the valve stem is retracted.

As a result of the construction indicated above, when the valve stem is advanced toward the seat member the valve member will engage the seat member at first only under the comparatively light force of the resilient means. As the valve stem is then rotated the valve member may be rotated on its seat, thereby rolling out foreign matter without forcing the mounds of crushed solids deeply into the seating surfaces. In the

usual case the valve stem is advanced downwardly simultaneously with rotation thereof, with a helical motion (such as would result from a threaded valve stem support on a valve bonnet or other internally threaded bushing). In this case it is only after the valve member has completed one or more revolutions on its seat (with concomitant compression of the resilient means and advancement of the valve stem) that the abutment members come into engagement and positively force the valve to its seat or effecting the final closure of the valve. It is evident that the invention is not limited to use with valve stems which advance toward the valve seat while rotating, and that the valve stem may be actuated in any suitable manner, e. g., successively rotated and given axial movement. When installed in tank cars, for example, the valve stem may be actuated by any of the accepted mechanisms, known per se, for moving the vertical valve stem extending through the height of the car and into the dome thereof, such as external handwheels, worm drives, ratchets, etc.

The invention will be described in detail by reference to the accompanying drawings forming a part of this specification and illustrating three specific embodiments thereof by way of illustration. In the drawing:

Fig. 1 is a vertical longitudinal sectional view of a tank car, partly in elevation showing the installation of the valve;

Fig. 2 is a vertical sectional view of the valve structure according to a first embodiment taken transversely to the tank car;

Fig. 3 is a horizontal sectional view taken on line 3—3 of Fig. 2;

Fig. 4 is a vertical sectional view of a second embodiment;

Fig. 5 is a vertical sectional view of a third embodiment; and

Figs. 6 and 7 are horizontal sectional views taken on lines 6—6 and 7—7 respectively, of Fig. 5.

Referring to Figs. 1–3, the valve may be installed at the bottom of a tank 10, such as the tank of a conventional railroad tank car having a dome 11 and locking ratchet mechanism 12 comprising a conventional ratchet wheel and a cam or pawl, accessible when the dome cover is removed, for locking a valve stem 13 against rotary motion. The stem carries a handwheel 13a by which the stem may be turned to actuate the valve 14. The latter is disposed at the top of an outlet tube 15 extending out of the bottom of the tank.

As is indicated in Fig. 2, the tube 15 has a valve seat member 16 presenting an annular, upwardly directed, bevelled seating surface. Cooperating therewith is a valve member 17 having a frusto-conical seating surface matching the seat on the member 16 and having a valve stem guide 18 extending upwardly therefrom, i. e., away from the valve seat member. The valve stem guide may be formed integrally with the valve member, or may be formed separately and connected thereto in any suitable manner; in the present specification and claims it is referred to as a part of the valve member.

The valve guide stem is of non-circular, viz., polygonal shape, a rectangular shape having been indicated in Fig. 2. It is telescopically mounted with respect to the valve stem so as to have limited relative axial movement but to transmit torque by virtue of its non-circular shape. It is evident that the valve guide stem 18 or the valve stem 13 may be male or female members. In the illustrated embodiment both stems are male members and have rectangular cross-sectional shapes at their near ends. A sleeve 19, which may be made of one piece, as shown, or of several pieces as indicated in the embodiment shown in Figs. 5 to 7, encloses the ends of the stems and is axially slidable with respect to at least one of the stems. In the instant embodiment the sleeve is slidable with respect to the valve guide stem 18 and secured to the valve stem by means of bolts 20. The sleeve has rounded edges at the bottom to reduce friction against the valve guide stem 18. Immediately above the sleeve the valve stem is enlarged to provide an externally threaded portion having threaded engagement with a bushing 21 supported by means of supports 22 welded to the tank wall. It will be understood that the valve stem is journalled at the top within the ratchet mechanism 12, and that this, together with the bushing 21, provide means for supporting the valve stem and permitting axial and rotary movement.

The valve member 17 is urged away from the valve stem 13 by means of a coil spring 23 engaging an annular groove forming a spring abutment at the bottom of the sleeve 19 and an abutment 25 at the top of the valve member. Outward movement of the valve member is restrained by a shoulder or lift pin 26 attached to one of the axially movable members and running in a slot in the other of these members, it being understood that the stem 18 and sleeve 19 are the members referred to. Thus, the pin may be given a drive fit within a transverse hole in the guide stem 18 and run within a vertical slot 27 in the side wall of the sleeve. The lower end of the slot 27 forms a lift pin abutment, limiting the downward travel of the pin with respect to the sleeve 19 and acting to lift the pin, and with it, the valve member from its seat when the valve stem is retracted. The slot 27 is preferably made wide enough to prevent engagement of the pin 26 with the slot edges to prevent transmission of torque through the pin, the torque being preferably transmitted entirely by the sleeve directly to the guide stem.

For forcing the valve member positively against its seat there are abutments on (i. e., forming a part of or attached to) the valve stem and valve member. In the illustrated embodiment the lower end 28 of the valve stem and the upper end 29 of the valve guide stem form the abutments and may be shaped spherically as shown to permit full contact regardless of minor angular displacements. The slot 27 is made sufficiently long to prevent engagement of the pin with the upper end of the slot. Hence, the ends of the stems 13 and 18 will come into engagement to transmit the downward thrust from the bushing 21 and lower portion of the valve stem 13 directly to the valve member through its guide stem 18.

It will be noted from the foregoing construction that the lift pin preferably transmits neither torque nor axial thrust toward the valve seat, and that it functions merely to lift the valve member from its seat; it is, therefore, subjected to a force only slightly greater than that imposed by the spring 23, insuring dependable functioning of the valve.

A port 30 may be formed in the wall of the sleeve 19 near the top to prevent trapping fluid within the rectangular bore when the sleeve is sealed to the valve stem 13, but may be omitted when other fluid escape means are present, e. g.,

when the valve guide stem 18 fits loosely within the sleeve, as shown in the drawing. Upward travel of the valve stem 13 may, optionally, be limited by a stop member 31 secured to the valve stem to engage the bottom of the bushing 21.

It is desirable that the valve member 17 have some free seating ability. For this purpose the surfaces of the valve stem guide 18 and the sleeve 19 should be dressed for a slight lost motion and for smooth, free telescopic movement. This will hold the valve in line with its seat but still permit some free movement to insure proper seating. It should, further, be noted that the ends of the spring 23 are preferably flattened, as shown, whereby the valve is given a straight downward thrust; this thrust will not interfere with some free seating. In most installations it is undesirable to have guide vanes or other structural parts beneath the valve member 17 (such, for example, as the vanes 32 shown in the embodiment according to Figs. 5–7) because they hinder the insertion of the wooden blocks which are customarily inserted into the outlet leg 15 in the case of tank cars to absorb the pressure due to freezing for preventing cracking of the outlet leg when water from condensation or other external sources freezes; and because such structural parts, extending into the leg, may prevent operation of the valve when moisture within the leg freezes into a solid plug. However, the invention is applicable to cases where such guide vanes are used.

The operation of the valve is as follows: The valve being initially clear of its seat, the operator turns the valve stem 13 by means of the wheel 13*a*, thereby advancing the valve stem through the bushing 21 toward its seat; all movable parts are rotating together during this phase, and the pin 26 is at the bottom of the slot 27. When the parts have been advanced to the position shown in Fig. 2 the valve member 17 first contacts the valve seat. As the operator continues rotation, the spring 23 is progressively compressed and the valve is rotated on its seat; simultaneously, the valve stem 13 and sleeve 19 descend, causing the pin 26 to move upwardly within its slot with respect to the sleeve. If scale has lodged under the valve, this rotary movement under spring pressure should be a backward and forward or reciprocating movement, as in valve grinding, thereby pulverizing scale which will then wash out. If desired, valve grinding compound can be applied to the valve seat and the valve reground without removal from the car.

As rotation is continued the abutments 28 and 29 come into engagement, thereby positively forcing the valve member 17 against its seat. This insures solid contact, the force being transmitted from the bushing 21 through the abutments to the valve member and seat member, thereby preventing even hard jars from unseating the valve. The locking ratchet 12 prevents reverse rotation of the stem 13.

When the valve is to be opened the ratchet mechanism 12 is unlatched and the stem 13 is rotated in the opposite direction; the valve member will rotate while remaining on its seat until the lift pin 26 engages the lift pin abutment, i. e., the bottom of slot 27. Continued rotation will then lift the valve member from its seat.

The number of revolutions that the valve member makes on its seat under spring tension is determined by the pitch of the threads in the bushing 21 in relation to the vertical distance between the abutments 28 and 29 when the lift pin is at the bottom of the slot 27. It is preferred to provide for one complete revolution of the valve member under spring tension, but this may, of course, be varied, e. g., by providing for less than a whole turn or for several complete revolutions.

In the modified embodiment shown in Fig. 4 similar parts bear the same reference numbers as in Figs. 2 and 3. In this case the sleeve 19 is fixed to the valve guide stem 18 and is axially movable with respect to the valve stem 13. The pin 26 is fitted tightly within the stem 13 and extends into the slot 27 in the sleeve; in this case the lift pin abutment is at the top of the slot 27, and the slot extends far enough down to prevent engagement of the pin with the bottom of the slot when the abutments 28 and 29 are moved into engagement. The coil spring 23 extends the entire height of the sleeve assembly and abuts a collar 33 which limits the upward movement of the valve. The valve according to this embodiment may be readily disassembled by merely driving out the pin 26 and removing the valve stem 13 upwardly through the bushing 21.

In the modified embodiment shown in Figs. 5–7, the sleeve is formed integrally with the valve stem 13 by bifurcating the end of the stem. Side cover plates 35 and 36 are fastened to the bifurcated ends of the stem, thereby providing a bore of rectangular cross-section for receiving the valve guide stem 18. The slot 27 is, in this embodiment, preferably formed in the side plates 35 and 36 so as not to weaken the bifurcated ends of the stem 13, which, during the final closing movement of the valve, abut an annular boss 37 surrounding the guide stem 18 and formed integrally with the valve member; the top of the guide stem 18 does not act as an abutment and the stem 18 may, therefore, be made of lighter material than in the previous embodiments. The spring 23 abuts a shoulder 38 on the part of the valve stem 13 below the slot. The valve member 17 is provided with radial guide vanes 32, which may be long enough to remain within the tube 15 when the valve member is fully lifted.

With the differences noted above, the operation of the devices according to Figs. 4 to 7 is the same as that previously described.

I claim as my invention:

1. In a self-cleaning valve, the combination of a valve stem adapted for axial and rotary motions having a non-circular end; a valve member adapted to engage a seat member having an annular seating surface and disposed beyond the said end of the valve stem; a valve guide stem fixed on the valve member toward the valve stem and substantially coaxial therewith, at least the end of said valve guide stem being non-circular; a sleeve enclosing said non-circular portions of said stems and having engagement therewith to transmit torque from the valve stem to the valve guide stem, at least one of said stems being axially slidable within the sleeve to permit axial motion between said stems; resilient means for urging the valve member away from the valve stem; abutment means operative to transmit axial thrust from said valve stem to said valve member after at least partial compression of said resilient means; and means independent of said abutment means for limiting the axial movement of the valve member away from the valve stem, whereby the valve member may be lifted from the seat member when the valve stem is retracted.

2. The combination according to claim 1 wherein the other of said stems is secured to the sleeve and the said abutment means are the ends of the stems within the sleeve.

3. The combination according to claim 2 wherein the sleeve is provided with a longitudinal slot having a lift pin abutment at one end of the slot, and the said means limiting the axial movement of the valve member comprises a lift pin fixed to the stem which is axially slidable within the sleeve and extending into said slot.

4. A self-cleaning discharge valve for tanks and the like comprising a seat member at the tank outlet having an annular seating surface facing toward the interior of the tank; a cooperating valve member having a matching seating surface and a valve guide stem extending away from the seating surface; a valve stem mounted for axial and rotary motions; torque transmitting means connecting the valve stem to the valve guide stem permitting limited axial movement between said stems and transmitting rotary motion from the valve stem to the valve member, said torque transmitting means comprising a sleeve on one of said stems fitting telescopically over the other stem with a sliding fit, the engaging surfaces of the sleeve and said other stem being non-circular in cross-section; resilient means for urging said valve member away from the valve stem and toward said seat member; abutment means on said valve stem and valve member positioned to engage each other after at least partial compression of said resilient means subsequent to the seating of said valve member on the seat member to urge the valve member positively against said seat member; and means connected between said valve stem and valve member for lifting the valve member from its seat after partial retraction of the valve stem from said seat member.

5. A self-cleaning discharge valve for tanks and the like comprising a seat member at the tank outlet having an annular seating surface facing toward the interior of the tank; a cooperating valve member having a matching seating surface and the valve guide stem extending away from the seating surface; a valve stem mounted for axial and rotary motions; torque transmitting means connecting the valve stem to the valve guide stem permitting limited axial movement between said stems and transmitting rotary motion from the valve stem to the valve member, said torque transmitting means comprising a sleeve on one of the said stems fitting telescopically over the other stem with a sliding fit, the engaging surfaces of the sleeve and said other stem being non-circular in cross-section; said sleeve being separate from both of said stems having ends of non-circular cross-section; resilient means for urging said valve member away from the valve stem and toward said seat member; abutment means on said valve stem and valve member positioned to engage each other after at least partial compression of said resilient means subsequent to the seating of said valve member on the seat member to urge the valve member positively against said seat member; and means connected between said valve stem and valve member for lifting the valve member from its seat after partial retraction of the valve stem from said seat member.

6. A self-cleaning discharge valve for tanks and the like comprising a seat member at the tank outlet having an annular seating surface facing toward the interior of the tank; a cooperating valve member having a matching seating surface and a valve guide stem extending away from the seating surface; a valve stem mounted for axial and rotary motions; torque transmitting means connecting the valve stem to the valve guide stem permitting limited axial movement between said stems and transmitting rotary motion from the valve stem to the valve member; resilient means for urging said valve member away from the valve stem and toward said seat member; abutment means formed by the ends of the valve stem and the valve guide stem engaging each other after at least partial compression of said resilient means subsequent to the seating of said valve member on the seat member to urge the valve member positively against said seat member; and means connected between said valve stem and valve member for lifting the valve member from its seat after partial retraction of the valve stem from said seat member.

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