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MECHANICAL VENT FOR TANKS

Filed April 15, 1964

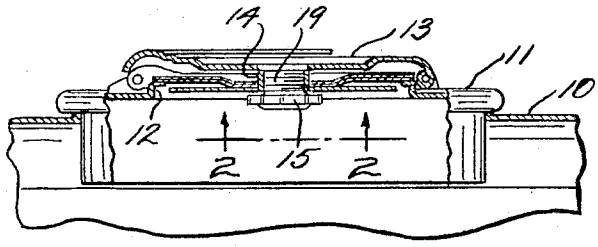


FIG. 1

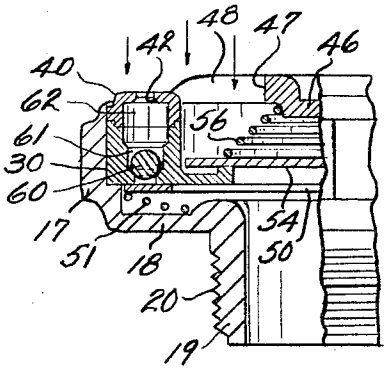


FIG. 5

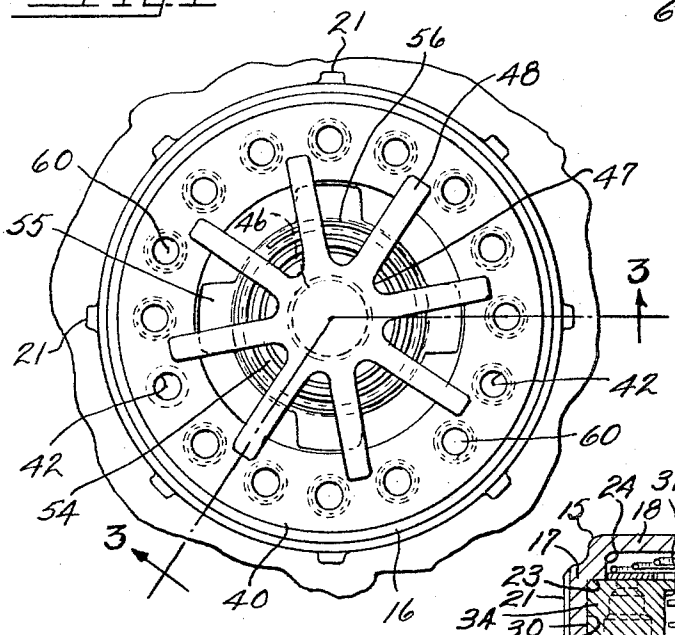


FIG. 2

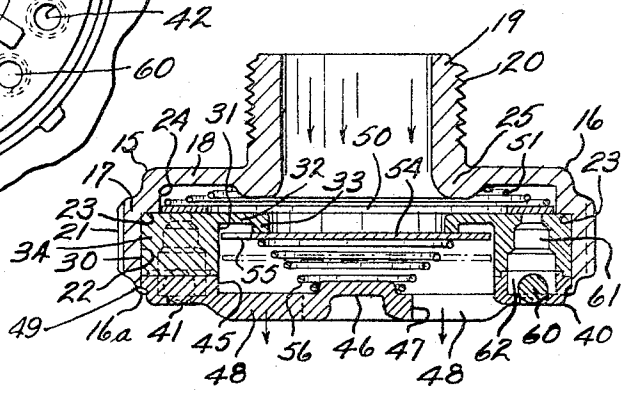


FIG. 3

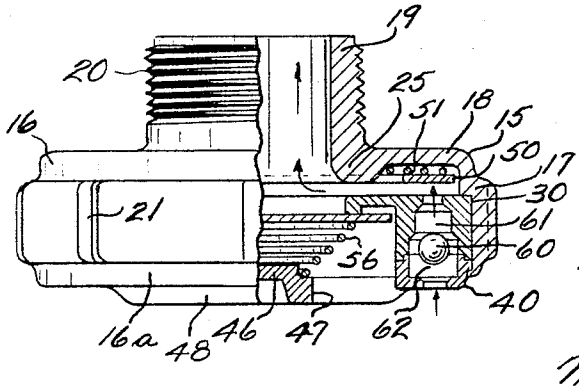


FIG. 4

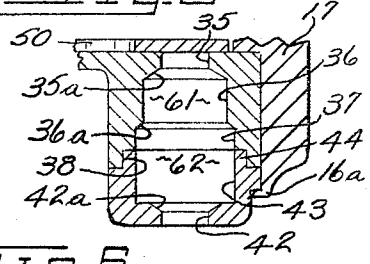


FIG. 6

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MECHANICAL VENT FOR TANKS

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This invention relates to vent mechanisms and particularly to a mechanical vent adapted for use with mobile tanks such as gasoline transportation tanks. The vent is adapted to be mounted in the manhole cover of a tank for venting the tank and preventing spillage if the tank is overturned.

It is an object of this invention to provide a novel and improved mechanical vent of the above type which automatically vents air into the tank with which it is associated to replace liquid removed from the tank.

Another object of the invention is to provide a mechanical vent having the above characteristics which automatically exhausts from the tank pressurized vapors which are caused by expansion or evaporation of the contents of the tank.

Still another object is to provide such a mechanical vent which automatically checks the outward flow of liquid if the tank overturns.

Yet another object is to provide a mechanical vent having the above features which is capable of exhausting vapors at a pressure which is higher than that possible with conventional tank vents.

A further object is to provide a mechanical vent as set forth above incorporating a ball check means which automatically closes to check spillage if the tank overturns but which will not close during normal exhausting of vapors where the pressure differential on either side of the vent is as much as 3 p.s.i.

Other objects of the present invention and a number of its advantages will be evident from the following description of one embodiment of the invention, illustrated in the accompanying drawings in which:

FIG. 1 is a fragmentary section through a tank showing a manhole cover therefor in partial section and the mechanical vent of this invention carried by said manhole cover;

FIG. 2 is an enlarged, bottom plan view of the vent as seen from the line 2—2 of FIG. 1;

FIG. 3 is a section taken along the line 3—3 of FIG. 2 showing the check balls in the normal position;

FIG. 4 is a side elevation of the vent partially sectioned showing a check ball in the unseated position;

FIG. 5 is a fragmentary detail of the vent partially sectioned and in the inverted position; and

FIG. 6 is an enlarged sectional detail of an exhaust flow control cavity alone of the mechanical vent of this invention.

Referring now to FIG. 1 of the drawings, 10 represents a fragmentary portion of the top wall of a gasoline transportation tank of a type carried by a gasoline truck, said tank having a manhole housing 11 mounted in an upper wall portion thereof. The tank and manhole housing are formed of sheet metal with the housing 11 being circular in shape and welded to the tank 10. The housing 11 has an annular collar 12 upon which is seated a hinged manhole cover 13. A description of the details of the manhole housing and manhole cover is not necessary to the understanding of the present invention; however, said housing and cover are fully described in my patent No. 2,783,913 issued March 5, 1957 and entitled, Manhole Cover Attaching Means.

The manhole cover 13 has a centrally disposed, axially vertical, internally threaded socket 14 which defines an opening through said cover and is adapted to receive a mechanical vent 15 of this invention. Referring now to

FIGS. 3 and 6, the vent 15 has a cup-shape housing 16 comprising a vertically disposed, circumferential wall 17, an upper horizontal wall 18, and a centrally disposed, upstanding collar 19. The collar 19 is externally threaded as indicated at 20 whereby it is adapted to be thread fitted upwardly into the socket 14 of the manhole cover 13. Circumferentially evenly disposed, vertically directed bosses 21 are provided on the outer peripheral surface of the wall 17 to facilitate handling and turning of the housing for insertion of the collar thereof into the socket 14.

The circumferential wall 17 is interiorly, diametrically outwardly stepped by means of a counterbore 22 thereby affording a downwardly facing shoulder 23 and a diametrically reduced bore portion 24 disposed just above said shoulder. An annular boss 25 projects downwardly below the upper wall 18 adjacent to the lower end of the collar 19.

The counterbore 22 is adapted to receive an upper retainer ring 30 which seats upwardly against the circumferential shoulder 23. Said retainer ring has a central bore 31 and an annular horizontal wall 32 which projects radially inwardly at the upper end of said retaining ring. A downwardly projecting, circumferentially continuous flange 33 is provided at the inner periphery of the annular wall 32. The upper retainer ring 30 comprises a circumferential wall 34 of substantial dimension or thickness in a radial direction. The wall 34 is provided with a plurality of circumferentially evenly spaced, upwardly opening ports 35 each of which has an annular, beveled seat 35*a* at its lower end intersecting a coaxial first counterbore 36 disposed therebelow. Each said first counterbore has a downwardly diverging, frusto-conical end portion 36*a* intersecting a coaxial second counterbore 37 which, in turn, intersects a third counterbore 38.

A lower retainer ring is provided at 40 which has a circumferential wall 41 having the same horizontal dimensions as the wall 34 of the upper retainer ring 30. Said lower retainer ring has a plurality of ports 42 of the same number and size as the ports 35 and registering vertically with the latter ports. The ports 42 open at the bottom surface of the circumferential wall 41, and each said port has an annular, beveled seat 42*a* at its upper end intersecting a counterbore 43 disposed thereabove. The upper ends of the counterbores 43 are surrounded by collars 44 which are adapted to closely and slidably interfit the counterbores 38 of the upper retaining ring whereby the counterbores 36, 37 and 43 and the ports 35 and 42 are positioned and held in vertical alignment. The lower retainer ring 40 has a central bore 45 having the same diameter as the central bore 31 of the upper retainer ring 30. Said lower retainer ring also has a web 47 at its lower end having an upwardly projecting, centrally disposed protuberance 46. The web is connected to the circumferential wall 41 by a plurality of radiating arms 48. The outer surface of the lower retainer ring 40 has a downwardly facing, annular step 49, and the lower end of the housing 16 has a thin, annular collar 16*a* which is swaged over said step to secure both retainer rings within the counterbore 22. Said lower retainer ring, the upper retainer ring, and the housing may be made of any suitable, rigid material and in the form shown are each integrally formed as a die casting.

The circumferentially disposed ports 35 of the upper retainer ring 30 are normally closed by an exhaust ring 50 which is of such diameter as to cover all of said ports and fit loosely within the upper bore portion 24 of the housing 16. Said exhaust ring is biased downwardly against the upper surface of the circumferential wall 34 by a conical coil spring 51. The lower, larger end of said spring bears against the upper surface of the exhaust ring 50, and the upper, smaller end thereof seats

around the annular boss 25. The coil spring 51 may be made of stainless steel or brass and exerts a very slight downward pressure against the exhaust ring.

Thme opening defined by the flange 33 of the upper retainer ring 30 is closed from the bottom by an intake disk 54 having radiating arms 55. The radiating arms 55 are disposed in diametrically opposite pairs and the distance across each pair of arms is slightly less than the diameter of the central bore 31 of the upper retainer ring 30 whereby said intake disk fits loosely within said central bore. The central portion of the intake disk, not including the arms 55, is of sufficient diameter to completely close the passageway defined by the flange 33, and said intake disk is biased upwardly against said flange by a conical coil spring 56 the upper end of which bears against said intake disk and the lower, smaller end of which is seated around the protuberance 46. The spring 56, like the spring 51, may be made of stainless steel or brass and exerts a very light upward pressure against said intake disk.

A check ball 60 is normally disposed within each cavity formed by the counterbores 37 and 43 of the retainer rings 30 and 40 respectively. Said check balls are larger in diameter than the ports 35 and 42, but smaller than any of the counterbores 36, 37 or 43 whereby said check balls are captively held between and within the retainer rings. For convenience of description, the first counterbore 36 will hereinafter be referred to as the upper chamber 61 and the aligned counterbores 37 and 43 will hereinafter be referred to as the lower chamber 62 (FIGS. 4 or 5). The check balls 60 can move freely through the upper chambers 61 to close off the upper ports 35, but they normally close off the lower ports 42, the force of gravity causing the balls to drop to the bottoms of the chambers 62.

From the foregoing it will be understood that the normal position of the mechanical vent of this invention is that illustrated in FIGS. 1, 3 and 4 wherein the collar 19 of the housing 16 is directed upwardly and the check balls 60 are held by gravity seated over the ports 42. If the vapors within the tank 10 become pressurized due to expansion or evaporation within the tank, said vapors will be exhausted through the ports 42, the chambers 62 and 61, the ports 35, and the collar 19. The pressurized vapors will first displace the check balls 60 whereby the pressure inside the chambers 61 and 62 will also increase. When the chambers 61 and 62 are sufficiently pressurized, the exhaust ring 50 will move upwardly against the coil spring 51 whereby the vapors can escape into the housing 16 above the intake disk 54 and thus be exhausted through the collar 19. Since the exhaust ring 50 is held over the ports 35 with only a very slight pressure, the interior of the tank 10 is vented when the pressure therein rises only slightly.

If the pressure inside the tank 10 drops even a small amount due, for example, to removal of liquid from the tank, the intake disk 54 moves downwardly away from the flange 33 against the bias of the coil spring 56 to equalize the pressure between the outside and the inside of the tank. The springs 51 and 56, in the form of the invention shown, are adapted to allow opening of the exhaust ring 50 or the intake disk 54 if the pressure differential on either side of the vent mechanism exceeds approximately two ounces.

Referring now to FIG. 5, if the tank is accidentally overturned whereby the vent 15 becomes inverted or nearly so, the liquid inside the tank will attempt to flow outwardly through said vent. The intake disk 54 will be even more firmly pressed against the flange 33 thereby preventing escape of the liquid through the center of the upper retainer ring 30. At the same time, the check balls 60 will drop by the force of gravity from the chambers 62 into the chambers 61 whereby they will cover the ports 35. The liquid will then be retained within the tank since the pressure of said liquid will hold both the intake disk 54 and the check balls 60 in the positions illustrated in FIG. 5.

Ordinarily, the maximum differential pressures across the vent are quite low and amount to merely a few ounces. However, due to the surging of the gasoline or other liquid within the tank, the vent may sometimes be subjected momentarily to exhaust pressures of a pound or more. In such instances, the check balls 60 will be moved a substantial distance away from the ports 42 in the direction of the ports 35. It has been found in use of a cavity of the design herein disclosed and illustrated that the check balls 60 will remain suspended within the cavity formed by the chambers 61 and 62 and will not become entrained with outrushing fluid at pressures at least up to 3 p.s.i. In other words, the ball check arrangements shown will continue to function and the check balls will not become entrained at pressures substantially in excess of those ordinarily to be anticipated in use of a tank of the type described.

If, due to a surging action of the liquid within the tank 10, the liquid itself becomes entrained with the vapors, the sudden reduction in the velocity of the vapors which takes place at the collar 19 will cause the entrained liquid to settle out and return to the tank through the opening defined by the flange 33 of the upper retainer ring 30. A very slight accumulation of liquid on the intake disk 54 will displace said disk thereby allowing the liquid to flow through the vent and back into the tank. It should be further noted at this point that the opening through the upper retainer ring 30 is quite large, exceeding the inner diameter of the collar 19 in the form illustrated. It should also be noted that the intake path is quite direct as opposed to the more tortuous exhaust paths. The result is that the vent of this invention has the capacity to pass a large volume of air into the tank when needed but substantially inhibits an outward flow of surging liquid.

It is applicant's belief that the check balls 60 do not become entrained in exhausting vapors up to at least 3 p.s.i., with the consequent shutting off of the ports 35, due to the configuration of the cavities provided by the chambers 61 and 62. When liquid or gas flows in a confined passage, producing a static pressure within the moving current, this pressure decreases as the velocity of the current increases, for example in areas where the passage is constricted. I have utilized this principle in controlling the action of the check ball 60 with relation to the inner contour of the chamber in which the ball is confined.

It is applicant's theory that when pressure begins to build up in the tank it will first merely slightly dislodge the check ball 60 and vent itself into chambers 61 and 62. Eventually the pressure will reach a value sufficient to dislodge plate 50. There will then be a momentary upward rush by vapor between ball 60 and its lowermost seat 42*a*, and consequently a higher velocity of gaseous stream through the restricted passage around and below the ball as compared with a lower velocity in the enlarged portion of the chamber above the ball. The pressure therefore is lowest in said restricted passage. Augmented by the weight of the ball, and the relatively higher pressure above the ball, the resultant forces acting on the ball tend to move it in the direction of lowest pressure, namely downwardly, so that while an ordinarily entraining pressure continues the ball will float in the gaseous stream at some equilibrium level, but it will drop to its seat when and if the gaseous pressure drops sufficiently within the tank. This scientific principle of a decrease in pressure accompanying an increase in velocity in a confined stream has previously been recognized, but has not previously been utilized in the provision of novel internal contours for a ball vent chamber, as far as is known to me. The present structure permits venting of any pressure in excess of the bias of spring 51 up to at least 3 p.s.i. without blocking the vent escape passage 35

above the ball. Of course if the tank overturns, the ball **60** will then drop by gravity to block passage **35** and prevent liquid outflow.

Applicant concludes that, taking into consideration the normal pull of gravity on the check ball **60**, the illustrated configuration of the chambers **61** and **62** effects a substantially equal pressure on both the top and bottom of the check ball thereby permitting a flow of vapors through the cavities without the ball becoming entrained up to at least 3 p.s.i. pressure within the tank **10**. In offering the above theory of operation, the applicant in no way intends to limit the scope of the present invention.

Excellent results have been obtained by providing each cavity in the retainer rings **30** and **40** with an upper chamber **61** which is .312" in diameter and a lower chamber **62** which is .375" in diameter. The port **35** is .187" in diameter and has an axial dimension of .069" not including the beveled seat **35***a* which has an axial dimension of .036". The port **42** also has a diameter of .187" with an axial dimension of .050" not including the beveled seat **42***a* which has an axial dimension of .025". The upper chamber **61** has an axial dimension of .172" not including the bevel **36***a* which has an axial dimension of .018". The lower chamber **62** has an axial dimension of .290". All of the bevels **35***a*, **36***a* and **42***a* are 30° from the horizontal. The coil springs **51** and **56** are rated at two ounces loaded, and the check balls **60** are stainless steel having a diameter of .250". It will be understood that the above dimensions are given by way of illustration of one specific embodiment of the invention and as representative of proportions which, if substantially adhered to, will give satisfactory results and are not intended as a limitation of the invention. The present embodiment illustrates a use of sixteen of the above described ball check arrangements in a single vent, but it will be readily understood that the number may be varied.

It will be further understood that many changes in the details of the invention as herein described and illustrated may be made without, however, departing from the spirit thereof or the scope of the appended claims.

What is claimed is:

1. Vent means for mounting in a manhole cover of a tank; said vent means comprising means defining cavity means having ports at the top and bottom thereof; check ball means captively disposed in said cavity means and adapted to close off either of said ports by force of gravity; first spring biased valve means overlying and normally closing off the uppermost of said ports; means defining a separate passage through said vent means; and second spring biased valve means normally closing off said separate passage from the bottom thereof, whereby a pressure differential on either side of said vent means is substantially equalized either through said cavity means by unseating said check ball means and said first valve means or through said separate passage by unseating said second valve means, and whereby when said vent is inverted, said check ball means closes off the uppermost of said ports to prevent spillage from the tank.

2. A vent for mounting in the manhole cover of a tank; said vent comprising annular wall means having a centrally apertured, horizontal wall projecting radially inwardly from the upper end thereof; means defining at least one cavity in said wall means having ports at the top and bottom thereof; a check ball captively disposed in said cavity and adapted to close off either of said ports by force of gravity; a first spring biased valve member overlying and normally closing off the uppermost of said ports; means defining an annular valve seat carried by said horizontal wall and surrounding said central aperture; and a second spring biased valve member normally seated on said valve seat and closing off said central aperture from the bottom thereof whereby a pressure differential on either side of said vent is substantially equalized either through said cavity by unseating said check ball and said first valve member or through said central aperture by unseating said second valve member, and whereby when said vent is inverted, said check ball closes off the uppermost of said ports to prevent spillage from the tank.

3. A vent for mounting in the manhole cover of a tank; said vent comprising annular wall means having a centrally apertured, horizontal wall projecting inwardly from the upper end thereof; means defining a plurality of circumferentially spaced cavities in said wall means each having ports at the top and bottom thereof; a check ball captively disposed in each said cavity and adapted to close off either of said ports by force of gravity; an annular, spring biased exhaust valve member overlying and normally closing off the uppermost of said ports; means defining an annular valve seat carried by said horizontal wall and surrounding said central aperture; and a spring biased intake valve member normally seated on said valve seat and closing off said central aperture from the bottom thereof whereby a pressure differential on either side of said vent is substantially equalized either through said cavities by unseating said check balls and said exhaust valve member or through said central aperture by unseating said intake valve member, and whereby when said vent is inverted, said check balls close off the uppermost of said ports to prevent spillage from the tank.

4. A vent for mounting in a manhole cover of a tank; said vent comprising annular wall means having a centrally apertured, horizontal wall projecting inwardly from the upper end thereof; means defining a plurality of circumferentially spaced cavities in said wall means each having coaxial circular ports at the top and bottom thereof; each cavity comprising a large, cylindrical lower chamber and a relatively smaller, cylindrical upper chamber coaxial with said ports, said ports being of smaller diameter than said smaller chamber; a check ball of larger diameter than said ports and of smaller diameter than said upper chamber disposed within each said cavity and normally closing the lowermost associated port; an annular, spring biased exhaust valve member overlying and normally closing off the uppermost of said openings; means defining an annular valve seat carried by said horizontal wall and surrounding said central aperture; and a spring biased intake valve member normally seated on said valve seat and closing off said central aperture from the bottom thereof whereby a pressure differential on either side of said vent is substantially equalized either through said cavities by unseating said check balls and said exhaust valve member or through said central aperture by unseating said intake valve member, and whereby when said vent is inverted, said balls drop into said smaller chambers and close off the uppermost of said ports to prevent spillage from the tank.

5. A vent as set forth in claim **4**; each said port having a diameter substantially three-fourths the diameter of said check balls; each said lower chamber having a diameter substantially 1½ times the diameter of said check balls; each said upper chamber having a diameter substantially 1⅕ times the diameter of said check balls; and each said lower chamber having a vertical dimension in excess of the diameter of said check balls.

6. A mechanical vent comprising a cup-shape housing opening downwardly and having an upwardly directed, externally threaded collar for mounting to the inner side of a manhole cover; annular retainer means mounted within said housing comprising circumferential wall means; means providing a plurality of cavities in said wall means circumferentially evenly spaced around said wall means; each cavity comprising a cylindrical lower chamber and a relatively smaller, coaxial, cylindrical upper chamber joined by an annular beveled portion and disposed on a vertical axis; means defining like circular ports at the top and bottom of each said cavity coaxial with said chambers, said ports being of smaller diameter than said upper chamber; means defining a beveled seat

at each said port disposed inwardly of its associated chamber; a check ball of larger diameter than said ports and of smaller diameter than said upper chamber disposed within each said cavity and normally closing the lowermost of said ports; said retainer means having a central opening with a downwardly directed annular seat at the uppermost end thereof and perforated support means disposed across the lower end thereof below said annular seat; a ring member disposed upon said retainer means and closing the uppermost of said ports; a spring disposed within said housing and biasing said ring member downwardly against said retainer means; a disk covering said annular seat; and a coil spring disposed between said support means and said disk and biasing said disk against said annular seat whereby a pressure differential on either side of said vent is substantially equalized either through said cavities by unseating said check balls and said ring member or through said central opening by unseating said disk, and whereby when said vent is inverted, said check balls seat over the uppermost of said ports and prevent spillage through said vent.

7. A mechanical vent as set forth in claim **6**; each said port having a diameter substantially ¾ the diameter of said check balls; said large chamber having a diameter susbtantially 1½ times the diameter of said check balls; said smaller chamber having a diameter substantially 1⅛ times the diameter of said check balls; and each of said chambers having a vertical dimension in excess of the diameter of said check balls.

8. A mechanical vent as set forth in claim **7**; each

said beveled seat beveled at an angle of 30 degrees from the horizontal.

9. A mechanical vent as set forth in claim **6**; each said cavity having substantially the proportions of a cavity wherein said lower chamber is .375″ in diameter and .290″ along its axis, said upper chamber is .312″ in diameter and .172″ along its axis, said annular beveled portion is disposed at an angle of 30° from the horizontal, said top port being .187″ in diameter and .069″ along its axis with the beveled seat associated therewith being disposed at an angle of 30° from the horizontal and having an axial dimension of .036″, said bottom port being .187″ in diameter and .050″ along its axis with the beveled seat associated therewith being disposed at an angle of 30° from the horizontal and having an axial dimension of .025″, and with said check ball having a diameter of .250″.

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