Feb. 12, 1946. D. G. GRISWOLD 2,394,911

AUTOMATIC VACUUM BREAKER

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Fig. 1.

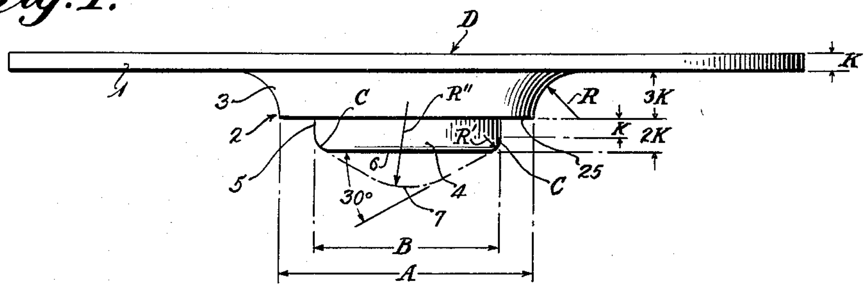


Fig. 2.

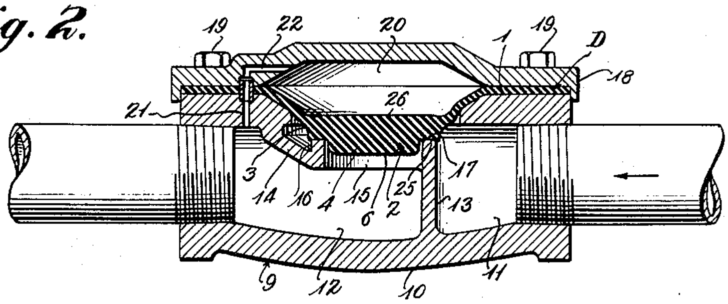


Fig. 3.

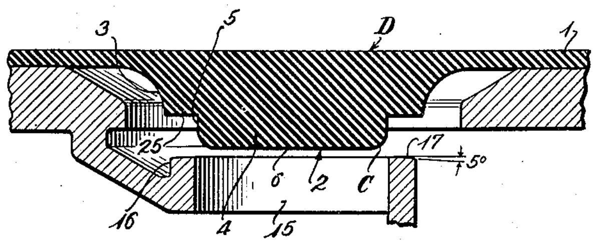


Fig. 4.

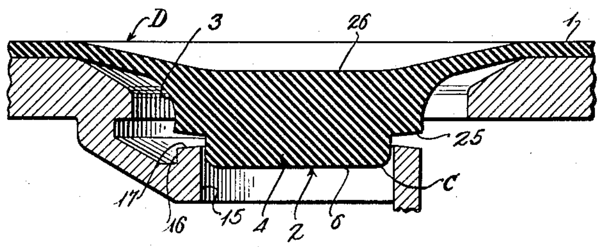
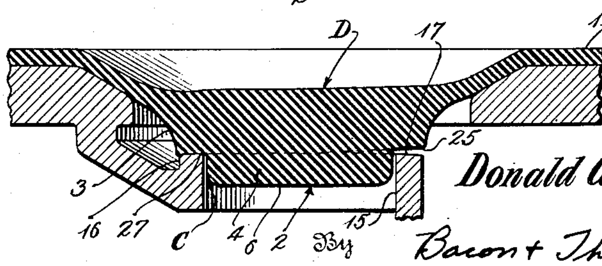


Fig. 5.



Inventor

Donald G. Griswold

By Bacon + Thomas

Attorneys

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Fig. 6.

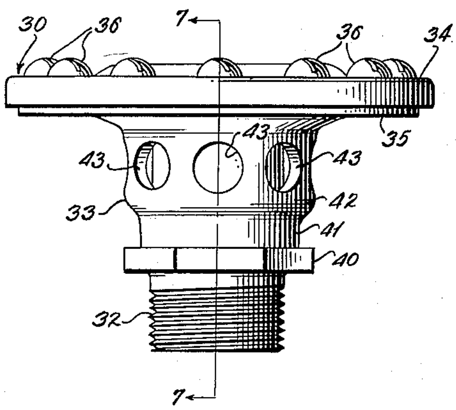


Fig. 7.

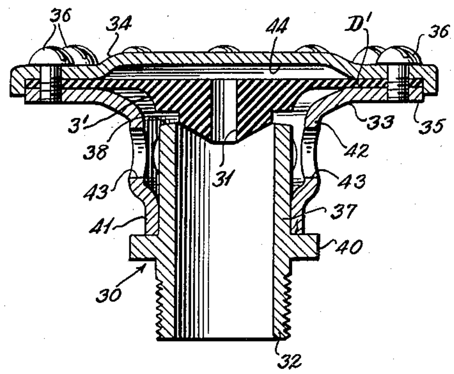


Fig. 8.

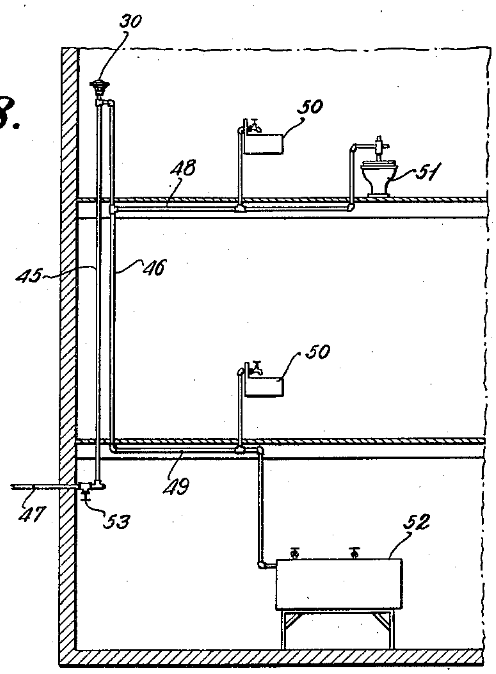
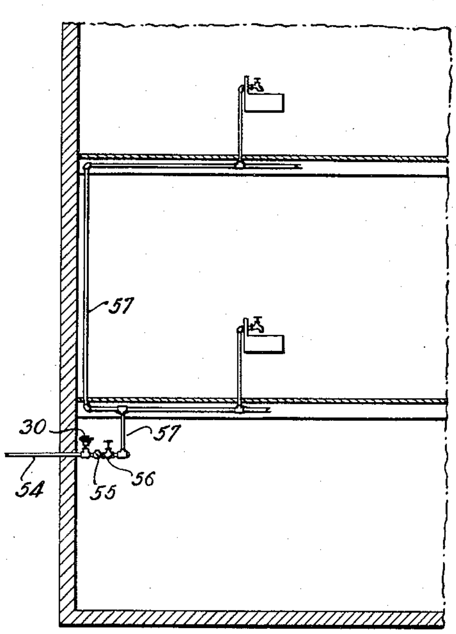


Fig. 9.



Inventor

Donald G. Griswold

By Bacon + Thomas

Attorneys

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UNITED STATES PATENT OFFICE

2,394,911

AUTOMATIC VACUUM BREAKER

Donald G. Griswold, Alhambra, Calif., assignor to Clayton Manufacturing Company, Alhambra, Calif., a corporation of California

Application September 9, 1943, Serial No. 501,701

4 Claims. (Cl. 137—153)

The present invention relates to a novel molded diaphragm structure adapted for general use in valves, siphon breakers, etc.

One of the novel features of the present diaphragm is that it includes a "button" integrally formed therewith of such shape and configuration as to cooperate with an annular seat to effect quiet sealing and thus eliminate the usual noise and chattering commonly encountered with conventional diaphragm structures.

Another feature of the diaphragm is that the body and button may be reinforced with fabric, if desired, and made of rubber or neoprene having a predetermined, desired Shore scleroscope hardness. In certain instances, the main body portion of the diaphragm may be made of neoprene or rubber of one hardness and the "button" of another hardness.

For the purpose of illustrating the adaptability of the present diaphragm for various uses, the same is disclosed herein in connection with an automatic check valve and with an automatic vacuum or siphon breaker. One of the principal advantages of the present diaphragm in valve structures is that it eliminates the usual valve stem, clamping plates, valve stem guides, etc., and, being devoid of the usual valve stem opening, it eliminates the difficulties encountered in conventional valves when used with, for example, high air pressures, because it prevents the air from infiltrating into and through the body of the diaphragm and causing leakage.

The principal object of the invention is to provide a molded diaphragm structure adapted for general use in valves, etc., wherein the diaphragm includes a portion which directly engages a seat and cooperates with said seat and the opening therein to produce quiet operation.

Another object of the invention is to provide an improved automatic vacuum or siphon breaker embodying the novel diaphragm of the present invention adapted to prevent contamination or pollution of water supply systems.

Other objects and advantages of the invention will be apparent from the following description, taken in conjunction with the accompanying drawings, in which:

Figure 1 is an enlarged elevational view of a diaphragm constructed in accordance with the principles of the invention;

Figure 2 is a longitudinal sectional view through an automatic check valve containing a diaphragm such as shown in Figure 1;

Figures 3, 4 and 5 are diagrammatic views illustrating the novel coaction between the diaphragm button and an annular seat during the downward flexing of the diaphragm, and whereby chattering, squealing and other noises incident to closing are eliminated;

Figure 6 is an elevational view of an automatic siphon breaker including a diaphragm embodying the principles of the present invention;

Figure 7 is a transverse sectional view taken on the line 7—7 of Figure 6;

Figure 8 is a diagrammatic view illustrating the manner in which the siphon breaker shown in Figures 6 and 7 may be installed in a pipe system of a house or other building to prevent back-siphoning; and

Figure 9 is a view similar to Figure 8 but showing a modified piping installation.

Referring now to Fig. 1, the diaphragm is generally indicated by the letter D and includes a circular body portion 1 provided with a relatively thick, integral, central button 2 consisting of circular boss 3 and a circular protuberance or mound 4 formed upon said boss. The thickness of the body portion 1 is indicated by the letter K and the thickness of the boss 3 is indicated by the dimension 3K inasmuch as said boss is approximately three times as thick as the body portion 1. The periphery of the boss 3 is merged with the body portion 1 along an arc defined by a radius R which is equal to 3K, the axial thickness of said boss. The protuberance or mound 4 is indicated as having a thickness 2K; that is, about twice as thick as the body portion 1. Half the height of the mound 4, indicated by the dimension K, constitutes a cylindrical portion 5, whereas the remainder of the periphery of the mound 4 is curved upon an arc C having a radius R′ equal to the dimension K. The lower side of the mound 4 is flat as indicated at 6, but instead of being made flat, certain advantages in flow can be obtained if the arc R′ at the corner of the mound is merged into tangents extending at an angle of about 30° to the horizontal as indicated by the dot-and-dash lines, so that the mound then takes the form of a flat cone 7 having a rounded peak struck on a radius R″ equal to about five times the thickness K.

The diaphragm D may be made of rubber but is preferably made of neoprene having a Shore scleroscope hardness of 60 to 80. Neoprene is preferred to rubber because it will not stick to a brass seat, whereas, rubber as it ages, has a tendency to do so. The body 1, and the button 2 may be reinforced with laminated fabric (not shown) if desired, in order to add strength thereto. For certain small valves, the body portion

1 and the button 2 will both be made of a hardness of 60, as measured by the Shore scleroscope. For larger types of valves, the body 1 will have a hardness of about 60 and the button 2 will have a hardness of about 80. Of course, the body 1 may be made of a hardness ranging from 60 to 80, as may also the button 2. The foregoing range of Shore scleroscope hardness of 60 to 80 provides a diaphragm structure of the desired flexibility conducive to the mode of coaction with a cooperating seat described hereinafter.

Figure 2 shows the manner in which the diaphragm D may be incorporated in an automatic check valve. The check valve is generally indicated by the numeral 9 and includes a body 10 having an inlet opening 11 and an outlet opening 12 separated by a partition wall including a vertical portion 13 and an inclined wall portion 14 which are merged to provide a circular opening 15 between the chambers 11 and 12. The opening 15 is surrounded by an upwardly projecting flange 16, the upper annular surface 17 of which forms a seat cooperable with the button 2 of the diaphragm D. The surface 17 may be made flat, but better results are obtained if the same is slightly inclined downwardly and outwardly on an angle of about 5° to the horizontal, as shown in Fig. 3.

The diaphragm D is disposed between the valve body 10 and a cover plate 18 secured to the body by a suitable number of machine screws 19. The cover 18 is dished to provide a pressure chamber 20 above the diaphragm 1. Communication between the outlet opening 12 and the diaphragm pressure chamber 20 is established by a passageway 21 in the valve body 10, which communicates with a passageway 22 in the cover 18 opening into the pressure chamber 20. It will be apparent that, as the pressure builds up on the outlet side 12 of the valve 9, such pressure will be communicated through the passageways 21 and 22 to the pressure chamber 20 and cause downward flexing of the diaphragm 1 to cut off flow between the chambers 11 and 12. In this manner, the check valve 9 automatically closes in response to changes in pressure in the outlet chamber 12. It will also be apparent that, as the pressure drops in the outlet chamber 12, the diaphragm D will be raised from its seat 17 by the pressure in the inlet chamber 11, and raising of the diaphragm will cause the fluid in the pressure chamber 20 to be forced out of said chamber through the passageways 22 and 21 back into the outlet chamber 12, to eventually permit full opening of the valve.

The mound 4 has a diameter indicated by the letter B, which for a 1½″ valve is about 0.02 to 0.03 of an inch less than the diameter of the seat opening 15. The diameter of the lower face 25 of the boss 3 is indicated by the dimension A and preferably is slightly larger than the outside diameter of the seat 17.

The novel manner in which the diaphragm D cooperates with the seat 17 during closing of the valve is diagrammatically illustrated in Figures 3 to 5, the clearances being exaggerated to facilitate illustration. Figure 3 shows the body 1 of the diaphragm D substantially flat and when in this condition the lower face 25 of the boss 3 lies in a horizontal plane parallel with that of the plane of the body 2. As the diaphragm D is flexed downwardly due to the increasing pressure in the chamber 20, the central portion of said diaphragm is flexed downwardly out of a horizontal plane and is caused to assume the somewhat dished contour indicated at 26 in Fig. 4. The mound 4 enters the opening 15 and the lower face 25 of the boss 3 is caused to assume a slight angle to the horizontal, the portions defined by the arcs C being flexed slightly outwardly into closer proximity with the inner surface of the opening 15. The curvature of the arcs C gradually constricts the flow between the inlet and outlet chambers 11 and 12 of the valve as the mound 4 further enters the opening 15. At the same time, the surface 25 is approaching the inclined face 17 of the valve seat so that, while there is a constriction of flow at this point, all objectionable eddying is avoided. One of the peculiar characteristics of the present diaphragm construction is that, as the annular face 25 of the boss 3 approaches the seat 17, it does not simultaneously form a line-contact with all portions of the edge of said seat, but on the other hand will first engage said edge at a point 27 (Fig. 5) at one side of the seat and gradually and progressively engage the remainder of said edge on both sides of said point until final and complete contact is made at a point substantially diametrically opposite the initial point of engagement. Fig. 5 shows the seat 17 contacted by the boss 3 for about half-way around its periphery. Thus, the protuberance or mound 4 enters the seat opening 15 axially to gradually constrict the flow through the seat opening and, while this is being done, the surface 25 is approaching the seat 17 and upon engagement therewith gradually cuts off flow circumferentially through the opening 15. It is such gradual constriction and cutting off of flow through the opening 15 (due to the gradual axial and circumferential restriction of flow through said opening 15), which results in the unusual quiet operation of the diaphragm. Moreover, it is the predetermined flexibility of the diaphragm D within the scleroscope hardness range of 60 to 80 and the specific shape of the button 2 which permit such coaction.

Referring now to Figs. 6 and 7, a modified diaphragm D′, similar to the diaphragm D, except that it is provided with a central passageway 31, is incorporated in a siphon breaker generally indicated by the numeral 30. The siphon breaker 30 includes a hollow cylindrical mounting element 32, and a body comprising a hood 33 and a cover plate 34. The diaphragm D′ is clamped between the cover 34 and a horizontal flange 35 on the hood 33, said hood and cover being secured together by a suitable number of screws 36. The mounting member 32 includes a cylindrical portion 37 projecting upwardly into the hood 33 and terminating at its upper end in an inclined face 38 adapted to serve as an annular seat for a boss 3′ on the diaphragm D′. The mounting member 32 includes an intermediate hexagonal flange 40 against which a lower reduced end 41 of the hood 33 is adapted to engage. The inner surface of the portion 41 snugly engages the outer periphery of the cylindrical portion 37 and the hood 33 is preferably mounted on the mounting member 32 by sweating the portion 41 onto the portion 37, although it will be understood that other means of securing the hood to the portion 37 can be employed. The hood 33 has an enlarged portion 42 adjacent the reduced end 41 provided with a series of vent openings 43, the total area of which is at least as great as the area of the opening surrounded by the annular seat 38. The cover 34 is dished as indicated at 44 to provide a pressure chamber above the diaphragm D′.

Fig. 8 diagrammatically illustrates the manner in which the vacuum breaker 30 shown in Figs. 6 and 7 may be installed in a piping system associated with a dwelling or other building. It will be understood that the vacuum breaker 30 may be mounted at each plumbing fixture, but for the sake of economy only one need be used and can be conveniently mounted at the highest point in the line supplying water to the dwelling or building. Thus, in Fig. 8 the vacuum breaker 30 is mounted at the highest point between two vertical pipe lines 45 and 46. The line 45 is connected with a supply pipe 47 and the line 46 is connected by branch lines 48 and 49 with various plumbing fixtures in the building such as wash basins 50, toilet 51, and a stationary tub 52. A shut off valve 53 is connected in the service line 47.

In operation, so long as there is any pressure in the line 45, fluid will flow through the passageway 31 in the diaphragm D' into the chamber 44, and as the pressure in said chamber builds up, the diaphragm D' will be flexed downwardly to engage the seat 38 (in the same manner described in connection with the valve of Fig. 2) to automatically seal off the upper end of the mounting member 32 from the atmosphere. The siphon breaker 30 will remain closed so long as the pressure in the line 45 is above atmospheric pressure. However, if the pressure in the line 45 drops below atmospheric pressure for any reason, the fluid from the chamber 44 will flow back through the passageway 31 in the diaphragm D' into the pipe line 45, and atmospheric pressure effective through the vent openings 43 will act upon the lower side of the diaphragm D' and flex it upwardly out of contact with the seat 38 and thus vent the pipe 45 to the atmosphere and prevent the formation of any vacuum therein which would tend to cause back-siphoning of liquid from the basin 50, toilet 51 and tub 52. In this manner, all possible contamination of the water in the line 45, supply pipe 47 and any main connected with said supply pipe is avoided, as is also any damage that might result by water rushing back into the line 45 if the vacuum were not broken.

Fig. 9 illustrates a modified piping system including the siphon breaker 30 in which said siphon breaker is not connected in the system at the highest point thereof. Thus, the siphon breaker 30 is shown connected directly in a supply line 54. A check valve 55, which may be of conventional construction, is connected on the building side of the siphon breaker 30 and a conventional globe or gate shut off valve 56 is connected in the line 54 on the inlet side of the check valve 55. Water from the supply pipe 54 is supplied to the various fixtures in the building through a riser 57. In this system, if the pressure should fail in the supply pipe 54, the siphon breaker 30 will automatically open and connect the supply line 54 with the atmosphere in the same manner described in connection with Fig. 8. Moreover, the check valve 55 will prevent the water in the riser 57 and other piping in the dwelling from flowing back into supply line 54. The check valve 55 alone would prevent objectionable back-siphoning, but would not relieve any vacuum condition that might be created in the service line 54. On the other hand, the siphon breaker 30 avoids all possibility of producing a vacuum in the supply line 54 and the dangers incident thereto.

It will be understood that the diaphragm disclosed herein is not limited to use in valves and siphon breakers but is adapted for general utility. It will also be apparent that various changes may be made in certain details of construction of the valve and siphon breaker per se, without departing from the spirit of the invention or the scope of the annexed claims.

I claim:

1. An automatic vacuum breaker comprising: a substantially cylindrical hollow member terminating at its upper end in an annular seat; a hood mounted upon said cylindrical member; a cover having a chamber for fluid under pressure; and a flexible diaphragm between said hood and cover, said diaphragm having a central circular boss arranged to engage said annular seat, said boss having a diameter slightly greater than that of said annular seat, said boss having a central protuberance arranged to be received within the opening of said annular seat, said protuberance including a portion of a diameter only slightly less than that of the opening of said annular seat, said hood having vent openings for establishing communication between the atmosphere and said seat opening when the pressure in said cylindrical hollow member is less than atmospheric pressure, said diaphragm having a central passageway extending through said body, boss and protuberance, whereby fluid under pressure greater than atmospheric pressure may pass through said diaphragm to the upper side thereof and into said chamber in said cover to cause said diaphragm to be flexed downwardly into engagement with said annular seat.

2. An automatic vacuum breaker comprising: a hollow cylindrical member terminating at its upper end in an annular seat; a hood surrounding said cylindrical member and having its lower end secured to said cylindrical member, said hood including a cylindrical portion arranged above said lower end, said cylindrical portion having a series of vent openings extending therethrough and terminating at its upper end in a horizontal flange; a diaphragm above said flange arranged to be flexed downwardly into engagement with said annular seat; a cover overlying said diaphragm; means securing said cover to said horizontal flange for clamping the marginal portion of said diaphragm against said hood, said cover having a chamber formed therein above said diaphragm, said diaphragm having a passageway opening into said chamber, said passageway serving in the normal operation of said vacuum breaker as the sole means for introducing fluid into and exhausting fluid from said chamber.

3. An automatic siphon breaker comprising: a member having a substantially cylindrical body portion, said body portion terminating at its upper end in an annular seat; a hood surrounding said cylindrical portion and including a lower end portion secured to said cylindrical portion and a radial flange of relatively greater diameter than said lower end portion at its upper end portion extending substantially perpendicular to said cylindrical portion; a diaphragm engaging the upper side of said radial flange; a dished cover member overlying said diaphragm, said diaphragm including a portion movable toward said annular seat and having a central opening through which fluid normally passes into the dished portion of said cover to effect downward flexing of said diaphragm toward said annular seat when the pressure in said cylindrical portion is greater than atmospheric, said hood being provided with vent openings for venting said cylindrical portion to the atmosphere when the fluid

pressure in said cylindrical portion is less than atmospheric, said central opening further and normally serving to exhaust fluid from said cover to permit atmospheric pressure to flex said diaphragm away from said annular seat when the pressure in said cylindrical portion is less than atmospheric to effect opening of said siphon breaker.

4. An automatic vacuum breaker comprising: a mounting member having a hollow cylindrical portion terminating at its upper end in an annular seat and having a radially extending peripheral flange substantially medially of its length; a hood surrounding said cylindrical portion having a reduced lower end portion engaging said flange and sweated onto said cylindrical portion, said hood including an enlarged cylindrical portion above said reduced lower end portion, said enlarged portion having a series of vent openings extending therethrough and terminating at its upper end in a horizontal flange; a flexible diaphragm engaging said flange; a cover member overlying said diaphragm; means securing said cover to said horizontal flange for clamping the marginal portion of said diaphragm against said hood, said cover member having a chamber formed therein above said diaphragm for operating fluid, said diaphragm having an opening for establishing communication between the interior of said hollow cylindrical portion and said chamber, whereby fluid from said hollow cylindrical portion can pass through said opening in said diaphragm and enter said chamber to automatically effect closing of said vacuum breaker.

DONALD G. GRISWOLD.