United States Patent [19]

Yapp

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[45] **July 8, 1975**

[54] **HUB CAP ASSEMBLY**

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[21] Appl. No.: **416,690**

[52] **U.S. Cl.** ..... **301/108 A;** 308/187.1

[51] **Int. Cl.** **B60b 27/00**

[58] **Field of Search** ..... 301/108 R:108 A, 108 TW; 180/1 H; 308/187, 187.1; 137/225, 225.3

[56] **References Cited**

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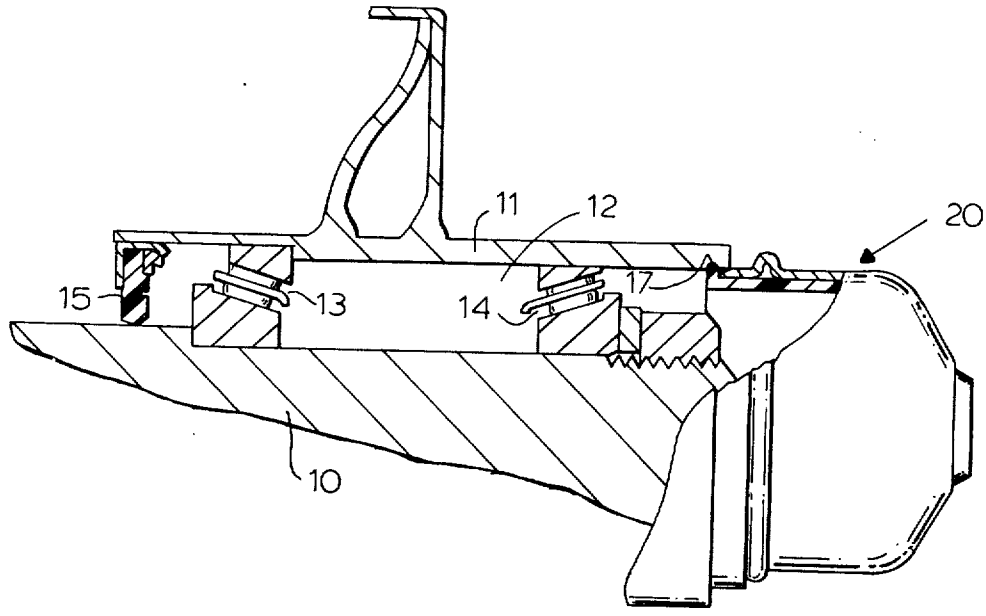
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Assistant Examiner—D. W. Keen
Attorney, Agent, or Firm—Owen, Wickersham & Erickson

[57] **ABSTRACT**

A closure device for a wheel hub rotatably mounted upon an axle. A diaphragm member has a cylindrical portion and a distal covering wall portion that is movable axially with respect to the hub to accommodate expansions and contractions of gases and lubricant contained within the hub. A protective metal shell preferably surrounds and overlies the diaphragm, having a cylindrical wall and a closure wall which lies beyond the distal wall, usually being spaced therefrom. The shell encloses the device, except for a central opening which may be left open to enable viewing the position of the distal covering wall or may be closed by a removable cap fitting. A check valve is provided in the cylindrical wall of the shell or in the distal wall portion of the diaphragm member for admitting lubricant from a pressure lubricator and for retaining the admitted lubricant.

21 Claims, 11 Drawing Figures



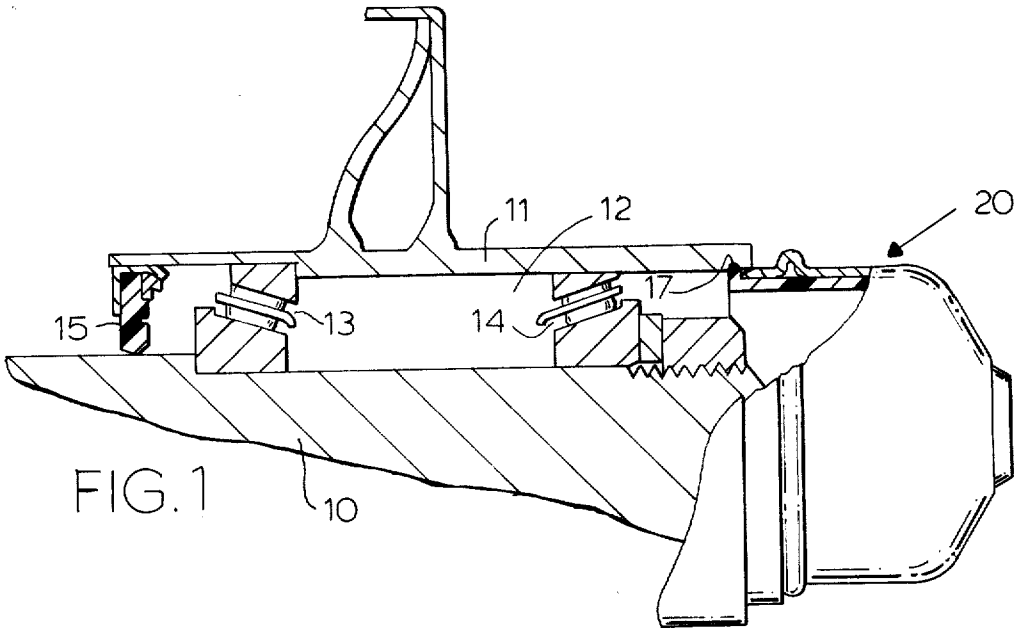


FIG. 1

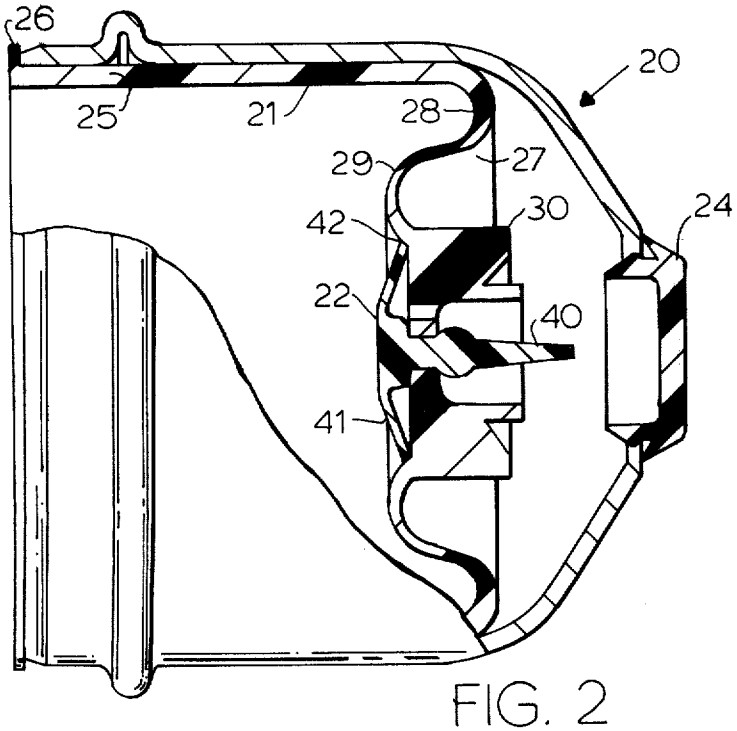


FIG. 2

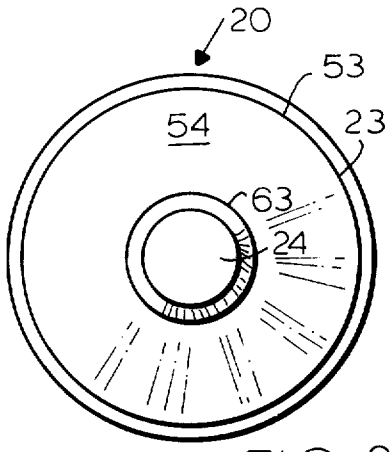


FIG. 3

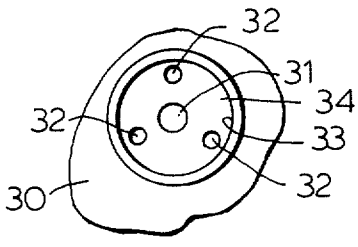


FIG. 5

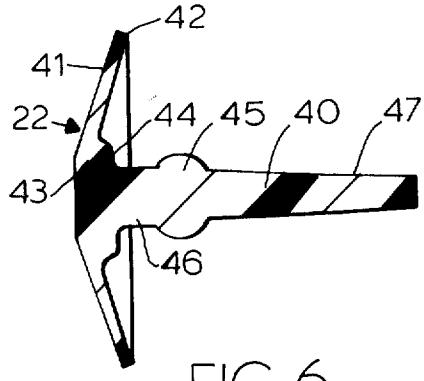


FIG. 6

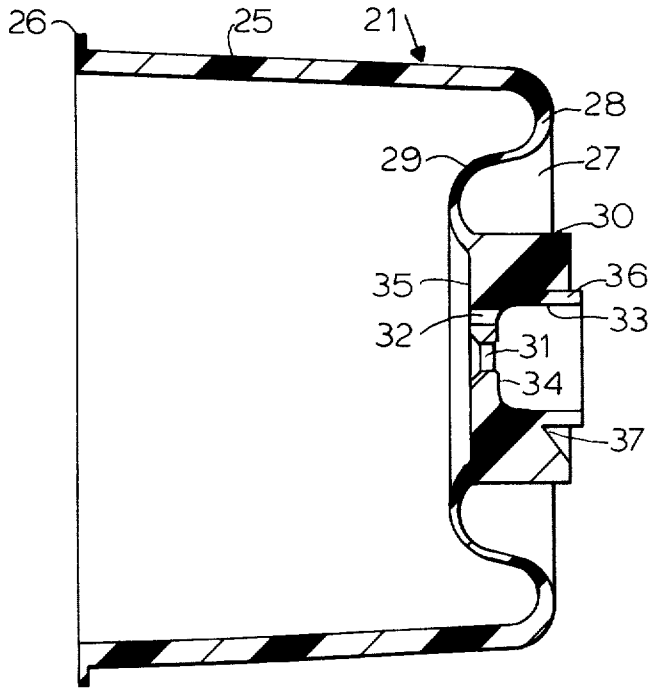


FIG. 4

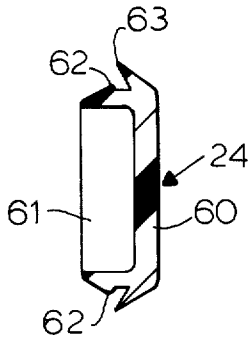


FIG. 8

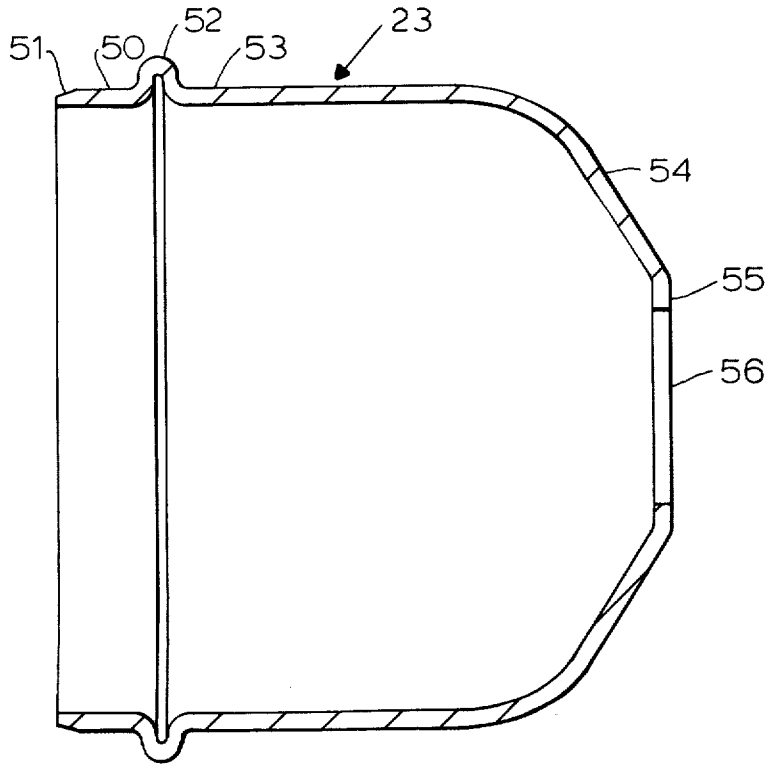


FIG. 7

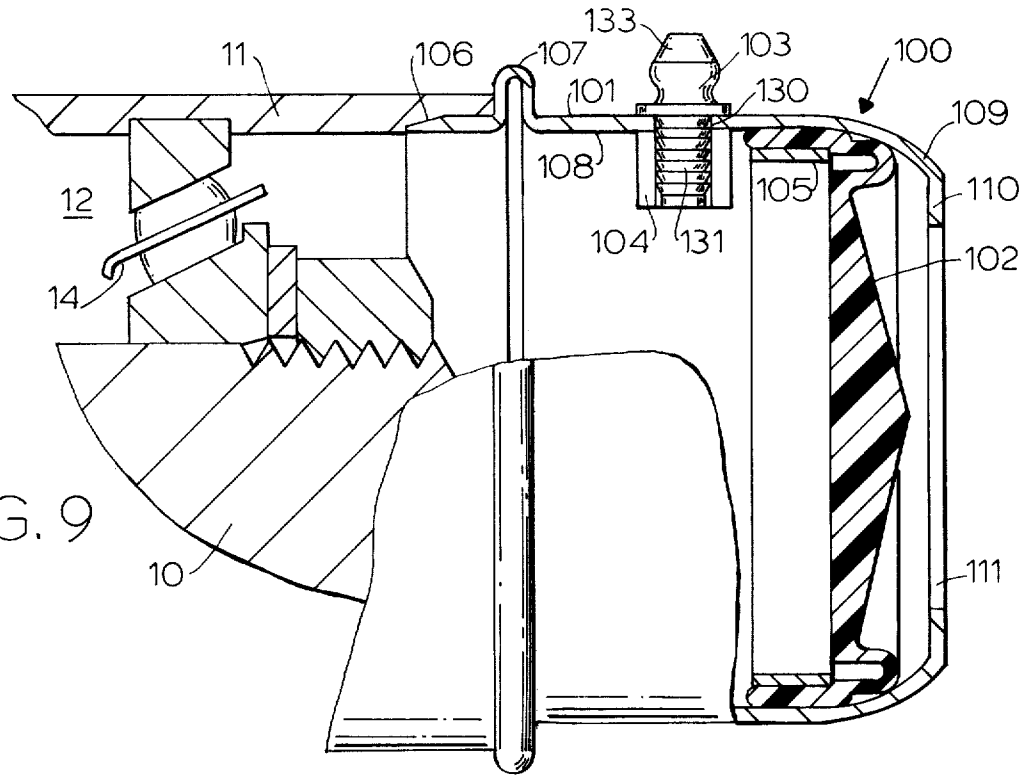


FIG. 9

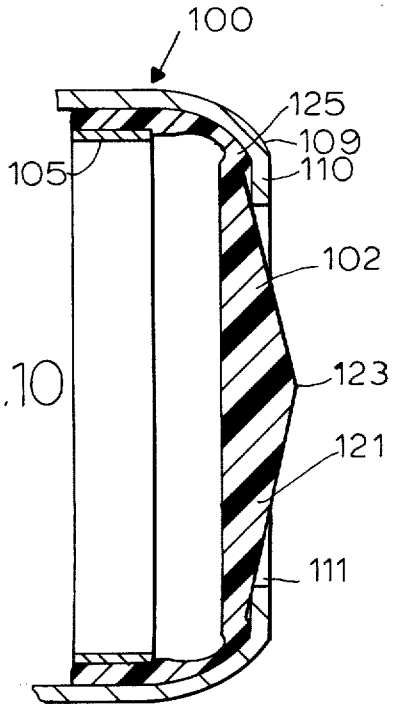


FIG. 10

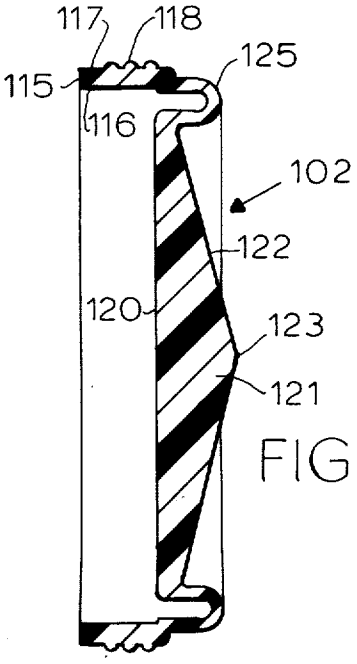


FIG. 11

HUB CAP ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates to a hub cap assembly. It has particular application to the hub caps for boat trailers and for agricultural implements, devices where the problems are particularly severe.

The general purpose of the invention is to provide a closure device for the wheel hub that will give a long life to the bearings inside as well as to the cap itself, with a minimum of maintenance.

The problem with boat trailers is well-known. Typically, the wheel hub has a pair of tapered roller bearings in between a grease cap that seals the outboard end of the hub cavity and an inboard grease seal. The free space in the hub cavity is filled typically up to 50 or 60% capacity with a suitable grease. When the boat trailer is being pulled at high speed on a highway, the air and the grease are heated to 150°F. and higher, sometimes over 200°F., and they expand. The air expands more than the grease, since its thermal coefficient of expansion is higher, and its expansion is therefore more significant. Then, typically, while the device is still at this high temperature, the user launches his boat and submerges the wheel hub assembly in water which is typically at 50°–70°F. and which may be either fresh water or salt water. This immersion rapidly reduces the temperature of the air and grease and so decreases the volume occupied by the grease and the air, thereby producing a partial vacuum in the grease cavity. As a result, water and other contaminants are then sucked in through the inboard seal. Once water gets inside the hub, the bearings rust, and eventually they fail. Thus, an important object of the invention is to provide means for controlling the pressure within the cavity, such that there is never a negative pressure greater than the sealing capacity of a good inboard wheel seal.

One of the early attempts to solve this problem is exemplified by Law U.S. Pat. No. 3,077,948 which utilizes a sliding member with springs and a grease fitting. This device is expensive and has been considered to be unsatisfactory because of its complicated construction and the number of movable parts. Furthermore, these movable parts have had facing surfaces between which water is apt to seep. Still further, the exposure of the grease fittings results in their possibly being damaged by contact with other objects and the possibility of their injuring a person who comes in contact with them.

Reilly U.S. Pat. No. 3,149,883 shows a diaphragm type of hub closure of natural or synthetic rubber. This device must be removed when the bearings are lubricated, and it, too, is fully exposed.

Eberle U.S. Pat. No. 3,226,162 incorporates a device in which pressure may be added to the grease chamber from a tire valve and provides a relief valve for excessive pressure. Again, the cap, which is rigid, must be removed for insertion of the grease, and the structure is unduly complex.

Isenbarger U.S. Pat. No. 3,316,022 shows a hub cap assembly having a filler plug and a transparent window on a rather complicated device. It is bolted on by several bolts.

Kaufman U.S. Pat. No. 3,393,015 shows a rigid metallic stamping with a grease fitting secured to it. It provides for air relief through a vent hole with an O-ring over the hole that is intended to prevent the grease from seeping by but permitting air to do so. The effectuality of this device is not certain, and its reliance upon a press fit may be questioned.

Walther U.S. Pat. No. 3,642,327 contains a diaphragm and a metallic cover for it but is another complex apparatus that is in some cases not fillable except by removal and in other cases embodies the use of a complex fitting going through both members.

Molinare U.S. Pat. No. 3,649,080 shows another construction with a metal stamping provided with both the grease fitting and a pressure relief valve. This device is uncovered and is likely to permit seeping.

SUMMARY OF THE INVENTION

The present invention utilizes a diaphragm member which preferably is made of an elastomeric compound. The diaphragm member has a generally cylindrical portion, and it has a cover wall that is movable axially with respect to the hub to accommodate the expansions and contractions of the gases and lubricant contained within the hub. A protective metal shell having a cylindrical wall surrounds and snugly overlies the generally cylindrical wall of the diaphragm moving it in radially to a cylindrical shape, and it has a closure wall at one end which overlies the cover wall of the diaphragm and is normally spaced from it to permit movement thereof. A check valve is secured to the cylindrical portion of the steel shell (or in some forms to the cover wall at its center) and serves to admit and to contain therein lubricant from a pressure lubricator. A central opening in the closure end of the shell may be normally open to serve as a viewing port for checking whether the device is properly lubricated or may be normally closed by an imperforate cap which is readily removable.

Other objects and advantages of the invention will appear from the following description of a preferred form of the device.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. **1** is a view in elevation and in section of a wheel hub incorporating a closure device embodying the principles of the invention.

FIG. **2** is a view in elevation and in section of the assembly of the closure device itself.

FIG. **3** is a view in elevation of the assembly of FIG. **2.**

FIG. **4** is a view in elevation and in section of the diaphragm of the FIG. **2** device, shown on an enlarged scale with respect to FIG. **2.**

FIG. **5** is a view in front elevation of the central portion of FIG. **4.**

FIG. **6** is a view in side elevation of the check valve member.

FIG. **7** is a view in side elevation of the metal shell which covers the diaphragm.

FIG. **8** is a view in side elevation of the closure cap for the metal shell.

FIG. **9** is a view in side elevation and in section of a wheel hub incorporating a modified form of closure device embodying the principles of the invention.

FIG. **10** is a fragmentary view in side elevation with the diaphragm member expanded by internal pressure.

FIG. **11** is a view in side elevation and in section of the diaphragm element.

DETAILED DESCRIPTION OF TWO PREFERRED EMBODIMENTS

The embodiment of FIGS. 1–8

The assembly shown in FIG. 1 illustrates one application of the invention to a boat trailer hub. Thus, the complete device of this embodiment includes an axle **10** and a hub **11** which is stationary relative to the axle **10**. Between the axle **10** and the hub **11** is a cavity **12** in which is a pair of tapered roller bearing assemblies **13** and **14**. On the inboard side of the inboard bearing **13** is a grease-retaining seal **15**. The problem lies mainly with the outboard side of the outboard bearing **14**. In this form of invention, a lock for a closure assembly **20** of the invention is provided by an annular groove **17**.

The assembly **20** is shown locked into the groove **17**. This assembly **20** is shown separately in FIGS. **2** and **3**. The assembly **20** comprises four members: a diaphragm member **21**, which is typically made of an elastomer of a type that has some flexibility, such as a polyester, e.g., Hytrel, or polychloroprene (Neoprene) or Hydrin; a check valve **22** which may be made from metal or from plastic; a protective shell **23** which is typically made from metal; and a closure cap **24** for the shell, which may be made from metal or plastic.

FIG. **4** shows a still greater enlargement of the diaphragm **21**, a very important part of this form of the invention. The entire member **21** is unitary and is not an assembly. The diaphragm **21** is generally cylindrical but, preferably, not quite so; it has a somewhat frustoconical wall **25** with a locking flange **26** on its inboard end. The wall **25**, on assembly with the shell **21**, becomes cylindrical. It will be noted that the wall has no portion flaring outwardly relative to the flange **26**. At the outboard end of the wall **25** is a movable cover wall **27**. This wall **27** may have a recurved portion **28** leading to a thin diaphragm portion **29** which then leads in to a much thicker central plug portion **30**. The plug portion **30** has a central opening **31** and a plurality of openings **32** surrounding the central opening **31**. The plug **30** also has on its outside surface a cylindrical bore portion **33** leading to an end wall portion **34**, and on its inside surface it has a flat central wall portion **35**. The bore portion **33** may be somewhat extended by a wall **36** around which is an annular inset gap **37**.

It will be apparent from the structure so far described that when the openings **31** and **32** are closed, pressure greater than atmospheric in the cavity **12** will cause outward movement of the wall **27** and particularly of the plug portion **30**, and that a sucking pressure will cause inward movement of this same wall **27** and especially of the plug portion **30**. Substantial changes in pressure can be accommodated in this manner.

The valve **22** is shown enlarged in FIG. **6**, while FIG. **2** shows the cooperation between the valve **22** and the diaphragm member **21**. This valve **22**, which may be made from fluorosilicone, has a stem **40** and an end cap **41** which is flexible but somewhat stiff, the rim **42** of which bears normally against the flat wall **35** of the diaphragm plug **30**. The portion **41** is thin, but there is a central thickened portion **43** which has an inner surface **44** that lies against the wall **35**. The stem **40** also includes, at a spaced distance from the portion **44** an enlarged portion **45** which seats against the wall **34** to prevent leakage of air or grease out from the diaphragm **21**. The portion **45** is joined to the portion **44** by a stem portion **46** that is substantially cylindrical, and its length is equal to the distance between the portions of the walls **34** and **35** against which the portions **44** and **45** abut in a leak-tight fit. The opening **31** is thus closed at all times. A stem portion **47** extends outwardly beyond the portion **45** and may, if desired, be tapered.

Interior pressures normally keep the rim **42** closed against the wall **35**, thereby closing off all of the openings **32**. When pressure is exerted by a grease gun, the rim **42** is flexed away from the wall **35**, and grease enters the cavity **12** through the openings **32**.

The device as so far described would be operable without any cover and may be used in that manner, if desired. However, since boat trailers get rough use it is preferred to provide protection for the device that has been heretofore described, and this includes principally the metal shell **23** which is shown enlarged in FIG. **7**. The metal shell **23** has a generally cylindrical portion **50**, with a tapered end portion **51**, preferably tapered at 15° to not interfere with the flange **26**. Spaced somewhat away from the end is an outwardly extending generally shotgun-shell-shaped stop portion **52** which serves the purpose of limiting entry of the shell **23** into the bore of the hub **11**. The stop portion **52**, which is annular, is succeeded by a cylindrical shell portion **53** which leads to an end wall portion **54**. The walls **50** and **53** are smaller in inner diameter than the as-molded outer diameter of the diaphragm wall **25** and therefore engage it very snugly and hold it to a cylindrical shape upon assembly. The wall **54** is substantially frustoconical but may be curved, and it ends at a short annular radial portion **55**, which has a circular opening **56** therein. The opening **56** is normally filled by the plug **24** which is shown enlarged in FIG. **8**.

The plug **24** has a flat end wall portion **60** and a generally cylindrical portion **61** which extends into the hole **56**. There is an exterior bump **62** which, once inserted through the opening **56**, serves to lock and prevent the plug **24** from coming out until it is purposely pulled out. Removal is enabled partly by an angular cap portion **63**, which surrounds the portion **60** and can be used somewhat as a handle or as a means for applying a screwdriver or other member to pry off the plug **24** when lubrication is desired.

During all normal use, the stem **40** is out of contact with the plug **24**, and the portions **27** and **30** do not contact the shell **23**. The space between the shell **23** and the diaphragm member **21** allows free expansion of the heated air and grease inside the cavity **12**.

The embodiment of FIGS. **9–11**

A portion of the boat trailer hub assembly of FIG. **1** is shown in FIG. **9**, and, except for a modified assembly **100**, the remainder of the hub assembly is also the same as in FIG. **1**, with the seal **15** on the inboard side of the inboard bearing **13**. The assembly **100** comprising a preferred embodiment of the invention is made up, basically, of three elements, namely, a shell **101**, a diaphragm member **102**, and a check valve **103**. In addition, there are two annular members **104** and **105**.

The shell **101** has, successively, a lead-in portion **106** to fit in the bore of the hub **11**, a shotgun stop portion **107**, a cylindrical portion **108**, and an inwardly curved portion **109**. The portion **109** terminates in an annular radial portion **110**, through which is an opening **111**.

The diaphragm member **102** is shown in FIG. **11** before insertion into the shell **101**. It has a generally cylin-

drical portion **115** with an inner periphery **116** which is smooth and an outer periphery **117** having a plurality of outwardly extending annular knurls or ribs **118.** The periphery **117** is substantially the same size as the inner periphery of the cylindrical portion **108,** so that the ribs **118** result in interference and act to hold the diaphragm member **102** very firmly in the shell **101.** To increase this hold, the ring **105** is inserted; its outer periphery **106** is larger than the inner periphery **116,** and this interference causes further expansion and flow of the elastomer of the member **102** and provides very, very tight seal of the member **102** to both members **101** and **105,** so that the diaphragm member **102** is held in place even against rather large amounts of pressure tending to move it in any direction relative to the members **101** and **105.**

The diaphragm member **102** also has a radially extending wall **120** which forms one side of a centrally thickened portion **121.** The outer surface **122** of this portion **121** is conical and is thickest at the center **123.** The whole thickened portion **121** is connected to the cylindrical portion **115** by an arcuate flexing portion **125** representing a 180° curve in the position in which the diaphragm member **102** is molded. Thus, positive pressures tending to move the portion **121** outwardly act as shown in FIG. **10,** so that the surface **120** of the thickened portion **121** remains planar, while the cylindrical portion **115** remains stationary and the portion **125** is flexed outwardly into a shape such as shown in FIG. **10.** Similarly, negative pressure will tend to move the thickened portion **121** inwardly, that is to the left in respect of any of FIGS. **9** through **11,** and the flexing portion **125** will accommodate this also while the surface **120** remains substantially radial and planar. It will be noted that any tendency to expand will necessarily be applied more at the edges than it will in the center, and this tends to keep the surface **120** planar also.

With the member **102** installed and held securely in place by the ring **105,** the check valve **103** can be installed in the shell **101.** For this purpose, the shell has a central opening **130** through which a stem portion **131** of the check valve **103** can extend. Then the expandable cylindrical tubular member **104,** which is preferably made of plastic, is force fitted over the stem portion **131** of the check valve to hold it in place relative to the shell **101** by means of the interferences between the two members. The check valve **103** enables the lubricator to put in the grease through a fitting **133,** and the check valve aspect prevents the pressure inside from returning the grease as well as from admitting air under normal circumstances. This is a well known type of grease fitting, and a complete showing is, of course, unnecessary.

In operation, there is a very tight seal between the diaphragm member **102** and the shell **101,** and the press fit between the shell **101** and the housing **11** is sufficient to retain the assembly **100** in place under considerable pressure. When the assembly **100** is first installed, grease is charged to the interior through the fitting **133** of the check valve **104,** and pressure is exerted to a desired degree, preferably to a point where there is some expansion of the diaphragm member **102,** with movement of the thickened portion **121** to the right in FIG. **9.** Observation through the opening **111** is preferably used to determine this expansion at an optimum amount, which is prescribed usually by the manufacturer and corresponds to a given amount of grease fill and internal pressure. During hot running, that is, when the vehicle is on the highway, expansion may occur again to an extent approaching that shown in FIG. **10,** and then, when the axle is plunged into a lake or other body of water, a negative pressure results which will pull the diaphragm portion **121** back, usually to the left of the position shown in FIG. **9** but without admitting any air and without affecting the effectiveness of the grease seal **15.**

In order to test a device of the invention for use with boat trailers, a bench test was designed to simulate the effect of road speed and also to provide immersion in cold water, both of which are experienced by boat trailers. As a representative speed, 70 miles per hour was chosen, corresponding with a hub speed of nearly 1,495 rpm based on calculations that use the smallest available trailer tire size, which is 15¾ inches outside diameter. A pan was attached to the test stand in such a way that the spindle and hub assembly could be completely submerged in water. A commercial (Ford) spindle hub assembly was chosen, with tapered bearings and a brand new inboard seal. A thermocouple was positioned in the center of the axis of the spindle and was wired to a recorder, to enable continuous monitoring of the spindle temperature.

The hub was then filled with a standard amount of grease, which was 67 grams of the lubricant recommended by the manufacturer. The assembly was then tested for repeatability at stable operating temperature. Cooling blowers were used to lower the spindle operating temperature from the 210°F. that it obtained without blowers to a more acceptable and realistic 150°F., corresponding to the air cooling which such a device gets in actual use. The variation from run to run was about plus or minus 3°F., the variation possibly being attributed to mechanical error in the recorder.

Using 150°F. as a standard operating temperature, the system was then tested using the present invention. With the assembly described fully attached, the device entrapped a quantity of air, which was approximately 10% of the total free space. It was found through experiment that with a good inboard seal the device should be pumped with grease only until the portion **30** of the diaphragm **21** or the portion **121** of the diaphragm **102** moved outwardly approximately one-fourth inch. The device tested did not incorporate any mechanism for relief of pressure with the increasing temperature, but care was taken not to fill the hub so full that with expansion the entrapped air might blow off the device. The stable temperature reached when using this cover was approximately 15° higher than the stable temperature of the manufacturer's grease-cap system.

To compare the test device described with one having a badly worn inboard seal where fuel level was not critical, a worn seal was also applied in another test, and through continuous purging and refilling, the grease cavity was cleared of the entrapped air and purging reduced to a minimum. In this device the material was pumped full of grease until the diaphragm moved outward approximately one-half inch. Driven at the standard test speed of 70 miles per hour, grease was purged through the back seal, and the device returned to its relaxed state in approximately an hour and a half. When the same test was run without rotation of the hub, the diaphragm returned to a relaxed state in 4 days. The stabilized temperature was exactly the same as with the good seal.

For testing immersion, the spindle temperature was irst brought to a stabilized operating temperature. The nachine was then shut off, and the spindle and hub assembly were immediately submerged in water at a temperature of 55°F. The hub was rotated clockwise and ounterclockwise by hand for several rotations to simuate backing the trailer into the water. After cooling the ıub to the water temperature, the quench water was lrained from the tank. The hub was then taken off the pindle, and the quantity of water seepage into the hub vas measured. Using the device of this invention, there vas no water leakage observed, but with the standard grease cap which came with the manufactured device, ıpproximately 1.2 ml of water had seeped into the hub grease cavity, showing the problem observed earlier in his application. Tests indicate, therefore, that the pres-nt device avoids the sucking of water into the hub, and t does not result in excessive operating temperatures. Moreover, the device is simple, is easy to manufacture, ınd is quite practical.

To those skilled in the art to which this invention reates, many changes in construction and widely differng embodiments and applications of the invention will ;uggest themselves without departing from the spirit ınd scope of the invention. The disclosures and the de-;cription herein are purely illustrative and are not in-:ended to be in any sense limiting.

I claim:

1. A closure device for a wheel hub rotatably mounted upon an axle, including in combination:

a diaphragm member having a generally cylindrical wall joined to a cover wall that is movable axially with respect to said hub to accommodate expansions and contractions of gases and lubricant contained within said hub,

and

a protective metal shell having a cylindrical portion surrounding, overlying and continuously engaging the cylindrical wall of said diaphragm member in a leak-tight fit and having a radially extending retention means at one end for limiting axial movement of said cover wall and normally spaced therefrom and a central opening in said radially extending retention means.

2. The closure device of claim 1 having check valve means secured to said device for admitting lubricant from a pressure lubricator and for retaining admitted lubricant.

3. The closure device of claim 2 wherein said radially extending retention means is spaced from said cover wall, in the normal unpressurized rest position of said cover wall, by and amount such that when said hub is pressurized by increased temperature or by admitting grease through said check valve means, an exterior portion of said cover wall rests against said radially extending retention means until internal pressure within said hub is relieved.

4. The closure device of claim 3 wherein said check valve is secured to said shell and extends through the cylindrical wall thereof.

5. The closure device of claim 3 wherein said check valve means is secured to said cover wall portion at the center thereof.

6. The closure device of claim 1 having a removable imperforate cap fitting in and closing said central opening.

7. The closure device of claim 1 wherein said diaphragm's cylindrical wall is clamped tightly between an annular ring on its interior surface and said cylindrical portion of the wall.

8. The device of claim 1 wherein said cylindrical portion is thinned by sloping inwardly adjacent where it mates with said hub.

9. A closure device for a wheel hub rotatably mounted upon an axle, including in combination:

an elastomeric diaphragm member having a generally cylindrical portion and a cover wall that is movable axially with respect to said hub to accommodate expansions and contractions of gases and lubricant contained within said hub, and

a protective metal shell having a cylindrical wall surrounding, overlying, and snugly engaging substantially the full length of the cylindrical portion of said diaphragm member in a non-leak, non-slip fit, thereby retaining said cylindrical portion against radial movement and having at one end a radially inwardly extending annular rim structured to limit the axial movement of said cover wall and normally spaced therefrom and defining a central opening through which the axial position of said cover wall may be observed.

10. The closure device of claim 9 having check valve means secured to said shell and extending radially through said cylindrical wall for admitting lubricant from a pressure lubricator and for retaining admitted lubricant.

11. The closure device of claim 9 wherein said cover wall is a thickened portion of said elastomeric diaphragm member and is connected to said cylindrical portion by a thinned flexing recurved portion thereby enabling axial movement of said cover wall.

12. The closure device of claim 11 wherein said cover wall has a radial internal surface and a conical outer surface that is thickest at the center thereof thereby limiting flection of said member substantially to said flexing recurved portion.

13. The closure device of claim 9 wherein said cylindrical portion is clamped and squeezed between said cylindrical wall and an cylindrical metal ring.

14. The device of claim 9 wherein said rim is spaced from said cover wall, in the normal unpressurized rest position of said cover wall, by an amount such that when said hub is filled with grease through said check valve means, said cover wall rests against said rim until internal pressure in said hub is relieved.

15. A closure device for a wheel hub rotatably mounted upon an axle, including in combination:

a diaphragm member having a generally cylindrical portion with an end flange for attachment of said member in an annular recess in the hub and a cover wall that is axially movable with respect to said hub to accommodate expansions and contractions of gases and lubricant contained within said hub,

check valve means secured to said cover wall at the center thereof for admitting lubricant from a pressure lubricator and for retaining admitted lubricant,

a protective metal shell having an overlying cylindrical wall surrounding and embracing substantially all of the cylindrical portion of said diaphragm member and having a closure wall at one end covering said cover wall and normally spaced therefrom and a central opening in said closure wall.

16. The device of claim 15 also including a removable imperforate cap fitting in and closing said central opening.

17. The device of claim 15 wherein said cylindrical wall is thinned by sloping inwardly adjacent where it approaches said end flange.

18. The device of claim 15 wherein said closure wall is spaced from said cover wall, in the normal unpressurized rest position of said cover wall, by an amount such that when said cavity is filled with grease through said check valve means, said cover wall rests against said closure wall until internal pressure in said hub is relieved.

19. The closure device of claim 15 wherein when said protective shell is removed said generally cylindrical portion becomes actually slightly frustoconical, tapering slightly inwardly from said end flange to where said cover wall joins said generally cylindrical portion.

20. The closure device of claim 15 wherein said cover wall has a recurved portion connecting it to said generally cylindrical portion and succeeded by a thin diaphragm portion leading to a central plug portion that is thicker than any of the other walls of said diaphragm member, said central plug portion having a central opening and a plurality of openings radially spaced away from said central opening identical distances, said check valve means having a stem extending through said central opening and having an end cap inside said diaphragm member and with a perimeter normally resting against said central plug portion just radially outside said plurality of openings.

21. A grease cap for a wheel hub, including in combination:

an expansible member having a radially fixed and rigid tubular portion with hub lock-in means adjacent one end and a closure wall at the other end expansive only along the axis of said tubular portion and having opening means, and

check valve means normally closing said opening means against entry from outside and exit from inside but urgeable to an open position by a predetermined pressure for admitting grease for lubrication which is much greater than any pressure within or without said hub developed incident to its use.

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