EXPLOSION PROOF HOUSING COVER SEAL

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ABSTRACT
The invention is an explosion proof housing cover seal. The cover seal includes a housing and a cover, where the housing has an interior and an opening into the interior defined by a housing sidewall. The housing sidewall has a threaded portion. The cover has a sidewall with a cover threaded portion that mates with the housing sidewall threaded portion. The cover sidewall includes a circumferential cover bevel portion, and the housing sidewall has a matching circumferential housing bevel portion, where the two bevel portions contact circumferentially when the cover is sealingly engaged with the housing opening. The explosion proof housing cover seal further has a seal channel to contain a seal member. Each of the bevel portions has a proximal end, and the bevel proximal ends are positioned adjacent to the seal channel when the cover is sealingly engaged with the housing opening.
EXPLOSION PROOF HOUSING COVER SEAL

[0001] This application claims the benefit of provisional application for patent Ser. No. 61/122,958 filed on Dec. 16, 2008, which is incorporated by reference herein in its entirety.

FIELD OF INVENTION

[0002] Cover and seals for explosion proof housings.

BACKGROUND OF THE INVENTION

[0003] Many devices, particularly electronic/electrical device that interface sensors, are positioned in housings that are located in hazardous environments containing a risk of explosion due to the presence of volatile gases or flumes. A spark caused by operations of the housed electronic components can create an explosion within the housing interior. It is desirable that the housing openings (such as to an access opening or access port) be closed with a cover and seal that contain such an interior explosion, and thus prevent the possibility of the explosion spreading beyond the housing.

[0004] An explosion within the housing results in excessive pressures in the housing interior. The generally accepted test to establish a specific housing as “explosion proof” (the ability to contain an interior explosion) is that of the International Electrotechnical Commission (IEC) standard, IEC 60079-1, hereby incorporated by reference. This standard sets forth a specific testing criteria. First, a “housing explosion pressure reference” is established by setting of an explosion in the interior of the specific housing model, using pre-defined explosive gas mixtures. The manufacturer can then state that his housing model meets the IEC standard by utilizing one of two test: (i) hydrostatically test every individual housing to pressures of 150% of the reference pressure; or (ii) hydrostatically test a single sample housing to pressures of 400% of the reference pressure. If the pressures are contained, the standard is met.

[0005] At these high interior pressures, any sealing member, particularly an elastic sealing surface such as an O-ring, can cause the cover seal to deform/move away from the high pressure environment. The presence of spaces or gaps adjacent to the seal on the low pressure ambient side of the seal, can result in the seal being deformed or pushed into such gaps (“seal migration”). With sufficient seal migration, the seal may fail. Current cover and seals contain a gap or space between the cover and the housing which is undesirable. Additionally, it is not unusual for a housing cover to be threaded into an upstanding wall of the housing, which can be thinner than the housing wall away from the opening. The thinner wall may “flex” under high internal pressures, placing additional dynamic stress on the seal that can result in or contribute to seal failure.

SUMMARY OF THE INVENTION

[0006] The invention is an improved threadable housing cover and seal. The cover may be internally threaded into the housing opening, or externally threaded over the housing opening. The cover has an inclined portion substantially matching an inclined portion on the housing wall adjacent to the housing opening. The cover includes a seal groove to retain the seal, positioned between the inclined portion and the cover threads.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 shows a cross section of a prior housing cover seal.

[0008] FIG. 1A is a detail of the shoulder area of the housing cover seal of FIG. 1.

[0009] FIG. 1B is a cross section of another prior art cover seal embodiment.

[0010] FIG. 2 is a cross section of the invention employing external threads on the cover.

[0011] FIG. 2A is a detail of the shoulder area of the cover seal in FIG. 2.

[0012] FIG. 3 is an embodiment of the invention employing internal threads on the cover.

[0013] FIG. 3A is a detail of the shoulder area of the cover seal in FIG. 3.

[0014] FIGS. 4A and 4B are cross sections through two embodiments of the seal system where the threads are on the interior surface of the housing.

[0015] FIGS. 5A and 5B are cross sections through two embodiments of the seal system where the threads are on the exterior surface of the housing.

[0016] FIGS. 6A, 6B, 6C and 6D are cross section through a housing depicting the vertical axis and the measurement of the bevel or angle from that axis.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Shown in FIG. 1 is a prior art cover 10 for an opening 101 in a housing 100. In general, references to the housing portions contain three digits, e.g. 113, while references to the cover portions contain two digits, e.g. 13. The housing opening 101 is defined by a sidewall 112 in the housing 100, here shown as sidewall that is upstanding from the body of the housing. The housing sidewall opening can also be flush (or even recessed) with the housing body, as shown in FIG. 1B. The cover 10 has a top portion 11, and a sidewall 12 projecting away from the top portion 11. As shown, the sidewall 12 has exterior facing threads 14, adapted to interface interior facing threads 114 positioned in interior surface of the upstanding sidewall 112. An alternative design is where the sidewall 112 of the housing opening may have exterior facing threads 114, adapted to interface interior facing cover threads 14 (such as shown in the improved cover seal of FIG. 3).

[0018] As shown in FIG. 1, located on the cover sidewall 12 is a circumferential seal channel 13 that faces the interior of the cover sidewall 114 when installed. Seal channel 13 is shown have two sidewalls (a trailing channel sidewall 13E2 and a leading channel sidewall 13D2) and a flat bottom, but may be formed from a shaped channel, such as hemispherical shape to accommodate the an O-ring seal member disposed therein. Seal channel is positioned the “above” threads 14 in FIG. 1 and has two terminating edges, a trailing edge 13E1 (the edge closest to the threads and to the interior of the housing)) and a leading edge 13D1 (the edge furthest from the threads, and closest to the exterior surface of the housing, as shown in FIG. 1A). An alternative design is have the seal channel 13 located on the interior of the upstanding housing sidewall (that is the seal member will be carried in the housing, not the cover). This is preferred in the instant configuration as the diameter of the threaded portion of the cover
sidewalls 12 must smaller then the non-threaded cover side-wall portions so that the cover's threads will clear a sealing member when positioned in a housing seal channel.

[0019] Also shown is a second circumferential channel 15 located below the seal channel 13, and above the threads 14. This channel 15 is an artifact of the manufacturing process for the cover 10, as it is difficult to machine threads up to the lower wall surface 13A of the seal channel 13. A seal member 16 (typically an O-ring) is positioned in seal channel 13, where the seal member 16 forms a seal by compression of the seal member 16 between housing interior sidewall 114 and the bottom of the seal channel 13 (see the detail IA of FIG. 1A, showing the direction of the seal). As can be seen in the detail of FIG. 1A, the facing sidewalls of the housing and cover, located above the seal channel 13 and below portion 60 of the cover, are substantially vertical (0 degrees), and do not touch, but are offset by a gap, shown as distance D. Even with close machine tolerances of the cover sidewalls and the opening sidewalls, the distance D can be on the order of several 1/1000 of an inch. Hence, current cover/seat designs provide a circumferential vertical gap or slot 30 between the cover and housing facing sidewalls. This gap is positioned on the low pressure side of the seal in the event of an interior explosion, and is located immediately above the seal member 16. This gap 30 can be reduced with very close machine tolerances, but cannot be eliminated, even if the cover where tightened to the point where the cover shoulder 60 contacts the housing. Consequently, with sufficient pressures in the interior of the housing, the seal member 16 may migrate into the gap 30, potentially resulting in the loss of an effective seal, and the possible non-containment of an interior explosion.

[0020] FIG. 2 shows an improved cover/housing design. In this design, the top of the housing opening sidewall 112 has a first bevel portion 120 positioned below the shoulder 60 of the cover but above the seal channel 13. As shown, the bevel faces the interior of the opening, but the first bevel could also be outwardly facing. The bevel cannot be 90 degrees. The cover 10 also has a corresponding first bevel 20, designed to intermate or touch with the housing opening sidewall first bevel 120 when the cover 10 is in place. As shown, the cover first bevel portion 20 and the housing first bevel portion 120 have a proximal ends respectively (21 and 121) that are adjacent to the seal chamber (in particular, the exterior leading edge 13D1 of the seal channel 13) when the cover is engaged with the housing sidewall (see FIG. 2A). The first bevel portions surround the entire mating surfaces, that is, they are circumferential around the cover sidewall and housing sidewall. When the cover is engaged with the housing (threaded into position until the bevel portions touch), the respective first bevel portions contact substantially around the opening (e.g. circumferentially). Due to machine tolerances in the beveled surfaces, there may be spots where contact is lacking but these generally will be very minimal and will not diminish the effectiveness of the improved seal. It is preferred that the bevel begin immediately at the exterior leading edge 13D1 of the seal channel to eliminate any space or gap on above the above the seal member. First bevel portion 20 may run all the way to the exterior of the cap, leaving no flat shoulder portion 60, but this is not preferred as the sidewall will have a weak sharp edge. Small gaps below the bevel, while not preferred, can be tolerated, provided the gap space is not sufficient to allow loss of seal under seal migration. If the gap is sufficiently small, the available space is insufficient to accommodate enough of the seal member during seal migration to cause loss of seal. The angle of the bevel portion (the “bevel”) (as measured from vertical) can be from a few degrees to almost 180 degrees, provided that it is not 90 degrees. A preferred bevel is in the range of 25-155 degrees from vertical (considering an axis aligned substantially perpendicular to the threads on the sidewalls as oriented “vertically,” with the angle measured from the top to the threads, see FIG. 6), with the most preferred bevel being around 45 degrees or 135 degrees from the vertical.

[0021] With this improved design, the cover will be threaded onto the housing until the first beveled surfaces 120 and 20 touch or mate, and further tightening will only ensure a good mating between the two beveled surfaces. During an explosion in the housing, the seal member 16 may deform and move elastically into available spaces, but there is not gap or space present above the seal member 16, hence deformation of the seal member 16 due to increased internal pressures will essentially result in further flattening the sealing member 16 within the seal channel 13, resulting in an even tighter more efficient seal.

[0022] An added benefit of the beveled portions is that this bevel arrangement assists in the assembly of the cover over the housing opening. In the prior design, as the cover is threaded onto (or into) the housing, a entry bevel is needed to compress the seal member 16 in full sealing contact with the exterior wall while threading the cover to the housing. The bevel feature of the new design also provides that functionality.

[0023] FIG. 3 shows an embodiment of the new design using a cover having interior threads that mesh with exterior facing threads on the housing. The parts are labeled in accordance with that of FIG. 2, except in this design, as shown, the seal channel 113 is positioned in the housing opening sidewall 112, not the cover. Hence, the channel 113 has a leading edge 113D1, a leading sidewall 113D2, a trailing edge 113E1 and a trailing sidewall 113E2.

[0024] FIG. 4 shows another embodiment of the internally thread cover, which is threaded into an upstanding sidewall opening of the housing. In this embodiment, the cap has a second bevel portion 62, positioned between the first bevel portion and the cap exterior wall, that intermates with a corresponding second bevel portion 162 on the upstanding sidewall of the opening. The second bevel portion 62, is orientated at an angle opposed to that of the first bevel portion 20, so that the angle between the first bevel portion 20 and the second bevel portion 62 is a “v” shaped angle less than 180 degrees (an angle in the range of about 30 to 120 degrees between the bevel portions is preferred, with 90 degrees more most preferred). If the first bevel angle is less than 90 degrees (see FIG. 4A, 51), then the sum of the first bevel angle and the angle between the first and second bevel portions must be greater than 90 degrees and less than 180 degrees (otherwise, the second bevel portion would be 90 degrees from the vertical). For instance, with a preferred angle of 45 degrees, and a 90 degree angle between the two surfaces, the sum is 135 degrees. If, however, the first bevel angle is greater than 90 degrees, then the sum of the first bevel angle and the angle between the first and second bevel portions must be greater than 180 degrees and less than 270 degrees (see FIGS. 4B, 5A). With a preferred angle of 135 degrees, and a 90 degree angle between the two surfaces, the sum is 225 degrees.

[0025] A flat 62.1 may be interposed between the two beveled portions to avoid a sharp edge on the upstanding wall. Generally, the upstanding sidewall is thinner than other por-
An explosion proof housing cover seal comprising a housing and a cover, said housing having an interior and an opening into said interior defined by a housing sidewall, said housing sidewall having a threaded portion positioned on said housing sidewall interior surface, said housing sidewall having a top edge, said top edge having a sidewall first beveled portion where said bevel portion begins on said housing sidewall interior surface; a cover, said cover having a top portion, and a cover sidewall extending from said top portion, said cover sidewall’s exterior surface having threads thereon for mating with said housing sidewall threads, said cover having a seal channel positioned between said cover sidewall threads and said cover top, said cover having a cover first bevel portion adapted to mate with said sidewall tope edge bevel portion when said cover is sealingly engaged with said housing opening, said cover first bevel portion beginning on said cover sidewall exterior surface and positioned between said cover top portion and said seal channel.

8. An explosion proof housing cover seal comprising a housing and a cover, said housing having an interior and an opening into said interior defined by an upstanding housing sidewall, said housing sidewall having a threaded portion positioned on said housing sidewall’s exterior surface, said housing sidewall having a first bevel portion positioned on said housing sidewall’s exterior surface, said housing sidewall having a first bevel portion and said housing sidewall first bevel portion and said housing sidewall threaded portion; a cover, said cover having a top portion, and a cover sidewall extending from said top portion, said cover sidewall’s interior surface having threads thereon for mating with said housing sidewall threads, said cover having a cover first bevel portion beginning on said cover sidewall’s interior surface, said cover first bevel portion adapted to mate with said housing sidewall first bevel portion when said cover is sealingly engaged with said housing opening.

9. The explosion proof housing cover seal of claim 1 wherein said cover includes a circumferential cover second portion and said housing includes a circumferential housing second bevel portions, said second bevel portions adapted to contact substantially circumferentially when said cover is sealingly engaged with said housing opening, and wherein the bevel of said cover first bevel portion is greater than 90 degrees and the sum of the bevel of the first portion plus the angle between said first cover bevel portion and said second cover bevel portion is less than 270 degrees but greater than 180 degrees.

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