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(54) Title: MULTILAYER STATIC GASKET WITH BEAD COMPRESSION LIMITER

(57) Abstract: A multilayer static cylinder head gasket has at least one metal functional layer and a metal distance layer having registered openings. The functional layer has a full bead located radially outwardly from and extending about its opening. The opening in the distance layer is formed in a first portion having a first thickness. A second portion of the distance layer extends radially outwardly from the opening and the first portion, wherein the second portion has a second thickness that is less than the first thickness. A compression limiter is formed in at least one of the functional layer or the distance layer. The compression limiter prevents the full bead from being completely flattened, which in turn maintains the full bead in high sealing pressure against the distance layer relative to the remaining portion of the functional layer and also prevents premature fatigue cracks from forming in the full bead.

MULTILAYER STATIC GASKET WITH BEAD COMPRESSION LIMITER

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application Serial No. 61/028,317, filed February 13, 2008, and also U.S. Provisional Application Serial No. 61/109,682, filed October 30, 2008, both of which are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Technical Field

[0002] This invention relates generally to static gaskets of the type used to establish a gas/fluid-tight seal between two members to be clamped together, and more particularly to multilayer static gaskets, such as a cylinder head gasket.

2. Related Art

[0003] In establishing a gas/fluid-tight seal between two members to be clamped together, such as a cylinder head and engine block, it is common to use a static cylinder head gasket having multiple layers. Generally, at least one of the layers of the multilayer gasket, sometimes referred to as a functional layer, has a seal bead to facilitate establishing a fluid tight seal. Another of the layers, sometimes referred to as a distance layer, is configured to abut the functional layer in an effort to establish the fluid tight seal by compressing the seal bead of the functional layer. Unfortunately, while fastening the cylinder head to the engine block, damage can occur to the seal bead by over-compressing the seal bead. If the seal bead is over-compressed and substantially flattened, in addition to losing its ability to exert a high compression sealing pressure, fatigue cracks can form in the area of the seal bead, such as during initial clamping or while in use. If formed, fatigue cracks ultimately reduce the ability of the static gasket to establish an air and/or fluid-tight seal, thereby diminishing the life and performance of the engine.

SUMMARY OF THE INVENTION

[0004] A multilayer static gasket for providing a gas/fluid tight seal between a cylinder head and an engine block is provided. The gasket provides a full compression seal bead, referred to hereafter as full bead, that is assured of remaining only partially

compressed during assembly and while in use. As such, the seal bead is assured of maintaining a high sealing pressure between a peak of the full bead and an abutting surface to establish a reliable air and/or fluid-tight seal. Further, the seal bead resists failing prematurely due to its ability to avoid the onset of premature fatigue crack formation, and thus, exhibits a long and useful life.

[0005] According to one aspect of the invention, the multiple layers of the gasket have openings configured to register with one another and with at least one corresponding cylinder bore. At least one of the layers is a metal functional layer and another of the layers is a metal distance layer. The functional layer has the full bead formed therein, with the full bead being located radially outwardly from and extending about the opening in the functional layer. The full bead extends out of a plane of the functional layer a predetermined first distance. The opening in the distance layer is formed in a first portion having a first thickness. A second portion of the distance layer extends radially outwardly from the opening and the first portion, wherein the second portion has a second thickness that is less than the first thickness. A compression limiter is formed in at least one of the functional layer or the distance layer. The compression limiter prevents the full bead from being completely flattened, and thus, the full bead is assured of having its peak extending outwardly from the plane of the functional layer while being compressed in a fully assembled state between the cylinder head and engine block throughout use. Accordingly, the peak of the full bead continually produces a high sealing pressure relative to the remain portion of the functional layer, and also remains free from premature fatigue cracks.

[0006] The compression limiter, when formed in the functional layer, includes a sinuous form in radial cross-section having peaks and valleys facing away from one another on opposite sides of the functional layer. The sinuous form has legs extending between the peaks and valleys, wherein the legs extend at an angle of inclination from the plane of the functional layer to provide a level of rigidity to the legs to prevent their being fully compressed under load between the cylinder head and engine block. The sinuous form extends circumferentially about the opening in the functional layer between the full bead and the opening and is arranged for engagement with the first portion of the distance layer.

[0007] The compression limiter, when formed on the distance layer, includes at least one of a third portion adjacent the second portion, wherein the third portion has a third

thickness that is less than the second thickness with the second portion positioned between the first and third portions, or an outer periphery terminating between the full bead and the outer periphery of the functional layer. In accordance with one aspect of the distance layer, the first, second and third portions are constructed of a single piece of material. In accordance with another aspect of the invention, the third portion is constructed of a separate piece of material from the first and second portions, which are constructed of a single piece of material. Accordingly, the third portion can be constructed as a single piece of material having a uniform thickness.

[0008] A multilayer gasket constructed in accordance with another aspect of the invention has a pair of functional layers on opposite sides of the distance layer. Each functional layer has a full bead. The compression limiter of the gasket is provided on both the distance layer and on at least one of the functional layers. The compression limiter on the distance layer prevents over-compression of one of the full beads, and the compression limiter on the functional layer prevents over-compression of the other of the full beads.

[0009] A multilayer gasket constructed in accordance with yet another aspect of the invention has a functional layer with a full bead and a distance layer constructed of separate first and second portions of material. The first portion of the distance layer provides a main body, extending between the opening in the distance layer and an outer periphery. A recessed section in the first portion extends from the opening radially outwardly, wherein the recessed section is sized to receive the second portion. The second portion, upon being received in the recessed portion, extends axially outwardly from a surface of the first portion to provide a surface for abutment with the full bead. Otherwise, as with the embodiments above, at least one of the functional layer or the distance layer provide a compression limiter to prevent complete compression of the full bead to a completely flattened state.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] These and other aspects, features and advantages of a multilayer gasket constructed in accordance with the invention will become more readily appreciated when considered in connection with the following detailed description of presently preferred embodiments and best mode, appended claims and accompanying drawings, in which:

[0011] Figure 1 is a radial cross-sectional side view of a multilayer cylinder head gasket constructed in accordance with one aspect of the invention;

[0012] Figure 1A is a radial cross-sectional side view of a multilayer cylinder head gasket constructed in accordance with another aspect of the invention;

[0013] Figure 2 is a radial cross-sectional side view of a multilayer cylinder head gasket constructed in accordance with yet another aspect of the invention;

[0014] Figure 3 is a radial cross-sectional side view of a multilayer cylinder head gasket constructed in accordance with yet another aspect of the invention;

[0015] Figure 4 is a radial cross-sectional side view of a multilayer cylinder head gasket constructed in accordance with yet another aspect of the invention;

[0016] Figure 5 is a radial cross-sectional side view of a multilayer cylinder head gasket constructed in accordance with yet another aspect of the invention;

[0017] Figure 6 is a radial cross-sectional side view of a multilayer cylinder head gasket constructed in accordance with yet another aspect of the invention;

[0018] Figure 7 is a radial cross-sectional side view of a multilayer cylinder head gasket constructed in accordance with yet another aspect of the invention;

[0019] Figure 8 is a radial cross-sectional side view of a multilayer cylinder head gasket constructed in accordance with yet another aspect of the invention;

[0020] Figure 9 is a radial cross-sectional side view of a multilayer cylinder head gasket constructed in accordance with yet another aspect of the invention; and

[0021] Figure 10 is a radial cross-sectional side view of a multilayer cylinder head gasket constructed in accordance with yet another aspect of the invention.

DETAILED DESCRIPTION OF PRESENTLY PREFERRED EMBODIMENTS

[0022] Referring in more detail to the drawings, Figure 1 illustrates a radial cross-sectional view taken through a portion of a multilayer gasket, referred to hereafter as gasket 10, constructed in accordance with one aspect of the invention. The gasket 10 has at least one functional layer, represented here as a pair of functional layers 12, 14, and a distance layer 16. The functional layers 12, 14 are arranged to abut opposite sides 18, 20 of the distance layer 16, such that the distance layer 16 is sandwiched between the functional layers 12, 14, wherein the individual layers can be fixed to one another, such as by a weld joint or rivet, preferably at an outermost periphery (not shown) of the gasket 10. The functional layers 12, 14 each have an opening 22 sized to register with an

opening 24 in the distance layer 16, wherein the respective openings are each arranged with one another to register with a cylinder bore 26. The functional layers 12, 14 each have full compression seal beads 28 extending outwardly from a plane 30 of the layers 12, 14 to facilitate establishing a gas-tight seal about the cylinder bore 26. A compression limiter, shown generally at 32, is formed in at least one of the functional layers 12, 14 or the distance layer 16. The compression limiter 32 prevents the full beads 28 from being completely flattened within the plane 30 upon fastening the cylinder head (not shown) to the engine block (not shown). As such, the full beads 28 are assured of maintaining a generally constant, high sealing pressure against the distance layer 16 relative to the remaining portions of the functional layers 12, 14, thereby providing and maintaining a gas-tight seal about the circumference of the cylinder bore 26. In addition to maintaining the desired gas-tight seal about the cylinder bore 26, the beads 28, by not being over-compressed and completely flattened, remain free from the formation of premature fatigue cracks both during assembly and while in use.

[0023] The functional layers 12, 14 are constructed from a resilient metal, such as spring steel, for example, and can be provided having a thickness of about 0.1 to 0.3 mm, for example. The functional layers 12, 14, as shown in Figure 1, are constructed having mirrored profiles facing one another, with each having the aforementioned full beads 28 adjacent the cylinder bore 26, with half beads 34 extending to an outer periphery portion 36, such as may provide a fluid-tight seal adjacent a fluid passage, such as an oil or coolant passage 38, for example. The functional layers 12, 14 have generally planar main body portions 40 extending along the plane 30, with the full beads 28 extending axially outwardly from the plane 30 a predetermined distance D1. The beads 28 are formed radially outwardly from an inner periphery portion 41 that lies along the plane 30 and terminates at the respective cylinder bore 26 upon assembly. The half beads 34 extend axially outwardly from the plane 30 a predetermined distance D2. The full beads 28 each have circumferentially extending peaks 42 facing one another for gas-tight sealing abutment with the distance layer 16, while the half beads 34 each have plateaus or flat surfaces 44 facing one another and extending generally parallel to the plane 30 for fluid-tight sealing abutment with the distance layer 16. As such, the peaks 42 and flat surfaces 44 of each functional layer 14 extend outwardly from the plane 30 in the same direction. Upon being compressed between the cylinder head and engine block, neither the full beads 28 nor the half beads 34 are fully compressed to a flattened state.

Accordingly, both the full beads 28 and half beads 34 extend outwardly from the plane 30 and thus, remain elastically biased to retain their ability to established high sealing pressures to form gas and fluid-tight seals, respectively.

[0024] The distance layer 16 can be constructed from a relatively rigid metal material, such as cold rolled steel or stainless steel, for example. The distance layer 16 can be constructed having a symmetrical body 46 as viewed in radial cross-section such that the opposite sides 18, 20 are mirrored across a central plane CP. Each side 18, 20 extends along a first portion 48 having a first thickness (t1), wherein the thickness t1 is represented here as being the thickest portion of the distance layer 16. The first portion 48 extends radially outwardly to a second portion 50 having a second thickness (t2) that is less than the thickness t1. The second portion extends radially outwardly a predetermined distance to a third portion 52 having a third thickness (t3) that is less than t2. The third portion 52 extends to an opening 54 that facilitates sealing a fluid passage, such as the oil port or a coolant chamber 38, for example. It should be recognized that the respective thicknesses t1, t2, t3 of the first, second and third portions 48, 50, 52 can be varied circumferentially, such as by being stepped or having a smooth gradient, and further, that they can be varied in relation to respective thicknesses of other portions of the gasket 10 wherein more than one opening 22, 24 is formed in the functional and distance layers 12, 14, 16 to provide gas-tight seals about multiple cylinder bores 26. Given the distance layer is symmetrical as viewed in radial cross-section, it should be recognized that the relative thicknesses t1, t2 and t3 are centered relative to one another.

[0025] Upon assembly, the outer functional layers 12, 14 overlie the sandwiched intermediate distance layer 16. The inner periphery portions 41 overlie the first portion 48 of the distance layer 16; the beads 28 overlie the second portion 50 of the distance layer 16, and the half beads 34 overlie the third portion 52 of the distance layer 16. Upon fastening the cylinder head to the engine block, the peaks 42 of the beads 28 are compressed into sealing abutment against the second portion 50 to establish a high compression sealing pressure along the peaks 42 of the beads 28 to prevent combustion gas from leaking out from the respective cylinder bore 26. The beads 28 are assured of being at least partially compressed and not fully flattened, as the height D1 of the beads 28 is greater than the recessed depth [(t1-t2)/2] of the second portion 50, wherein the recessed depth can be about 10 to 20μm, by way of example and without limitation. In addition, the plateaus 44 of the half beads 34 are compressed against the third portion 52

to establish a high compression sealing pressure to prevent fluid from leaking out from oil ports or coolant chambers 38, for example. The half beads 34 are assured of being partially compressed and not fully flattened, as the height D2 of the half beads 34 is greater than the recessed depth [(t1-t3)/2] of the third portion 52, wherein the recessed depth of the third portion can be about 30-75μm, by way of example and without limitation. Further, yet, with the third portion 52 being further recessed from the second portion 50, such that the thickness t3 is less the thickness t2, the beads 28 are assured of remaining less than fully compressed, regardless of any distortion of the cylinder head upon being clamped to the engine block or while in use.

[0026] Figure 1A illustrates a multilayer gasket 10' constructed according to another aspect of the invention. The assembled structure of the gasket 10' is substantially the same as that of the previously discussed gasket 10, however, a distance layer 16' is constructed as a two-piece member from different pieces of material. The distance layer 16' has first, second and third portions 48', 50', 52' as discussed above, however, rather than being constructed of a single piece of the same material, the first and second portions 48', 50' are constructed as a single piece of the same material, such as from a material having a high yield strength, e.g. SS301/SS430 stainless steel, with their relative different thicknesses t1 and t2 being as described above. Meanwhile, the third portion 52' is constructed of a separate piece of material from the first and second portions 48, 50, and can also be formed of a different type of material, such as from a lower grade steel, e.g. SS430 stainless steel, with its reduced thickness t3 being as described above. As such, the third portion 52' can be formed from a sheet of material without having to reduce its thickness in a secondary operation, thereby improving manufacturing efficiencies. The material of the first and second portions 48', 50' can be fixed to the material of the third portion 52', such as via a weld joint (WJ). Accordingly, other than the distance layer 16' being constructed of two separate pieces of material, the multilayer gasket 10' is the same as described above for the multilayer gasket 10.

[0027] Figure 2 illustrates another multilayer gasket 110 constructed according to another aspect of the invention, wherein the same reference numerals used above offset by 100 are used to illustrate like features. The gasket 110 has a pair of functional layers 112, 114 arranged to abut opposite sides 118, 120 of a distance layer 116. The functional layers 112, 114 each have an opening 122 sized to register with an opening 124 in the distance layer 116, wherein the respective openings 122, 124 are each arranged

concentrically with one another to register with a cylinder bore 126. The functional layers 112, 114 each have full compression seal beads 128 extending outwardly from a plane 130 of the layers 112, 114 to facilitate establishing a gas-tight seal about the cylinder bore 126. A compression limiter, shown generally at 132, is formed in the functional layers 112, 114 adjacent the full beads 128 to prevent the full beads 128 from being completely flattened within the plane 130.

[0028] In contrast to the first embodiment, the distance layer 116 is not symmetrical as viewed in radial cross-section, but rather is asymmetrical, wherein the side 118 has stepped surfaces and the opposite side 120 is planar. In addition, the distance layer 116 has a first portion 148 with a first thickness t1 and a portion corresponding to a third portion 152 having a thickness t3, but it does not have an intermediate portion corresponding to the second portion 50 discussed above. Accordingly, the distance layer 116 has a single reduction in thickness from the first thickness t1 to the third thickness t3, wherein the reduction is formed in one side 118.

[0029] The functional layers 112, 114 are formed similarly to the functional layers 12, 14 above, including having full beads 128 and half beads 134, however, the compression limiter 132 is also integrated in the functional layers 112, 114, rather than in the distance layer 116. The compression limiter 132 is represented here, by way of example and without limitation, as being formed in the material and in the inner periphery portion 141 of the functional layers 112, 114, such as via an embossing process. The compression limiter 132 is shown here, for example, as being formed between the full bead 128 and the opening 122. The compression limiter 132 is provided by an undulating or sinuous form in radial cross-section having peaks 60 and valleys 62 facing away from one another on opposite sides of the functional layers 112, 114. The sinuous form has legs 64 extending between the peaks 60 and valleys 62, wherein the legs 64 extend at an angle of inclination from the plane 130 of the respective functional layer 112, 114. The angle of inclination of the legs 64 is such to provide sufficient rigidity and strength to prevent their being fully compressed under load between the cylinder and engine blocks. The sinuous form of the compression limiter 132 extends circumferentially about the opening 122 in the functional layer 112, 114 adjacent the full bead 128 and is arranged for engagement with the first portion 148 of the distance layer 116.

[0030] Upon assembly, the outer functional layers 112, 114 overlie the sandwiched intermediate distance layer 116. The inner periphery portions 141 overlie the first portion 148 of the distance layer 116. As such, the beads 128 and the compression limiters 132 overlie the first portion 148 of the distance layer 116, while the half beads 134 overlie the third portion 152 of the distance layer 116. Upon fastening the cylinder head to the engine block, the peaks 142 of the beads 128 are partially compressed against the first portion 148 to establish a high compression sealing pressure to prevent combustion gas from leaking out from the cylinder bore 126. The beads 128 are assured of only being partially compressed and not fully flattened as a result of the adjacent compression limiters 132. Accordingly, as noted above, the full beads 128 remain free from the formation of premature fatigue cracks during assembly and in use. In addition, the plateaus 144 of the half beads 134 are compressed against the third portion 152 to establish a high compression sealing pressure to prevent fluid from leaking out from oil ports or coolant chambers 138, for example.

[0031] Figure 3 illustrates a multilayer gasket 210 constructed in accordance with another aspect of the invention, wherein the same reference numerals used above offset by 200 are used to illustrate like features. The gasket 210 has the same general geometric configuration as the gasket 10, including having the same functional layers 212, 214 as the functional layers 12, 14, and a distance layer 216 with first, second and third portions 248, 250, 252 having respective thicknesses t1, t2, t3. However, the distance layer 216, rather than being constructed as a single piece of material as the distance layer 16, is constructed of separate first and second pieces, also referred to as portions, of material 70, 72. The first and second portions 70, 72, in construction, can be attached to one another, such as via a welding or crimping operation, for example, with each have a generally planar shape at the time of attachment. Then, the first portion 70 can be coined or stamped, and the second portion can be machined, such as in an electrochemical machining process, or otherwise. As such, by being constructed of separate pieces of material and being subsequently joined to one another, the gasket 210 can be constructed from individual pieces of material having a reduced thickness, thereby eliminating potential waste of material.

[0032] The first portion 70 of the distance layer 216 provides a main body 74, extending between the combustion chamber opening 224 in the distance layer 216 and a fluid opening 254. An annular recessed section 76 in the first portion 70 extends from

the opening 224 radially outwardly, wherein the recessed section 76 is sized to receive the second portion 72. The second portion 72, upon being received in the recessed section 76, extends axially outwardly from a surface 78 of the first portion 70 to provide a surface corresponding to the first and second portions 248, 250 for abutment with an inner periphery portion 241 and full bead 228 of the functional layer 212.

[0033] Figure 4 illustrates a multilayer gasket 310 constructed in accordance with another aspect of the invention, wherein the same reference numerals used above offset by 300 are used to illustrate like features. The gasket 310, as with the gasket 210, is constructed of separate first and second portions of material 370, 372. The gasket 310 has the same functional layers 312, 314 as the functional layers 112, 114, with a sinuous compression limiter 332 integrated in an inner periphery portion 341 of the functional layers 312, 314. Further, the gasket has a distance layer 316 that is symmetrical as viewed in radial cross-section with first and third portions 348, 352 having respective thicknesses t1, t3.

[0034] The outer functional layers 312, 314 overlie the sandwiched intermediate distance layer 316, with the inner periphery portions 341 overlying the first portion 348 of the distance layer 16. As such, the beads 328 and the compression limiters 332 overlie the first portion 348 of the distance layer 316, while the half beads 334 overlie the third portion 352 of the distance layer 316. Upon fastening the cylinder head to the engine block, the peaks 342 of the beads 328 are compressed against the first portion 348 to establish a high compression sealing pressure to prevent combustion gas from leaking out from the cylinder bore 326. The beads 328 are assured of only being partially compressed as a result of the adjacent compression limiters 332. Accordingly, the full beads 328 remain free from the formation of premature fatigue cracks during assembly and in use. In addition, the plateaus 344 of the half beads 334 are compressed against the third portion 352 to establish a high compression sealing pressure to prevent fluid from leaking out from oil ports or coolant chambers, for example, wherein the half beads are assured of not being fully flattened or compressed, as discussed above with regard to the previous embodiments.

[0035] Figure 5 illustrates a multilayer gasket 410 constructed in accordance with another aspect of the invention, wherein the same reference numerals used above offset by 400 are used to illustrate like features. The gasket 410 has a pair of outer functional layers 412, 414 and a sandwiched intermediate distance layer 416. The functional layer

412 is generally the same as the functional layer 12 discussed above in the first embodiment, and the functional layer 414 is generally the same as the functional layer 114 discussed above in the second embodiment. Correspondingly, the distance layer 416 has an upper side 418 arranged to abut the functional layer 412 and configured the same as the side 18 of the distance layer 16, and thus, having first, second and third portions 448, 450, 452 with respective thicknesses t1, t2, t3, wherein t1 is greater than t2, and t2 is greater than t3. Further, the distance layer 416 has a lower side 420 that is flat or planar and arranged for abutment with the functional layer 414. Accordingly, the gasket 410 is a hybrid of the gaskets 10, 110, providing the upper surface as described for the gasket 10 and the lower surface 420 as described for the gasket 110.

[0036] Figure 6 illustrates a multilayer gasket 510 constructed in accordance with another aspect of the invention, wherein the same reference numerals used above offset by 500 are used to illustrate like features. The gasket 510 is similar to the gasket 410, having outer functional layers 512, 514 configured the same as the functional layers 412, 414. Further, the gasket has a sandwiched intermediate distance layer 516 having first, second and third portions 548, 550, 552 with respective thicknesses t1, t2, t3, wherein t1 is greater than t2, and t2 is greater than t3. Further, the distance layer 516 has a side 518 configured generally the same as the side 418 for abutment with the functional layer 512. However, the distance layer 516 has an opposite side 520 with an inner periphery portion 541 having a recessed annular portion 80 configured for abutment with a sinuous compression limiter 532 on the functional layer 514. The recessed portion 80 has a depth that ensures engagement of the recessed portion 80 with the peaks of the compression limiter 532 while at the same time preventing full compression of a full bead 528 on the functional layer 514 during assembly and while in use. Accordingly, as with all the previous embodiments, the beads 528 of the functional layers 512, 514 remain less than fully compressed both during assembly and while in use, thereby maximizing the sealing pressures exerted by the beads 528 and preventing premature fatigue thereto.

[0037] Figure 7 illustrates a multilayer gasket 610 constructed in accordance with another aspect of the invention, wherein the same reference numerals used above offset by 600 are used to illustrate like features. The gasket 610, unlike all those previously discussed, has a single functional layer 614. The functional layer 614 is shaped generally the same as the functional layers 14, 214. Accordingly, the functional layer

614 has a full compression seal bead 628 formed radially outwardly from an opening 622 and radially outwardly from an inner periphery portion 641 that lies along a plane 630. The functional layer also has a half bead 634 formed to extend to an outer periphery portion 636, with the beads 628, 634 facing axially outwardly from the plane 630 in the same direction.

[0038] The gasket 610 further includes a distance layer 616 configured to lie partially along the plane 630 of the functional layer 614. The distance layer 616 has a first portion 648 forming an opening 624 substantially flush with the opening 622 of the functional layer 614 with the first portion 648 having a first thickness (t1), wherein the thickness t1 is the thickest portion of the distance layer 616. The first portion 648 extends radially outwardly from the opening 624 to a step that transitions to a second portion 650 having a second thickness (t2) that is less than the thickness t1. The second portion 650 is configured to start between the opening 622 and the full bead 628 of the functional layer 614, shown here as originating about midway between the opening 622 and the full bead 628. The second portion 650 extends across the full bead 628 to an outer periphery 654 that terminates between the full bead 628 and the half bead 634 of the functional layer 614, and is shown here as terminating about midway between the full bead 628 and the half bead 634. The second portion 650 conforms in contour with the full bead 628 as it extends across the full bead 628, and thus, undulates in mating abutment with the full bead 628. Accordingly, the gasket 610 has a thickest region as viewed in axial cross-section across the first thickness t1 of the first portion 648 between the opening 622 and the full bead 628. Further, the gasket 610 has an intermediate thickness region as viewed in axial cross-section across the second thickness t2 of the second portion 650 starting about midway between the opening 622 and the full bead 628 and extending to about midway between the full bead 628 and the half bead 634. Further, the gasket 610 has a minimum thickness region as viewed in axial cross-section across the functional layer 614 starting about midway between the full bead 628 and the half bead 634 and extending to the outer periphery portion 636. As such, the minimum thickness region is provided solely by the functional layer 614.

[0039] Figure 8 illustrates a multilayer gasket 710 constructed in accordance with another aspect of the invention, wherein the same reference numerals used above offset by 700 are used to illustrate like features. The gasket 710 has a single functional layer 714 shaped the same as the functional layer 614. Accordingly, the functional layer 714

has a full compression seal bead 728 formed radially outwardly from an opening 722 and radially outwardly from an inner periphery portion 741 that lies along a plane 730. The functional layer also has a half bead 734 formed to extend to an outer periphery portion 736, with the beads 728, 734 facing axially outwardly from the plane 730 in the same direction.

[0040] The gasket 710 further includes a distance layer 716 shaped similarly to the distance layer 616. Accordingly, the distance layer 716 has a first portion 748 with an opening 724 substantially flush with the opening 722 of the functional layer 714 with the first portion 748 having a first thickness (t1), wherein the thickness t1 is the thickest portion of the distance layer 716. The first portion 748 extends radially outwardly from the opening 724 to step that transitions to a second portion 750 having a second thickness (t2) that is less than the thickness t1. The second portion 750 is configured to start between the opening 722 and the full bead 728 of the functional layer 714, shown here as originating about midway between the opening 722 and the full bead 728. The second portion 750 extends across the full bead 728 to an outer periphery 754 that terminates between the full bead 728 and the half bead 734 of the functional layer 714, and is shown here as terminating about midway between the full bead 728 and the half bead 734. However, unlike the previous distance layer 616, the distance layer is placed against an opposite side of the functional layer 614. As such, the second portion 750 is a flat, planar construction that extends across a valley of the full bead 728, and does not conform in contour with the full bead 728. Accordingly, the second portion 750 traverses the undulation of the full bead 728 without conforming therewith. As with the previous gasket 610, the gasket 710 has a thickest region as viewed in axial cross-section across the first thickness t1 of the first portion 748 between the opening 722 and the full bead 728. Further, the gasket 710 has an intermediate thickness region as viewed in axial cross-section across the second thickness t2 of the second portion 750 starting about midway between the opening 722 and the full bead 728 and extending to about midway between the full bead 728 and the half bead 734. Further, the gasket 710 has a minimum thickness region as viewed in axial cross-section across the functional layer 714 starting about midway between the full bead 728 and the half bead 734 and extending across the half bead 734. As such, as with the functional layer 614, the minimum thickness region is provided solely by the functional layer 714.

[0041] Figure 9 illustrates a multilayer gasket 810 constructed in accordance with yet another aspect of the invention, wherein the same reference numerals used above offset by 800 are used to illustrate like features. The gasket 810 has a single functional layer 814 shaped similar to the functional layers 614, 714, however, the functional layer has a stepped portion formed in an inner periphery portion 841. Otherwise, the functional layer 814 is the same as the functional layers 614, 714. Accordingly, the functional layer 814 has a full compression seal bead 828 formed radially outwardly from an opening 822 and radially outwardly from the inner periphery portion 841 that lies partially along a plane 830, with the stepped portion extending axially outwardly from the plane 830 in the same direction as the full bead 828, however, not to the extent of a peak 842 of the full bead 828. Accordingly, an upper surface of the stepped portion lies between the plane 830 and a plane tangent to the peak 842 of the full bead 828. The functional layer 814 also has a half bead 834 formed to extend to an outer periphery portion 836, with the beads 828, 834 facing outwardly from the plane 830 in the same direction.

[0042] The gasket 810 further includes a distance layer 816 shaped the same as the distance layer 716. Accordingly, the distance layer 816 has a first portion 848 forming an opening 824 substantially flush with the opening 822 of the functional layer 814 with the first portion 848 having a first thickness (t1), wherein the thickness t1 is the thickest portion of the distance layer 816. The first portion 848 extends radially outwardly from the opening 824 to a step that transitions to a second portion 850 having a second thickness (t2) that is less than the thickness t1. The second portion 850 is configured to start between the opening 822 and the full bead 828 of the functional layer 814, shown here as originating about midway between the opening 822 and the full bead 828. The second portion 850 extends across the full bead 828 to an outer periphery 854 that terminates between the full bead 828 and the half bead 834 of the functional layer 814, and is shown here as terminating about midway between the full bead 828 and the half bead 834. As with the distance layer 716, the distance layer 816 is arranged to abut the opposite side of the functional layer 614 from which full and half beads 828, 834 extend. The notable difference with the gasket 810 from the gasket 710 is that the stepped, first thickness t1 of the first portion 848 faces and is received in the stepped region of the functional layer 814. As with the previous gaskets 610, 710, the gasket 810 has a thickest region as viewed in axial cross-section across the first thickness t1 of the first portion 848 between the opening 822 and the full bead 828. Further, the gasket 810 has

an intermediate thickness region as viewed in axial cross-section across the second thickness t2 of the second portion 850 starting about midway between the opening 822 and the full bead 828 and extending to about midway between the full bead 828 and the half bead 834. Further, the gasket 810 has a minimum thickness region as viewed in axial cross-section across the functional layer 814 starting about midway between the full bead 828 and the half bead 834 and extending across the half bead 834. As such, the minimum thickness region is provided solely by the functional layer 814.

[0043] Figure 10 illustrates a multilayer gasket 910 constructed in accordance with yet another aspect of the invention, wherein the same reference numerals used above offset by 900 are used to illustrate like features. The gasket 910 has three functional layers 912, 912' and 914, and a distance layer 916. The functional layers 912, 914 are configured and arranged essentially the same as discussed above with respect to the functional layers 12, 14. Accordingly, the functional layers 912, 914 are arranged to abut opposite sides 918, 920 of the distance layer 916, such that the distance layer 916 is sandwiched between the functional layers 12, 14. Meanwhile, the functional layer 912' overlies and abuts the functional layer 912. The functional layers 912, 912', 914 each have an opening 922 sized to register with an opening 924 in the distance layer 916, wherein the respective openings are each arranged with one another to register with a cylinder bore 926. The functional layers 912, 914 each have full compression seal beads 928 extending outwardly from a plane 30 of the layers 12, 14 to facilitate establishing a gas-tight seal about the cylinder bore 926. The functional layer 912' also has a full compression bead 928' sized generally the same as the other functional beads 928 and configured to align opposite the functional bead 928 of the functional layer 912.

[0044] The distance layer 916, rather than being constructed having a symmetrical geometry as viewed in radial cross-section, is constructed having an asymmetrical geometry as viewed in radial cross-section. As with the embodiment of Figure 1, each side 918, 920 extends radially outwardly from the opening 924 along a first portion 948 having a first thickness (t1), wherein the thickness t1 is the thickest portion of the distance layer 916. The first portion 948 extends radially outwardly to a second portion 950 having a second thickness (t2) that is less than the thickness t1, and the second portion 950 extends radially outwardly a predetermined distance to a third portion 952 having a third thickness (t3) that is less than t2. The third portion 952 extends to an opening 54 that facilitates sealing a fluid passage, such as the oil port or a coolant

chamber 38, for example. The thicknesses t1 and t2 of the respective first and second portions 948, 950 are offset relative to one another as viewed in radial cross-section. As such, a step height difference is provided on opposite sides of the distance layer 916. For example, a first step height (S1) is provided on one side and a step height (S2) is provided on the opposite side, wherein S1 is greater than S2. In one preferred embodiment, S1 is twice the height of S2, wherein the bead heights 928, 928' are generally the same. It should be recognized that the relative heights of the steps S1 and S2 can be otherwise configured and that the relative heights of the beads 928, 928' can be otherwise configured.

[0045] Upon assembly, the abutting functional layers 928, 928' are arranged such that their respective full bead 928, 928' are aligned in mirrored relation with one another, with their respective peaks 948, 948' facing away from one another. With the gasket 910 having two abutting functional layers 912, 912' with oppositely facing full beads arranged to abut the second portion 950, and a third functional layer 914 having a full bead arranged to abut an opposite side of the second portion 950, a greater dynamic gap formed between the cylinder head and the engine block in use can be sealed against gas leaks from the cylinder bore 926.

[0046] Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A multilayer metal static cylinder head gasket configured to establish a seal between a cylinder head and an engine block, comprising:

a metal functional layer having an outer periphery and an inner periphery forming an opening configured to surround a cylinder bore and a full compression bead radially outwardly from and circumferentially surrounding said opening, said full compression bead extending out of a plane of said functional layer a predetermined first distance;

a metal distance layer having a first portion with a first thickness extending to an opening configured to register with said opening of said functional layer and a second portion extending radially outwardly from said first portion with said second portion having a second thickness that is less than said first thickness; and

a compression limiter provided by at least one of said functional layer or said distance layer, said compression limiter preventing said full compression bead from being completely flattened between the cylinder head and engine block, said compression limiter of said functional layer having a sinuous form as viewed in radial cross-section with peaks extending away from one another on opposite sides of said functional layer, said sinuous form extending circumferentially about said functional layer opening adjacent said full compression bead for engagement with said first portion of said distance layer, said compression limiter of said distance layer having at least one of a third portion adjacent said second portion with said second portion being between said first and third portions, said third portion having a third thickness that is less than said second thickness or an outer periphery terminating between said full bead and said outer periphery of said functional layer.

2. The multilayer metal static cylinder head gasket of claim 1 wherein said distance layer has separate pieces of material attached to one another.

3. The multilayer metal static cylinder head gasket of claim 2 wherein one piece of material forms said third portion and another piece of material forms at least part of said first and second portions.

4. The multilayer metal static cylinder head gasket of claim 3 wherein said first and second portions are formed of said another piece of material.

5. The multilayer metal static cylinder head gasket of claim 4 wherein said one piece of material and said another piece of material are different types of material.

6. The multilayer metal static cylinder head gasket of claim 1 wherein said distance layer is symmetrical in radial cross-section.

7. The multilayer metal static cylinder head gasket of claim 6 wherein said distance layer has said third portion.

8. The multilayer metal static cylinder head gasket of claim 1 wherein said distance layer is asymmetrical in radial cross-section.

9. The multilayer metal static cylinder head gasket of claim 8 wherein said distance layer has said third portion.

10. The multilayer metal static cylinder head gasket of claim 9 wherein said distance layer has opposite sides with one of said sides being planar.

11. The multilayer metal static gasket of claim 9 wherein said second portion and said third portion are symmetrical in radial cross-section.

12. The multilayer metal static gasket of claim 11 wherein said distance layer has opposite sides and further comprising a pair of functional layers abutting one another on one side of said distance layer and another functional layer abutting said distance layer on the other side of said distance layer.

13. The multilayer metal static gasket of claim 12 wherein said pair of functional layers have full compression beads facing away from one another in mirrored relation with one of said full compression beads abutting said second portion of said distance layer and said another functional layer having a full compression bead abutting said second portion.

14. The multilayer metal static cylinder head gasket of claim 1 wherein said full compression bead abuts said second portion of said distance layer.

15. The multilayer metal static cylinder head gasket of claim 14 wherein said functional layer has a half bead extending to said outer periphery.

16. The multilayer metal static cylinder head gasket of claim 15 wherein said half bead abuts said third portion.

17. The multilayer metal static cylinder head gasket of claim 14 further comprising a pair of said functional layers with said distance layer sandwiched between said functional layers.

18. The multilayer metal static cylinder head gasket of claim 17 wherein at least one of said functional layers has said compression limiter.

19. The multilayer metal static cylinder head gasket of claim 1 wherein said distance layer outer periphery terminates between said full bead and said outer periphery of said functional layer.

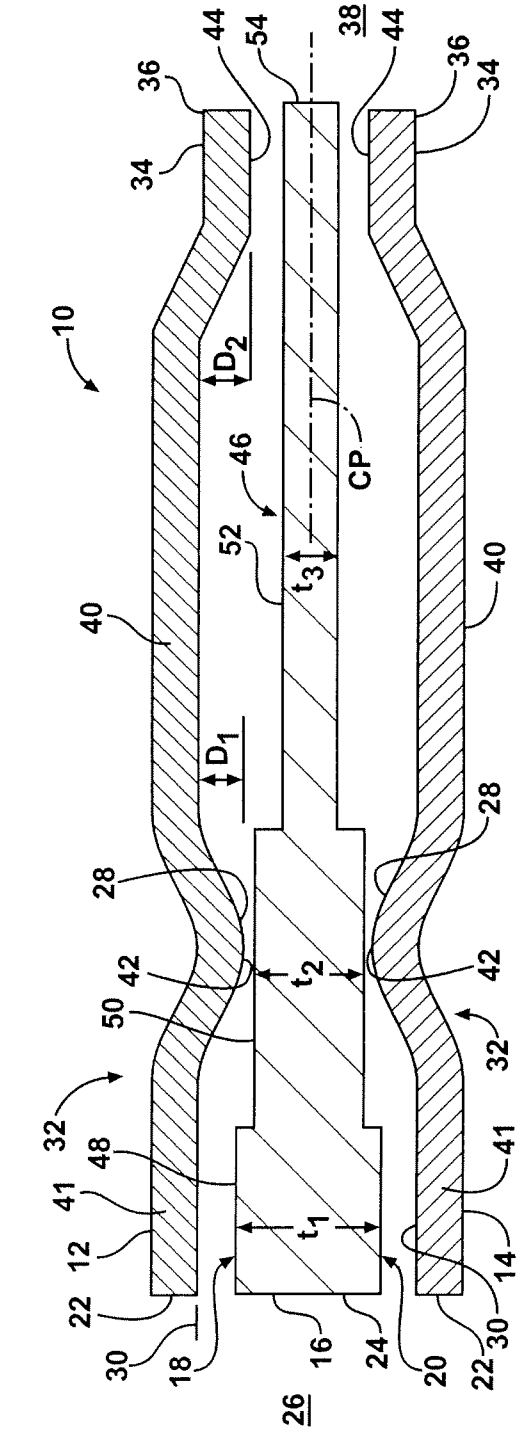

10
34
36
44
54
38
44
36
34
D_2
CP
46
52
t_3
40
40
D_1
28
28
42
t_2
42
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t_1
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22
30
14
26

FIG. 1

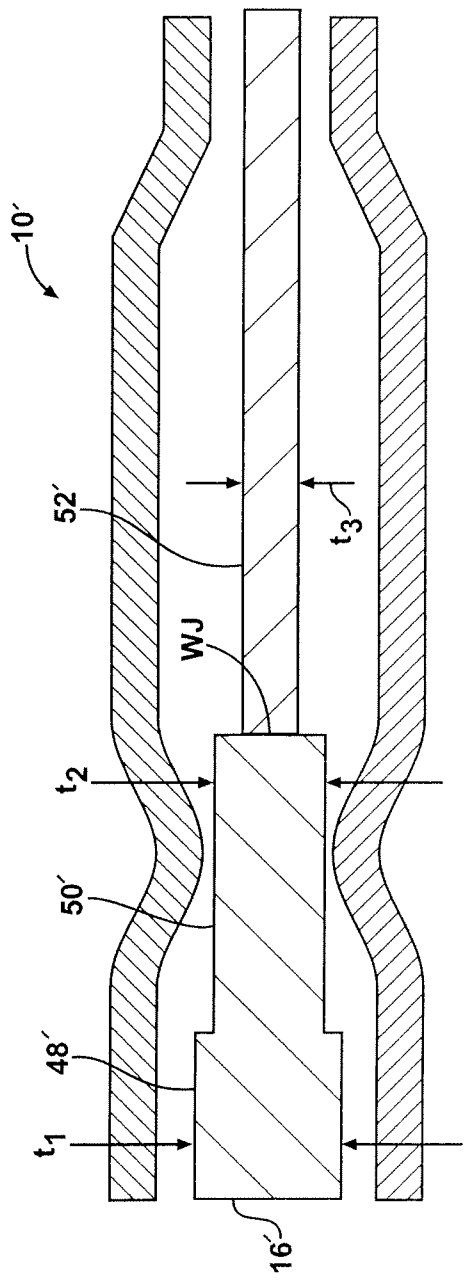

10′
52′
t_3
WJ
t_2
50′
48′
t_1
16′

FIG. 1A

FIG. 2

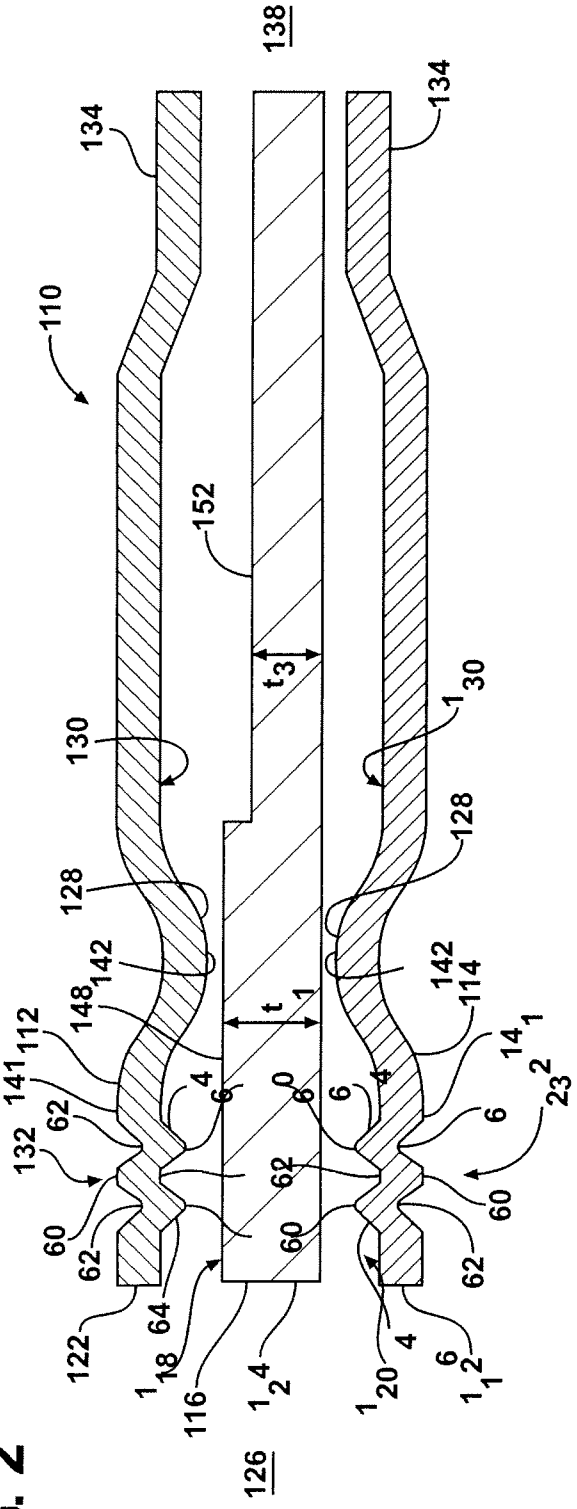
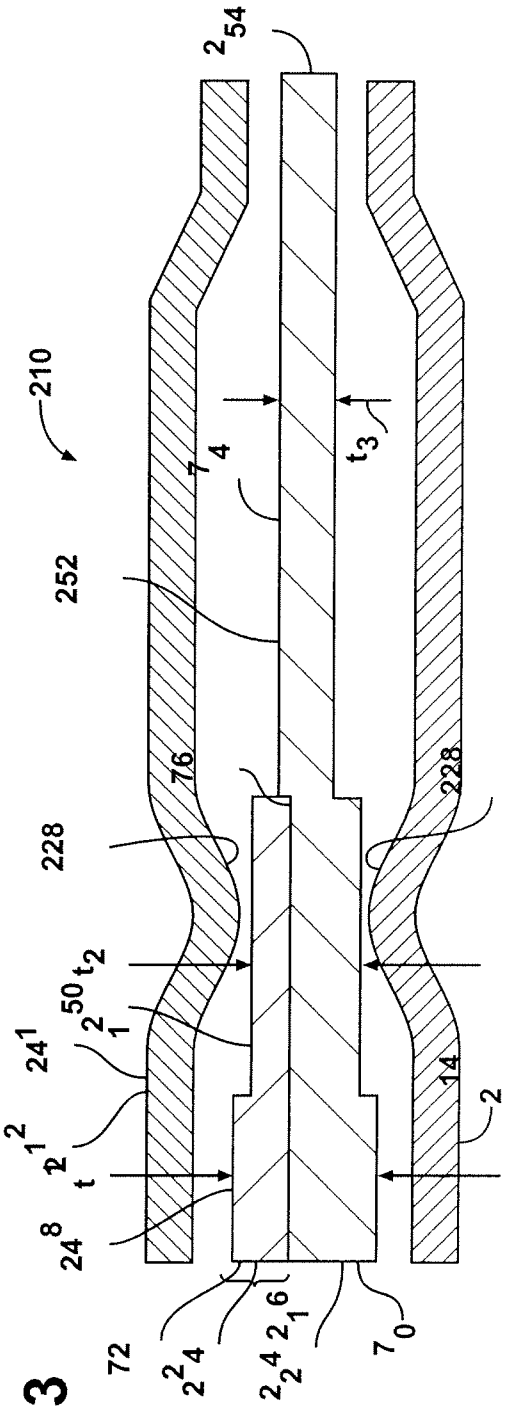

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134
138
152
130
128
142
148
112
141
62
132
60
122
64
116
126
t_3
t_1
114
23
14
t_2
50
24
72
76
252
254
210
228
14
2
70

FIG. 3


210
254
252
74
t_3
76
228
t_2
50
241
212
t
248
224
226
70

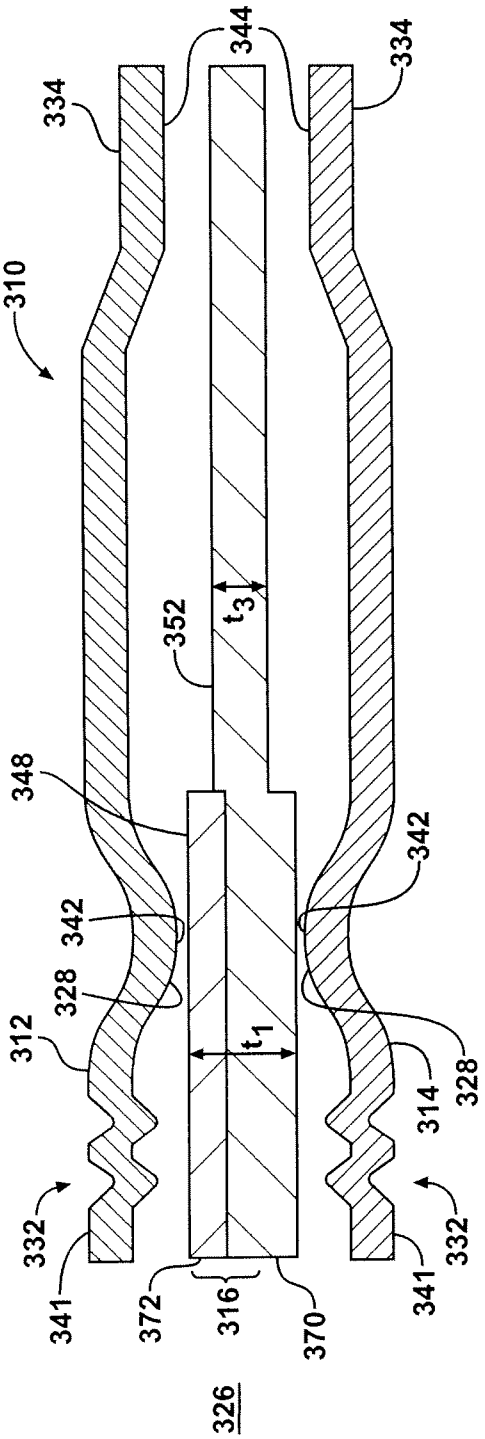

310
334
344
334
352
t_3
348
342
342
328
312
t_1
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314
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332
341
372
316
370
341
326

FIG. 4

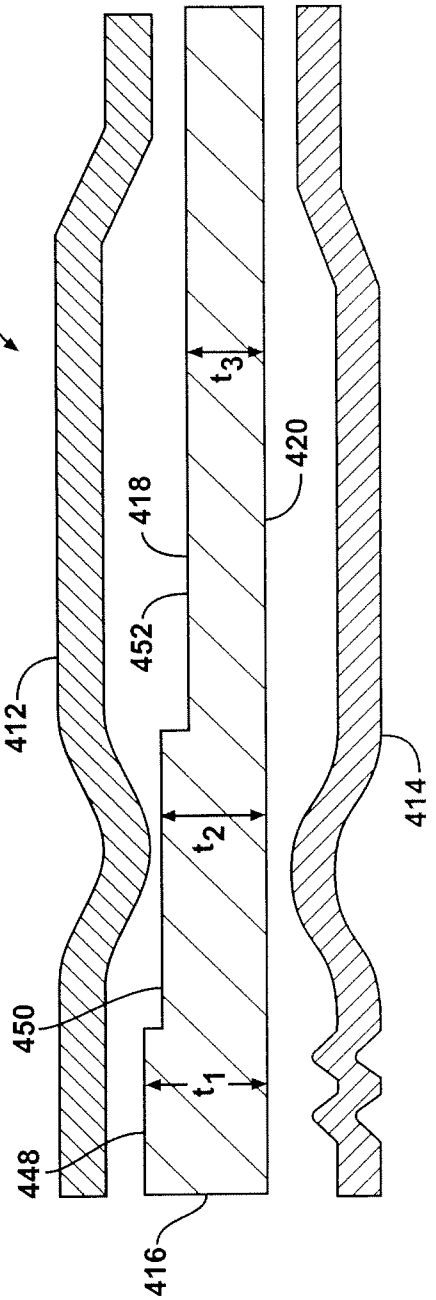

410
t_3
420
418
452
412
414
t_2
450
t_1
448
416

FIG. 5

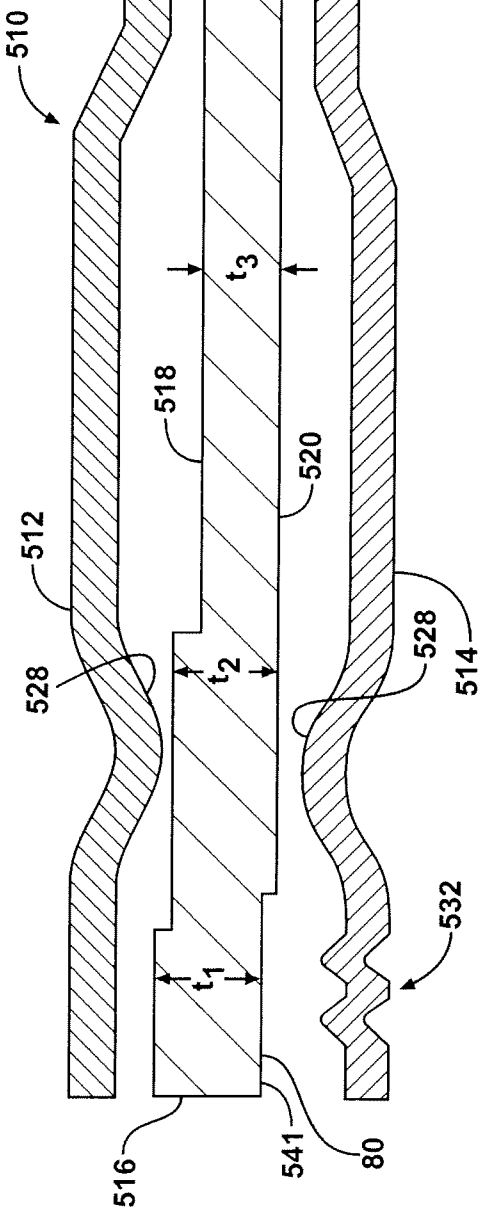


FIG. 6

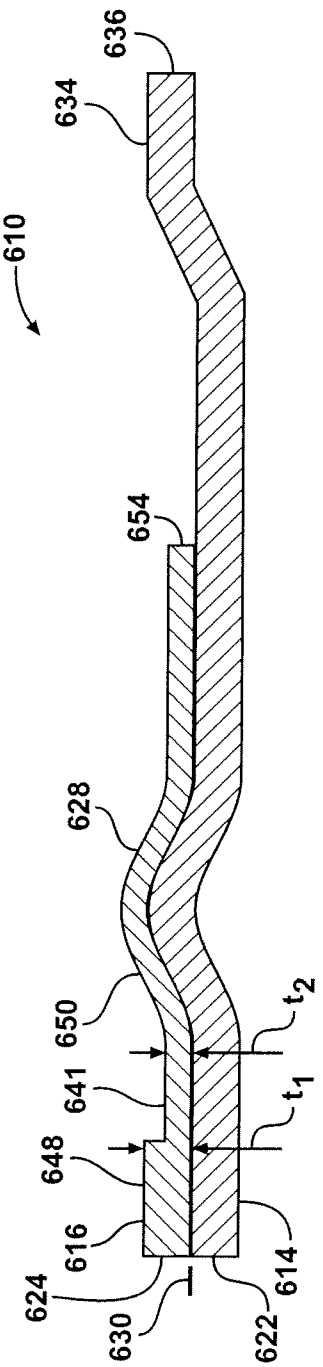


FIG. 7

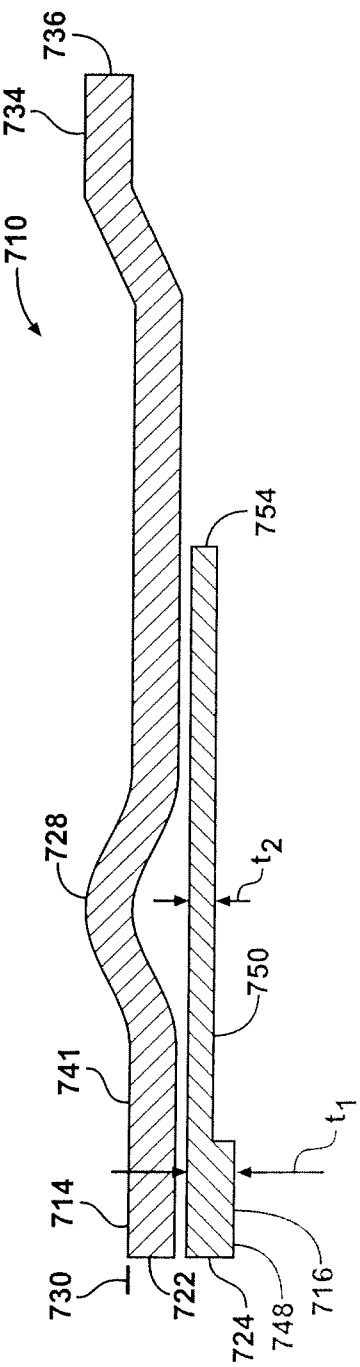


FIG. 8

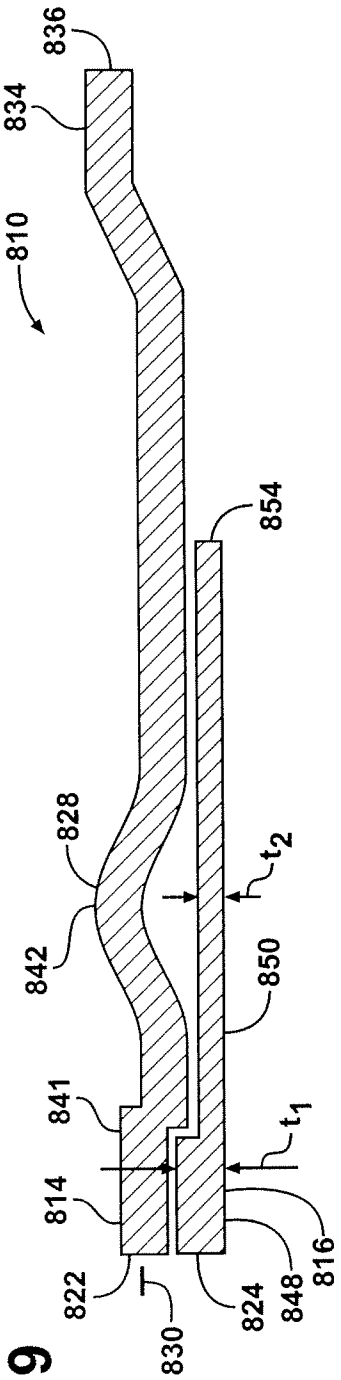

836
834
810
854
828
842
t_2
850
841
t_1
814
816
822
848
824
830

FIG. 9

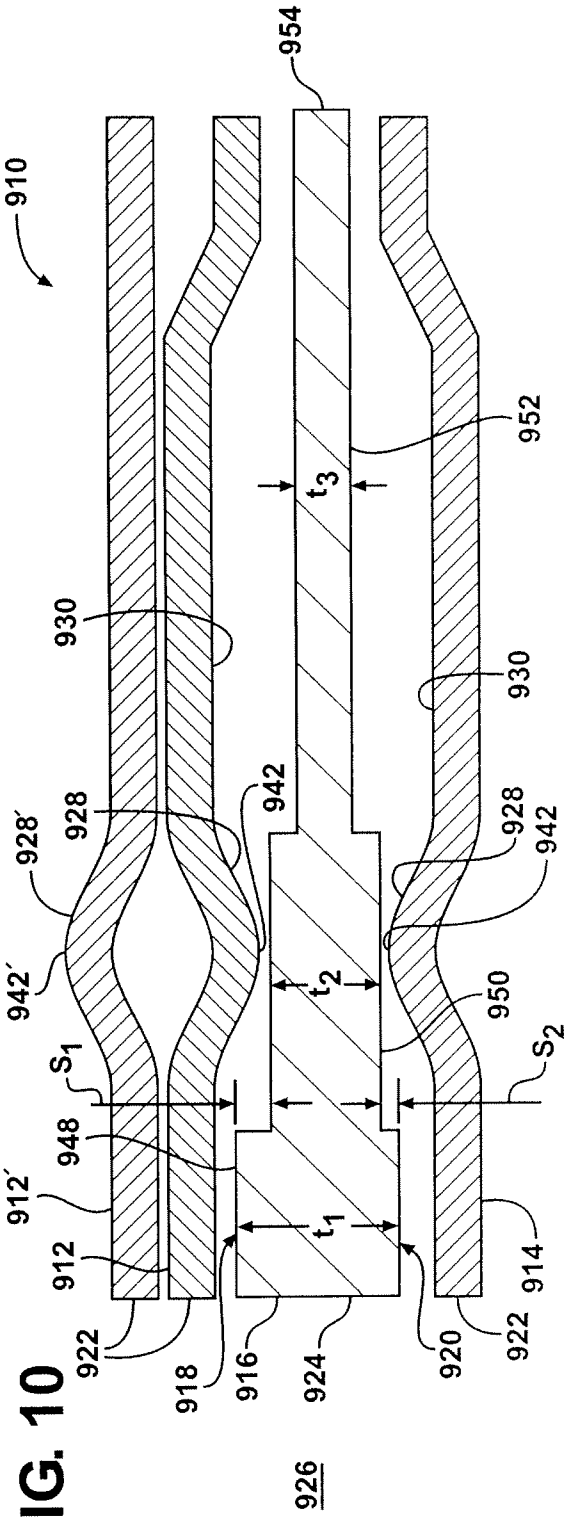

954
910
952
t_3
930
930
928'
928
942
928
942
942'
t_2
950
S_1
S_2
948
912'
t_1
912
914
922
918
916
924
920
922
926

FIG. 10