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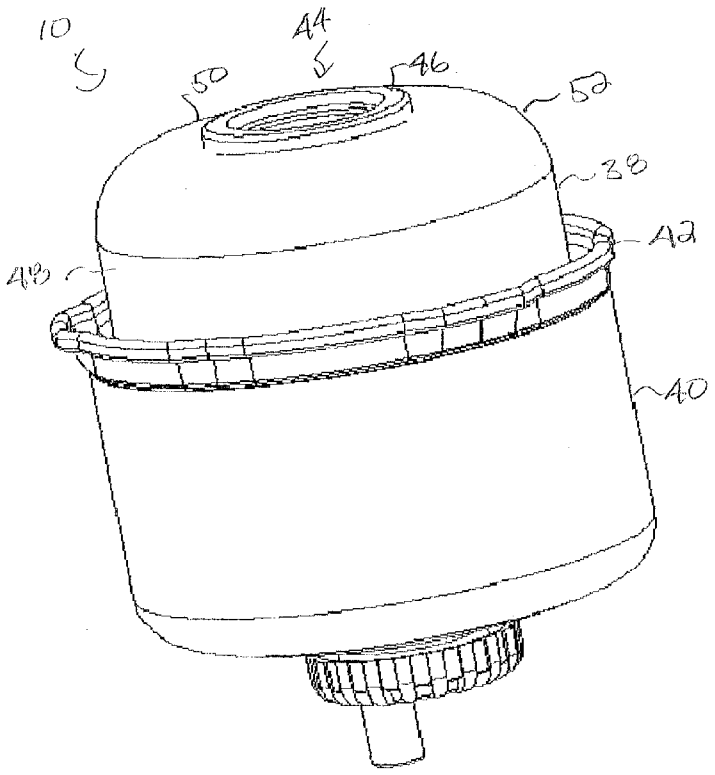
(54) Title: PRESSURE RESISTANT FILTER CARTRIDGE



(57) Abstract: A fuel filter cartridge includes a housing having first and second shell sections. The shell sections are generally symmetric about a cartridge axis and joined together. The first shell section has a convex-shape when viewed from a side and includes an end portion, a cylindrical side wall portion, and a transition portion connecting the side wall portion to the end portion. The end portion has an end surface forming a cartridge opening coaxial with the cartridge axis. The transition portion has a radius of 0.125-1.125 inches. A filter having at least one filter element is disposed within the housing.

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PRESSURE RESISTANT FILTER CARTRIDGE

Background

[0001] This invention relates generally to devices for filtering and separating liquids. More particularly, the present invention relates to fuel filters for removing foreign particles and separating water from fuel of the fuel supply system of an internal combustion engine.

[0002] The absence of high standards of quality control in diesel fuel supplies dictates that an effective fuel filter be incorporated into the fuel supply system for a diesel engine. It is not uncommon for diesel fuel to have significant quantities of abrasive particles and water. The abrasive particles present the potential for permanent damage to components of the fuel injection pump. The abrasive particles can also adversely effect the performance of the pump by destroying the ability of the fuel injection pump to precisely meter and deliver fuel at high pressures. The presence of water in the diesel fuel supply can cause rusting of engine components, and during freezing conditions, can result in interruption of the fuel injection system and/or seizure of moving components.

[0003] A number of conventional fuel filters perform the dual function of removing particulate material from the diesel fuel and separating water from the fuel. Commonly, the fuel filters employ a disposable filter cartridge which is replaced at pre-established intervals of filter usage. U.S. Pat. No. 6,471,070 assigned to the assignee of the present invention, discloses such a fuel filter. When the fuel filters are installed in a fuel line having relatively high fuel pressure, the substantially planar upper surface of the top cap of these conventional filter cartridges has a tendency to bulge upward. The displacement of the top cap upper surface can result in fuel leakage and/or cause binding of the retainer collar mounting the filter cartridge to the filter base.

Summary

[0004] There is provided a fuel filter cartridge comprising a housing including opposing first and second shell sections. The shell sections are generally symmetric about a cartridge axis and joined together. The first shell section has a convex-shape when viewed from a side and comprises an end portion, a cylindrical side wall portion, and a transition portion connecting the side wall portion to the end portion. The end portion has an end surface forming a cartridge opening substantially coaxial with said cartridge axis. The transition portion has a radius of 0.125-1.125 inches. A filter having at least one filter element is disposed within the housing.

[0005] The transition portion may have a radius of 0.5-0.625 inches.

[0006] The first section end portion also includes a clip element having a substantially cylindrical inner side wall segment that defines the cartridge opening. An outer rim segment extends axially inward and radially inward from the end surface to the inner side wall segment first end section.

[0007] The clip element also has a circumferential lip segment extends radially outward from the inner side wall segment second end section.

[0008] The filter cartridge may also comprise a sealing grommet mounted within the cartridge opening. The sealing grommet includes an upper shoulder extending radially over the clip element outer rim segment and a lower shoulder extending radially under the clip element lip segment.

[0009] The sealing grommet may also include a recess surface disposed intermediate the upper and lower shoulders. The recess surface engages the clip element inner side wall segment.

[0010] The sealing grommet may also include an inner wall defining a bore and at least one seal protrusion extending radially inward from the inner wall. The seal protrusion has a substantially triangular cross-sectional shape.

Brief Description of the Drawings

[0011] The present disclosure may be better understood and its numerous objects and advantages will become apparent to those skilled in the art by reference to the accompanying drawings in which:

[0012] Figure 1 is a perspective view of a conventional fuel filter;

[0013] Figure 2 is an enlarged sectional view of the top cap of the fuel filter of Figure 1;

[0014] Figure 3 is a perspective view of a pressure resistant filter cartridge in accordance with the disclosure;

[0015] Figure 4 is a sectional view of the filter cartridge enclosure of Figure 3;

[0016] Figure 5 is an enlarged perspective view of the filter cartridge enclosure top cap of Figure 3;

[0017] Figure 6 is a sectional view of the top cap of Figure 5;

[0018] Figure 7 is a perspective view of a variation of the filter cartridge enclosure top cap of Figure 3;

[0019] Figure 8 is a sectional view of the top cap of Figure 7;

[0020] Figure 9 is an enlarged view of area IX of Figure 4;

[0021] Figure 10 is a stress analysis of the top cap of Figure 2 showing the stress distribution at 41 psi; and

[0022] Figure 11 is a stress analysis of the top cap of Figure 4 showing the stress distribution at 150 psi.

Detailed Description

[0023] With reference to the drawings wherein like numerals represent like parts throughout the several figures, a pressure resistant filter cartridge in accordance with the present disclosure is generally designated by the numeral 10. The filter cartridge 10 is especially adapted for incorporation into the fuel supply system of an internal combustion engine (not illustrated), such as a diesel engine, for removing particulate matter from fuel and separating the water from the fuel.

[0024] The filter cartridge 10 is removably mounted to a filter base by means of a retainer collar in a manner similar to that of the filter cartridge of U.S. 6,471,070 hereby incorporated by reference. As shown therein, the base is an inverted cup-like receptacle which forms a skirt defining a lower receiving cavity for upper portions of the filter cartridge 10. An elongated sleeve-like inner conduit and an outer concentric sleeve-like conduit extend axially downward from the center of the base. The conduits provide generally coaxial fluid communication between the base and the disposable cartridge. An inlet connector connects with the fuel line to provide fluid communication through the conduit, an upper chamber of the filter cartridge, and an interior passageway. An outlet connector connects with the fuel line to provide external fluid communication from conduit.

[0025] With reference to Figure 1, conventional filter cartridges 12 comprise a can-like enclosure formed by a pair of opposed upper and lower sections 14, 16 that are joined along a circumferential roll seam 18. The upper section, or top cap 14, which is smaller in diameter than the lower section 16, is received by the base receptacle. The upper section 14 is dimensioned to be closely accommodated in the base receptacle. A central axial opening 20 in the upper section 14 is dimensioned to receive the second and first conduits, respectively. A sealing grommet 22 mounted at the opening 20 in the upper section 14 diametrically fluidically seals against outer conduit.

[0026] The filter cartridge 12 employs a filter element having a continuous fan-like configuration. The inner surface of the lower section and the outer surface of the filter element media create one fuel plenum. The inner surface of the primary filter element media and the outer surface of an inner cylinder of the primary filter element create a second fuel plenum. Passages at the bottom of the two plenums provide fluid communication with the inner and outer conduits.

[0027] With additional reference to Figure 2, the upper surface 24 of the top cap 14 of the conventional filter cartridge 12 acts as a substantially planar surface in spite of having an upwardly extending outer protrusion 26, a downwardly extending

intermediate protrusion 28 and a planar inner flange 30. The edge 32 of the inner flange 30 forms the axial opening 20 in which the sealing grommet 22 is mounted, with the edge 35 being received within a circumferential recess 34 in the outer wall 36 of the sealing grommet 22. When fuel filters of this type are installed in a fuel line having relatively high fuel pressure, the upper surface 24 of the top cap 14 has a tendency to bulge upward. Due to their relatively short height and small radius, the protrusions 26, 28 do not provide sufficient mechanical strength to resist the force exerted by the high pressure fuel. The displacement of the top cap upper surface 24 may pull the inner flange edge 32 out of the sealing grommet recess 34, allowing fuel to leak between the inner flange 30 and the sealing grommet 22. The displacement can also cause the top cap 14 to exert force on the inner surface of the filter base, biasing the filter cartridge away from the filter base and thereby binding the retainer collar mounting the filter cartridge to the filter base.

[0028] With reference to Figures 3-6, the enclosure of a pressure resistant filter cartridge 10 in accordance with the present disclosure comprises an enclosure formed by a pair of opposed upper and lower sections 38, 40 that are joined along a circumferential roll seam 42. Similar to the conventional filter cartridge 12, the upper section, or top cap 38, is received by the base receptacle. A central opening 44 in the top cap 38 is coaxial with axis 45 and dimensioned to receive the second and first conduits, respectively. A sealing grommet 46 mounted at the opening 44 in the top cap 38 diametrically fluidically seals against outer conduit.

[0029] The top cap 38 has a convex-shape when viewed from the side. More specifically, the side wall portion 48 of the top cap 38 is joined to the top portion 50 of the top cap 38 by an arcuate transition portion 52 having a large radius compared to the radius of the outer protrusion 26 of the conventional filter cartridge 12. The radius 54 of the transition portion 52 may be 0.125-1.125 inches, and preferably is 0.5-0.625 inches.

[0030] Experimentally, it has been shown that changing the shape of the top cap 38 provides a significant increase in the yield stress over that of the conventional

top cap 14. In one set of tests, Figures 10 and 11, the pressure required to cause failure of the top cap structure increased from 41 psi (for conventional top cap 14) to 150 psi (for the subject top cap 38).

[0031] With additional reference to Figure 9, the top portion 50 of the top cap 38 includes an inner clip element 56 instead of the planar inner flange 30 of the conventional filter cartridge top cap 14. The clip element 56 has an outer rim 58 that extends axially inward and downward from the top surface 50 to a substantially cylindrical inner side wall segment 60. The side wall segment 60 extends axially downward to a circumferential lip segment 62 that extends radially outward from lower end 64 of the side wall segment 60.

[0032] The outer surface 66 of the sealing grommet 46 includes circumferential upper and lower shoulders 68, 70 separated by a circumferential intermediate recess 72. As shown in Figure 9, the clip element side wall segment 60 is positioned in the sealing grommet recess 72, with the upper shoulder 68 extending radially over the clip element outer rim 58 and the lower shoulder 70 extending radially under the clip element lip segment 62. The bore 74 of the sealing grommet may include one or more seal protrusions 76 extending radially inward from the inner wall 78 of the sealing grommet 46. The seal protrusions 76 may have a substantially triangular cross-sectional shape, whereby the outer surface of the outer conduit elastically deforms the seal protrusions 76 when the filter cartridge 10 is installed to provide a fluid-tight seal.

[0033] It should be appreciated that when the fuel system is operating and high pressure fuel applies force to the inner surface of the top cap 38, the clip element side wall segment 60 is biased radially inward by this force. If the fuel pressure force is sufficient, the clip element side wall segment 60 pivots about the clip element outer rim 58 and is forced into firmer engagement with surface of the sealing grommet recess 72. Accordingly, any displacement of the top cap 38 caused by the high pressure fuel promotes improvement of the fluid-tight seal

between the top cap 38 and the sealing grommet 46 rather than causing the top cap 38 to separate from the sealing grommet 46.

[0034] The filter cartridge 10 may assume a wide variety of configurations. For example, in the variation shown in Figures 7 and 8, the outer lip 80' of the top cap 38' utilized in forming the roll seam 42 with the lower section 40 is substantially circular compared to the scalloped outer lip 80 of the top cap 38 of Figures 1-6.

[0035] It will be appreciated that variations of the above-disclosed and other features and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. Also that various presently unforeseen or unanticipated alternatives, modifications, variations or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

What is claimed is:

1. A filter cartridge comprising:

a housing including opposing first and second shell sections, the shell sections being generally symmetric about a cartridge axis and being joined together, the first shell section having a convex-shape when viewed from a side, the first shell section comprising:

an end portion having an end surface defining a cartridge opening substantially coaxial with said cartridge axis,

a cylindrical side wall portion, and

a transition portion connecting the side wall portion to the end portion, the transition portion having a radius of 0.125-1.125 inches; and

a filter disposed within the housing, the filter including at least one filter element.

2. The filter cartridge of claim 1 wherein the transition portion has a radius of 0.5-0.625 inches.

3. The filter cartridge of claim 1 wherein the first section end portion also includes a clip element having:

a substantially cylindrical inner side wall segment having oppositely disposed first and second end sections, the inner side wall segment defining the cartridge opening; and

an outer rim segment extending axially inward and radially inward from the end surface to the inner side wall segment first end section.

4. The filter cartridge of claim 3 wherein the clip element also has a circumferential lip segment extends radially outward from the inner side wall segment second end section.

5. The filter cartridge of claim 4 further comprising a sealing grommet mounted within the cartridge opening, the sealing grommet comprising:

an upper shoulder extending radially over the clip element outer rim segment; and

a lower shoulder extending radially under the clip element lip segment.

6. The filter cartridge of claim 5 wherein the sealing grommet also comprises a recess surface disposed intermediate the upper and lower shoulders, the recess surface engaging the clip element inner side wall segment.

7. The filter cartridge of claim 5 wherein the sealing grommet also comprises:

an inner wall defining a bore; and

at least one seal protrusion extending radially inward from the inner wall.

8. The filter cartridge of claim 7 wherein the seal protrusion has a substantially triangular cross-sectional shape.

9. A filter cartridge housing comprising first and second shell sections, the shell sections being generally symmetric about a cartridge axis and being joined together, the first shell section having a convex-shape when viewed from a side and comprising:

an end portion including

an end surface,

clip element having

a substantially cylindrical inner side wall segment having oppositely disposed first and second end sections, the inner side wall segment defining a cartridge opening substantially coaxial with said cartridge axis,

an outer rim segment extending axially inward and radially inward from the end surface to the inner side wall segment first end section, and

a circumferential lip segment extending radially outward from the inner side wall segment second end section;

a cylindrical side wall portion;

a transition portion connecting the side wall portion to the end portion, the transition portion having a radius of 0.125-1.125 inches; and

a sealing grommet mounted within the cartridge opening

10. The filter cartridge housing of claim 9 wherein the transition portion has a radius of 0.5-0.625 inches.

11. The filter cartridge housing of claim 9 wherein the sealing grommet comprises:

an upper shoulder extending radially over the clip element outer rim segment;

a lower shoulder extending radially under the clip element lip segment;

an outer recess surface disposed intermediate the upper and lower shoulders; and

an inner wall defining a bore.

12. The filter cartridge of claim 11 wherein the recess surface engages the clip element inner side wall segment.

13. The filter cartridge of claim 11 wherein the sealing grommet also comprises at least one seal protrusion extending radially inward from the inner wall.

14. The filter cartridge of claim 13 wherein the seal protrusion has a substantially triangular cross-sectional shape.

Prior Art

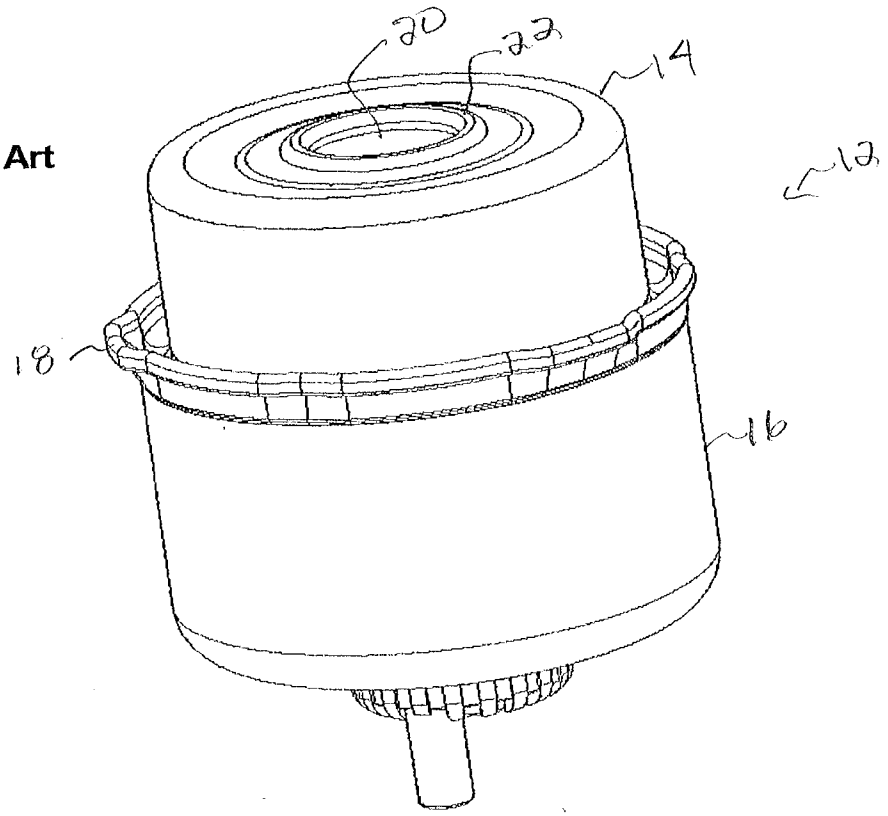


Fig. 1

Prior Art

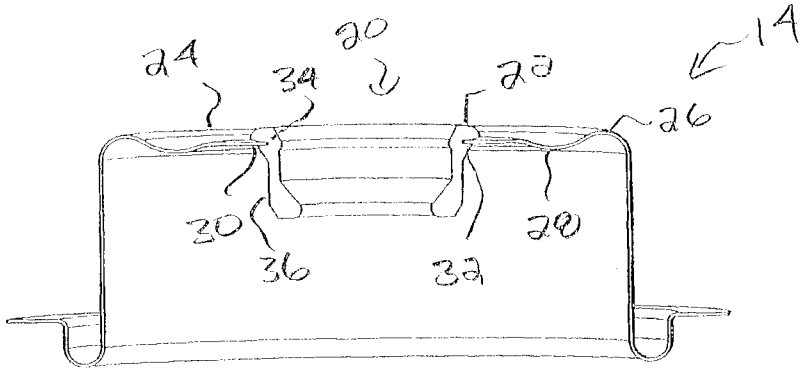


Fig. 2

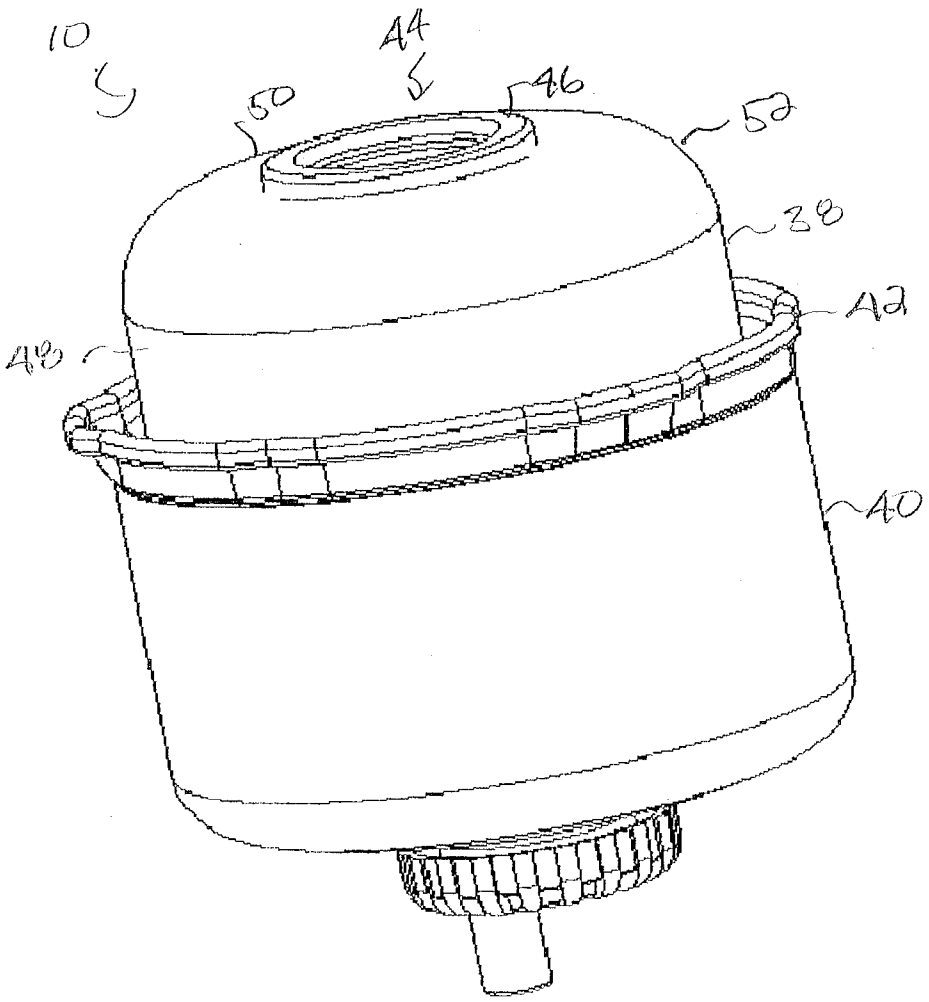


Fig. 3

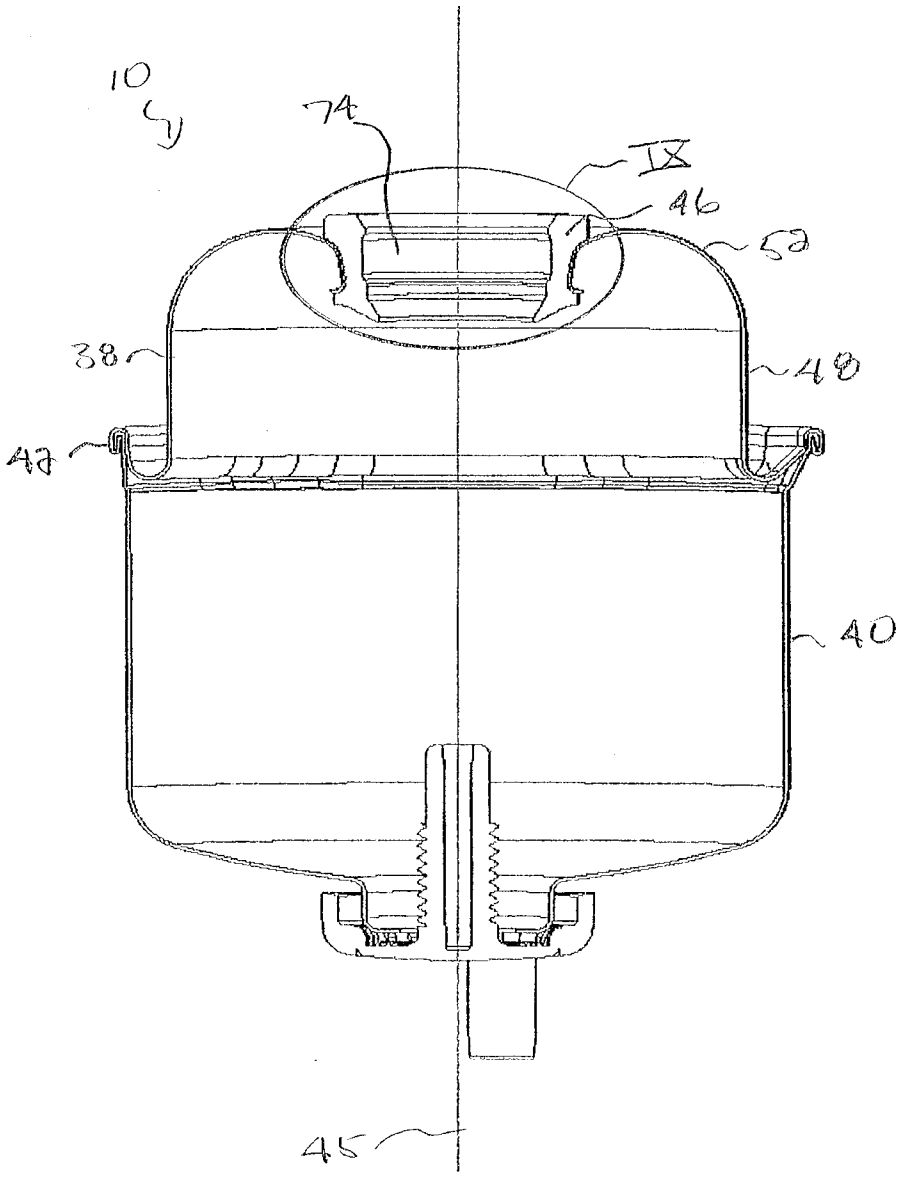


Fig. 4

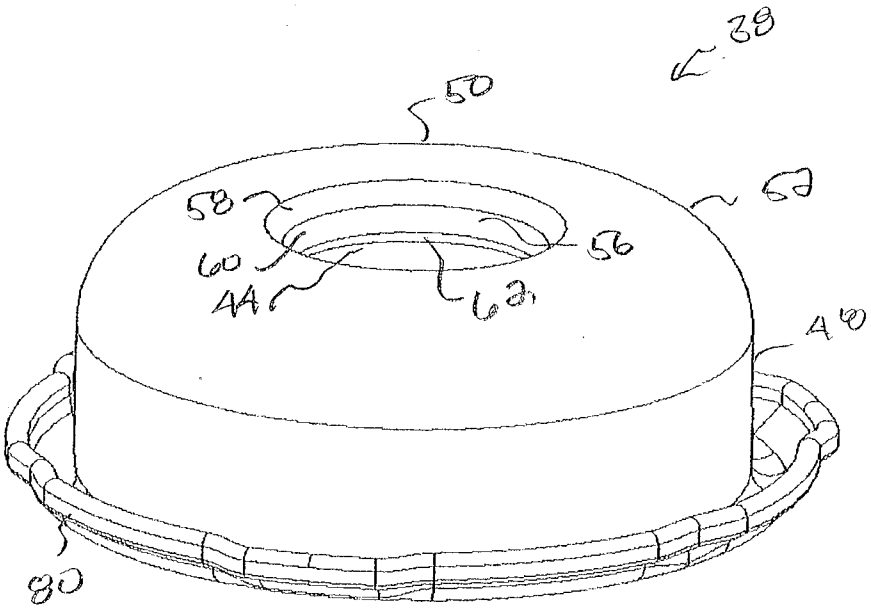


Fig. 5

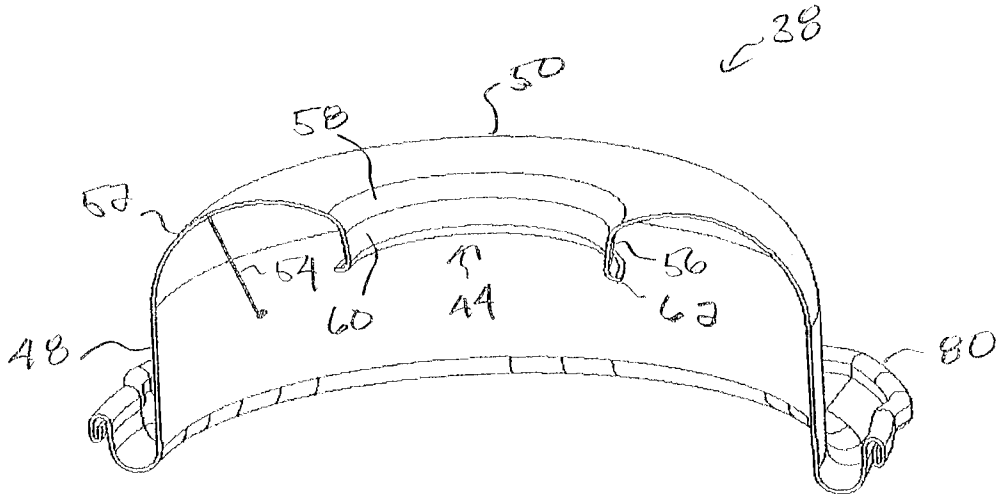


Fig. 6

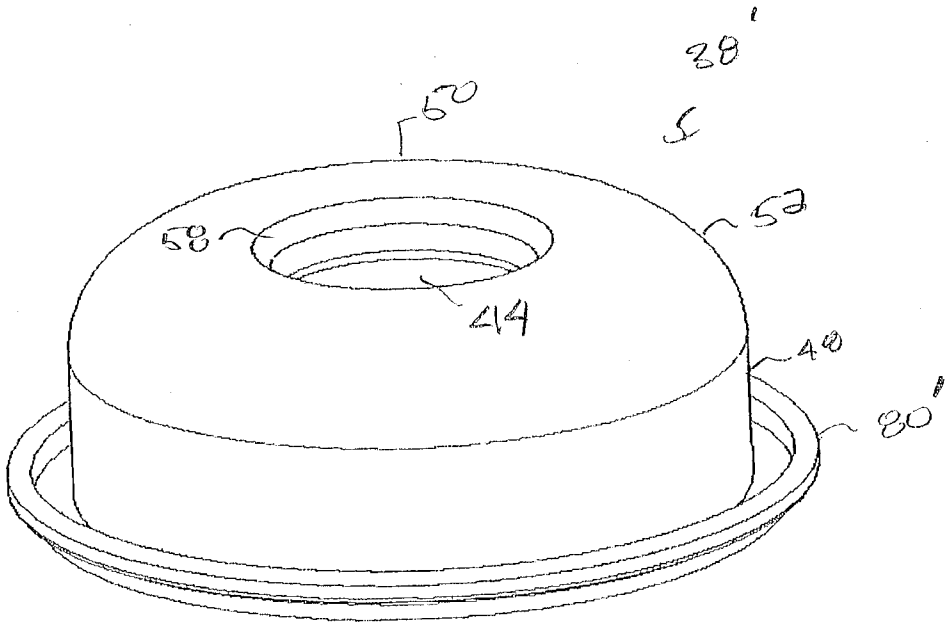


Fig. 7

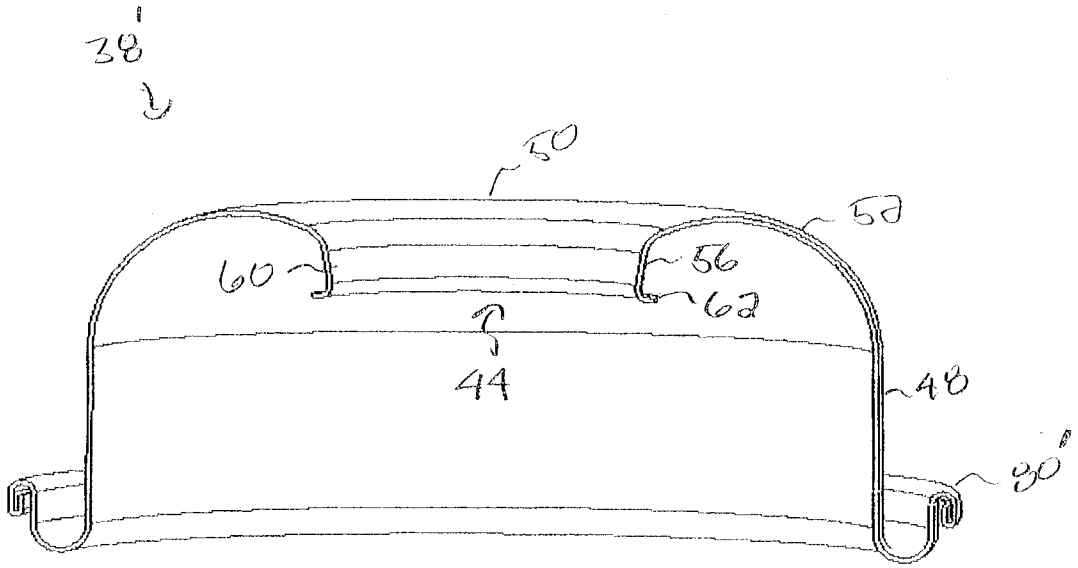


Fig. 8

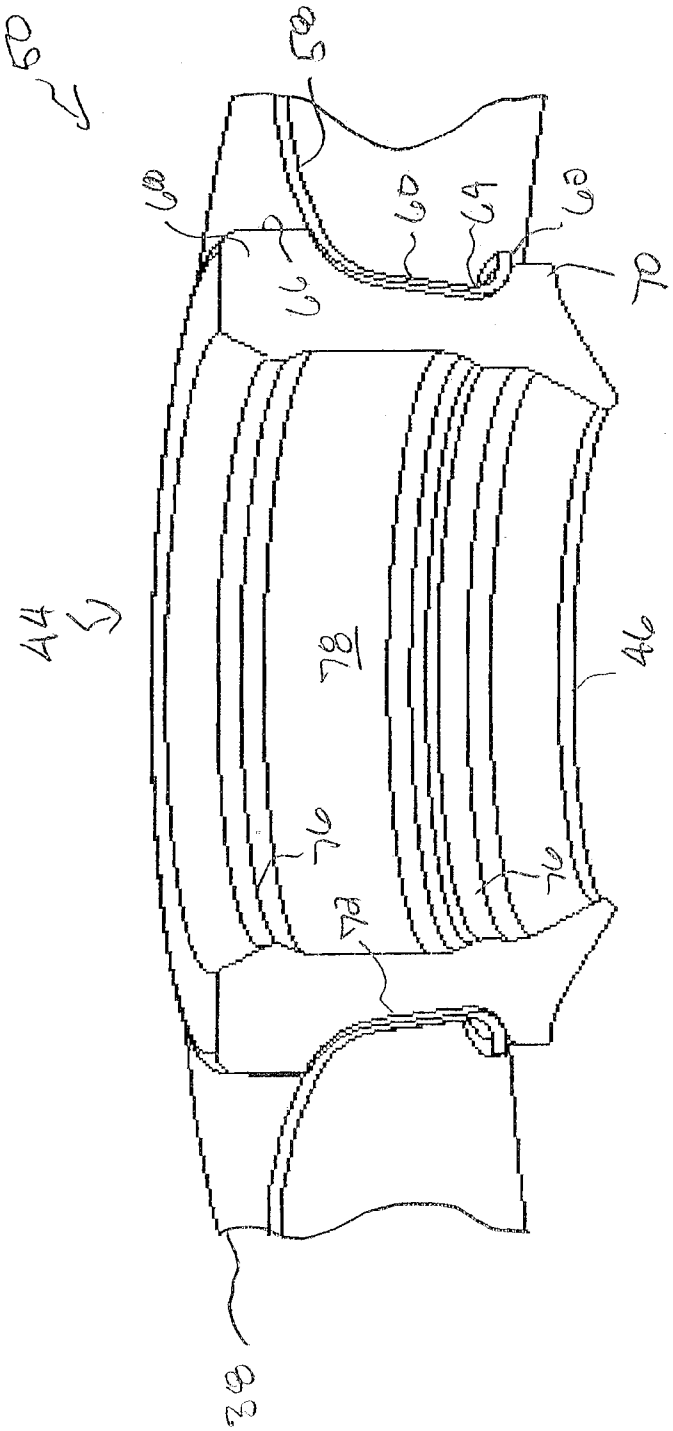
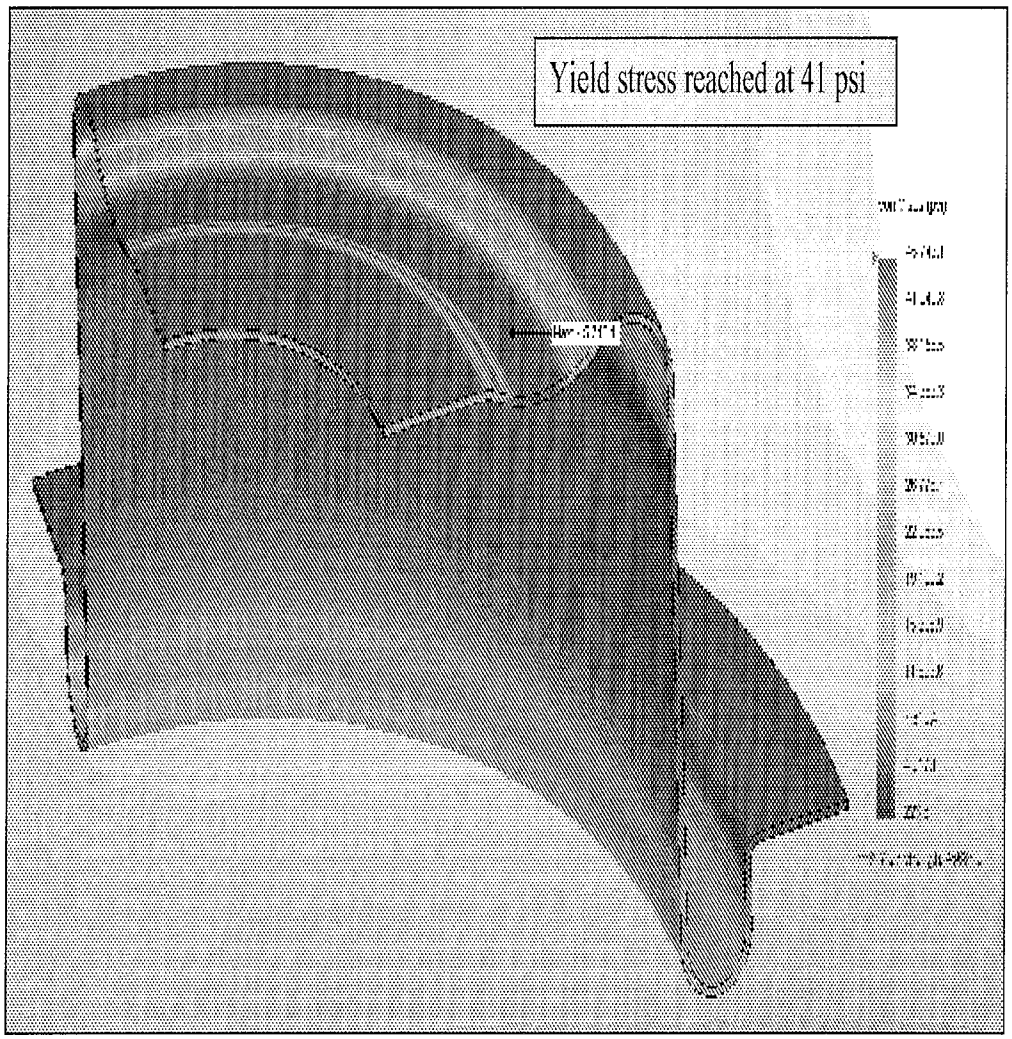
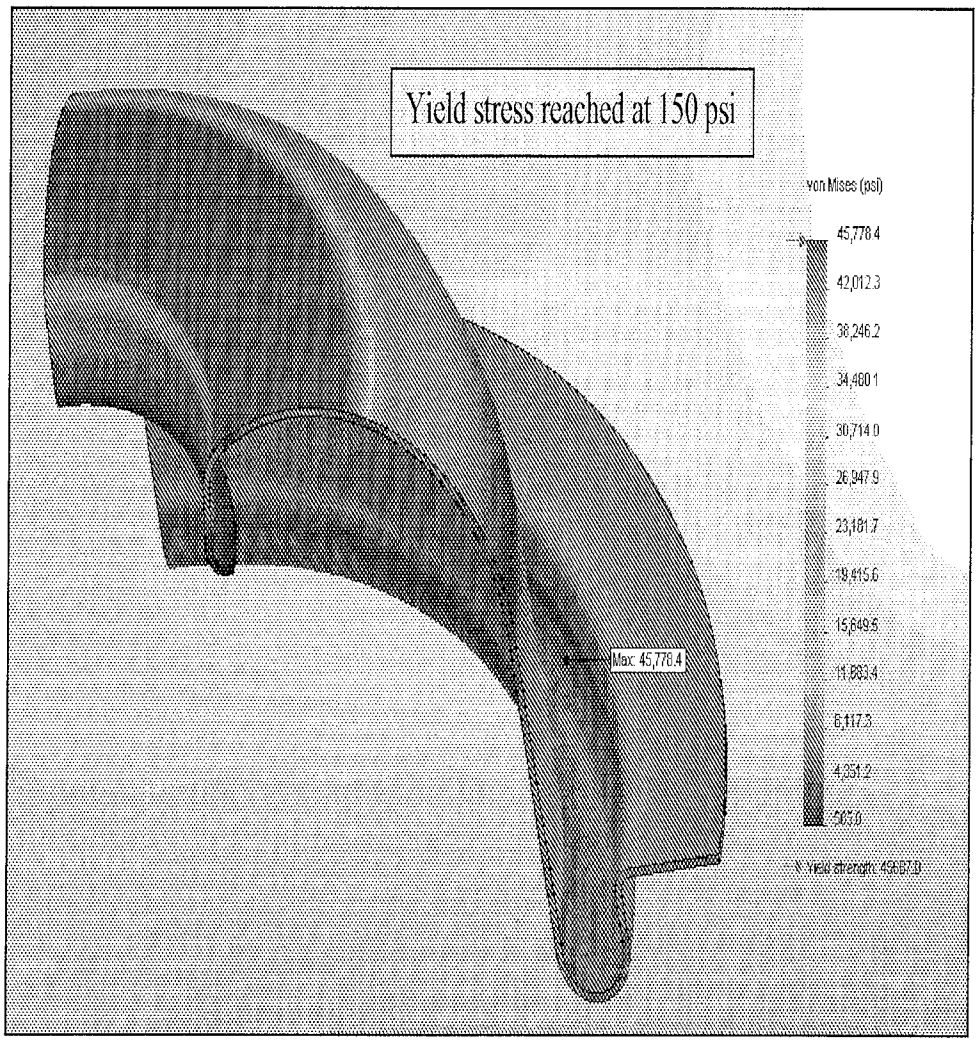


Fig. 9



Ultimate Tensile Stress = 60917 psi (ε = .39)
Yield Stress = 45687 psi (ε = .0015)
Endurance Limit = 30459 psi (1/2 UTS)
Tangent Modulus = 39202 psi

Fig. 10



Ultimate Tensile Stress = 60917 psi (ε = .39)
Yield Stress = 45687 psi (ε = .0015)
Endurance Limit = 30459 psi (1/2 UTS)
Tangent Modulus = 39202 psi

Fig. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/035739

A. CLASSIFICATION OF SUBJECT MATTER

F02M 37/22(2006.01)i, B01D 27/08(2006.01)i, B01D 35/30(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F02M 37/22; C02B 9/00; B01D 27/00; B01D 35/30; B01D 27/08; B01D 35/34; B23K 26/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords:filter, cartridge, end cap, radius and yield stress

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 51-062549 A (WILKES POOL CORPORATION) 31 May 1976 See claim and figure 4.	1,2
A	See claim and figure 4.	3-14
A	US 6,471,070 B2 (JANIK, LEON P.) 29 October 2002 See column 5, lines 9 - 53; figures 1, 1A.	1-14
A	US 2004-0084361 A1 (JANIK et al.) 06 May 2004 See abstract, paragraphs 0037, 0038, 0043; figure 1.	1-14
A	US 2011-0031181 A1 (HACKER et al.) 10 February 2011 See abstract, paragraphs 0032, 0038, 0047; figure 3.	1-14
A	WO 2009-070184 A1 (CUMMINS FILTRATION IP, INC.) 04 June 2009 See abstract, page 4, line 9 - page 6, line 16;figures 1,4.	1-14

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 OCTOBER 2012 (17.10.2012)	**18 OCTOBER 2012 (18.10.2012)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer HAN Joong Sub Telephone No. 82-42-481-5478

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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