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(54) **Multi-layer coolant reservoir**

(57) In various aspects of the invention a multi-layer pressurizable coolant reservoir includes an inner shell member shaped and configured to define at least one liquid storage chamber. An outer shell member is layered onto the inner shell member. The outer shell member is

particularly adapted to provide structural stability and resist pressure deformation of the inner shell. The outer shell is isolated from the coolant by the inner layer. The material of the inner shell is selected for compatibility with the coolant.

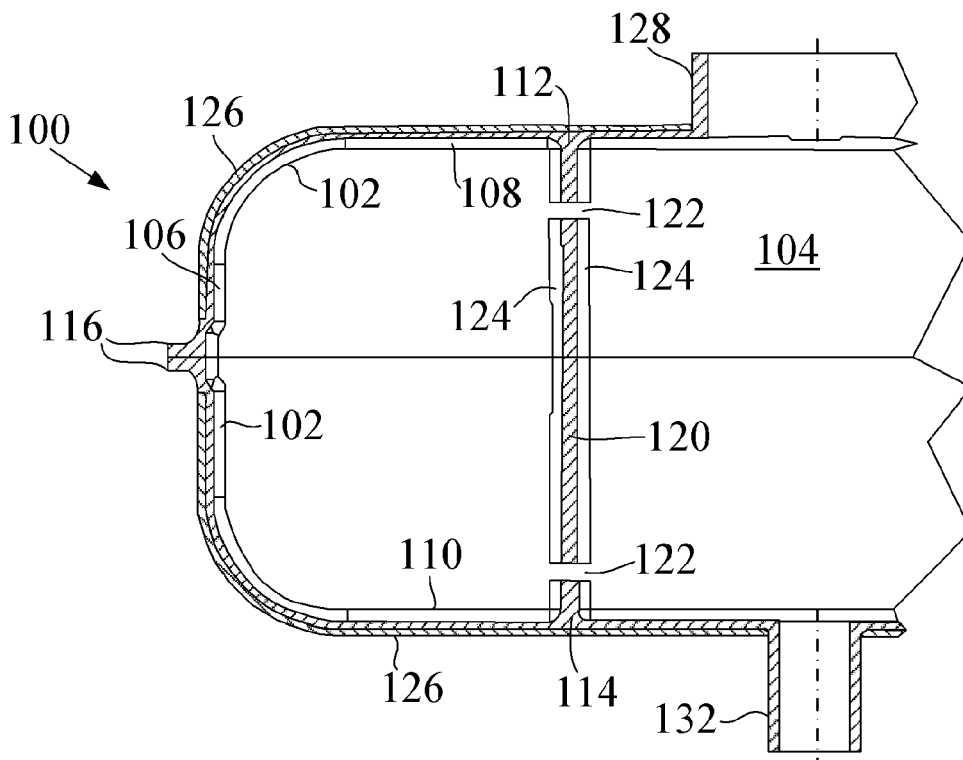


FIG. 2

Description

TECHNICAL FIELD

[0001] This disclosure relates generally to internal combustion engine cooling systems and, more particularly, to engine coolant reservoirs or surge bottles for such cooling systems.

BACKGROUND OF THE INVENTION

[0002] Most internal combustion engines require a cooling system to remove the heat generated during fuel combustion from the engine components. Typically such systems circulate a liquid heat conducting coolant around a closed fluid loop to conductively remove heat from a heat source such as an internal combustion engine and release the heat into a heat sink such as an air cooled radiator.

[0003] Such closed loop cooling systems typically include a coolant reservoir or surge bottle to provide additional on-demand coolant fluid capacity to compensate for small coolant losses as well as to provide surge capacity to allow for the volumetric thermal expansion of the coolant.

[0004] Although coolant reservoirs may be directly vented to the atmosphere, it is more common to operate coolant systems at a positive pressure. A higher operating pressure raises the temperature at which the coolant may boil, thereby allowing for higher engine operating temperatures without the danger of boiling or vaporizing the coolant fluid. Coolant reservoirs may also include means for extracting or venting gases from the coolant.

[0005] Additionally, coolants may be formulated to include chemical components intended to extend coolant life or to reduce corrosion as well as the formation of deposits in the cooling system. These chemical components may not be chemically compatible with or may adversely react with some materials used in some coolant reservoirs.

[0006] Coolant reservoirs, as OEM components, are now very much commodity items, which means that component price is a critical factor to the award of business. There remains a need in the art for a coolant reservoir that permits the use of a wider variety of materials and results in a reduction in material usage, weight and cost in keeping with commodity business trends.

[0007] It is therefore an object of the invention to provide a coolant reservoir that has reduced weight and is resistant to coolant fluids and additives.

SUMMARY OF THE INVENTION

[0008] This object is achieved by a multi-layer pressurizable coolant reservoir for providing surge and overflow capacity to an engine cooling system that includes an inner shell member shaped and configured to define at least one liquid storage chamber for storing coolant

therein. An outer shell member is layered onto at least a portion of the outer surface of the inner shell member. The outer shell member is particularly adapted to provide structural stability and to resist pressure deformation of what may be a less robust inner layer. The outer shell may be formed of a higher strength material relative to the inner layer. The outer shell is isolated from the coolant by the inner layer. The material of the inner shell is selected for compatibility with the coolant and for lower cost or material savings.

[0009] In another aspect of the invention, the material of the inner shell is selected to be compatible with the temperature and for chemical compatibility with the stored coolant. The outer shell material is selected for strength and low cost to provide structural stability to the reservoir. The resulting coolant reservoir formed of the inner and outer shells is lower in weight or uses less material than a single layer reservoir.

[0010] In another aspect of the invention, the inner shell member includes molded plastic material and the outer shell member comprises a material different than the inner shell material.

[0011] In another aspect of the invention, the material of the outer shell includes metal.

[0012] In another aspect of the invention, the inner shell member includes a molded plastic upper shell portion and a molded plastic lower shell portion. The upper and lower shell portions are compatibly sized and configured to be weldable along mateable edge portions to form the inner shell member.

[0013] In another aspect of the invention, the outer shell member includes an upper shell portion and a lower shell portion. The outer shell upper and lower shell portions are shaped and configured to substantially match the shape of and overlay onto the respective ones of the inner shell portions.

[0014] In another aspect of the invention, the upper portions of the shells are molded as a unit using a two shot injection molding process and the lower portions of the shells are molded as a unit using a two shot injection molding process.

[0015] In another aspect of the invention, a substantially rigid skeletal shell member is provided and secured onto portions of the outer surface of the outer shell member. The skeletal shell member is operative to provide further structural stability to the inner and outer shell members.

[0016] In another aspect of the invention, the material of the outer shell member comprises nylon or glass fibers to strengthen the outer shell member.

[0017] In another aspect of the invention, the inner layer material is selected from the group including: polypropylene and polyethylene.

[0018] In another aspect of the invention, the outer shell material is selected from the set consisting of: nylon, glass fiber filled polypropylene and metal.

[0019] In one embodiment, the combined thickness of the outer and the inner shell is approximately 3 mm. In

one preferred embodiment, the outer shell and the inner shell have a thickness of approx. 1,5 mm each.

[0020] In another aspect of the invention, the outer shell member forms ribs extending within the liquid storage chamber. The ribs are encapsulated by rib encapsulating members of the inner shell member. The encapsulating members are configured to cover and protect the ribs of the outer shell member.

[0021] In another aspect of the invention, the multi-layer coolant reservoir is configured to provide coolant storage, coolant surge or overflow capacity to an engine cooling system. The coolant reservoir includes an inner shell member that is shaped and configured to define a closed liquid storage chamber adapted for storing overflow or surplus engine coolant fluid therein.

[0022] In another aspect of the invention, the liquid storage chamber may be separated into sub chambers by one or more strengthening ribs or baffles. Ribs generally extend through the liquid storage chamber and may secure to opposing walls of the coolant reservoir.

[0023] In another aspect of the invention, at least some of the ribs typically include fluid passages or holes through the ribs that permit fluid to flow between the sub chambers defined by the ribs. In some variants of the invention, the coolant reservoir may be pressurized and the ribs provide additional structural support to the coolant reservoir to resist deformation due to the pressurization.

[0024] In another aspect of the invention, the coolant reservoir may include a fitting configured to receive a pressure relief device such as a pressure cap. The coolant reservoir may include one or more overflow connections and one or more outlet connections.

[0025] In coolant reservoirs, including prior art coolant reservoirs, the ribs are positioned and sized to provide structural support to the coolant reservoir to resist stresses induced by pressurization of the coolant as well as mechanical stresses and loads expected during use.

[0026] In another aspect of the invention, the ribs also act to break up the interior of the coolant reservoir into sub chambers that act to reduce "sloshing" or movement of the coolant and resulting foaming within the coolant reservoir.

[0027] In another aspect of the invention, surrounding and positioned supportively against the outside surface of the inner shell member is an outer shell member. The outer shell member is layered over at least a portion of the outer surface of inner shell member, and preferably is layered over a major portion if not the entirety of the outer surface of the inner shell member.

[0028] In another aspect of the invention, as the inner shell member is in contact with the coolant, the material of the inner shell member is selected to be compatible with the chemistry of the coolant and suitable for the expected coolant temperature. Advantageously, a wider variety of materials is available and may be utilized for the inner shell than would be the case in a conventional single layer coolant reservoir. In the multi-layer coolant

reservoir the inner shell member can rely upon outer shell members such as outer shell member to provide required structural stability and support. The inner shell member may therefore utilize materials that in and of themselves do not provide sufficient structural stability to meet design requirements on their own. Advantageously, the material of the inner shell member may be chosen to utilize less structurally robust but chemically and thermally suitable materials that are lower in cost than would otherwise be possible with prior art coolant reservoirs.

[0029] In another aspect of the invention, the inner shell member and the outer shell member may utilize different materials, each having properties selected to meet different requirements. For example, the inner shell member may utilize lower strength materials, such as (for example) a polypropylene or even a polyethylene or other low cost materials.

[0030] In another aspect of the invention, the outer shell member utilizes higher strength materials which are structurally stable and able to resist the maximum expected pressurization of the coolant reservoir and other expected mechanical and thermal stresses. Some examples of more structurally stable outer shell member materials include nylon, glass fiber filled polypropylene, or varieties of formed metal substrates.

[0031] In some variants of the invention, the ribs may be formed as part of the outer shell member, even though the outer shell member is covered in its interior by the inner shell member. This is advantageous as the outer shell in many variations will be formed of more structurally stable and rigid materials than the inner shell. In these variations the outer shell member material forming the ribs may be encapsulated or covered by rib encapsulating members formed with the inner shell member and overlaying the ribs formed by the outer shell member. In this way the outer shell member may form ribs in the interior of the reservoir that are covered and protected by the inner shell member.

[0032] In some variants of the invention, the upper shell portion of the inner shell and upper shell portion of the outer shell may be formed or molded as a unitary member by a two shot plastic injection molding process. Similarly, the lower shell portion of the inner shell and the lower shell portion of the outer shell may be formed as a unitary member by a similar two shot plastic injection molding process.

[0033] In another variant of the invention, the inner shell member and structurally stable outer shell member may be further strengthened by the addition of an overlaying outer skeletal shell. The skeletal shell, for example, may comprise a formed metal shell including steel or aluminum or other substantially rigid and structurally stable material. The skeletal shell may be adhesively or thermally welded onto the outer shell member and further operate to resist deformation of the inner and outer shell members due to stress loading, such as due to pressurization of the coolant in the coolant reservoir.

[0034] The above features and advantages and other

features and advantages of the present invention are readily apparent from the following detailed description of the best modes for carrying out the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] The accompanying figures, where like reference numerals refer to identical or functionally similar elements throughout the separate views and which together with the detailed description below are incorporated in and form part of the specification, serve to further illustrate various embodiments and to explain various principles and advantages all in accordance with the present invention.

[0036] Features of the present invention, which are believed to be novel, are set forth in the drawings and more particularly in the appended claims. The invention, together with the further objects and advantages thereof, may be best understood with reference to the following description, taken in conjunction with the accompanying drawings. The drawings show a form of the invention that is presently preferred; however, the invention is not limited to the precise arrangement shown in the drawings.

[0037] Figure 1 is a cut away perspective view of a multi-layer coolant reservoir, consistent with the present invention; and

[0038] Figure 2 is a partial side sectional view of a multi-layer coolant reservoir, consistent with the present invention.

[0039] Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help to improve understanding of embodiments of the present invention.

DETAILED DESCRIPTION

[0040] Before describing in detail embodiments that are in accordance with the present invention, it should be observed that the embodiments reside primarily in combinations of apparatus components related to an improved coolant reservoir. Accordingly, the apparatus components have been represented where appropriate by conventional symbols in the drawings, showing only those specific details that are pertinent to understanding the embodiments of the present invention so as not to obscure the disclosure with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein.

[0041] In this document, relational terms such as first and second, top and bottom, and the like may be used solely to distinguish one entity or action from another entity or action without necessarily requiring or implying any actual such relationship or order between such entities or actions. The terms "comprises," "comprising," or

any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element preceded by "comprises ... a" does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises the element.

[0042] Figure 1 is a cut away perspective view of a multi-layer coolant reservoir, consistent with the present invention. Figure 2 is a partial side sectional view of a multi-layer coolant reservoir, consistent with the present invention.

[0043] The multi-layer coolant reservoir 100 is configured to provide coolant storage, coolant surge or overflow capacity to an engine cooling system. The coolant reservoir includes an inner shell member 102 that is shaped and configured to define a closed liquid storage chamber 104 adapted for storing overflow or surplus engine coolant fluid therein. The liquid storage chamber 104 may be separated into sub chambers by one or more strengthening ribs or baffles 120. Ribs 120 generally extend through the liquid storage chamber 104 and may secure to opposing walls of the coolant reservoir 100. At least some of the ribs typically include fluid passages 122 or holes through the ribs that permit fluid to flow between the sub chambers defined by the ribs. In some variants of the invention, the coolant reservoir 100 may be pressurized and the ribs 120 provide additional structural support to the coolant reservoir to resist deformation due to the pressurization.

[0044] The coolant reservoir 100 may include a fitting 128 configured to receive a pressure relief device such as a pressure cap (not shown). The coolant reservoir 100 may include one or more overflow connections 130 and one or more outlet connections 132.

[0045] In coolant reservoirs, including prior art coolant reservoirs, the ribs are positioned and sized to provide structural support to the coolant reservoir to resist stresses induced by pressurization of the coolant as well as mechanical stresses and loads expected during use. The ribs 120 also act to break up the interior of the coolant reservoir into sub chambers that act to reduce "sloshing" or movement of the coolant and resulting foaming within the coolant reservoir.

[0046] Referring again to Figures 1 and 2, surrounding and positioned supportively against the outside surface 106 of the inner shell member is an outer shell member 118. The outer shell member 118 is layered over at least a portion of the outer surface of inner shell member 102, and preferably is layered over a major portion if not the entirety of the outer surface of the inner shell member 102.

[0047] As the inner shell member is in contact with the coolant, the material of the inner shell member is selected to be compatible with the chemistry of the coolant and

suitable for the expected coolant temperature. Advantageously, a wider variety of materials is available and may be utilized for the inner shell than would be the case in a conventional single layer coolant reservoir. In the multi-layer coolant reservoir 100 the inner shell member 102 can rely upon outer shell members such as outer shell member 118 to provide required structural stability and support. The inner shell member may therefore utilize materials that in and of themselves do not provide sufficient structural stability to meet design requirements on their own. Advantageously, the material of the inner shell member 102 may be chosen to utilize less structurally robust but chemically and thermally suitable materials that are lower in cost than would otherwise be possible with prior art coolant reservoirs.

[0048] Advantageously, the inner shell member 102 and the outer shell member 118 may utilize different materials, each having properties selected to meet different requirements. For example, the inner shell member may utilize lower strength materials, such as (for example) a polypropylene or even a polyethylene or other low cost materials.

[0049] The outer shell member 118 utilizes higher strength materials which are structurally stable and able to resist the maximum expected pressurization of the coolant reservoir and other expected mechanical and thermal stresses. Some examples of more structurally stable outer shell member 118 materials include nylon, glass fiber filled polypropylene, or varieties of formed metal substrates.

[0050] As shown particularly in Figure 2, in some variants of the invention, the ribs 120 may be formed as part of the outer shell member 118, even though the outer shell member 118 is covered in its interior by the inner shell member 102. This is advantageous as the outer shell 118 in many variations will be formed of more structurally stable and rigid materials than the inner shell 102. In these variations the outer shell member material forming the ribs may be encapsulated or covered by rib encapsulating members 124 formed with the inner shell member 102 and overlaying the ribs formed by the outer shell member. In this way the outer shell member may form ribs in the interior of the reservoir that are covered and protected by the inner shell member.

[0051] In some variants of the invention, the upper shell portion 108 of the inner shell 102 and upper shell portion 112 of the outer shell 118 may be formed or molded as a unitary member by a two shot plastic injection molding process. Similarly, the lower shell portion 110 of the inner shell 102 and the lower shell portion 114 of the outer shell 118 may be formed as a unitary member by a similar two shot plastic injection molding process.

[0052] In another variant of the invention, the inner shell member 102 and structurally stable outer shell member 118 may be further strengthened by the addition of an overlaying outer skeletal shell 126. The skeletal shell 126, for example, may comprise a formed metal shell including steel or aluminum or other substantially

rigid and structurally stable material. The skeletal shell may be adhesively or thermally welded onto the outer shell member and further operate to resist deformation of the inner and outer shell members due to stress loading, such as due to pressurization of the coolant in the coolant reservoir.

[0053] In the current art, coolant reservoir bottles are typically designed with a minimum wall thickness of 3.5mm to 4mm to meet the design and validation testing requirements of the application. Advantageously, use of a multi-layer coolant reservoir according to the present inventive disclosure permits the use of a wider range of structurally stable materials which are expected to result in the option to have reduced overall coolant reservoir wall thickness as well as a reduction in weight and materials usage. It is anticipated that a multi-layer coolant reservoir with an overall wall thickness of 3mm can result in about a 9% reduction in material relative to prior art coolant reservoirs. It is further expected that in a multi-layer coolant reservoir according to the present inventive disclosure the amount of internal ribbing 120 may be reduced, or the spacing between the ribs increased due to the additional structural strength provided by multi-layer design. It is anticipated that removing or re-spacing ribs 120 in the liquid storage chamber 104 of the coolant reservoir 100 can result in an overall weight reduction of about 19%.

[0054] Multi-layer coolant reservoirs are particularly useful as pressurized coolant reservoirs in heavy truck and off-road/ construction equipment applications. In these applications coolant reservoirs may utilize upwards of 3.8 Kg of material in order to provide the necessary structural strength and to meet durability requirements. Material and cost savings in such applications are expected to be quite considerable.

[0055] In the foregoing specification, specific embodiments of the present invention have been described. However, one of ordinary skill in the art appreciates that various modifications and changes can be made without departing from the scope of the present invention as set forth in the claims below. Accordingly, the specification and figures are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of the present invention. The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential features or elements of any or all the claims. The invention is defined solely by the appended claims including any amendments made during the pendency of this application and all equivalents of those claims as issued.

Claims

1. A multi-layer pressurizable coolant reservoir provid-

ing surge and overflow capacity to an engine cooling system, comprising:

- an inner shell member shaped and configured to define at least one liquid storage chamber for storing coolant therein, said chamber having at least one outer surface;
and
an outer shell member layered onto at least a portion of said at least one outer surface, said outer shell member adapted to provide structural stability and resist pressure deformation of said inner layer;
wherein said outer shell comprises a higher strength material relative to said inner layer;
wherein said outer shell is isolated from said coolant by said inner layer; and
wherein material of said inner shell is selected for compatibility with said coolant.
2. The coolant reservoir according to claim 1, wherein said material of said inner shell is selected to be compatible with operating temperature and chemical compatibility with the coolant;
wherein said outer shell material is selected for strength and low cost to provide structural stability to said reservoir; and
wherein said coolant reservoir formed of said inner and outer shells is lower in weight or uses less material than a single layer reservoir.
 3. The coolant reservoir according to any one of claims 1 - 2, wherein
said inner shell member comprises molded plastic material; and
wherein said outer shell member comprises a material different than said inner shell material.
 4. The coolant reservoir according to any one of claims 1 - 3, wherein said material of said outer shell comprises formed metal.
 5. The coolant reservoir according to any one of claims 1 - 4, wherein said inner shell member includes a molded plastic upper shell portion and a molded plastic lower shell portion, said upper and lower shell portions welded along mateable edge portions to form a one-piece inner shell member.
 6. The coolant reservoir of claim 5, wherein said outer shell member includes an upper shell portion and a lower shell portion, said outer shell upper and lower shell portions shaped and configured to substantially match the shape of and overlay onto respective ones of said inner shell portions.
 7. The coolant reservoir according to any one of claims 5 - 6, wherein
said upper portions of said shells are molded as a unit using a two shot injection molding process; and
said lower portions of said shells are molded as a unit using a two shot injection molding process.
 8. The coolant reservoir according to any one of claims 1 - 7, further comprising:
a substantially rigid skeletal shell member secured onto portions of the outer surface of the outer shell member, said skeletal shell member operative to provide further structural stability to said inner and outer shell members.
 9. The coolant reservoir according to any one of claims 1 - 8, wherein said material of said outer shell member comprises nylon or glass fibers, said fibers strengthening said outer shell member.
 10. The coolant reservoir according to any one of claims 1 - 9, wherein said inner layer material selected from the group including: polypropylene and polyethylene.
 11. The coolant reservoir according to any one of claims 1 - 10, wherein said outer shell material selected from the set consisting of: nylon, glass fiber filled polypropylene and metal.
 12. The coolant reservoir according to any one of claims 1 - 11, wherein said outer shell member forms ribs extending within said liquid storage chamber, said ribs encapsulated by rib encapsulating members of said inner shell member, said encapsulating members covering and isolating ribs of said outer shell member from said coolant.

