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(54) Title: 2-STAGE WATER SEPARATOR PRE-FILTER

(57) Abstract: The present invention relates to a pre-filter that separates water and foreign materials in fuel in diesel fuel supply systems. The present invention combines the first mesh that lumps water particles and the second mesh that intercepts lumped water particles in order to embody a new type of water separator that removes water and foreign materials contained in the fuel, thereby effectively removing water and foreign materials contained in the fuel at the same time substantially increasing the filter replacement cycle by preventing clogging.

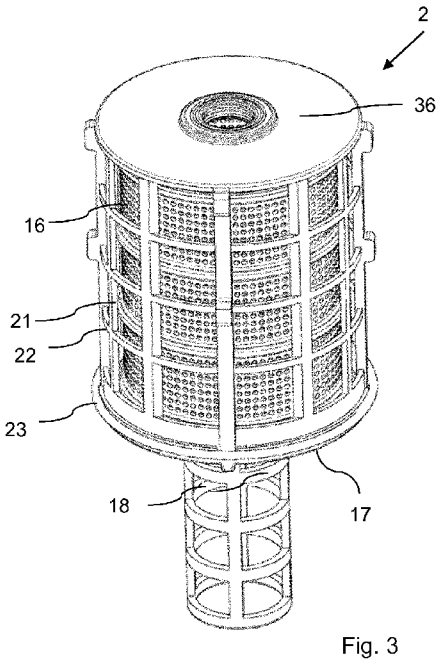

Fig. 3

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2-STAGE WATER SEPARATOR PRE-FILTER

The present invention relates to a 2-stage water separator pre-filter. More specifically, the present invention relates to a pre-filter that separates water from fuel in the diesel fuel supply system.

Background

A diesel engine fuel supply system usually comprises a fuel tank, a pre-filter that separates water from the fuel contained in the above fuel tank, a main filter that removes foreign materials that have passed through the above pre-filter, and an injection pump that pumps fuel from the abovementioned fuel tank to the injection system.

Here, the abovementioned pre-filter not only separates water from fuel but may also filter foreign materials, especially particles that are relatively large.

Usually, diesel engine fuels contain a small amount of water due to the moisture contained in the fuel tank. The amount of water depends, among other factors, on the changes in the external temperature and/or on the humidity of the surrounding air.

Recently, due to the rapid increase in the number of diesel vehicles that use the common rail fuel injection method, requirements regarding water separation from diesel fuel are increasing. In the case of diesel engines that use the common rail fuel injection method, systems are sensitive also to only small amounts of water, so moisture is a big problem for these vehicles.

In order to separate water, a pre-filter, which acts as a water separator, is often installed upstream of the main filter. The pre-filter allows drainage of water that has been separated from diesel. The water sinks down and is gathered at the bottom of the filter due to the difference in mass density between water and fuel. Such pre-filter is known from EP 1 194 207 A1, for example.

However, existing water filters generally separate moisture by using filter paper or nonwoven filter media materials. As a result, these filters are easily clogged by parrafins or by foreign matters, and as a result the filter replacement cycle is short. Also, the water separation efficiency of such filter media materials may decrease over time.

Therefore, the present invention was contrived after taking into consideration of this point. The object of the present invention is to provide a water separating pre-filter, preferably a two-stage water separating pre-filter, that is capable of effectively removing water and foreign materials contained in the fuel as well as increasing the filter replacement cycle. A further object of the present invention is to provide a new form of water separator that can remove water and foreign materials contained in the fuel, which reduces or prevents clogging of the filter by water or by foreign materials.

Summary of the Invention

These objects are solved by a pre-filter insert according to claim 1 and a pre-filter according to claim 17. The objects are further generally solved by combining a first mesh that acts as a coalescer and coalesces (lumps) small water droplets to bigger droplets or drops and a second mesh that intercepts and separates the water from the fuel flow. Thereby, a two-stage water separating pre-filter is created.

In one preferred embodiment of the invention, a pre-filter insert according to the present invention is preferably adapted for water separation in a diesel fuel filter and comprising a first mesh and a second mesh spaced from and located downstream of the first mesh, wherein the first mesh is configured to coalesce water droplets and the second mesh is configured to separate the water coalesced by the first mesh. Using a mesh for both filtration stages (coalescing and separation of water from the fuel flow) has several advantages. A mesh used as a media for the coalescing stage has the advantage of being less sensitive to clogging by particles separated at the coalescing stage than for example non-woven materials and can be back-flushed in case of clogging. It is also less expensive than a coalescing non-woven filter media. Preferably, the first mesh and the second mesh have a closed, tubular shape and are furthermore preferably positioned concentrically and radially spaced from each other to achieve a compact design. For in-out flow configurations, the first mesh may be positioned inside the second mesh. For out-in flow configurations, the second mesh may be positioned inside the first mesh.

In one preferred embodiment, at least one water discharge opening is provided at an axial end of the pre-filter insert between the first mesh and the second mesh for draining of the separated water from the pre-filter insert. The at least one water discharge opening may preferably be provided in an end cap of the pre-filter insert.

At least one of the meshes is preferably supported by a perforated, especially tubular support structure which supports the meshes against the forces created by the liquid flow. For example, the first mesh may be supported by a cylindrical core equipped with multiple holes or multiple openings. Also, the second mesh may be supported by a cylindrical frame equipped with multiple openings. The structure or the shape of the openings of the core and the frame may generally be similar or interchangeable. However, the support structure for the first mesh will be referred to as “core” and the support structure for the second mesh will be referred to as “frame” below in order to easily distinguish between the support structures for the first and second mesh.

Preferably, the meshes are permanently attached to the respective support structure. For example, this can be achieved by welding, gluing or overmolding. In case of overmolding, a mesh is permanently

attached to the support structure (core or frame) by injection-molding of the support structure around the mesh.

Preferably, the first mesh and/or the second mesh may be composed of stainless steel or polyester. It is furthermore preferred that the first mesh is hydrophilic and the second mesh is hydrophobic. This can be achieved either by choosing a hydrophilic or hydrophobic material or by coating the meshes with either a hydrophilic or hydrophobic coating.

The meshes each have openings (also called pores) that are usually and preferably substantially of the same size. Preferably, the opening size of the first mesh is larger than the opening size of the second mesh. The opening size may also be referred to as pore size.

In one preferred embodiment, the opening size of the first mesh is from 0.3mm to 0.5mm and/or the opening size of the second mesh is from 0.01mm to 0.15mm.

It has been found that, by choosing opening sizes of the meshes as described above, small water particles or droplets accumulate or coalesce by colliding while flowing through the openings in the first mesh, entering the space between the two meshes as bigger droplets. The bigger droplets can be separated from the liquid flow at the second mesh with preferably smaller opening size. Compared to non-woven coalescers, this solution provides good, constant and reliable coalescing function without degradation over time and a low pressure drop, especially on the coalescing stage.

The pre-filter insert according to the invention preferably comprises a lower end cap and/or an upper end cap for supporting the filter media (the meshes) and for axially closing the space or volume surrounded by the filter media. The pre-filter according to the invention preferably relies on gravity for removing the water from the liquid flow and into a bowl for collecting separated water. Therefore, a lower end cap is preferably adapted to being mounted in a housing in a position in which the lower end cap is located below the filter media (the meshes) and below the upper end cap. Therefore, the at least one water discharge opening described above is preferably provided in the lower end cap between the first mesh and the second mesh. The end cap can comprise one or a plurality of such openings which may be arranged in a circle.

In a preferred embodiment, at least one of the end caps comprises at least one of the support structures (the core and/or the frame) as a one-piece component. For example, the support structures can be glued to the end cap or preferably injection molded as a one-piece component together with the respective support structure. For example, the upper end cap can comprise the frame and/or the lower end cap can comprise the core, although the opposite configuration is also possible. Furthermore, at least one of the

core and/or the frame not comprised by an end cap as a one-piece component as described above may be clamped between the end caps. In a further preferred embodiment, the at least one support structure comprised by the at least one end cap may be snapped to the respective other end cap or connected to the respective end cap using a similar form-fit connection method. Further preferred, the at least one water discharge opening is provided in the lower end cap between the first mesh and the second mesh. The at least one water discharge opening may preferably be used as an opening for receiving a hook provided at a support structure to be snapped into the water discharge opening. In a preferred embodiment, the upper end cap comprises the frame which is snapped into the lower end cap. In this case, the core may preferably be clamped between the upper end cap and lower end cap or the core may alternatively be comprised by the lower end cap as described above.

In a preferred embodiment, a support is provided for holding the pre-filter insert above the water collection volume in the housing and/or bowl. The support may be embodied as radially projecting support ribs projecting from the radially inner wall of the bowl into the inner volume of the bowl and providing support edges for supporting a lower end cap of the pre-filter insert. The support also may be embodied as a projection projecting from the lower end cap downwardly, in a direction away from the upper end cap. In this way, it can be supported at the bottom of the bowl or water collection volume. The support ribs may leave a tubular volume in the bowl open for receiving a floater. Similarly, a floater may be provided inside a cage-like hollow cylindrical support or a ring-shaped floater may be provided, surrounding the support projecting from the lower end cap.

In a preferred embodiment, an O-ring or other gasket is attached to the periphery of the lower end cap for sealingly contacting a housing and/or bowl. The contact is preferably in radial direction, such that the pre-filter element and/or the bowl can generally be mounted into the housing in axial direction. The O-ring or seal is preferably operable for preventing separated water which already is resting in the bowl from overflowing out of the bowl into an outlet.

The invention also concerns a pre-filter for separating water in a diesel fuel filter, comprising a housing equipped with an inlet and an outlet, a pre-filter insert according to the invention operably positioned inside the housing, a bowl to collect water separated at the pre-filter insert or another means for providing a water collection volume below the pre-filter element. The bowl is preferably equipped with a drain plug for discharging water out of the bowl. The bowl or collection volume means may be removably or permanently attached to the housing or may be provided by the housing, especially the housing wall, in one-piece. For example, the housing can be provided as a pot-shaped spin-on filter housing, wherein the bottom of the housing is used as a water collection volume and wherein the pre-filter insert is spaced from the bottom of the housing to create the water collection volume.

In one preferred embodiment, the abovementioned bowl is composed of a transparent material such as transparent injection molded plastic. This allows for visibility of the water level. In a further preferred embodiment, a floater is positioned inside the bowl that floats on water to indicate the water level inside the bowl. The density of the floater should be between the density of water and the density of diesel fuel. The floater may be embodied as described above, adapted to embodiments of the bowl and/or the lower end cap.

In another embodiment of the invention, the abovementioned pre-filter is composed of the following components: a housing equipped with an inlet and an outlet to allow fuel to enter and exit; a bowl or a water collection volume with a drain plug that is integrated to the bottom of the abovementioned housing to collect and discharge water; an end cap and a support installed within the abovementioned housing and/or bowl to support the first mesh and the second mesh; and the first mesh and the second mesh positioned concentrically, one inside the other and radially spaced from each other at a certain distance, for example between 3 and 10 mm, wherein the first mesh coalesces (lumps) water particles and the second mesh intercepts those lumped water particles.

In general, the 2-stage water separating pre-filter or pre-filter insert according to this invention lumps water particles using the first mesh and intercepts water particles using the second mesh to effectively remove water and foreign materials that are contained in the fuel, thereby increasing the filter exchanging cycle substantially.

Brief description of the drawings

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view drawing that illustrates the exterior of the pre-filter in accordance with an embodiment of the present invention.

Figure 2 is a perspective view drawing that illustrates the pre-filter of Figure 1 in an explosive view.

Figure 3 is a perspective view drawing that illustrates a pre-filter insert in accordance with an embodiment of the present invention.

Figure 4 is a perspective, cross-sectioned view of the pre-filter insert of Figure 3.

Figure 5 is a perspective, cross-sectioned view drawing that illustrates the pre-filter of Figures 1 and 2 including a pre-filter insert according to Figures 3 and 4.

Figure 6 is a detailed view of the central region of the pre-filter as shown in Figure 5.

Figure 7 is a detailed view of the lower region of the pre-filter as shown in Figure 5.

Figure 8 is a plane drawing that illustrates the mesh structure of the pre-filter in accordance with an embodiment of the present invention.

Figure 9 is a cross-sectional drawing that illustrates the pre-filter in accordance with a second embodiment of the present invention.

Figure 10 and Figure 11 are perspective view drawings that illustrate a second embodiment of a pre-filter insert of the present invention as used in the second embodiment of a pre-filter according to Figure 9.

Figure 12 is a cross-sectional drawing that illustrates the pre-filter insert according to Figures 10 and 11.

Detailed Description

Below, the present invention will be described in detail by referring to the attached drawings. Because of visibility reasons, the structures of the fine meshes 15 and 16 are generally hidden in Figures 2 - 7 and 9 – 12 in order not to overlay all structure that is located behind the meshes 15, 16. However, the position of the meshes 15 and 16 are shown in Figures 4, 6, 7, 9 and 12 at the cut planes. Furthermore, serving as an example, Figures 10 and 11 schematically show one hole 19 of core 20 and one opening 21 of frame 22, each framing an area of the meshes 15 and 16, respectively. Obviously, although not shown in some of the Figures like Figures 10 and 11, the meshes 15 and 16 are provided all around the core 20 and frame 22 in a tubular shape and filling or covering all holes 19 of core 20 and all openings of frame 22 in all embodiments of the invention.

Figures 1 and 2 show perspective view drawings that illustrate the exterior of the pre-filter 1 in accordance with an embodiment of the present invention.

As illustrated in Figure 3 to 7, the pre-filter insert 2 included in the abovementioned pre-filter 1 effectively separates and removes water and foreign materials that are contained in the fuel through the first stage media 15 and the second stage media 16, preferably by using two meshes 15, 16 as shown for example in Fig. 8. However, other media types may also be used in the general technical design shown in the Figures and described in this document. The use of meshes is beneficial according to this invention. However, to benefit from the advantages of the geometric design features according to this invention that are described in this document and shown in and described with respect to the drawings, use of meshes as filter media is not necessary. The geometric design is beneficial for all sorts of 2-stage filter element applications and may also be used in oil, water or air filtration applications.

Preferably, the exterior of the abovementioned pre-filter 1 is composed of a cylindrical housing 12 and a bowl 14, and the abovementioned housing 12 and bowl 14 can be assembled by screwing the bowl 14 into the housing 12.

At the top of the abovementioned housing 12, an inlet 10 and an outlet 11 are formed in order to allow fuel to enter and exit. As can be seen in Fig. 1, the structure of inlet 10 and outlet 11 are preferably symmetric, each providing two openings opposite to each other, both of which can be used as inlet 10 or

outlet 11, respectively. The fuel that flows into the housing through the inlet 10 can flow out of the housing through the outlet 11.
Here, the abovementioned bowl 14 collects water that drops downward after being coalesced by flowing through the first mesh and separated from the fluid flow by the second mesh 16. The bowl 14 is composed of a transparent material. Accordingly, it is possible to check how much water has been collected.
Also, a cartridge type heater not illustrated could be installed inside the abovementioned housing's 12 inlet 10. Such a heater could be installed by being inserted through one of the two possible inlets. Here, using the abovementioned heater is an option. When not using the heater, it is possible to cover one inlet with a cap 25. Als, the outlet 11 opening not used can be closed in the same manner.

Also, at the bottom of the abovementioned bowl 14 a drain plug 13 may be installed that opens the drain hole 30, and when water is filled sufficiently, water may be discharged by opening the drain plug 13.

Figure 3 through Figure 4 show different aspects of a pre-filter insert 2 in accordance with an embodiment of the present invention; especially the second mesh 16; positions of the first mesh 15 and the second mesh 16. Figures 5 – 7 show the pre-filter 1 with the pre-filter insert 2 operably mounted in the pre-filter 1; wherein Figure 7 illustrates in more detail the bowl 14 with the drain plug 13. A drain plug gasket 38 may be provided between drain plug 13 and bowl 14.

As illustrated in Figure 3 through Figure 7, inside of the abovementioned housing 12 and bowl 14, the end cap 17 of pre-filter insert 2 is visible. The end cap 17 preferably comprises an especially central support 18, which may be designed as a one-piece component with lower end cap 17. The support 18 preferably supports the end cap 17 and the pre-filter insert 2 in the housing 12. Preferably, support 18 rests on the inner bottom surface of bowl 14. As shown in this embodiment, the support 18 may preferably project from the lower end cap 17, downwardly, away from the meshes 15 and 16. Here, support 18 is configured as a tubular open frame, although other designs are possible.
Preferably, the abovementioned lower end cap 17 is in the shape of a disk (end caps 17, 36 may also be called end discs), and supports the lower end faces of core 20 and frame 22.

The bottom of the abovementioned core 20 may be inserted into the core support 28b, which radially positions the core 20 and which for example may be provided as one single or two concentric, circular ribs formed on the top of the lower end cap 17 between or inside or outside which the core 20 may be inserted and/or rested. The abovementioned frame 22 could also or in addition be axially supported on the upper surface of the lower end cap 17. Here, the space between the abovementioned frame 22 and end cap 17 could be sealingly closed if needed, for example by gluing or welding. However, for water

separation purposes it will be sufficient that frame 22 contacts the lower end cap 17, preferably uniformly along the circumference of frame 22.

Also, at the circumference of the abovementioned lower end cap 17, a sealing for radially sealing the lower end cap to the bowl 14 or the housing 12 may be installed, for example an O-ring 23 as shown and indicated in Figures 3 and 7. This O-ring 23 prevents the water in the bowl 14 from overflowing to the outlet side.

Also, close to the outer edge of the abovementioned lower end cap 17, for example located between the first mesh 15 and the second mesh 16, at least one or preferably multiple water discharge holes 32 are located in the lower end cap 17. The water discharge holes 32 provide a fluid connection between the space between meshes 15 and 16 on the one hand, and the water collection volume in the lower part of the housing 12, preferably the volume provided by the bowl 14. The water particles or drops gathered between the first mesh 15 and the second mesh 16 can flow down through the water particle discharge hole 32 and be collected in the bowl 14. Instead of providing water discharge holes 32 in the lower end cap 17, it is also possible, as an alternative, to limit the diameter of the lower end cap 17 such that the frame 22 is not contacting the lower end cap 17 and a circular gap is provided between lower end cap 17 and the lower edge of frame 22. For example, with reference to Figure 6, the radial outer edge of lower end cap 17 could be flush with the outer edge of the core 20 or the outer edge of the core support 28b. In this case, end caps 17, 36 would preferably be fixedly connected to each other via core 20.

Also, in a further preferred embodiment, a ring-shaped floater 24 is positioned inside of the abovementioned bowl 14, preferably positioned around the outer circumference of the support 18. This has the advantage that an operator can easily check the water level by checking the position of the floater 24 that floats on the water. Eventually, it is possible to discharge water collected in the bowl 14 at an appropriate time depending on the water level.

In particular, the first mesh 15 and the second mesh 16 remove the water and preferably also other foreign materials contained in the fuel. The abovementioned first mesh 15 and second mesh 16 form concentric circles together inside of the housing 12 and are positioned concentrically, one inside the other, radially spaced at a certain interval, for example between 5 to 15 mm. This means that one mesh 15, 16 is preferably concentrically positioned inside the other mesh 16, 15. In a preferred embodiment, the first mesh 15 is positioned inside the second mesh 16 at a certain interval in the radius direction, which allows for an in-out flow configuration. For out-in flow configurations, first mesh 15 is positioned outside the second mesh 16 at a certain interval in the radial direction.

Here, as illustrated in Figure 8, the abovementioned first mesh 15 and second mesh 16 are preferably composed of stainless steel or plastic wires in a lattice form. Is has been surprisingly found that using stainless steel as material for at least one the meshes 15, 16 allows for a cheap and very durable water separating solution. Each mesh is preferably supported by the core 20 or the frame 22 in the form of a cylinder to be able to retain the form of a cylinder. In case of plastic wires, the wires preferably are made of polyester (PE). For achieving higher separation efficiency for water, coating the meshes with either a hydrophilic (especially for the first mesh 15) or hydrophobic (especially for the second mesh 16) coating is preferable. Alternatively, this can be achieved by using a hydrophilic or hydrophobic material for the meshes 15, 16 respectively, as for example hydrophobic and/or hydrophilic polyester.

For example, as shown in the embodiments, the abovementioned first mesh 15 is positioned inside of the core's 20 material and surrounded by the core's 20 material. This can be achieved by overmolding the core 20 around the first mesh, wherein the first mesh is inserted into a injection molding tool of the core 20 before injection molding the core 20, whereby the core is molded around the first mesh 15 and encloses the first mesh 15 in a form-fit manner. Thus, the first mesh 15 is comprised by the core 20, forming a one-piece component. The frame 22 can be overmolded over the second mesh 16 in the same way. Alternatively, the core 20 is overmolded over the second mesh 16 and the frame 22 over the first mesh 15 for creating an out-in flow configuration. The first mesh 15 formed this way may form the inner column side of the core 20, with some areas being buried by the ribs at the axis direction and by the ribs at the circumference direction in order to be formed as part of the core 20.

Also, the abovementioned core 20 and frame 22 preferably comprise plurality of holes 19 or openings 21 with an open surface or diameter that is larger, especially at least 10 or 100 times larger, than the opening size 37 of the mesh respective 15, 16. The water particles or drops/droplets that have been coalesced by the first mesh 15 go through the hole 19 in core 20, and then enter into the space that is defined between the core 20 and the frame 22.

In the first embodiment shown in Figures 1 to 7, the upper and lower axial ends of core 20 are inserted into the core supports 28a, 28b, provided at the upper end cap 36 and lower end cap 17, so that the entire core 20 including the first mesh 15 can be supported.

Preferably, as shown in Figures 4-6 and 9-12, the frame 22 is comprised by the upper end cap 36, for example by being injection molded in one piece with the upper end cap 36 or by being glued or welded to the upper end cap 36. Further preferably, as shown in Figures 9 and 12, the core 20 is comprised by the lower end cap 17, for example by being injection molded in one piece with the lower end cap 17 or by being glued or welded to the lower end cap 17.

Also, preferably, the tubular core 20 and/or the tubular frame 22 comprise or essentially consist of a plurality of ribs in axial direction and a plurality of ribs in circumferencial direction, creating a tubular grid with a plurality of holes 19 and/or openings 21, which are provided in the space between the ribs, wherein fluid, especially fuel can through the holes 19 and/or openings 21.

Also, at the outer circumference side of the abovementioned frame 22, preferably a plurality of protrusions 31 that are radially projecting from the frame 22 are provided that serve as spacers to provide constant radial spacing of the pre-filter insert 22 inside of the housing 12.

The upper end cap 36 preferably comprises a centrally located flow opening, indicated with reference numeral 27. Depending on the flow direction, this flow opening 27 may serve as an outlet or inlet opening. Preferably, a seal is provided at the flow opening 27 for sealingly connecting the flow opening 27 to a connection tube 26 in the pre-filter housing 12, which, in turn again is connected either to an inlet 10 or outlet 11 of the housing 12.

The abovementioned first mesh 15 lumps the water particles that go through the mesh, and the abovementioned second mesh 16 prevents water particles from seeping out because the opening size is smaller than the size of the lumped water particles. As a result, the water particles that come out of the first mesh 15 cannot go through the second mesh 16, and drop into the bowl 14 at the bottom through the water particle discharge hole 32 that is located at the end cap 17 between the first mesh 15 and the second mesh 16.

Preferably, the first mesh 15 and the second mesh 16 have different opening sizes. For example, the first mesh 15 could have a relatively larger opening size than the second mesh 16. For example, the opening size of the abovementioned first mesh 15 could be between 0.3 to 0.5 mm, and could advisably be 0.37 mm. Also, the opening size of the abovementioned second mesh 16 could be between 0.01 mm and 0.15 mm, and could advisably be 0.09 mm. Additionally, the abovementioned first mesh 15 could be formed with wires whose diameter could be between 0.1 mm and 0.2 mm and could advisably be 0.14 mm. Also, the abovementioned second mesh 16 could be formed with wires whose diameter could be between 0.04 mm and 0.06 mm and could advisably be 0.053 mm.

Therefore, with diesel fuel supply systems, the fuel that is supplied from the fuel tank goes through the pre-filter 1, 100 that is located upstream of the main filter (not shown). The fuel flows to the main filter after going through the following routes: inlet 10 → first mesh 15 → area between the first mesh 15 and the second mesh 16 → second mesh 16 → outlet 11. During the above fuel flow process, the water contained in the fuel is lumped to form bigger droplets in the process of going through the first mesh 15 that has a relatively large wire, fiber or thread diameter and opening size 37. The water particles lumped

in the shape of droplets are not able to go through the second mesh 16, which has a small wire, fiber or thread diameter and a smaller opening size 37 than the first mesh, so that the water droplets drop down to the bowl 14 below through the water discharge hole 32. As described above, those foreign materials with relatively large particles contained in the fuel may be filtered by the first mesh 15, and those foreign materials with relatively small particles may be filtered by the second mesh 16, so it is possible to effectively filter foreign materials contained in the fuel. A further advantage of both filter stages being meshes may be that the pre-filter insert 2, 200 may be cleanable when removed from the housing 12 or simply by back-flushing.
A pre-filter 100 and pre-filter insert 200 according to a second embodiment of the present invention is described below.

As illustrated in Figure 9 through Figure 12, the pre-filter 100 in another embodiment of the present invention is very similar to the pre-filter in the previous embodiment described above in terms of structure. The main differences in regard to the first embodiment are in how the support 18, 35 is realized and the details of the mechanical design of pre-filter insert 200.

As a means of removing water and foreign materials contained in the fuel, the first mesh 15 and the second mesh 16 are provided. The abovementioned first mesh 15 and second mesh 16 of the pre-filter insert 200 form concentric circles inside the housing 12, while being radially spaced from each other at a certain interval. Preferably, as shown in Figures 9-12, the frame 22 is comprised by the upper end cap 36, for example by being injection molded in one piece with the upper end cap 36 or by being glued or welded to the upper end cap 36. Further preferably, as shown in Figures 9 and 12, the core 20 is comprised by the lower end cap 17, for example by being injection molded in one piece with the lower end cap 17 or by being glued or welded to the lower end cap 17. For example, the abovementioned first mesh 15 is positioned inside of the cylindrical core 20 and at the same time inserted together with the core to form a single body, while the core is preferably injection-molded. The first mesh 15 molded this way forms an inner column side of the core 20 with some areas buried in the ribs in the axis direction and in the ribs in the circumference direction to become part of the core 20.

In a preferred embodiment such as for example shown in Figures 9-12, the upper edge of core 20 is inserted into the core supports 28a, 28b at the lower side of the upper end cap, similar to the first embodiment.

Preferably, as shown in Figures 11 and 12, the frame 22 which is preferably comprised by the upper end cap 36 may be snapped to the lower end cap 17 or connected to it using a similar form-fit connection method. At least one water discharge hole 32 is provided in the lower end cap between the first mesh and the second mesh and may preferably be used as an opening for receiving a hook 34 provided at the

frame 22 to be snapped into the water discharge hole 32. Alternatively, separate holes may be used for receiving the hooks 34. In a preferred embodiment as shown, the upper end cap 36 comprises the frame 22 which is snapped into the lower end cap 17. The core 20 may preferably be clamped between the upper end cap 36 and lower end cap 17 or the core 20 may alternatively be comprised by the lower end cap 17 as described above and shown in Figure 12.

Preferably, the frame 22 comprises multiple hooks 34 regularly or irregularly spaced around the circumference of the lower end of the frame 22 at a certain interval. Those hooks preferably interact with corresponding holes as described above to provide a snap connection between the frame 22 and/or upper end cap 36 and the lower end cap 17.

In a preferred embodiment, inside the bowl 14 a plurality of supports 35 are provided which are part of the bowl 14 and preferably are provided in one-piece with the bowl. The supports 35 preferably may protrude radially from the inner wall side of the bowl 14. For example, there are three to four supports 35, all having upper edges located in a plane perpendicular to the main rotation axis of the pre-filter 100 and pre-filter element 200. Therefore, lower end cap 17 may directly rest on and be supported by the support 35. Here, the abovementioned floater 24 is positioned inside the supports 25 and is formed to be able to move up and down.

Reference numbers

1: Pre-Filter
2: Pre-filter insert
10: Inlet
11: Outlet
12: Housing
13: Drain plug
14: Bowl
15: First mesh
16. Second mesh
17: Lower end cap
18: Support
19: Hole
20: Core; perforated, tubular support structure
21: Opening
22: Frame; perforated, tubular support structure
23: O-ring
24: Floater
25: cap
26: Connection tube
27: Flow opening
28a, 28b: Core support
29: Support
30: Drain hole
31: Interval protrusion
32: Water particle discharge hole
33: Hook fastening hole
34: Hook
35: Support
36: Upper end cap
37: Opening size
38: Drain plug gasket
100: Pre-filter
200: Pre-filter insert

Claims

1. Pre-filter insert for water separation in a diesel fuel filter, comprising a first mesh (15) and a second mesh (16) spaced from and located downstream of the first mesh, wherein the first mesh (15) is configured (15) to coalesce water droplets and the second mesh (16) is configured to separate the water coalesced by the first mesh (15).

2. Pre-filter insert according to claim 1, wherein the first mesh (15) and the second mesh (16) have a closed, tubular shape and are positioned concentrically and radially spaced from each other.

3. Pre-filter insert according to any of the previous claims, wherein at least one water discharge opening (32) is provided between the first mesh (15) and the second mesh (16) for draining of the separated water from the pre-filter insert.

4. Pre-filter insert according to any of the previous claims, wherein the first mesh (15) is positioned inside of the second mesh (16).

5. Pre-filter insert according to any of the previous claims, wherein the first mesh (15) is supported by a tubular cylindrical core (20) equipped with multiple holes (19) or openings and wherein the second mesh (16) is supported by a tubular cylindrical frame (22) equipped with multiple holes or openings (21).

6. Pre-filter insert according to claim 5, wherein the first mesh (15) is permanently attached to the core (20).

7. Pre-filter insert according to claims 5 or 6, wherein the second mesh (16) is permanently attached to the frame (22).

8. Pre-filter insert according to claims 6 and/or 7, wherein the first mesh (15) is permanently attached to the core (20) by injection-molding of the core around the first mesh (15) and/or the second mesh (16) is permanently attached to the frame (22) by injection-molding of the frame (22) around the second mesh (16).

9. Pre-filter insert according to any of the previous claims, wherein the first mesh (15) and/or the second mesh (16) are composed of stainless steel or polyester.

10. Pre-filter insert according to any of the previous claims, wherein the opening size of the first mesh (15) is larger than the opening size of the second mesh (16).

11. Pre-filter insert according to any of the previous claims, further comprising a lower end cap (17) and an upper end cap (36).

12. Pre-filter insert according to claim 11, wherein at least one of the end caps (17, 36) comprises at least one of the core (20) and/or the frame (22) as a one-piece component.

13. Pre-filter insert according to any of claims 11 or 12, wherein at least one of the core (20) and/or the frame (22) not comprised by an end cap (17, 36) is clamped between the end caps (17, 36).

14. Pre-filter insert according to any of claims 12 or 13, wherein the at least one at least one of the core (20) and/or the frame (22) comprised by the at least one end cap (17, 36) is snapped to the respective other end cap (36, 17).

15. Pre-filter insert according to any of claims 11 to 14, wherein the at least one water discharge opening (32) is provided in the lower end cap (17) between the first mesh (15) and the second mesh (16).

16. Pre-filter insert according to any of claims 13 or 14, wherein a gasket, especially an O-ring, is attached to the periphery of the lower end cap (17) for sealingly contacting a housing (12) and/or bowl (14) preferably for preventing separated water from overflowing out of the bowl (14) into an outlet.

17. Pre-filter for water separation in a diesel fuel filter, comprising
a housing (12) equipped with an inlet (10) and an outlet (12),
a pre-filter insert according to any of the previous claims operably positioned inside the housing (12),
a bowl (14) to collect water separated at the pre-filter insert, equipped with a drain plug (13) for discharging water, the bowl being removably or permanently attached to the housing (12).

18. Pre-filter according to claim 16, wherein the abovementioned bowl (14) is composed of a transparent material and wherein a floater (24) is positioned inside the bowl (14) that floats on water to indicate the water level inside the bowl.

19. Filter insert for a fluid filter, comprising a first end cap comprising a first tubular support structure, and a second end cap comprising a second tubular support structure, a first filter media (15) attached to or supported by the first support structure and a second filter media (16) attached to or supported by the second support structure, wherein the first filter media is spaced from and located downstream of the second filter media, wherein at least one of the support structures comprised by one end cap is snapped to the other end cap.

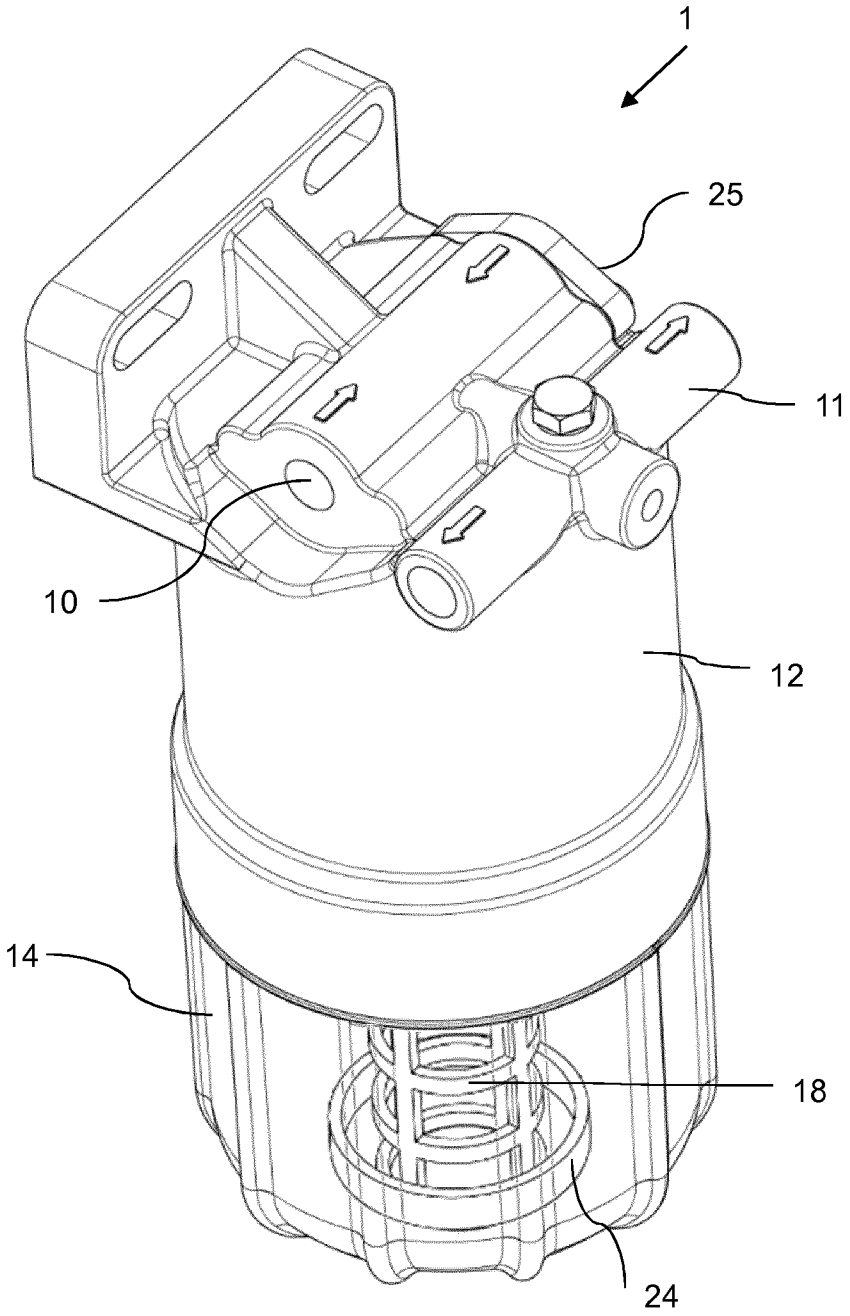

Fig. 1

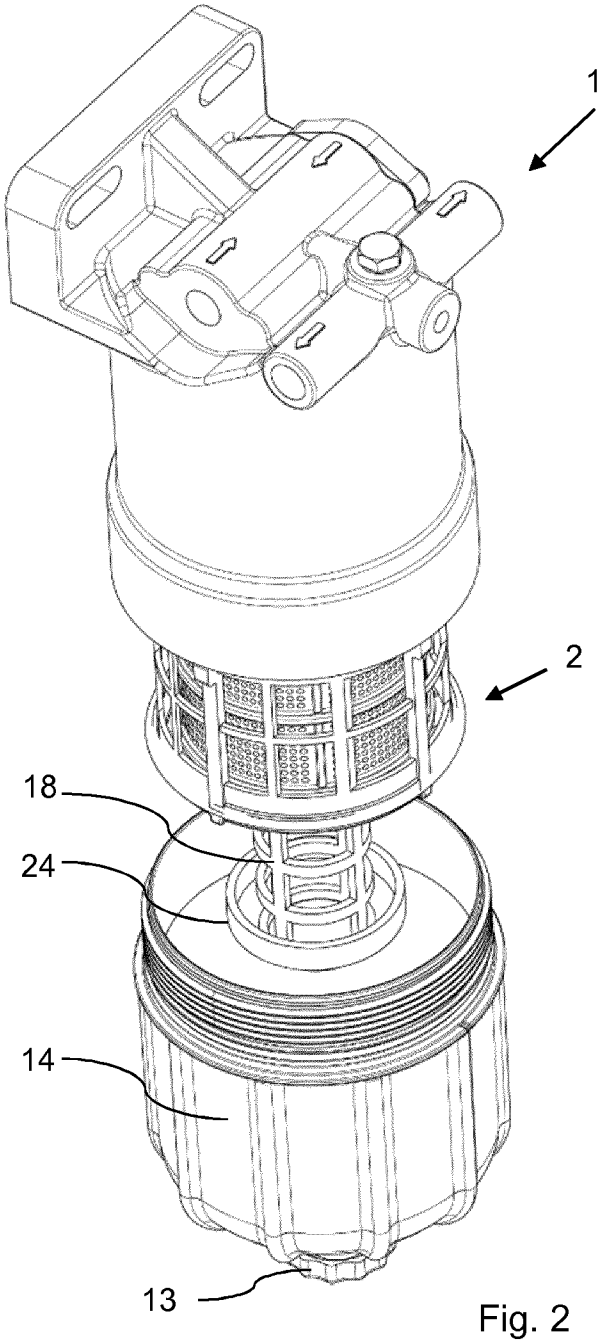

Fig. 2

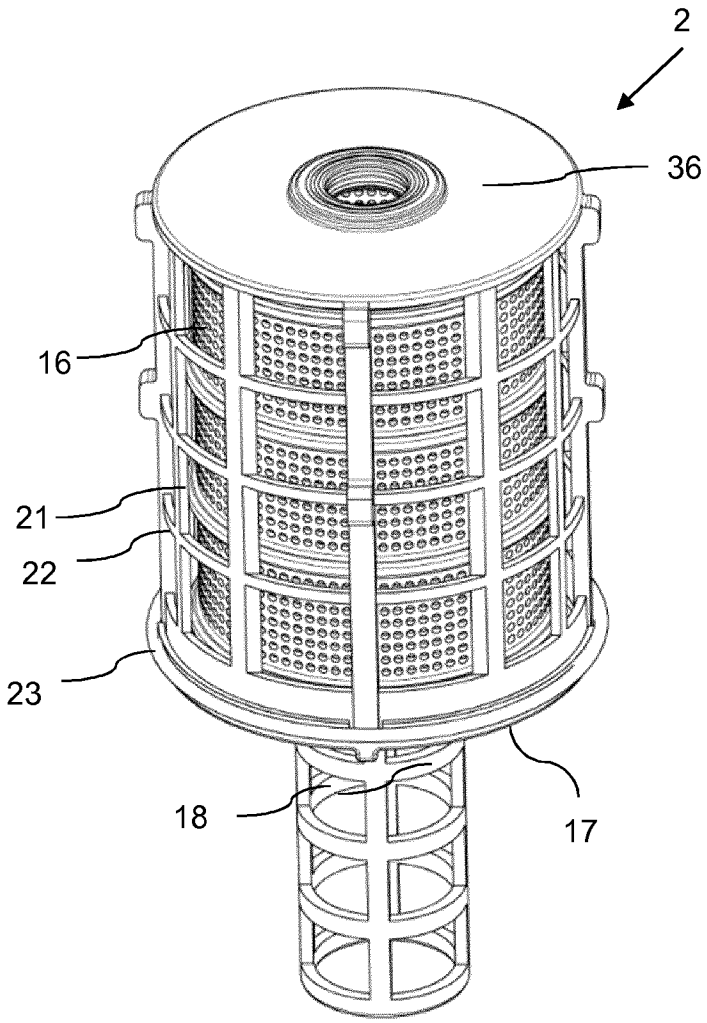

Fig. 3

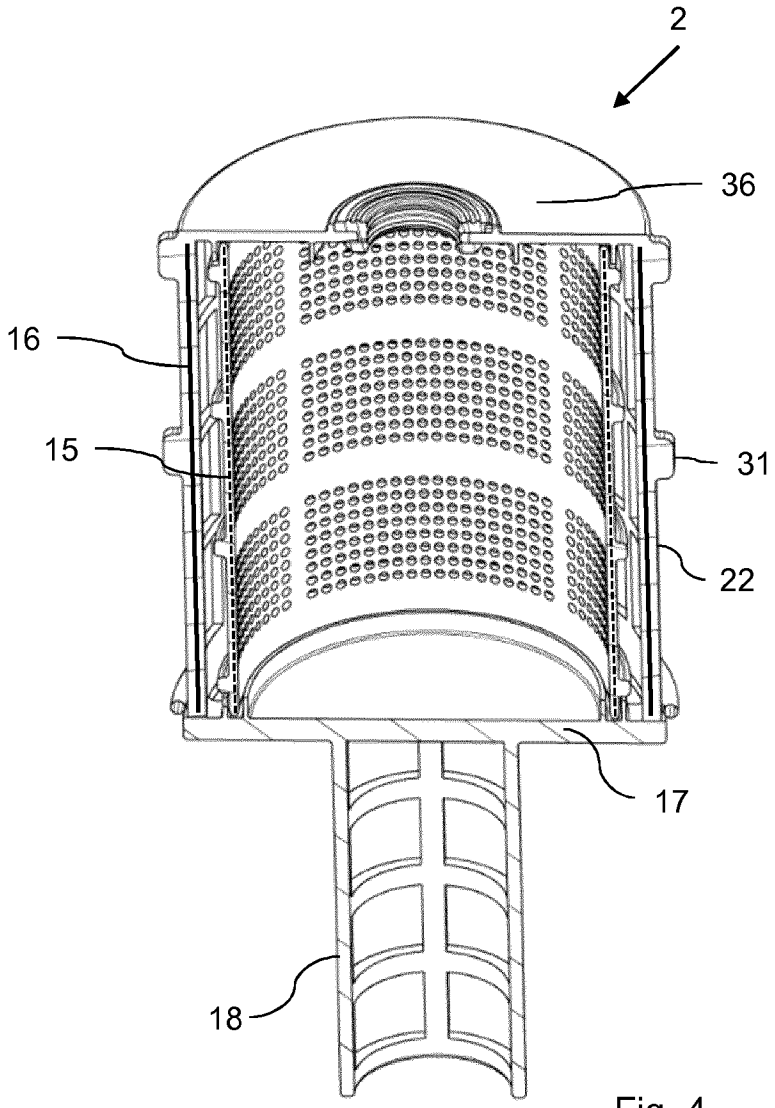

Fig. 4

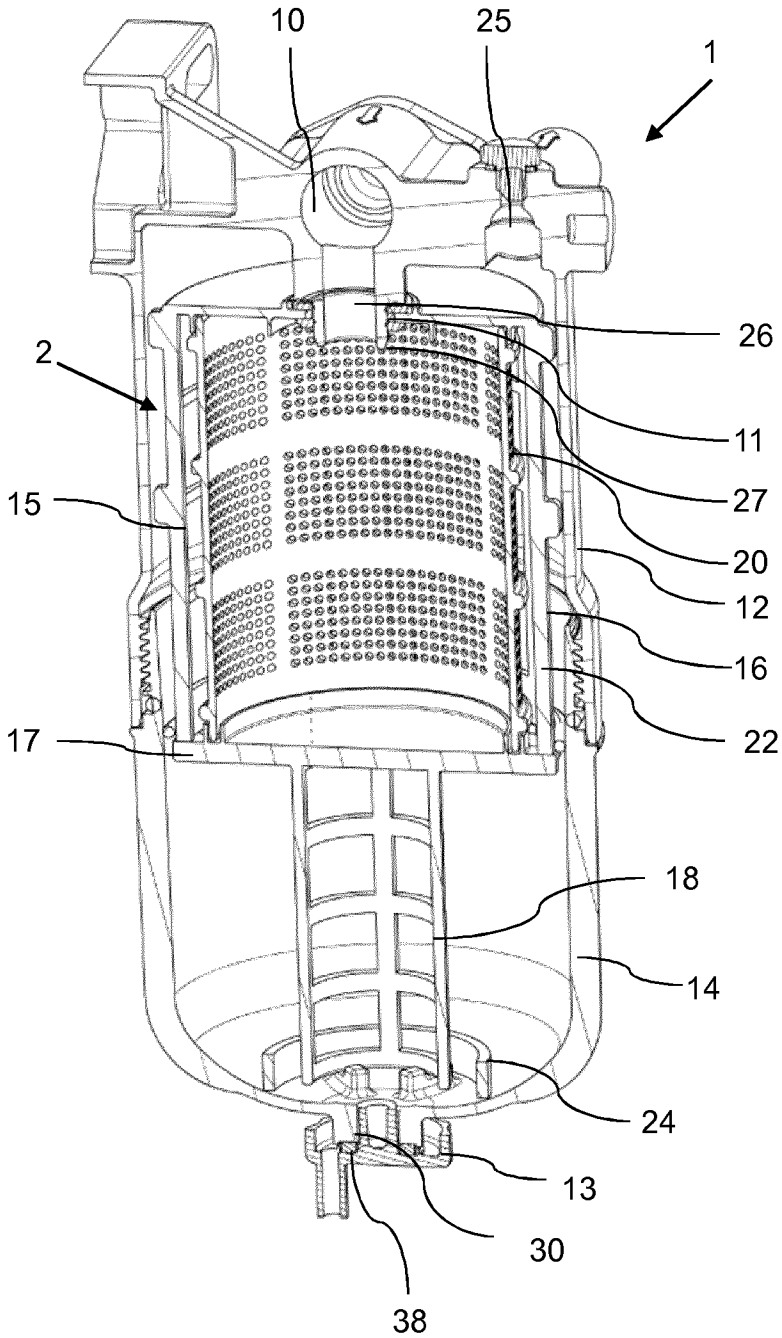

Fig. 5

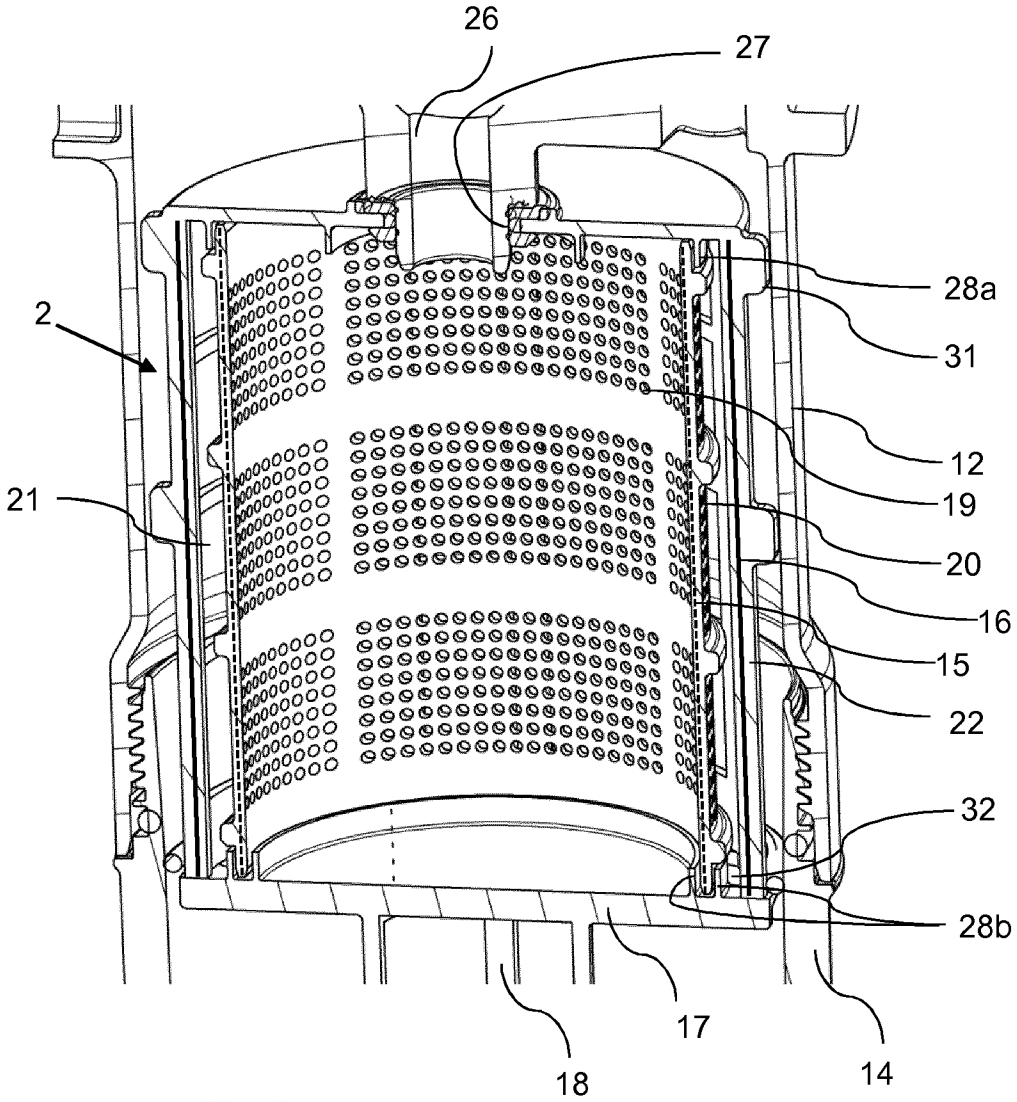

Fig. 6

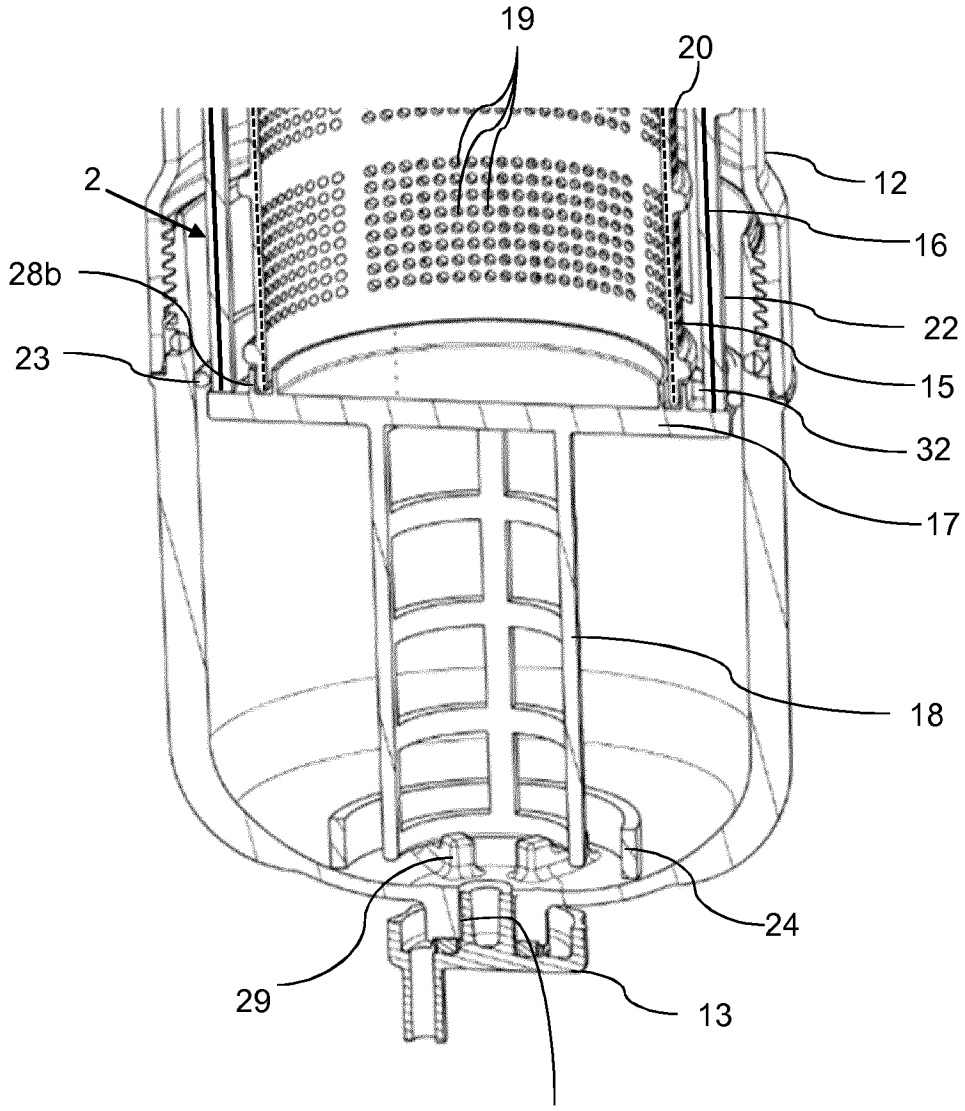

Fig. 7

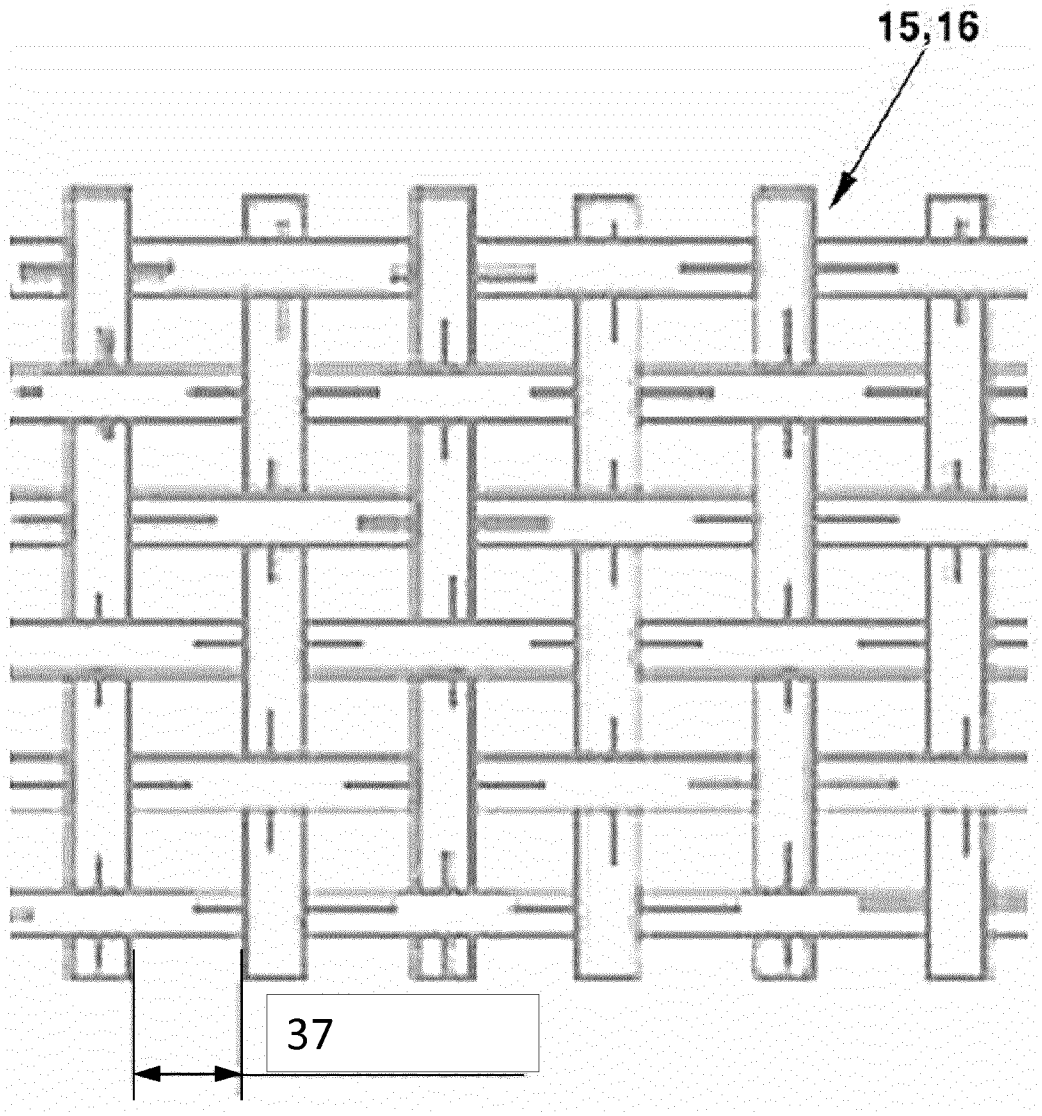

Fig. 8

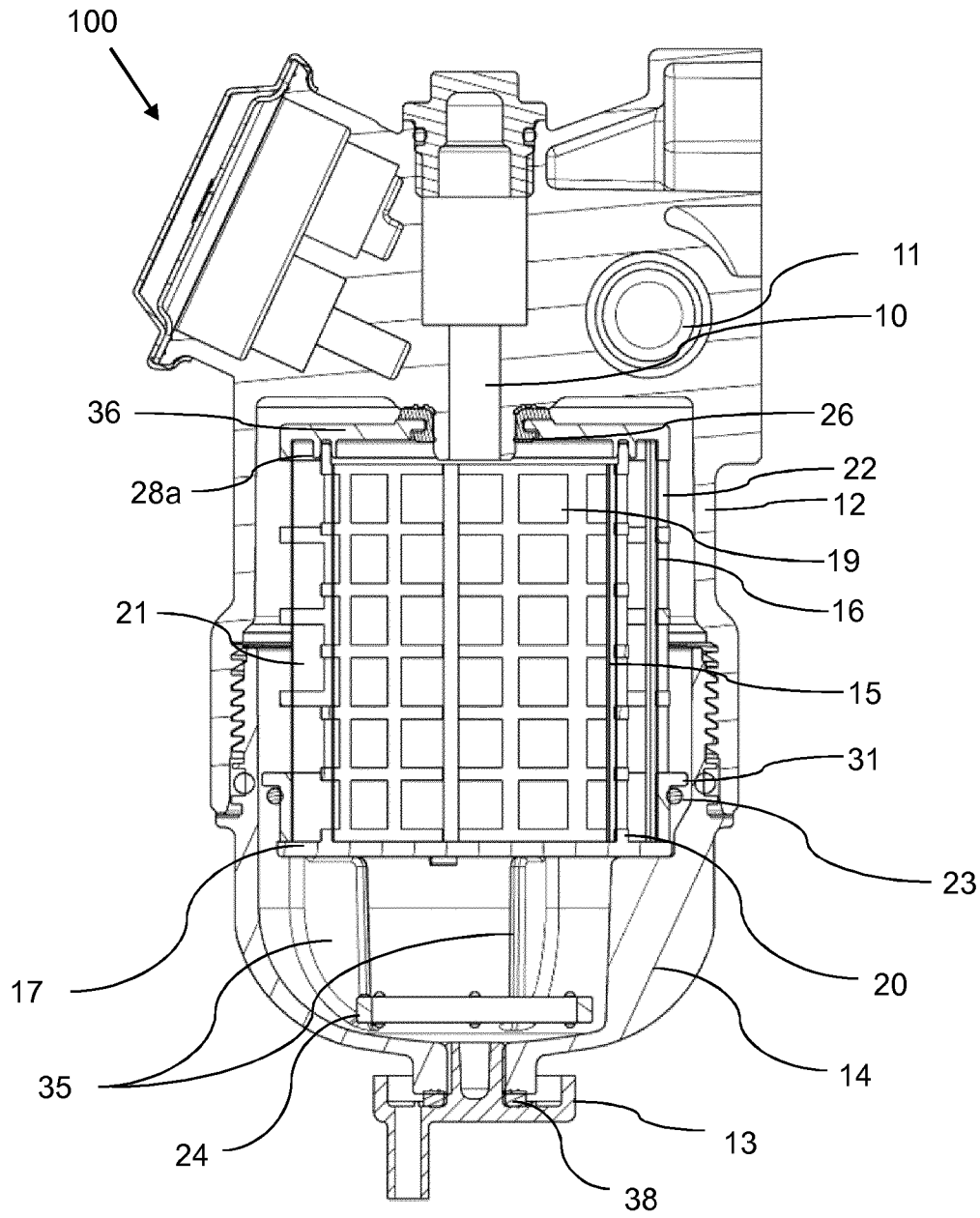

Fig. 9

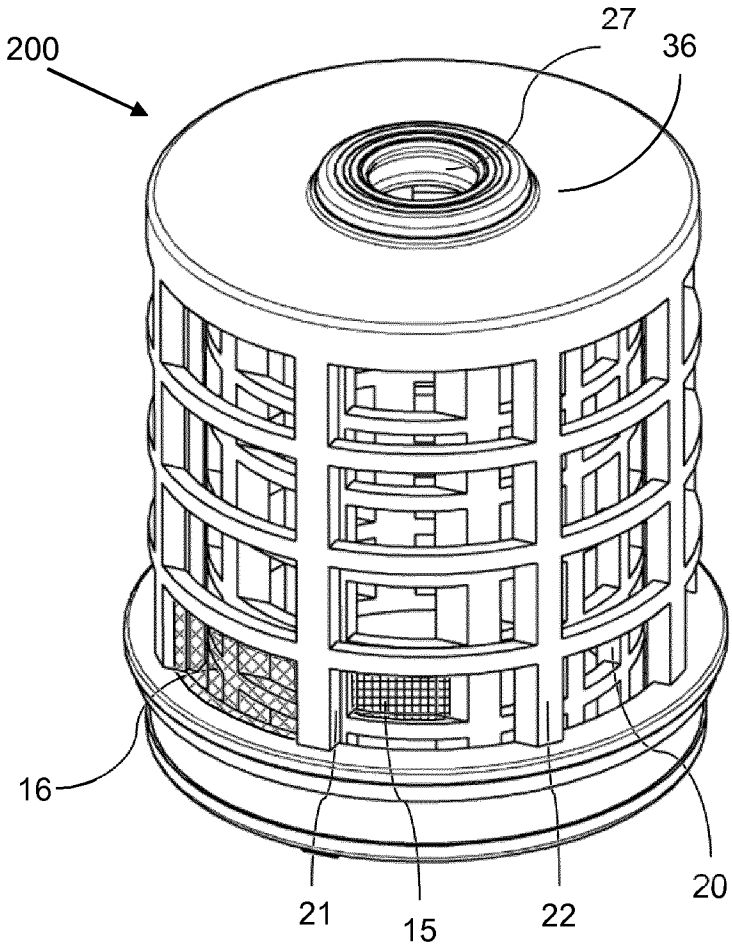

Fig. 10

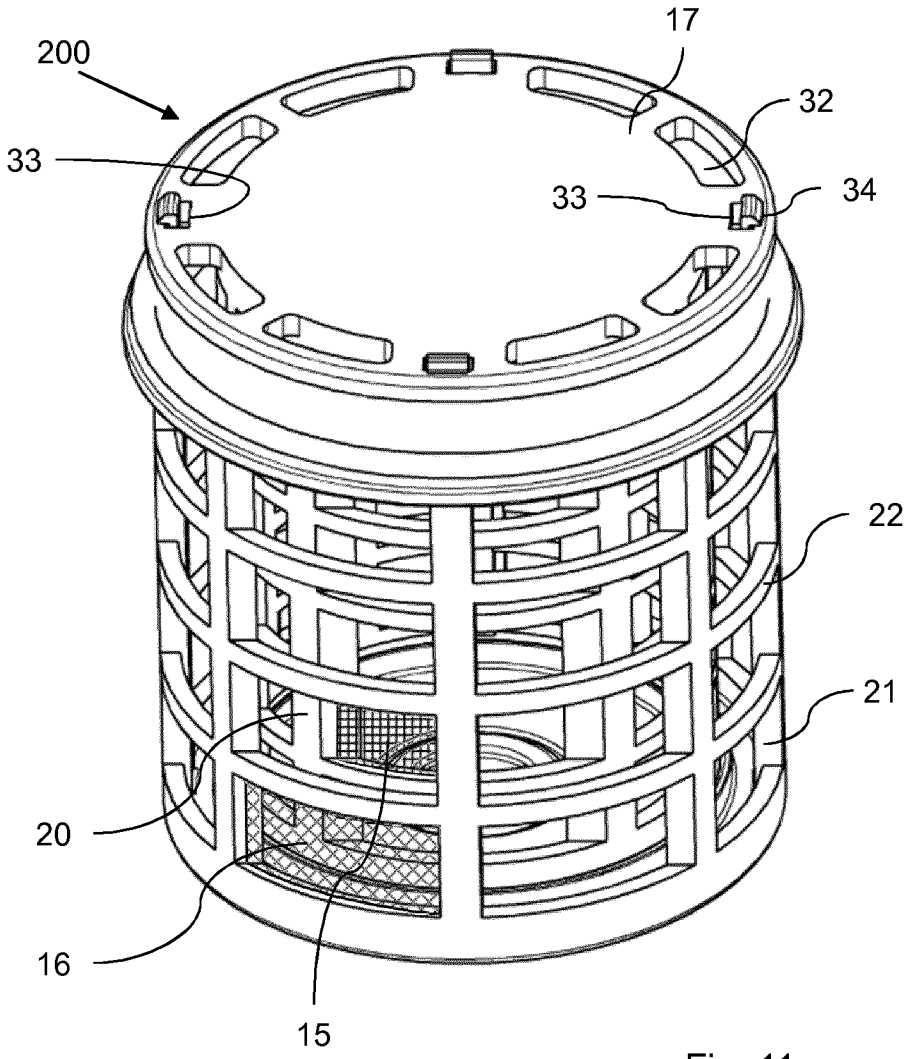

Fig. 11

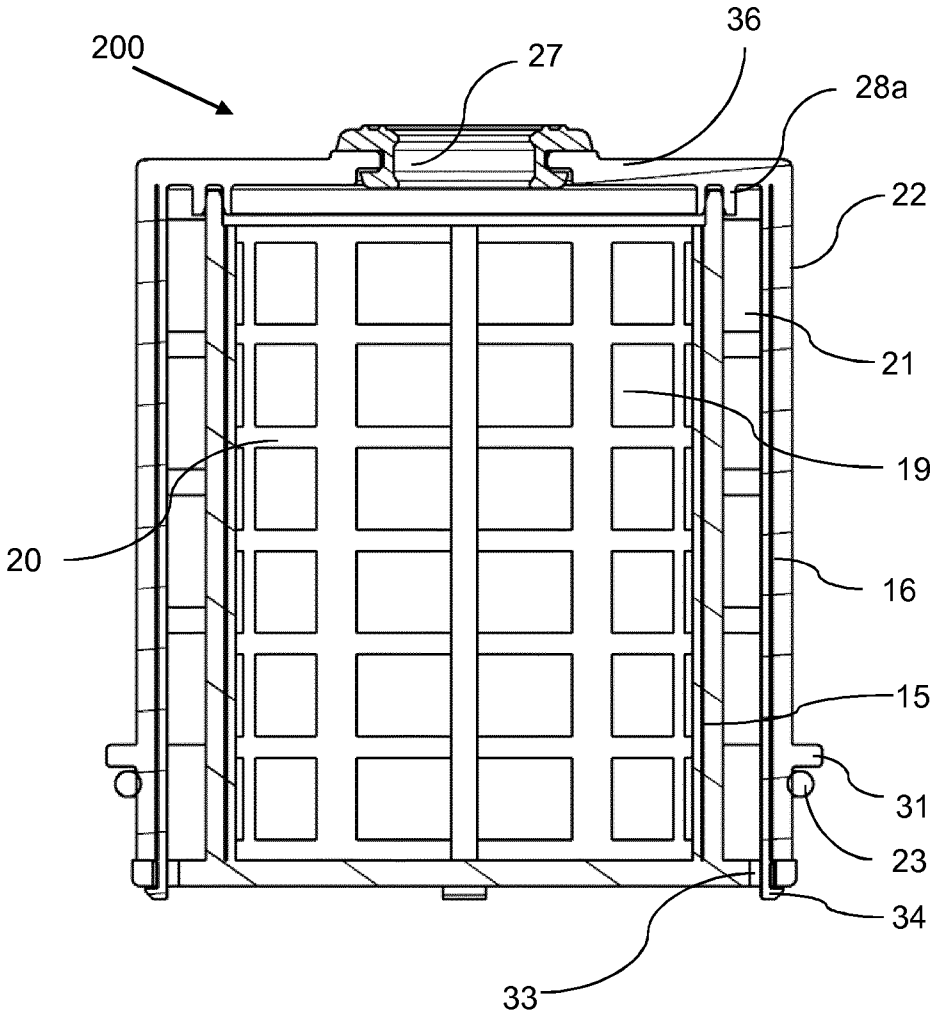

Fig. 12