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(71) Applicant: **Nissan Motor Manufacturing (UK) Ltd.**
Cranfield, Bedfordshire MK43 0DB (GB)

(72) Inventor: **GOMEZ BLANES, Juan Enrique,**
Nissan Technical
Cranfield, Bedfordshire MK43 0DB (GB)

(74) Representative: **Hufton, Victoria Alice**
Nissan Motor Manufacturing (UK) Ltd
IP Dept., Cranfield Technology Park
Moulsoe Road
Cranfield, Bedfordshire MK43 0DB (GB)

(54) Improvements in or relating to radiator tanks

(57) A radiator tank for a U-flow radiator is provided. The radiator tank comprises an internal bypass.

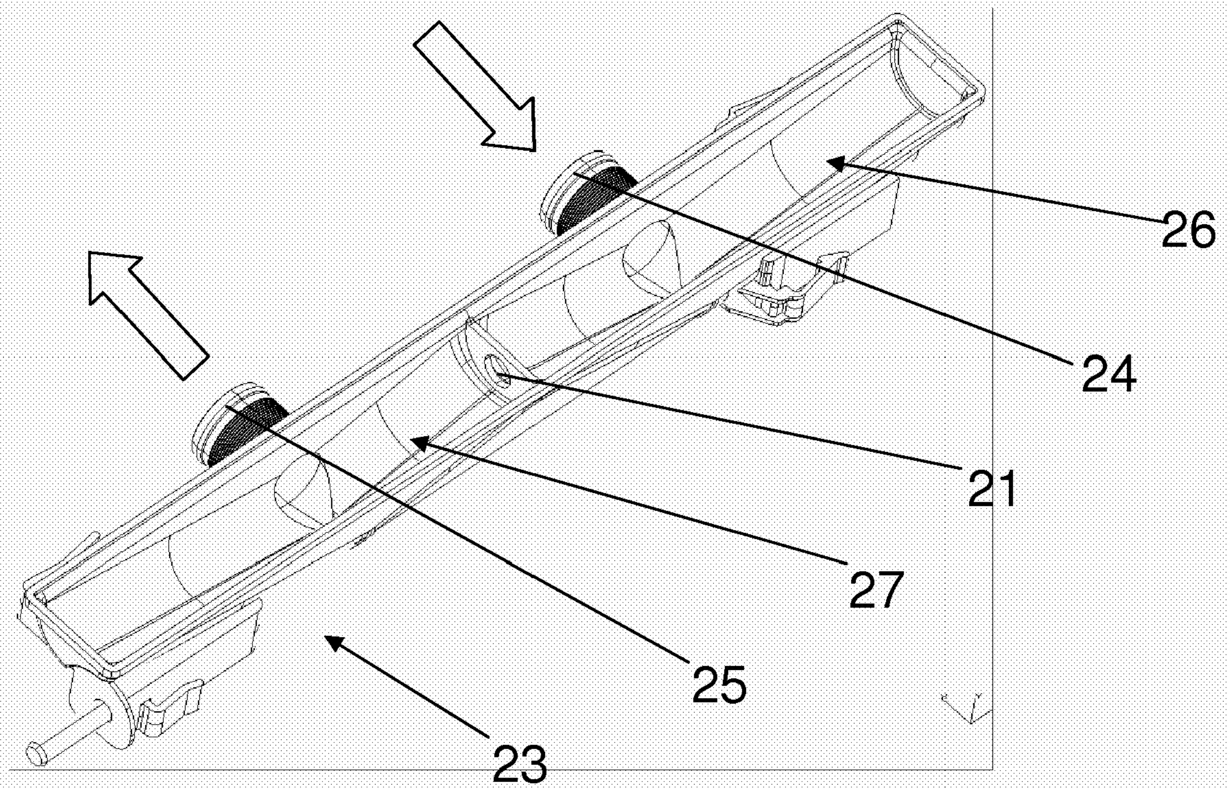

Figure 2

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Description

[0001] The present invention relates to an improved radiator for a motor vehicle and, more particularly, a radiator tank that is provided with a bypass.

[0002] There are three main types of radiator configuration that are commonly employed by the automotive industry: Cross-flow, Down-flow and U-flow. The choice of radiator type is influenced by a number of different factors, one of which is the layout constraints of the vehicle as a whole. The U-flow radiator has the advantage that the inlet and outlet are provided within the same radiator tank. This enables a greater degree of design freedom in the exact positioning of the inlet and outlet.

[0003] When the engine is under heavy load such as mountain driving, towing or off-roading, the engine is prone to overheating if insufficient coolant flow through the radiator is provided. To meet these high flow requirements the coolant pump may have to work beyond its optimal operating parameters. These conditions may result in the formation of partial vacuums in the coolant fluid. This phenomenon is generally referred to as cavitation. When a volume of liquid in contact with a pump is subjected to a sufficiently low pressure it may rupture and form a cavity behind the blade of the pump impeller. The cavitation bubble thus created will begin to collapse due to the higher pressure of the surrounding medium. As the bubble collapses, the pressure and temperature of the vapour within will increase. The bubble will eventually collapse to a minute fraction of its original size, at which point the gas within dissipates into the surrounding liquid releasing a significant amount of energy in the form of a shock wave. This energy can be responsible for the degradation of the internal surfaces of pump and especially the impeller blades.

[0004] In some vehicle configurations cavitation is becoming an increasingly normal side-effect of high stress driving conditions. As a result of the negative impact that cavitation has on the lifetime of relevant engine parts it is desirable for the flow of fluid through the radiator system to be managed so that it does not reach the point where cavitation begins.

[0005] JP-2005-325699 discloses a system that is intended to address this problem. The system comprises a pair of hoses connected respectively to bosses on the inlet and outlet sides of a U-flow radiator tank. The hoses join together to bypass the radiator via an externally mounted valve assembly.

[0006] The valve assembly comprises a valve member which protrudes into the hoses in a direction that is substantially orthogonal to the flow of fluid through the hoses. This system is intended to provide a bypass that has variable capacity depending on the extent of the intrusion of the valve member into the tube.

[0007] Another solution that has previously been employed in the automotive industry is to provide a tube that connects the radiator inlet hose directly to the radiator outlet hose. The diameter of the tube is selected to ensure that the proportion of fluid bypassing the radiator does not adversely affect the functionality of the cooling system as a whole.

[0008] It is against this background that the present invention has been made.

[0009] According to the present invention there is provided a radiator tank for a U-flow radiator, wherein the radiator tank comprises an internal bypass.

[0010] The radiator tank of the present invention also overcomes the layout concerns raised by known external bypass systems. Because a radiator tank according to the invention has the same packaging envelope as a standard U-flow radiator tank the radiator tank of the present invention is fully backwardly compatible and it does not raise any layout concerns that would not be encountered by a standard radiator tank. Furthermore, the tank can be made using the same manufacture tooling thus avoiding the need for costly new tooling.

[0011] The present invention is entirely failsafe in that if the bypass becomes blocked the volume of coolant that can bypass the radiator is reduced and therefore the radiator would operate as though it had no bypass. In contrast, a failure in the system shown in JP-2005-325699 could cause the loss of fluid from the engine cooling system. This circumstance has considerably higher potential for costly engine damage than cavitation under high load conditions because overheating affects the entire engine including the cooling system whereas cavitation damage occurs only within the coolant pump.

[0012] The radiator tank may further comprise a parting plate for dividing an inlet portion and an outlet portion. The bypass may be provided in the parting plate.

[0013] The internal bypass provided within the radiator tank of the present invention considerably reduces the complexity of the radiator system as a whole. By modifying an existing parting plate to provide the new, additional function of a bypass, the requirement for the additional tube and related packaging space employed by JP-2005-325699 can be avoided. The number of parts making up the radiator as a whole is reduced and, consequently, the number of potential failure points is also reduced.

[0014] The provision of the bypass as an orifice within the parting plate has the advantage that the length of the bypass is negligible. Both of the prior art arrangements discussed above comprise external bypasses that have a path length which far exceeds the flow cross section, thereby introduces an inherent impedance to the flow, simply as a result of the length of the bypass tube. By providing the bypass in the parting plate the effective length of the bypass is negligible and therefore the flow rate is dictated only by the cross sectional area of the orifice. As a result, the required diameter of the bypass aperture is smaller than the diameter of the external bypass tube required in the prior art to have the same affect on the pressure within the system.

[0015] The bypass may be an aperture, which may be circular.

[0016] A circular hole has the advantage that it is very simple to implement with a high level of certainty regarding the cross sectional area of the resulting aperture. Alternatively, if the parting plate is shaped such that the required cross sectional area cannot be achieved using a circular aperture then an oval or polygonal aperture could be created in order to provide the required cross sectional area within the constraints of the parting plate provided.

[0017] The bypass aperture may be provided with a valve that is operable between an open position and a closed position. The valve may be biased to the closed position. The valve may be either a multi-cuspid valve or a reed valve.

[0018] The provision of a valve within the aperture provides a further refinement of the basic premise of the internal bypass. The valve enables the cross sectional area of the aperture to change as a result of the pressure differential between the inlet and the outlet portions of the radiator tank. The valve is normally closed ensuring that flow through the bypass occurs only when cavitation would otherwise be likely to occur.

[0019] The valve may be integrally moulded into the radiator tank.

[0020] The valve may be operable to open when the pressure difference between the inlet portion and the outlet portion exceeds a predetermined level.

[0021] The radiator tank may further comprise a sensor for detecting the speed of the engine and control means for controlling the valve when the pressure difference between the inlet portion and the outlet portion exceeds a predetermined level for the sensed engine speed.

[0022] The present invention will now be described in detail, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a standard U-flow radiator system;

Figure 2 is a perspective view of a radiator tank according to a first example of the present invention;

Figure 3 is a perspective view of a part of the radiator tank of the present invention shown in Figure 2;

Figure 4 is a perspective view of a radiator tank according to a second example of the present invention;

Figure 5 is an end view of a valve provided within a radiator tank according to the second example of the present invention;

Figure 6 is a cross sectional view of the valve shown in Figure 5;

Figures 7a and b are a schematic diagrams of the pressure differentials in a radiator tank according to the second example of the present invention; and

Figure 8 is a graphical representation of the pressure and flow characteristics of a radiator system.

[0023] Figure 1 shows a standard U-flow radiator system 10. The radiator system 10 comprises a core 11 and two end-caps or tanks 12, 13. The tank 13 is divided into two portions: an inlet portion 16 and an outlet portion 17. The inlet and outlet portions 16, 17 are divided by a parting plate 18. The inlet and outlet portions 16, 17 are provided with respective inlet 14 and outlet 15 bosses. In use, hoses (not shown) are attached to the inlet and outlet bosses 14, 15. The standard flow through the system is as follows: fluid enters inlet portion 16 of the tank 13 through the inlet boss 14. The fluid then enters the core 11 and follows a U-shaped path as shown by the arrows in Figure 1. The fluid then leaves the system 10 by passing from the core 11 into the outlet portion 17 of the tank 13 and exiting through the outlet boss 15.

[0024] Figure 2 shows a tank 23 according to a first example of the present invention. The tank 23 is divided into inlet portion 26 and outlet portion 27 and is provided with inlet and outlet bosses 24, 25 similar to those shown in Figure 1 above.

[0025] The tank 23 is also provided with a parting plate 28 separating the inlet portion 26 from the outlet portion 27. The parting plate 28 is provided with an aperture 21 which acts as a bypass enabling fluid to flow directly from inlet portion 26 to outlet portion 27 thus bypassing the core of the radiator system.

[0026] Figure 3 shows a perspective view of the radiator tank 23 focussing on the parting plate 28. The bypass aperture 21 that allows fluid flow between the inlet portion 26 and the outlet portion 27 is substantially circular.

[0027] The example of the present invention shown in Figures 2 and 3 can be fabricated without any alteration to the standard tooling being required. The aperture shown in Figure 3 is substantially circular and has the advantage that it can be machined easily and with a high level of certainty regarding the cross sectional area of the resulting aperture. However, in an alternative example of the present invention (not shown in the Figures) the shape of the aperture could be selected from a variety of ovals, ellipses or polygons in order to provide the most efficient use of the available area of the parting plate 28.

[0028] The size of the hole is selected to achieve a compromise between the cooling performance of the radiator and the pressure reduction within the system required in order to avoid the onset of cavitation. In practice, a circular hole of 8mm diameter shows a good balance between these two criteria. A hole of this size enables approximately 150 litres of fluid to be bypassed per hour at a predetermined optimum rate of engine rotation. The optimum size of the hole will depend on the layout of the system as a whole and the trade-off between the required pressure reduction and the effective contribution of the radiator to the engine cooling system as a whole.

[0029] The figures above relate to a car radiator. However, the skilled man would appreciate that the invention could equally be applied to any motorcycle or larger vehicle using a U-flow radiator, although a suitable scaling of the aperture size would be required. In the automotive industry there are families of core sizes that are all provided with the same size radiator tank. The exemplary figures given above relate to a small core with a thickness ranging from 16mm to 20mm. A larger radiator core may have a thickness ranging from 27mm to 35mm. A single tank size is provided for this range and the aperture would typically be in the region of 30mm in diameter.

[0030] In place of a single aperture, multiple apertures could be employed in order to make best use of the packaging space available.

[0031] Figures 4 to 7 show a second example of the present invention. The tank 43 is divided into an inlet portion 46 and an outlet portion 47. The tank is also provided with inlet and outlet bosses 44, 45 similar to those shown in Figure 1 above.

[0032] The tank 43 is also provided with a parting plate 48. The parting plate 48 is provided with an aperture 41 which, like the aperture 21 shown in Figures 2 and 3 above, acts as a bypass enabling fluid to flow directly from inlet portion 46 to outlet portion 47 thus bypassing the core of the radiator system. The aperture 41 is partially closed by a control valve 42. The valve 42 is shown in more detail in Figures 5 and 6.

[0033] Figure 5 shows an end view of the valve 42 shown in Figure 4. The valve 42 is a multi-cuspid valve consisting of an outer rim 49 and an inner portion 50 divided into six segments 51.

[0034] As can be seen best in Figure 6, the outer rim 49 has a U-shaped cross section to enable it to form an interference fit with the edge of the aperture 41. The inner portion 50 has a considerably smaller thickness that the outer rim 49. The valve 42 is symmetrical so that the parts on either side of the parting plate 48 are identical and the inner portion 50 is typically in line with the parting plate 48.

[0035] When the pressure differential across the parting plate 48 exceeds a predetermined threshold value, the six segments 51 of the inner portion 50 flex to provide fluid communication between the inlet portion 46 and the outlet portion 47. As the pressure differential increases the segments 51 are forced to flex further and therefore present a larger cross sectional area of bypass aperture for the fluid to flow from the inlet portion 46 to the outlet portion 47.

[0036] The flexure of the segments 51 is shown schematically in Figures 7a and b. Figure 7a shows the segments 51 in their undeflected position. This is the configuration that would be expected during normal engine running and also when the engine is not in use. When high load conditions result in the pressure differential between the inlet portion 46 and the outlet portion 47 exceeding the predetermined threshold value, the segments 51 flex as shown in Figure 7b in order to allow the fluid to flow directly from the inlet portion 46 to the outlet portion 47, thus bypassing the radiator core.

[0037] The value of the predetermined threshold at which the segments 51 move to open the valve 42 is determined, at least in part, by the choice of material for the valve 42. This is typically a rubber material although, where appropriate, other polymeric or metallic materials may be used. The thickness and choice of material for the segments 51 provides an additional tuning parameter for the system because the rigidity of the segments 51 dictates the rate at which the valve 42 opens when the threshold pressure is reached.

[0038] In the illustrated embodiment, the optimum diameter of the circular aperture provided when the valve 42 is in its fully open configuration is typically between 10mm and 20mm. However, as set out above in connection with the simple aperture example of the present invention, the optimum diameter will depend on a number of different, apparently contradictory criteria.

[0039] In the example of the present invention using a valve, the physical upper size limit of the valve is related to the size of the parting plate itself. The parting plate 48 is provided with a sealing rubber which holds the tank 43 to the core 11. This seal typically forms a 5mm strip around the edge of the parting plate. Therefore the upper limit set for the area of the valve 42 is the area of the parting plate 48 minus the approximately 5mm band covered by the sealing strip.

[0040] Although the example of the present invention illustrated in Figures 4 to 7 uses a multi-cuspid valve, other types of valve could be used. For example a reed valve could be used and this would have the advantage that it would prevent backflow of the fluid from the outlet portion 47 into the inlet portion 46. A reed valve also has the added advantage that it could be integrally moulded with the tank 42.

[0041] In both of the examples of the present invention set out above the bypass permits a small percentage of the fluid to flow directly from the inlet portion of the radiator tank to the outlet portion. As a result of the diversion of this small percentage through the parting plate aperture, the fluid flow to the pump is augmented and cavitation is avoided.

[0042] The diameter of the aperture 21 and the threshold value for the valve 42 are selected with reference to a pump graphic of the type shown schematically in Figure 8. Each of the arcs on the diagram is a plot of the pressure (on the ordinate) against the flow (on the abscissa). Each arc represents a different rotation speed for the engine. Those closer to the origin represent lower speeds. The total pressure drop across the engine cooling system as a whole is represented graphically by the curve marked T. As the pressure drop across the pump increases so the risk of cavitation also increases. The pressure threshold at which the valve 42 should begin to open is set for the intersection between the pressure-flow arc at a preferred engine speed, in this example 3000rpm and the total pressure drop.

[0043] In a further example of the present invention, not shown, the opening threshold of the valve is varied in response to the speed of the engine and the pressure drop across the cooling system. This effectively enables the threshold for opening the valve to be set at the intersection of any one of the arcs for different engine speeds with the total pressure drop curve shown in Figure 8. This prevents the valve being opened prematurely when the engine is being run at a high speed.

Claims

1. A radiator tank for a U-flow radiator, wherein the radiator tank comprises an internal bypass.

2. The radiator tank according to claim 1, further comprising a parting plate for dividing an inlet portion and an outlet portion, wherein the bypass is provided in the parting plate.

3. The radiator tank according to claim 1 or claim 2, wherein the bypass is an aperture.

4. The radiator tank according to claim 3, wherein the bypass aperture is provided with a valve that is operable between an open position and a closed position.

5. The radiator tank according to claim 4, wherein the valve is biased to the closed position.

6. The radiator tank according to claim 4 or claim 5, wherein the valve is a multi-cuspid valve or a reed valve.

7. The radiator tank according to any one of claims 4 to 6, wherein the valve is integrally moulded into the radiator tank.

8. The radiator tank according to any one of claims 4 to 7, wherein the valve is operable to open when the pressure difference between the inlet portion and the outlet portion exceeds a predetermined level.

9. The radiator tank according to claim 8, further comprising a sensor for detecting the speed of the engine and control means for controlling the valve when the pressure difference between the inlet portion and the outlet portion exceeds a predetermined level for the sensed engine speed.

10. A vehicle comprising a radiator system including a radiator tank according to any of the preceding claims.

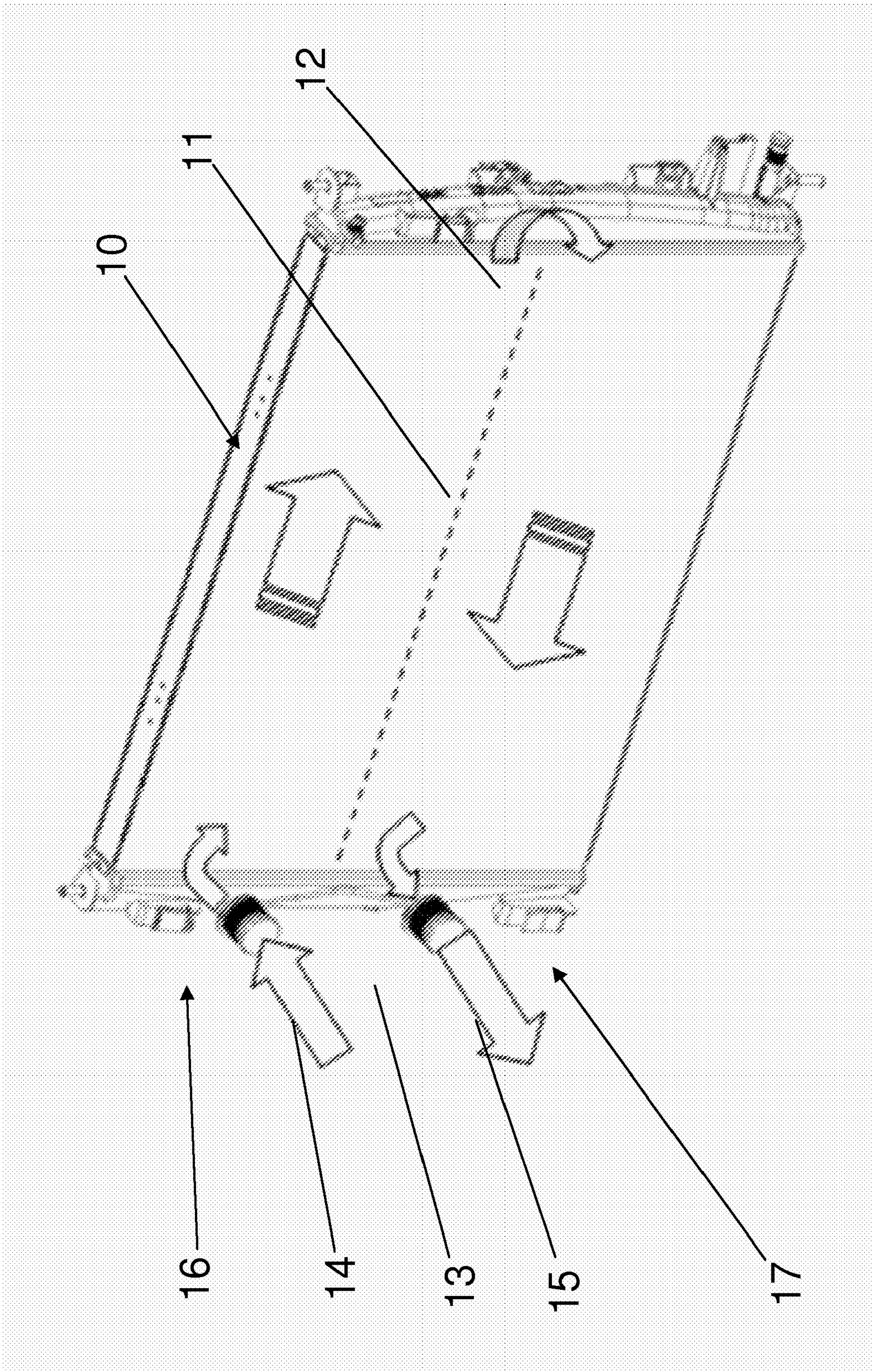

Figure 1

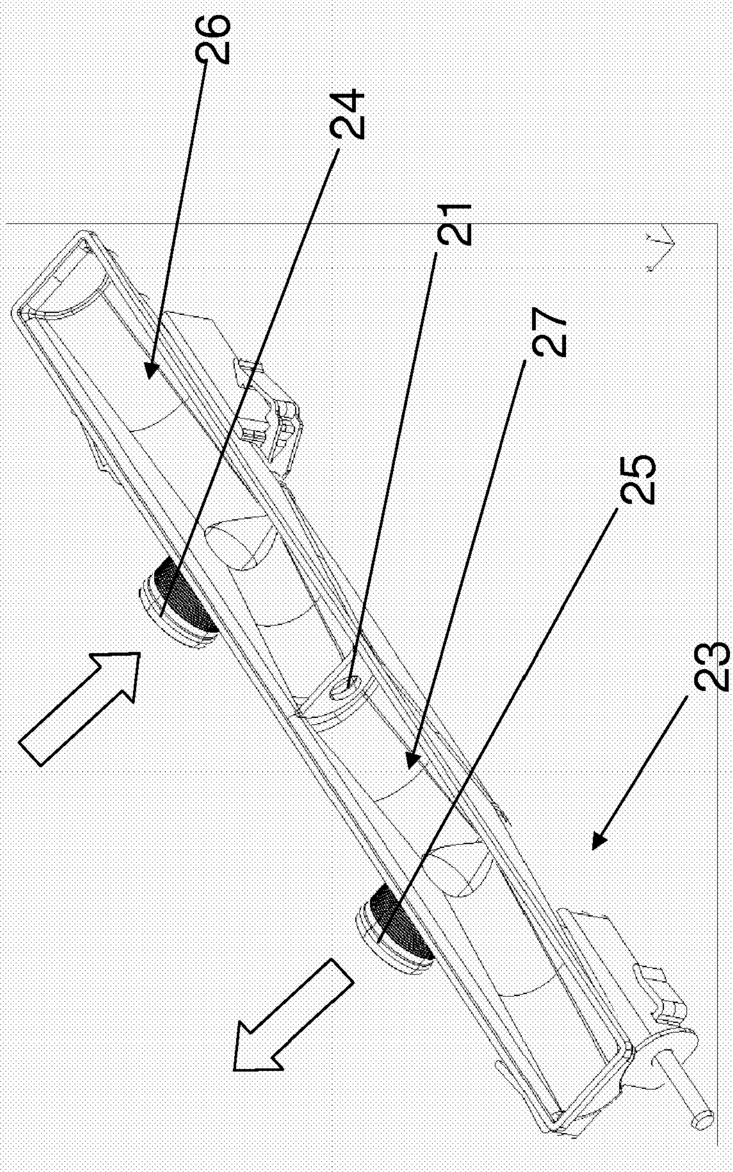

Figure 2

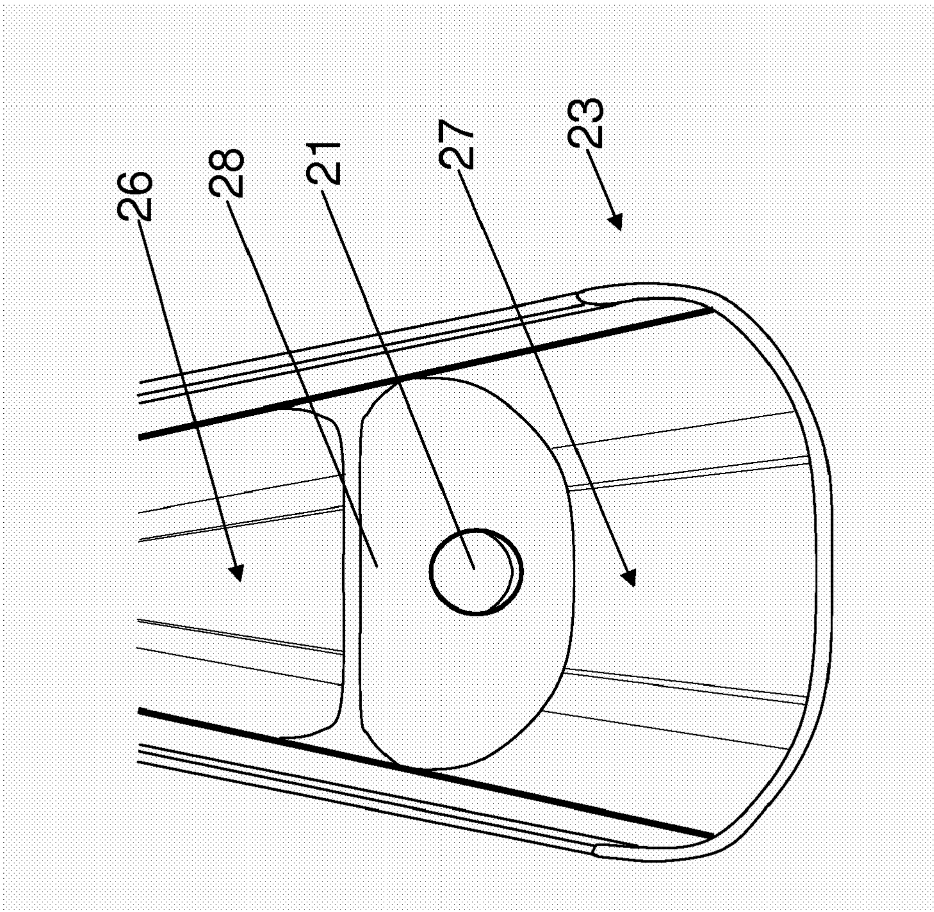

Figure 3

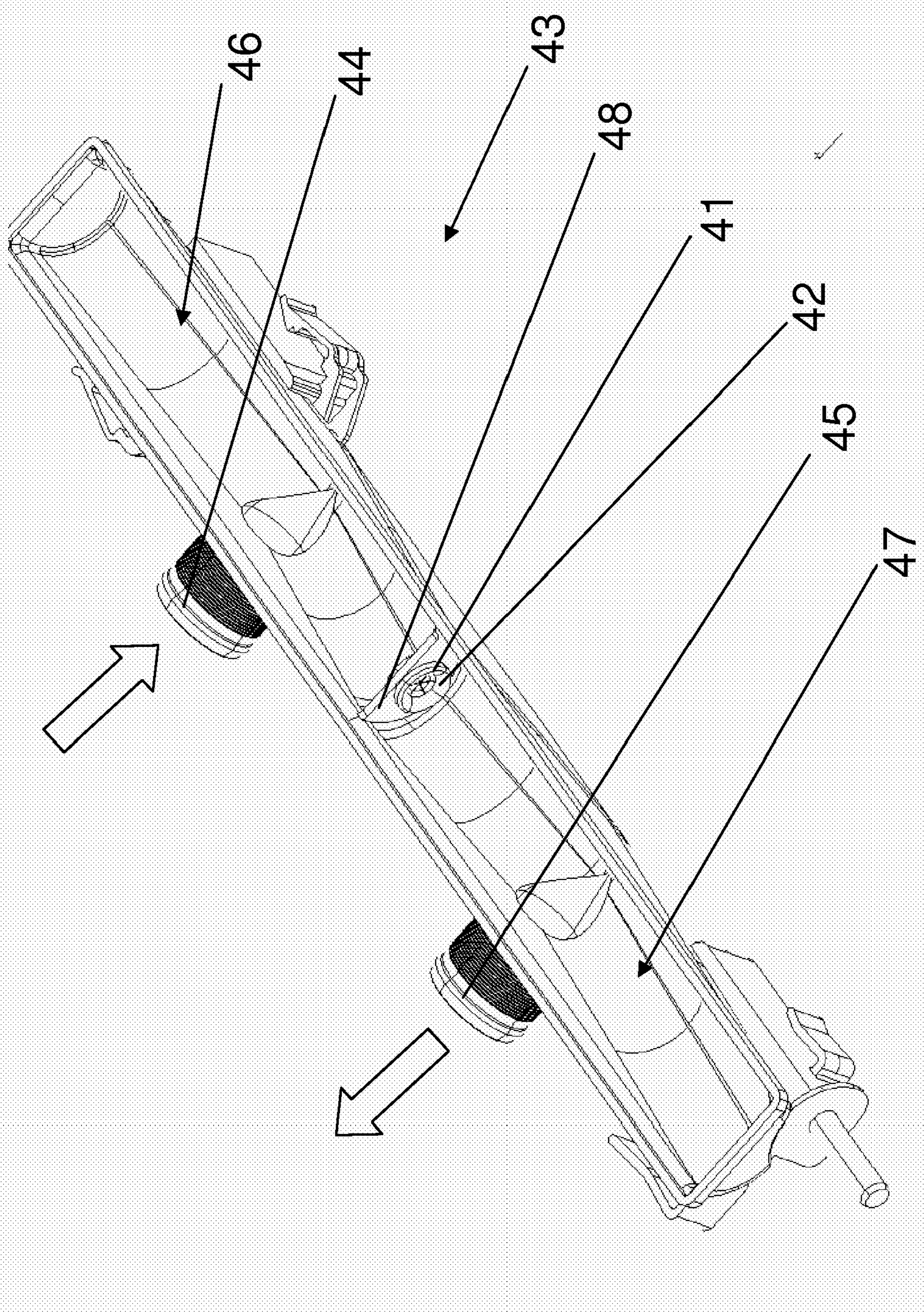

Figure 4

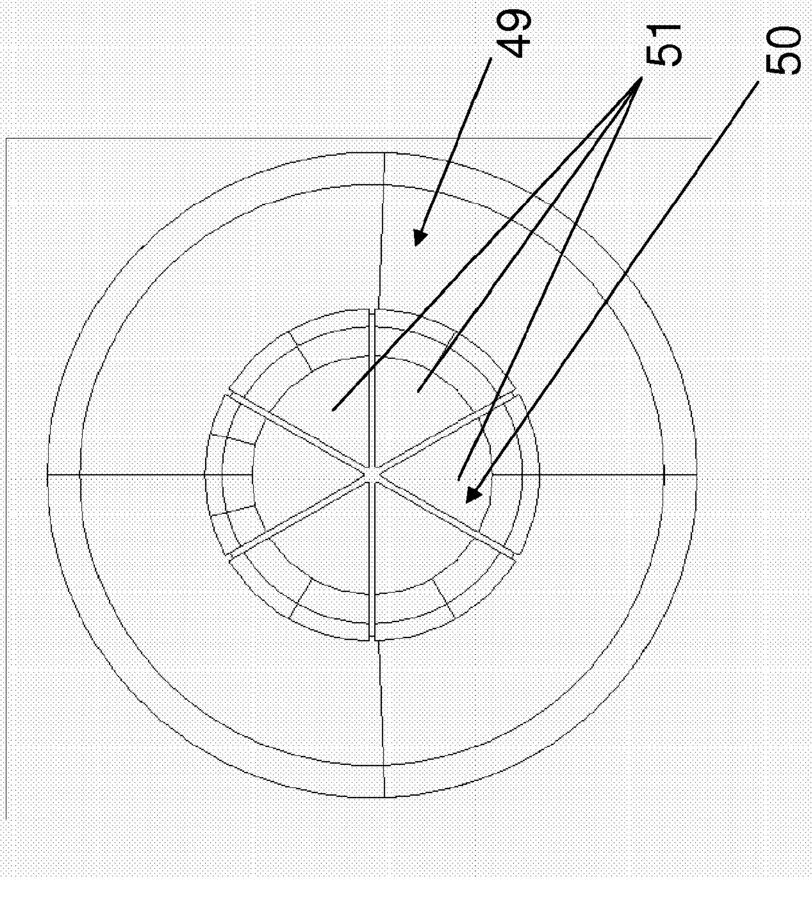

Figure 5

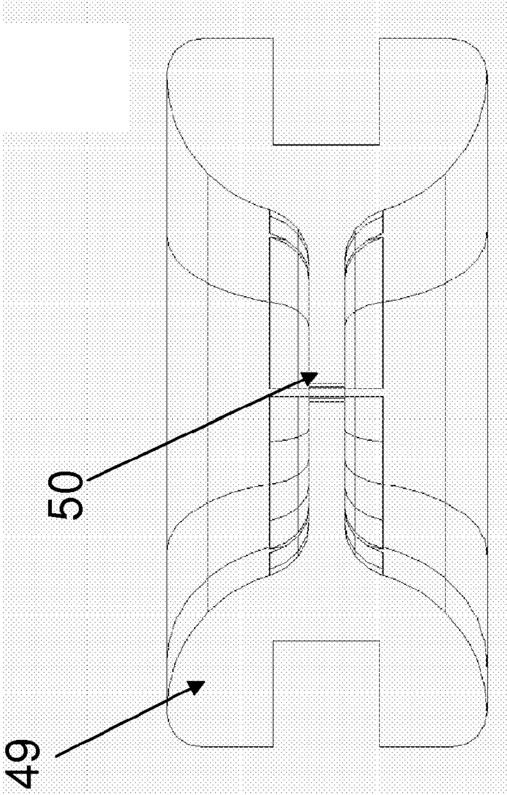

Figure 6

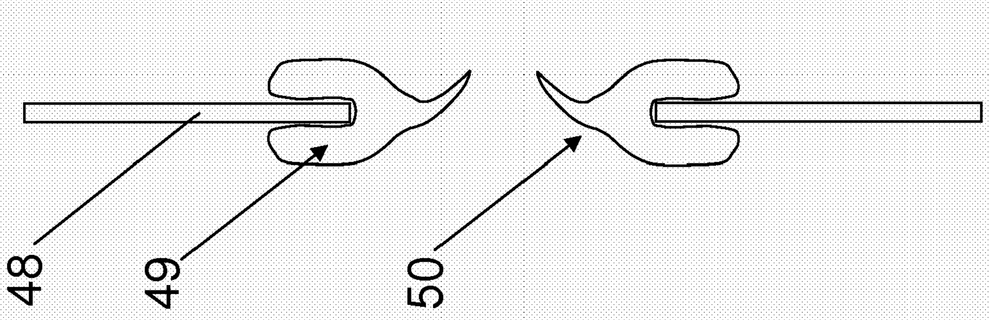

Figure 7b

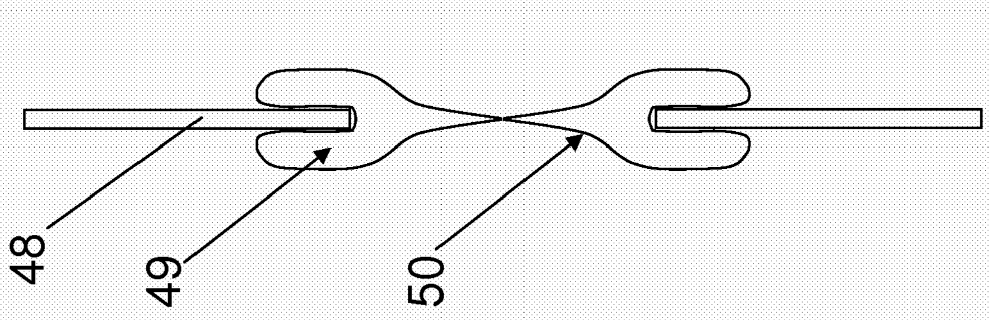

Figure 7a

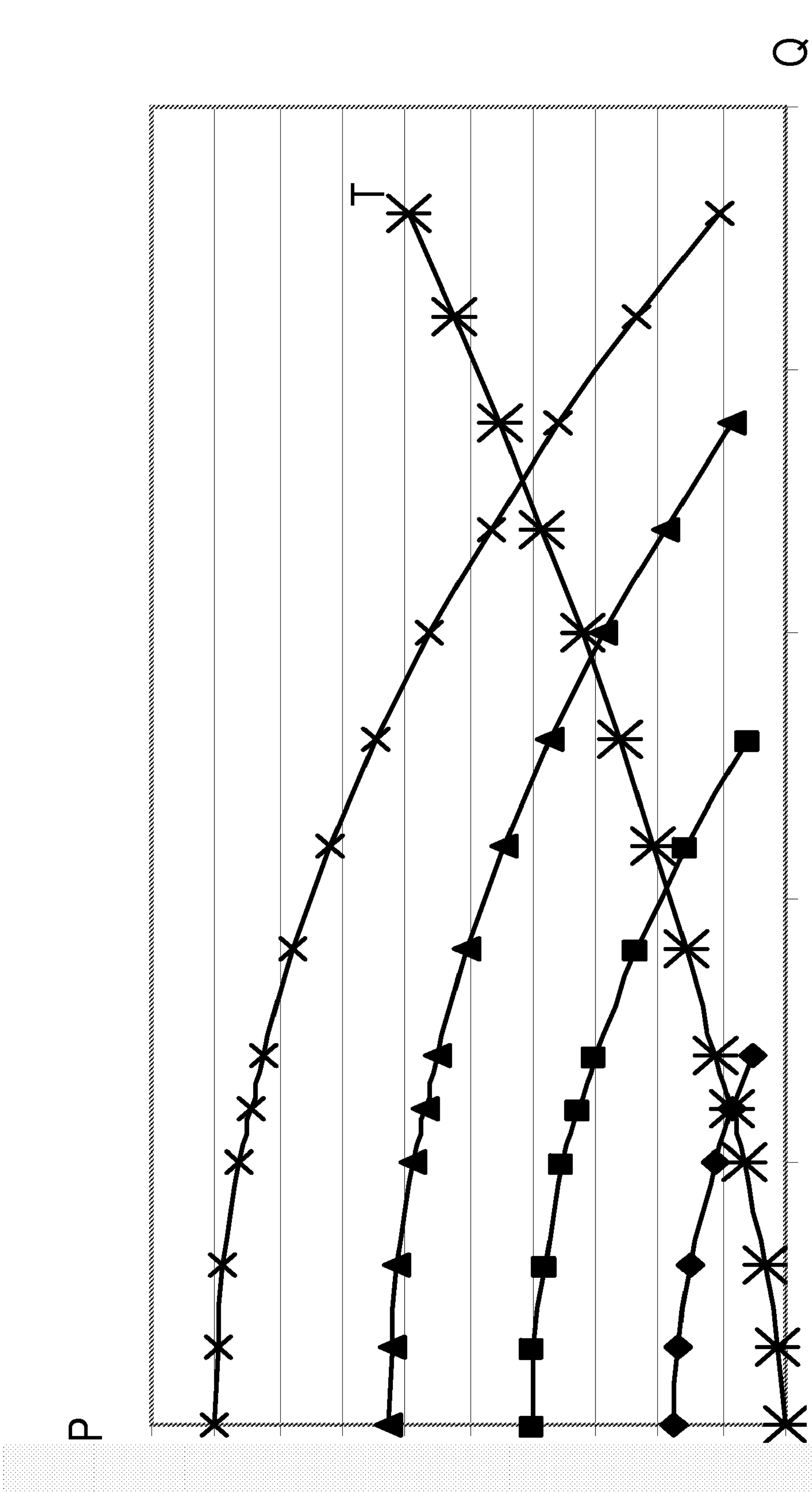

Figure 8

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EUROPEAN SEARCH REPORT

Application Number
EP 06 12 6918

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

F01P
F28F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	19 April 2007	MATRAY, J

CATEGORY OF CITED DOCUMENTS

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2

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REFERENCES CITED IN THE DESCRIPTION

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