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(54) RETENTION DEVICE FOR A HEAT EXCHANGER

(57) A number of variations may include a product comprising a retention device comprising a plurality of members, including an arch member and a spring member defining multiple contact points.

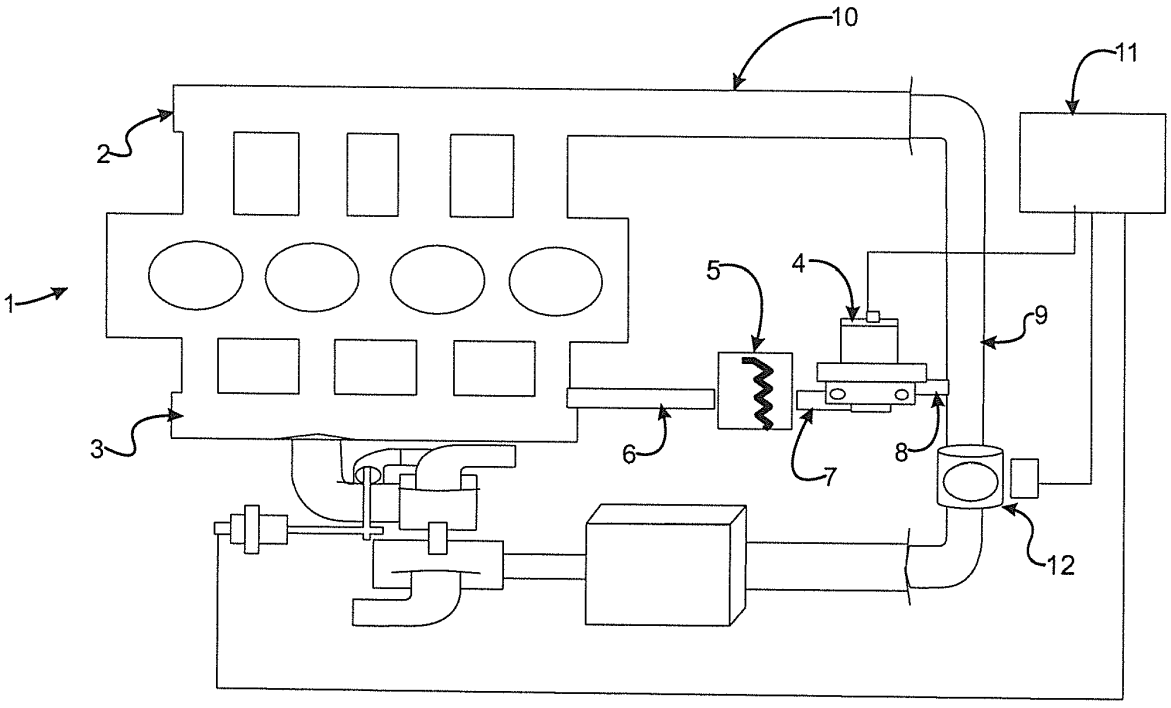

Fig.1

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of United States Application Serial No. 14/215,740 filed March 17, 2014.

TECHNICAL FIELD

[0002] The field to which the disclosure generally relates to includes retention device.

BACKGROUND

[0003] Retention devices may be used in a variety of applications.

SUMMARY OF ILLUSTRATIVE VARIATIONS

[0004] A number of variations may include a product comprising a retention device comprising a plurality of members, including an arch member and a spring member defining multiple contact points.

[0005] Other illustrative variations within the scope of the invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while disclosing variations within the scope of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Select examples of variations within the scope of the invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

Figure 1 is a schematic illustration of an EGR system in which a number of variations may be utilized.
Figure 2 illustrates a heat heater in which a number of variations may be utilized.
Figure 3 is an illustration of the heat exchange of Figure 2 with the housing removed.
Figure 3A is an enlarged view of a portion of Figure 3.
Figure 4 is a perspective sectional view of the heat exchange in Figure 2.
Figure 5 illustrates a baffle which may be utilized in a number of variations.
Figure 6 illustrate a product including a heat exchange bundle of tube having a retention device thereon according to a number of variations.
Figure 7 is a section illustration of retention device according to a number of variations.
Figure 8 is a perspective view of a product including a heat exchange bundle of tube having a retention device thereon according to a number of variations.
Figure 9 is a perspective view of a product including a heat exchange bundle of tube having two retention devices thereon according to a number of variations.
Figure 10 is a partial perspective view of a first retention device and second retention device have mating fastening and guide features in a connected arrangement according to a number of variations.
Figure 11 is a partial perspective view of a first retention device and second retention device have mating fastening and guide features in an unconnected arrangement according to a number of variations.
Figure 12 is a perspective sectional view of a heat exchanger having a first retention device and second retention device thereon according to a number of variations.
Figure 13 is an enlarged view of a portion of Figure 12.
Figure 14 is an enlarged view of a portion of Figure 13.
Figure 15 is a perspective view of a heat exchanger having a first retention device and second retention device in unconnected positions and ready for assembly with the heat exchanger according to a number of variations.
Figure 16 is a perspective view of a heat exchanger having a first retention device and second retention device in a connected relationship and assembled to the heat exchanger according to a number of variations.
Figure 17 is a perspective view of a retention device according to a number of variations.
Figure 18 is a perspective view of a first retention device and a first retention device which may have mating locking and/or guide feature and illustrating the direction of movement of the retention devices for assembly according to a number of variations.
Figure 19 is a perspective view of a first retention device and a first retention device which may have mating locking and/or guide feature and which may be connected together according to a number of variations.

DETAILED DESCRIPTION OF ILLUSTRATIVE VARIATIONS

[0007] The following description of the variations is merely illustrative in nature and is in no way intended to limit the scope of the invention, its application, or uses.

[0008] Control of vehicle exhaust emissions and meeting fuel economy standards are mandatory requirements in most countries. Oxides of Nitrogen (NOx) and particulate matter are two components of the engine exhaust emissions that must be controlled.

[0009] Formation of NOx will occur at higher engine combustion temperatures and particulates will form at lower combustion temperatures. A system, referred to as the exhaust gas recirculation (EGR) system, has been

developed to control combustion temperatures and control NOx and particulate emissions.

[0010] A schematic of an EGR system is shown in Figure 1. The engine 1 may have an intake manifold 2 and an exhaust Manifold 3. The EGR system may include an exhaust gas recirculation (EGR) valve 4 that controls the flow of exhaust gas to intake manifold 2. The heat exchanger 5 may be used to reduce the temperature of the exhaust gas. Conduits 6, 7, 8, 9 and 10 may provide the interconnection between the exhaust manifold 3, heat exchanger 5, EGR Valve 4, and Intake manifold 2. The system shown may use an electrically controlled EGR valve. An electronic control unit (ECU) 11 may provide a signal that will control the opening/closing of the valve. As the EGR valve opens and closes it will increase or decrease the flow rate of exhaust gas to the intake manifold. A throttle valve 12 may be provided to control airflow into the intake manifold.

[0011] A portion of the exhaust gas may be recirculated back to the intake manifold where it will be combined with incoming air and fuel. The exhaust gas portion of the mixture does not support combustion and when this mixture is compressed and ignited in the cylinder, the inert exhaust gas will control the combustion temperature and limit the formation of NOx and particulate in the exhaust.

[0012] The temperature of the recirculated exhaust gas may be a factor that determines the effectiveness of the NOx and particulate reduction. It is common for an EGR system to include a heat exchanger to remove heat from the exhaust gas and provide an optimize exhaust gas temperature for controlling emissions.

[0013] One type of heat exchanger 13 is shown in Figures 2, 3, and 4. It may include a number of tubes 15 in a rectangular array 16. Tube 15 may have an inner surface 29, wall 30, and outer surface 25, as shown in Figures 3, 3A View A and 4. This rectangular array 16 may also be referred to as the core and exchanger 13 may include one or more cores. The tubes 15 may be made of a metal such as stainless steel, aluminum or other suitable material. The core 16 may include metal headers 17 and 18 located at either end of the tubes 15. The headers 17 and 18 may also be made of a metal such as stainless steel, aluminum or other suitable material. The tubes 15 may be secured and sealed to metal headers 17 and 18 by brazing, soldering, or other suitable means.

[0014] The core 16 may be placed in a housing 14 and may be sealed into the housing by a gasket 19, O-ring 20 or other suitable means. At one end, header 18 may be attached to a cone 21 to transition to the O-ring seal 20. Housing 14, core 16, cone 21, gasket 19, and O-ring 20 may define a sealed space 22 within the housing 14. Sealed space 22 may be suitable for introducing a cooling fluid 24 that may contact tubes 15 in the rectangular array 16. Header 17 and gasket 19 may have a first opening 23 to allow a cooling fluid 24 to flow into sealed space 22. Cooling fluid 24 may contact the outer surface 25 of tubes 15. Header 17 and gasket 19 may also have a second opening 26 that may allow cooling fluid 24 to exit sealed space 22.

[0015] The heat exchanger shown in Figures 2, 3, 3A and 4 may function in the following manner. A fluid or gas 27 may enter tubes 15 from a first end 28. For this example, the fluid or gas 27 may be exhaust gas from an internal combustion engine. The exhaust gas 27 may be at a first temperature, for example 600°C. Exhaust gas 27 may flow through tubes 15 and may exit at a second end 29. Cooling fluid 24 may enter sealed space 22 and may contact the outer surface 25 of tubes 15 as shown in Figure 3. Cooling fluid 24 may be at a lower temperature than exhaust gas 27, for example 100°C.

[0016] As the exhaust gas 27 flows through tubes 15 it may transfer some of its heat to the inner surface 29, wall 30, and outer surface 25 of tubes 15. The transfer of heat may continue as the gas flows along the length of tubes 15 and the exhaust gas 27 may become progressively cooler. A portion of the heat transferred to inner surface 29, wall 30, and outer surface 25, of tubes 15, may then transfer to cooling fluid 24, contacting the outer wall 25 of tubes 15, in sealed space 22. Transferring heat from exhaust gas 27, to tubes 15, and to fluid 24, in sealed space 22, may have two effects as described in the following paragraphs.

[0017] The first effect may be the exhaust gas 27 exiting tubes 15 at second end 29 may be at a lower temperature than the exhaust gas 27 entering tubes 15 at the first end 28. For example exhaust gas 27 entering tubes 15, at first end 28, may be at 600°C and the exhaust gas 27 exiting tubes 15, at second end 29, may be at 200°C. The reduction in temperature may, in part, be due to the transfer of heat from exhaust gas 27, to tubes 15, and to cooling fluid 24 in sealed space 22.

[0018] The second effect may be the cooling fluid 24 exiting sealed space 22 at second opening 26 may be at a higher temperature than the cooling fluid 24 entering sealed space 22 at the first opening 23. For example the cooling fluid 24 exiting sealed space 22, at second opening 26, may be at 110°C and the cooling fluid 24 entering sealed space 22, at first opening 23 may be at 100°C. The increase in temperature may, in part, be due to the transfer of heat from exhaust gas 27, to tubes 15, and to cooling fluid 24 in sealed space 22.

[0019] Both first and second effects may be influenced in-part by parameters such as; the temperature of exhaust gas 27 entering tubes 15, the flow rate of exhaust gas 27, the materials of tubes 15, the wall thickness of tube 15, the length of tube 15, the surface area of tube 15, the fluid properties of the cooling fluid 24 in sealed space 22, the flow rate of the cooling fluid 24 in sealed space 22, or other parameters.

[0020] As the cooling requirements for the heat exchanger increase, it may be necessary to increase the number of tubes 15 or increase the length of the tubes 15. The longer tubes may require additional support. A baffle 31 shown in figures 4 and 5 may be located along the length of tubes15. The baffle 31 may be a metal plate

with multiple openings 32 that will receive and support tubes 15. Baffle 31 may add support but it may not be sufficient with high levels of vibration that may cause movement of the tubes 15 and the potential for fatigue of the tubes, the brazing joints, or other components.

[0021] The addition of a retention device may help to prevent the potential for movement and damage. Figure 6 shows a partial assembly of heat exchanger 13 with a retention device 33 installed on core 16. Retention device 33 may include at least one spring member 34. Figure 7 shows a portion of retention device 33 and spring member 34 viewed in the direction of arrow 44. Retention device 33 may include a first arch member 35 and a second member 36 extending from a first end 37 of first arch member 35. There may be a radius 38 at the transition between first arch member 35 and second member 36 that may define a first contact point 39. There may be a third member 40 extending from a second end 41 of first arch member 35. There may also be a radius 42 at the transition between first arch member 35 and third member 40 that may define a second contact point 43. Spring member 34 may extend from third member 40 and may define a third contact point 45 along the length of spring member 34. Spring member 34 may include a curved section 46 which may include the third contact point 45 as shown in Figure 7.

[0022] Referring to Figure 7, retention device 33 may function in the following manner. When the first contact point 39 and second contact point 43 are in contact with a substantially rigid surface 47 and a force, represented as arrow 48, is applied to third contact point 45, spring member 34 may deflect in direction 49 and transmit a force to the substantially rigid surface at first contact point 39 and second contact point 43. While force 48 is applied, first arch member 35 will remain substantially in the form of the arch and only the first contact point 39 and second contact point 43 will substantially contact rigid surface 47. The arch form of first arch member 35 and the minimum contact with rigid surface 47 may allow a less impeded movement of the retention device 33 along substantially rigid surface 47. The deflection of spring member 34, in direction 49, is shown as dashed line form 34A, in figure 7.

[0023] Referring to Figure 8, spring member 34, may extend along an axis 50 for a length 51. The length 51 may be 5mm, 10mm, or other suitable length to achieve the desired retention requirements. There may be an interrupted length 52 along axis 50 followed by a second spring member 34B having a length 53 along axis 50. Second spring member 34B may have the same length as first spring member 34 or it may have another length to achieve the desired retention requirements. The spring retention device 33 may be manufactured in many shapes to fit the shape of a core. For example it may be manufactured in rectangular shape to fit a rectangular core, a circular shape to fit a circular core, or other shape to suitably fit a core.

[0024] Figure 9 shows retention device 33 installed on rectangular core 16 of heat exchanger 13. Retention device 33 has been formed in a rectangular shape to fit the shape of core 16. The retention device 33 may be attached and retained to core 16 by interconnecting features 54 which may include a receptacle 55 and an engagement member 56 as seen in Figure 10 View B and Figure 11. When engagement member 56 engages receptacle 55, retention device 33 will define a closed form or loop and may be retained to core 16 as shown in Figure 9.

[0025] Figure 12, Figure 13 View C, and Figure 14 view D show retention device 33 installed on core 16. Retention device 33 may be assembled to core 16 prior to installing core 16 into housing 14. Core 16 along with retention devices 33 may be slid into housing 14 until core 16 comes into sealing contact with housing 14. Retention device 33 may engage housing 14 within space 22. A distance 57, between tubes 15 and an inside wall 58 of housing 14 may be less than a distance 59 between contact points 39, 43, and 45 on spring member 34 of retention device 33. It may be noted that distance 57 may be similar for each of the four inside walls of housing 14 that confront tubes 15 of core 16. Since dimension 57 may be less than dimension 59, there may be an interference dimension 60 that that is substantially the difference between dimension 59 and dimension 57. For example, in one variation the interference dimension 60 may be substantially 1 mm when dimension 59 is 7mm and dimension 57 is 6mm. Dimension 60 may vary with the tolerance of the components.

[0026] In a number of variations, interference dimension 60 may be 1 mm, 2mm, or other dimension that will provide the desired level of retention. The selection of interference dimension 60 may in-part be based upon the level of vibration, level of mechanical shock, or other relevant parameter.

[0027] Referring to Figure 14 view D, as core 16 is slid into housing 14, the contact with inside wall 58 and interference 60 may provide a force 73 on third contact point 45 and deflect spring member 34 in direction 62. Force 73 may cause first contact point 39 and second contact point 43, of retention device 33, to contact tubes 15 and transmit a force to the tubes. Tubes 15 may form a substantially rigid surface, for first contact point 39 and second contact point 43. When force 73 is applied to the third contact point 45 and spring member 34 deflects in direction 62, first arch member 35 will substantially remain in the form of the arch and only the first contact point 39 and second contact point 43 may substantially contact tubes 15. The deflected position 34A of spring member 34, in direction 62, is shown as a solid line in figures 14 View D. The initial position of spring member 34 is shown as dashed lines. The arched form of first arch member 35 and the minimum contact with the rigid surface of tubes 15, may allow a less impeded movement of retention device 33 along the surface of tubes 15. It may also be possible that only one of the first or second contact points, 39 or 43, may contact the rigid surface of

tubes 15. This may be in-part result from dimensional differences of components, assembly variation, or other factors.

[0028] Retention device 33 may extend along the four sides of the rectangular core 16 and may include additional portions of spring member 34. Retention device 33 may contact four inside surfaces of rectangular housing 14. Additional portions of spring member 34 may provide a force on tubes 15 at each location that may tend to prevent movement of the tubes 15 and core 16 when a force is applied to the heat exchanger 13. The force may be applied in any direction to heat exchanger 13 and may result from an impact, vibration, or other force. Preventing or limiting movement of tubes 15 and core 16 may lessen the potential for fatigue and failure of tube 15, brazing joints, or other component.

[0029] Referring again to Figures 9, 10 View B, and 11, in a number of variations it may be advantageous to include a guide feature 61 to guide interconnecting features 54 and aid with the assembly of retention device 33 to core 16. In a number of variations guide feature 61 may include two guide members 62 and 63 formed in retention device 33. Guide feature 61 may be designed to receive a guide portion 64 of retention device 33 that may include receptacle 55 or engagement feature 56. For example, guide portion 64 may include receptacle 55 as shown in Figures 10 View B and 11. Guide feature 61, including guide members 62 and 63, may align guide portion 64, receptacle 55, engagement feature 56, and facilitate engagement thereof as shown in Figures 9 and 10 View B.

[0030] As previously stated, guide feature 61 may include a first guide members 62 and second guide member 63 that may retain guide portion 64 and may prevent disengagement. An existing portion of retention device 33 may be used as a guide member. For example, guide member 63 may be a portion of the first arch member 35, second member 40, or spring member 34 as shown in figure 11. A guide member may also be formed as a separate portion of retention device 33 such as guide member 62 also shown in Figures 10 View B and 11.

[0031] Installing a one-piece retention device may require deformation to assemble it to the core. In a number of variations, to efficiently install the retention device it may be made in two pieces as shown in Figure 15. The 2-piece design may include a first retention device 33A and second retention device 33B. The 2-piece design will allow installation after assembly of core 16, including tubes 15, header 17, header 18, and baffle 31. The retention devices are shown assembled to core 16 in Figure 16.

[0032] Figure 17 shows first retention device 33A. Retention device 33A may have a first member 65, second member 66, and third member 67 formed to fit rectangular core 16. Each of the first, second, and third members may have a spring members 34 spaced along each member. Retention device 33A may have interconnecting feature 54 comprising receptacle 55 and engagement member 56 as previously described herein. Receptacle 55 may be located at a first end 68 of retention device 33A and engagement member 56 may be located at second end 70. Retention device 33A may also include guide feature 61 and guide portion 64 also preciously described herein. Guide feature 61 and guide portion 64 may be located at the first or second ends 68 and 70 of retention device 33A. For example, guide feature 61 may be located at the second end 70 and guide portion 64 may be located at the first end 68 as shown in figure 17. Guide portion 64 may also include receptacle 55 also shown in figure 17.

[0033] First retention device 33A and second retention device 33B may be substantially identical in form and may be made from the same manufacturing process. This may reduce cost, reduce tooling requirements, improve assembly, or provide other advantages.

[0034] First retention device 33A and second retention device 33B may be assembled to the core by rotating one of the first or second retention devices 180° about axis 69 and aligning them as shown in figures 18 and 19. Guide feature 61 located at second end 70 of first retention device 33A may align and receive guide portion 64 located at first end 68 of second retention device 33B. Guide feature 61 located at second end 70 of second retention device 33B may align and receive guide portion 64 located at first end 68 of first retention device 33A. The continued engagement of first and second retention devices 33A and 33B in the direction of arrows 71 and 72 may cause engagement feature 56, of first retention device 33A, to engage receptacle 55 of second retention device 33B. Continued engagement may also cause engagement feature 56 of second retention device 33B to engage receptacle 55 of first retention device 33A.

[0035] When engagement members 56 engage receptacles 55, retention devices 33A and 33B will define a closed form or loop as shown in figure 19. The retention devices 33A and 33B may be retained to core 16 as shown in figure 16.

[0036] While the afore written description and figures of the invention show a round tube 15 in a rectangular core 16, it may also be within the scope of the invention to be applied to a core having an oval tube, square tube, or a tube of another suitable shape to achieve the desired cooling requirements. A core having a shape other than a rectangle may also be utilized. For example, the retention device may be applied to a circular core, oval core, or a core of another suitable shape to achieve the desired requirements.

[0037] The following description of variants is only illustrative of components, elements, acts, product and methods considered to be within the scope of the invention and are not in any way intended to limit such scope by what is specifically disclosed or not expressly set forth. The components, elements, acts, product and methods as described herein may be combined and rearranged other than as expressly described herein and still are considered to be within the scope of the invention.

[0038] Variation 1 may include a product which may comprise at least one retention device which may comprise: a first member formed as an arch, a second member extending from a first end of the first member and defining a first contact point, a third member extending from a second end of the first member and defining a second contact point, at least one spring member extending from at least one of the first, second, or third members and defining a third contact point, and wherein when the first and second contact points are in contact with a substantially rigid surface, and a force is applied to the third contact point, a force is transmitted to the substantially rigid surface at one or both of the first or second contact points, and wherein the first member will substantially remain in the form of the arch and does not contact to the substantially rigid surface when the force is applied to the third contact point.

[0039] Variation 2 may include a product as set forth Variation 1 wherein the at least one spring member may comprise at least two spring members wherein the spring members are spaced apart from each other on the retention device.

[0040] Variation 3 may include a product as set forth in any of Variations 1-2 wherein the at least one retention device further comprising interconnecting features comprising a receptacle and an engagement member for engaging said receptacle, and wherein the receptacle and engagement member are spaced apart from each other and when the engagement member engages the receptacle, the retention device defines a closed form or loop for attachment to a product.

[0041] Variation 4 may include a product as set forth in Variation 3 wherein the at least one retention device further comprises a guide feature and a guide portion said guide feature comprising at least one guide member and said guide portion including at least one of interconnecting feature and, wherein the guide member are constructed and arranged to guide the guide portion.

[0042] Variation 5 may include a product as set forth in Variation 3 wherein the at least one retention device further comprises a guide feature and a guide portion said guide feature comprising at least one guide member and said guide portion including at least one of said interconnecting features and, wherein the guide member will guide the guide portion.

[0043] Variation 6 may include a product as set forth in Variation 1 wherein the product further comprising at least a second retention device, said first and second retention devices further comprising a guide feature on the first retention device constructed and arranged to guide a guide portion on the second retention device, and a guide feature on the second retention device constructed and arranged to guide a guide portion on the first retention device.

[0044] Variation 7 may include a product as set forth in Variation 3 wherein the product further comprising at least a second retention device, said first and second retention devices further comprising a guide feature on the first retention device constructed and arranged to guide a guide portion on the second retention device, and a guide feature on the second retention device constructed and arranged to guide a guide portion on the first retention device.

[0045] Variation 8 may include a product as set forth in Variation 4 wherein the product further comprising at least a second retention device, said first and second retention devices further comprising a guide feature on the first retention device constructed and arranged to guide a guide portion on the second retention device, and a guide feature on the second retention device constructed and arranged to guide a guide portion on the first retention device.

[0046] Variation 9 may include a product as set forth in any of Variations 5-8 wherein the shape of each retention device is substantially the same.

[0047] Variation 10 may include a product which may comprising a core comprising an array of tubes, a housing for receiving the core and supporting the core, a clearance between the core and the housing, at least one retention device positioned between the housing and core, the at least one retention device may comprise a first member formed as an arch, a second member extending from a first end of the first member and defining a first contact point along the axis of the tubes, a third member extending from a second end of the first member and defining a second contact point along the axis of the tubes, at least one spring member extending from at least one of the first, second, or third members and defining a third contact point with the housing, and wherein when the clearance between the housing and core may cause interference with the retention device and a force is applied to the third contact point of the at least one spring member, the at least one spring member will transmit a force to one or both of the first and second contact points and; wherein the first member may be constructed and arranged to substantially remain in the form of the arch and may not contact along the axis of the tubes when the force is applied to the third contact point.

[0048] Variation 11 may include a product as set forth in Variation 10 wherein the at least one retention device comprising at least two spring members wherein the spring members are spaced apart from each other on the retention device.

[0049] Variation 12 may include a product as set forth in Variation 10 wherein the at least one retention device further comprising interconnecting features comprising a receptacle and an engagement member for engaging said receptacle and, wherein the receptacle and engagement member are spaced apart from each other and when the engagement member engages the receptacle, the retention device defines a closed form or loop for attachment to a product.

[0050] Variation 13 may include a product as set forth in Variation 12 wherein the at least one retention device may further comprising a guide feature and a guide portion said guide feature comprising at least one guide

member and said guide portion including at least one of said interconnecting features and, wherein the guide member is constructed and arranged to guide the guide portion.

[0051] Variation 14 may include a product as set forth in Variation 10 wherein the at least one retention device may further comprising a guide feature and a guide portion said guide feature comprising at least one guide member and said guide portion including at least one interconnecting feature and, wherein the guide member will guide the guide portion.

[0052] Variation 15 may include a product as set forth in Variation 10 wherein the product may further comprise at least a second retention device, said first and second retention devices further comprising a guide feature on the first retention device constructed and arranged to guide a guide portion on the second retention device, and a guide feature on the second retention device constructed and arranged to guide a guide portion on the first retention device.

[0053] Variation 16 may include a product as set forth in claim 12 wherein the product further comprising at least a second retention device, said first and second retention devices further comprising a guide feature on the first retention device constructed and arranged to guide a guide portion on the second retention device, and a guide feature on the second retention device constructed and arranged to guide a guide portion on the first retention device.

[0054] Variation 17 may include a product as set forth in Variation 16 wherein the shape of each retention device is substantially the same.

[0055] The above description of select variations within the scope of the invention is merely illustrative in nature and, thus, variations or variants thereof are not to be regarded as a departure from the spirit and scope of the invention.

Claims

1. A product comprising at least one retention device comprising;
a first member formed as an arch,
a second member extending from a first end of the first member and defining a first contact point,
a third member extending from a second end of the first member and defining a second contact point,
at least one spring member extending from at least one of the first, second, or third members and defining a third contact point, and
wherein when the first and second contact points are in contact with a substantially rigid surface, and a force is applied to the third contact point, a force is transmitted to the substantially rigid surface at one or both of the first or second contact points, and
wherein the first member will substantially remain in the form of the arch and does not contact to the substantially rigid surface when the force is applied to the third contact point.

2. A product as set forth claim 1 wherein the at least one retention device comprises at least two spring members wherein the spring members are spaced apart from each other on the retention device.

3. A product as set forth in claim 1 wherein the at least one retention device further comprises interconnecting features comprising a receptacle and an engagement member for engaging said receptacle, and wherein the receptacle and engagement member are spaced apart from each other and when the engagement member engages the receptacle, the retention device defines a closed form or loop for attachment to a product.

4. A product as set forth in claim 3 wherein the at least one retention device further comprises a guide feature and a guide portion said guide feature comprising at least one guide member and said guide portion including at least one of interconnecting feature and, wherein the guide member is constructed and arranged to guide the guide portion.

5. A product as set forth in claim 1 wherein the at least one retention device further comprises a guide feature and a guide portion said guide feature comprising at least one guide member and said guide portion including at least one of said interconnecting features and, wherein the guide member will guide the guide portion.

6. A product as set forth in claim 1 wherein the product further comprising at least a second retention device, said first and second retention devices further comprising
a guide feature on the first retention device constructed and arranged to guide a guide portion on the second retention device and,
a guide feature on the second retention device constructed and arranged to guide a guide portion on the first retention device.

7. A product as set forth in claim 3 wherein the product further comprising at least a second retention device, said first and second retention devices further comprising
a guide feature on the first retention device constructed and arranged to guide a guide portion on the second retention device and,
a guide feature on the second retention device constructed and arranged to guide a guide portion on the first retention device.

8. A product as set forth in claim 4 wherein the product further comprising at least a second retention device,

said first and second retention devices further comprising

a guide feature on the first retention device constructed and arranged to guide a guide portion on the second retention device and,

a guide feature on the second retention device constructed and arranged to guide a guide portion on the first retention device.

9. A product as set forth in claim 6 wherein the shape of each retention device is substantially the same.

10. A product comprising;

a core comprising an array of tubes,

a housing for receiving the core and supporting the core,

a clearance between the core and the housing,

at least one retention device positioned between the housing and core, the at least one retention device comprising;

a first member formed as an arch,

a second member extending from a first end of the first member and defining a first contact point along the axis of the tubes,

a third member extending from a second end of the first member and defining a second contact point along the axis of the tubes,

at least one spring member extending from at least one of the first, second, or third members and defining a third contact point with the housing, and

wherein when the clearance between the housing and core causes interference with the retention device and a force is applied to the third contact point of the at least one spring member, the at least one spring member will transmit a force to one or both of the first and second contact points and;

wherein the first member will substantially remain in the form of the arch and does not contact along the axis of the tubes when the force is applied to the third contact point.

11. A product as set forth claim 10 wherein the at least one retention device comprising at least two spring members wherein the spring members are spaced apart from each other on the retention device.

12. A product as set forth in claim 10 wherein the at least one retention device further comprising interconnecting features comprising a receptacle and an engagement member for engaging said receptacle and, wherein the receptacle and engagement member are spaced apart from each other and when the engagement member engages the receptacle, the retention device defines a closed form or loop for attachment to a product.

13. A product as set forth in claim 12 wherein the at least one retention device further comprising a guide feature and a guide portion said guide feature comprising at least one guide member and said guide portion including at least one of said interconnecting features and, wherein the guide member is constructed and arranged to guide the guide portion.

14. A product as set forth in claim 10 wherein the at least one retention device further comprising a guide feature and a guide portion said guide feature comprising at least one guide member and said guide portion including at least one interconnecting feature and, wherein the guide member will guide the guide portion.

15. A product as set forth in claim 10 wherein the product further comprising at least a second retention device, said first and second retention devices further comprising

a guide feature on the first retention device constructed and arranged to guide a guide portion on the second retention device and,

a guide feature on the second retention device constructed and arranged to guide a guide portion on the first retention device.

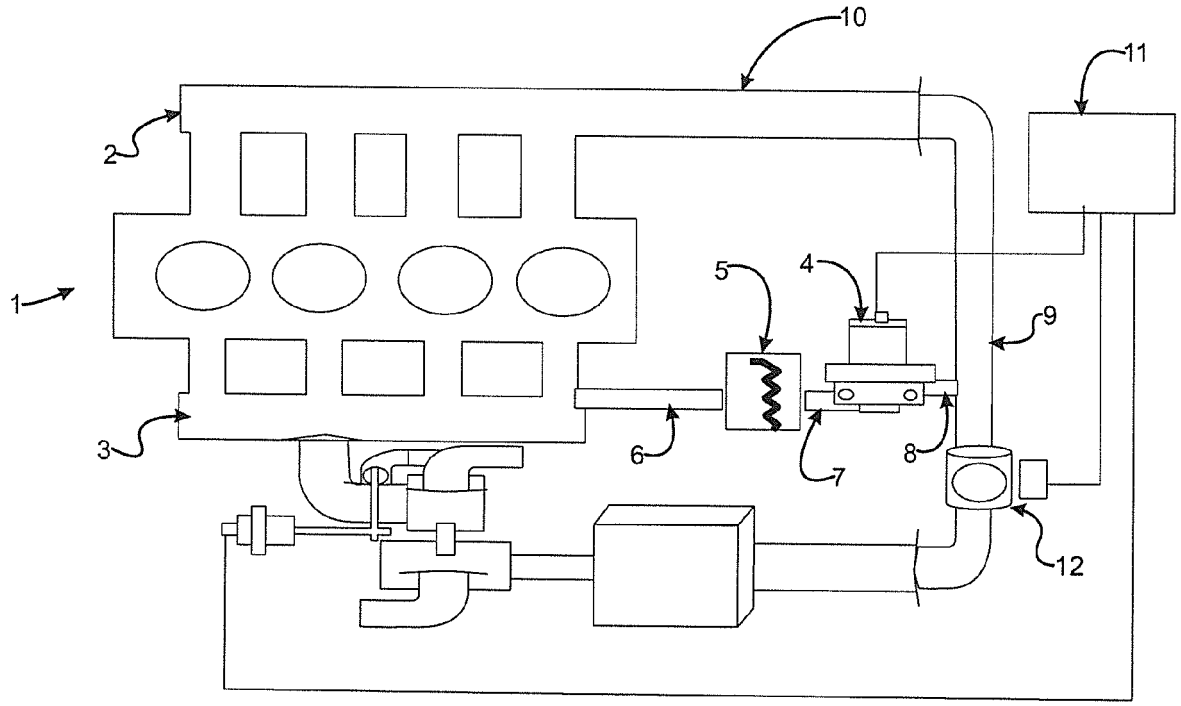

Fig.1

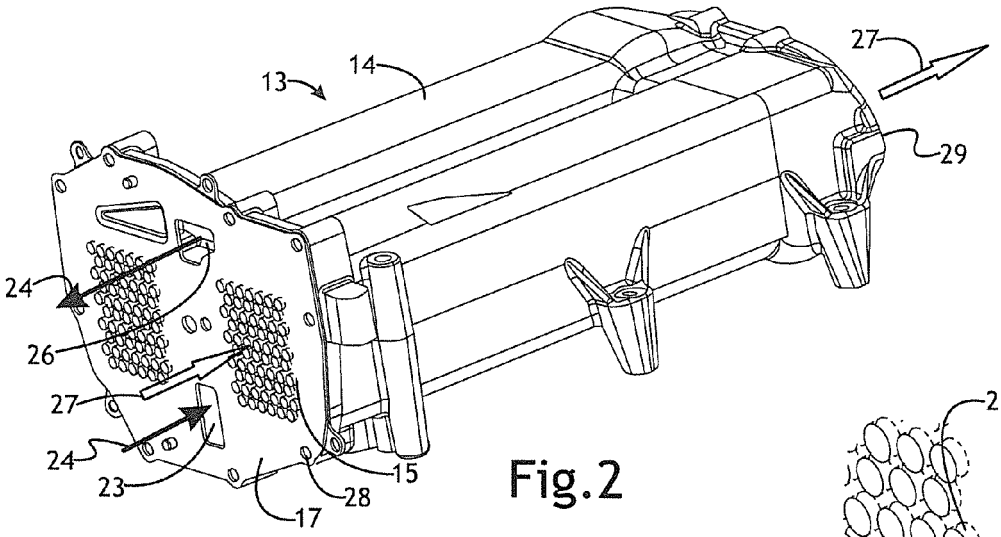

Fig.2

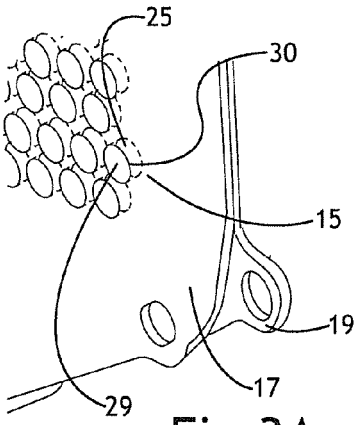

Fig.3A

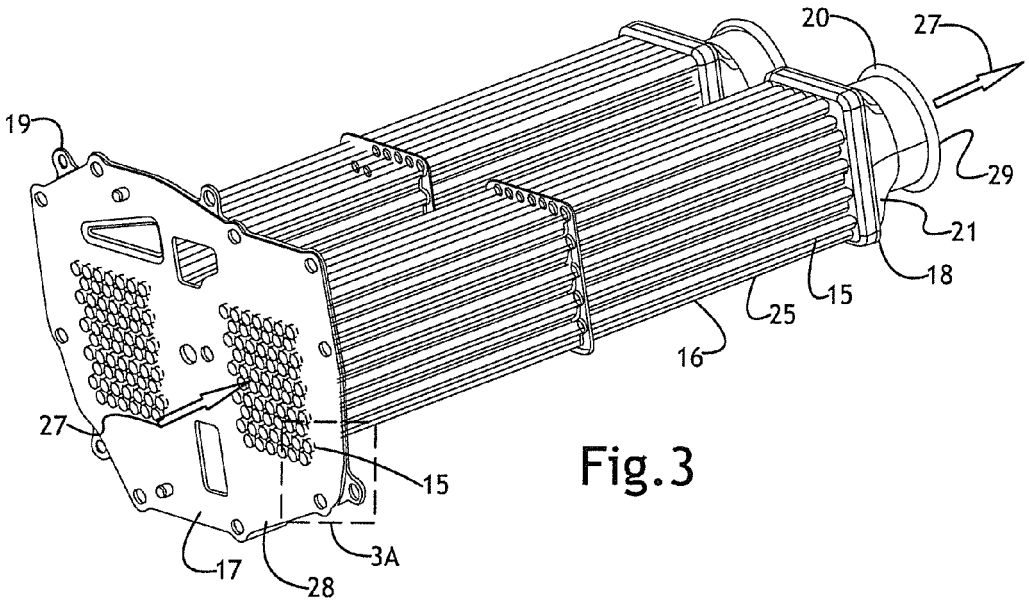

Fig.3

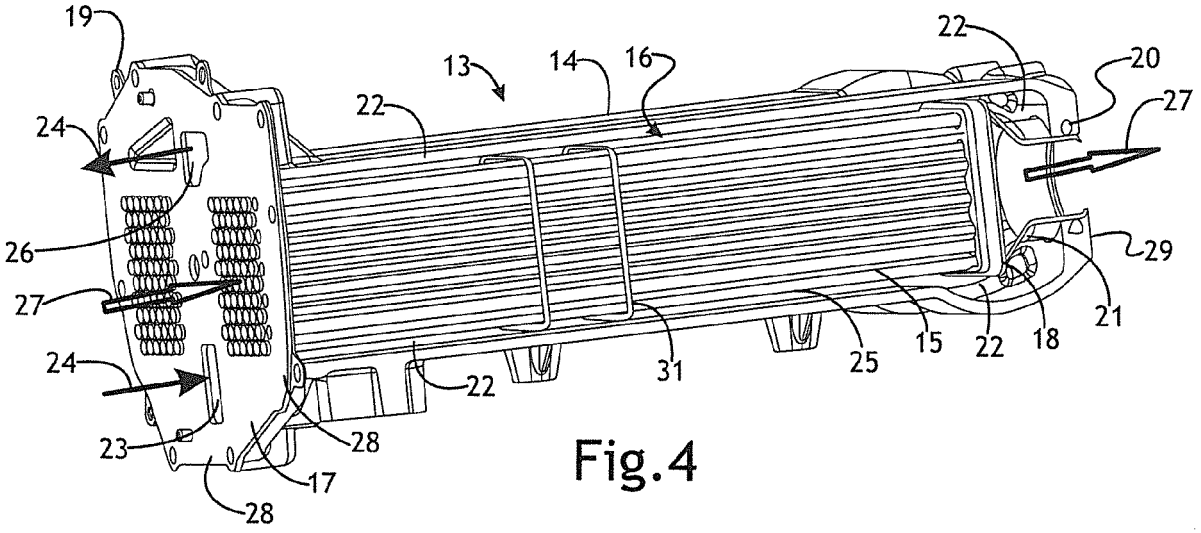
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Fig.4

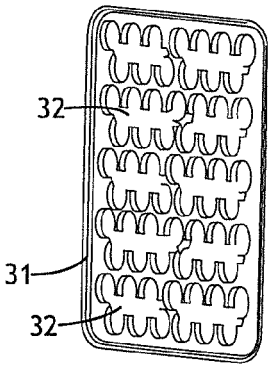
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Fig.5

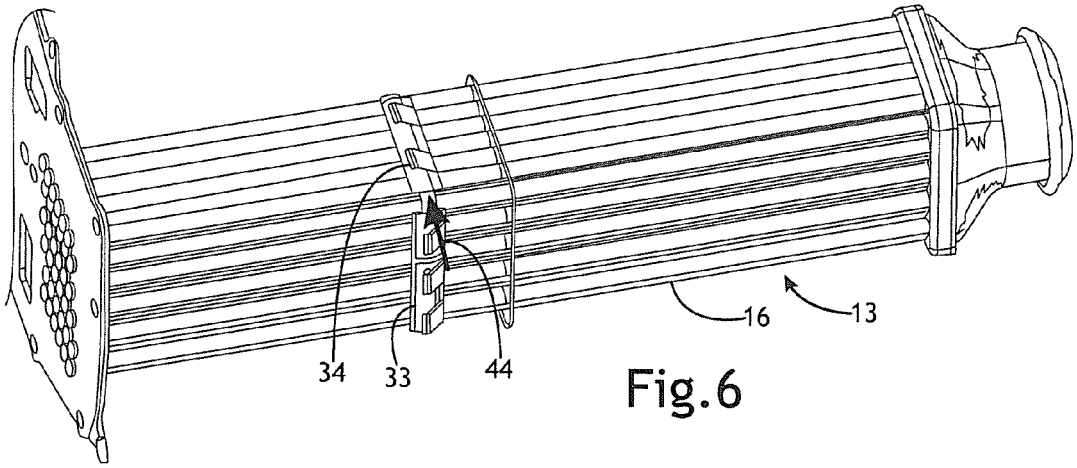

Fig.6

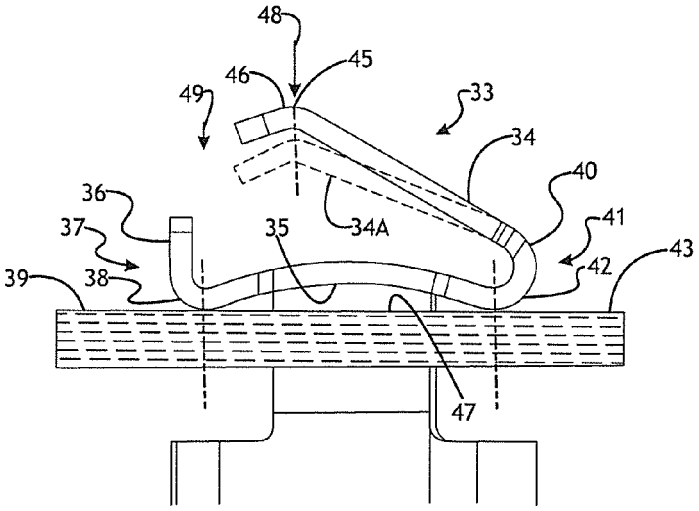

Fig.7

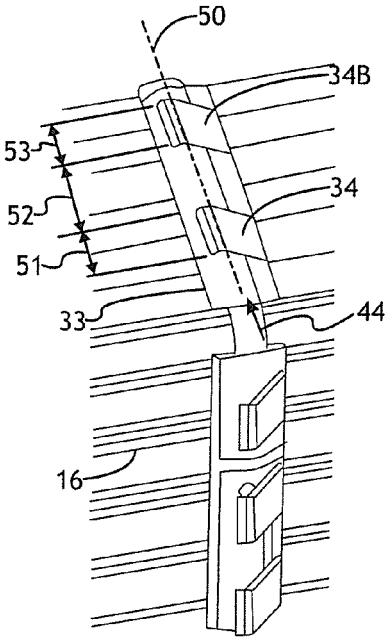

Fig.8

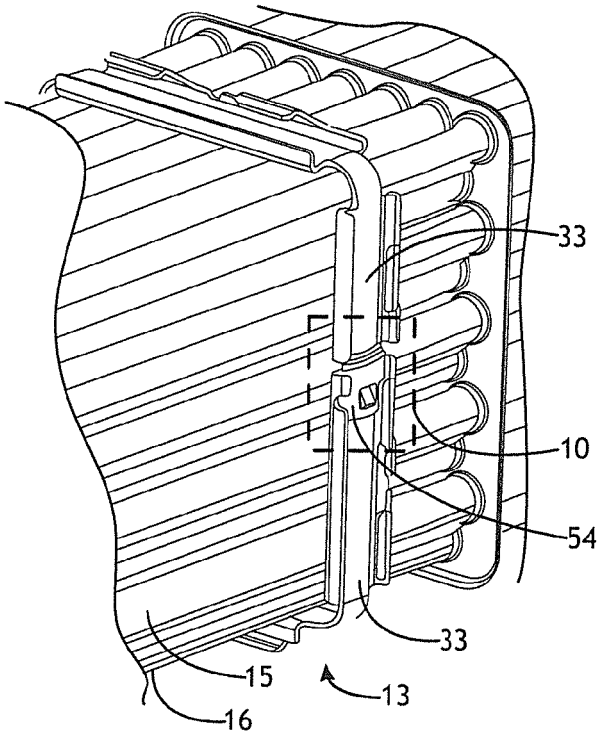

Fig.9

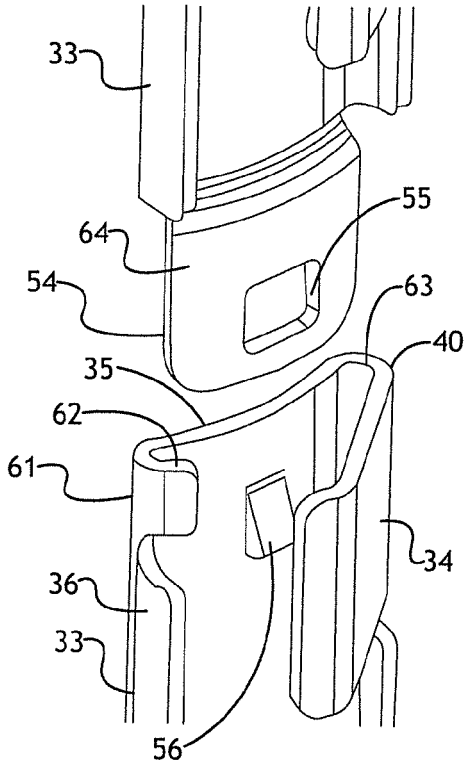

Fig.11

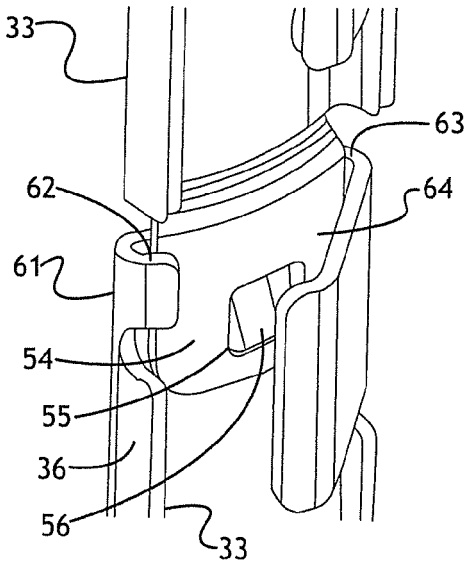

Fig.10

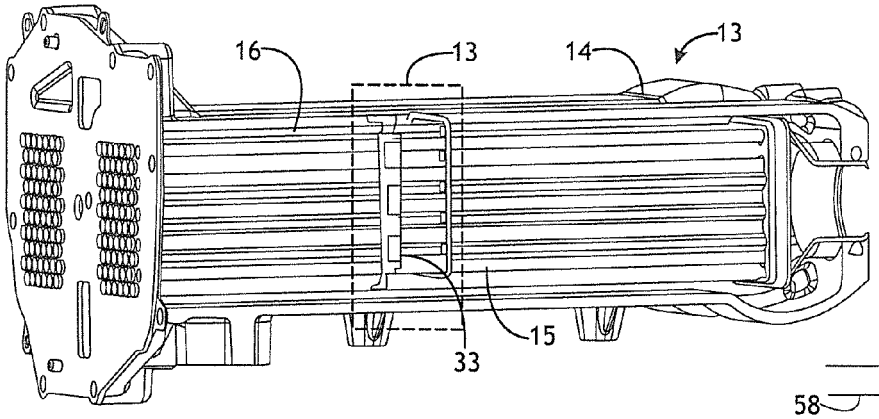

Fig.12

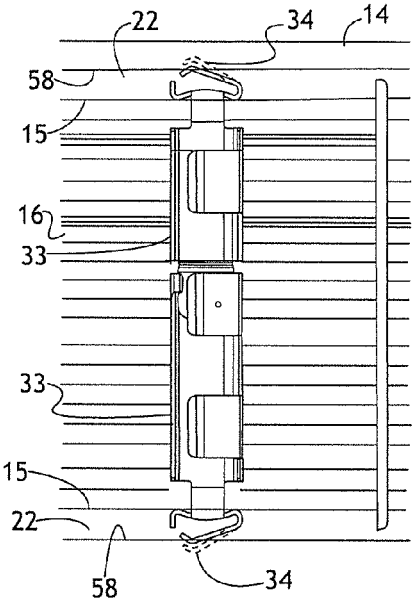

Fig.13

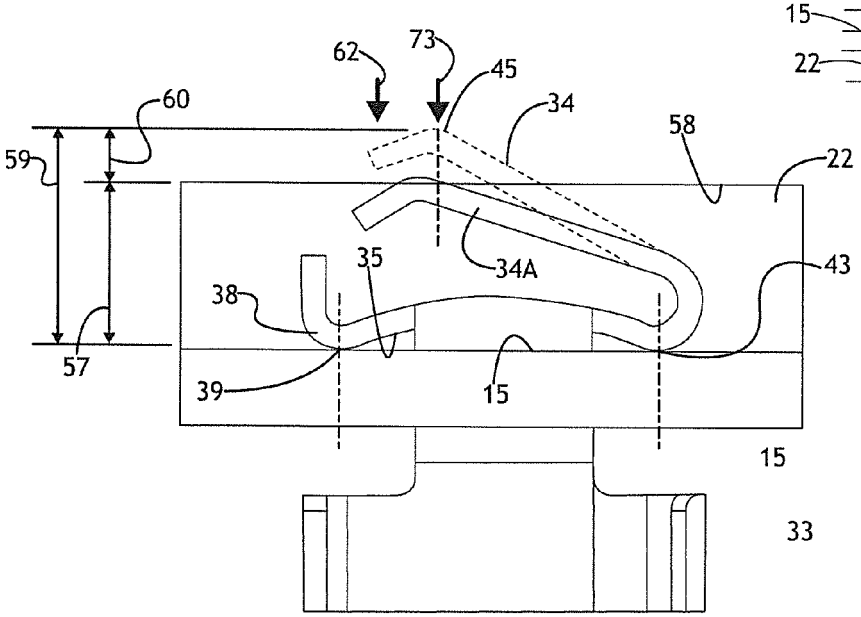

Fig.14

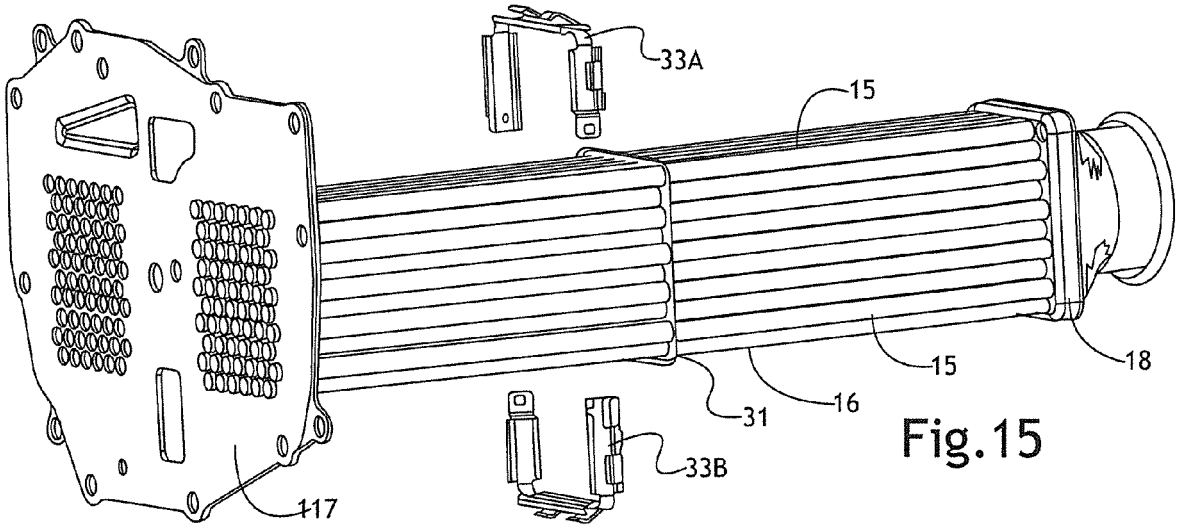

Fig.15

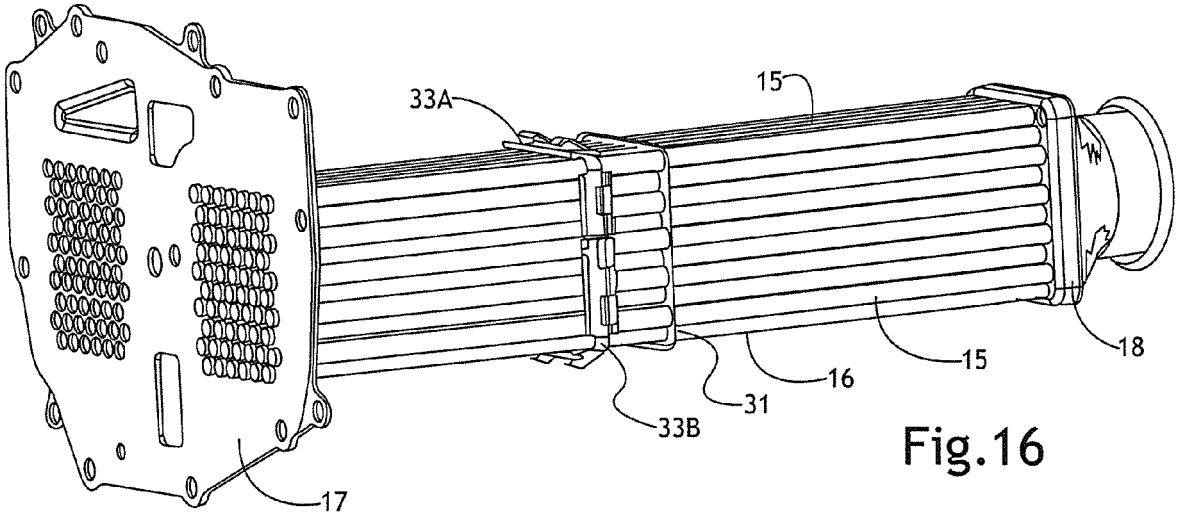

Fig.16

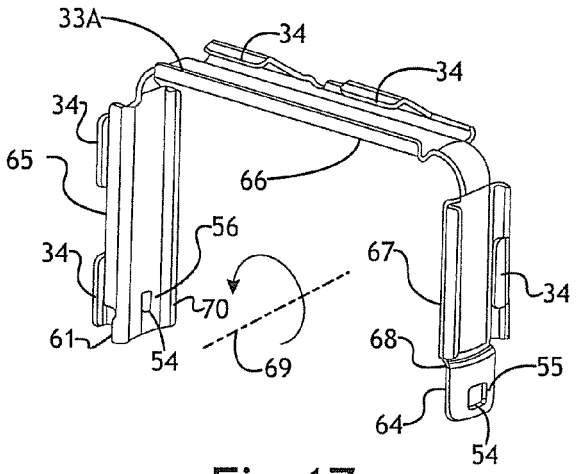

Fig.17

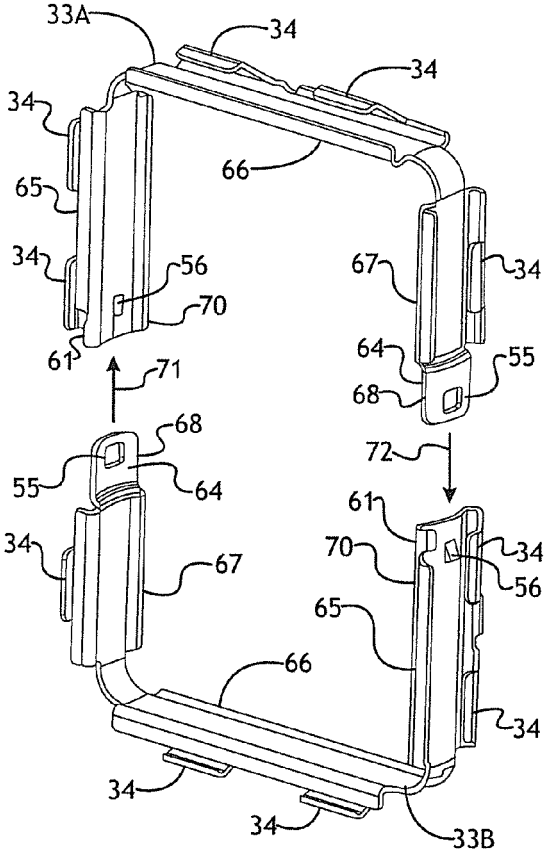

Fig.18

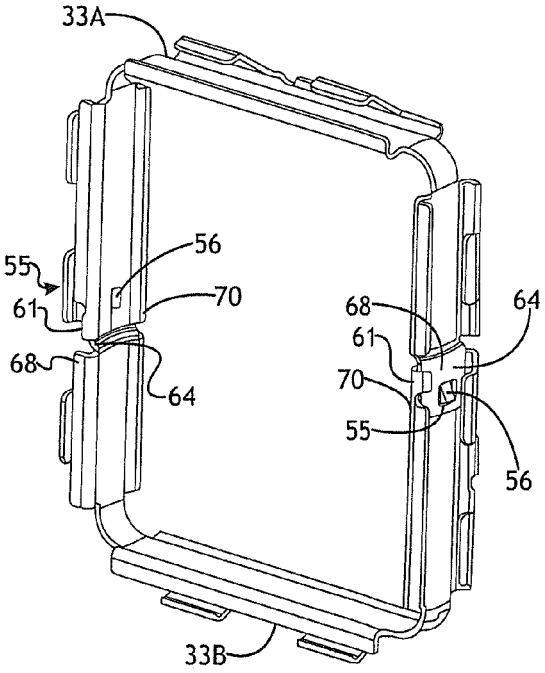

Fig.19

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EUROPEAN SEARCH REPORT

Application Number
EP 15 15 7913

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 522 943 A1 (BORGWARNER EMISSIONS SYSTEMS SPAIN S L [ES]) 14 November 2012 (2012-11-14) * figures 1-3 *	1-15	INV. F28F9/00 F28F9/013 F28D7/16
A	US 2008/006398 A1 (SCHATZ HARALD [DE] ET AL) 10 January 2008 (2008-01-10) * figure 2 *	1-15	
A	US 1 338 479 A (HANS ZIMMERMANN) 27 April 1920 (1920-04-27) * figures 3,4 *	1-15	

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F28F
F28D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 September 2015	Martínez Rico, Celia

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