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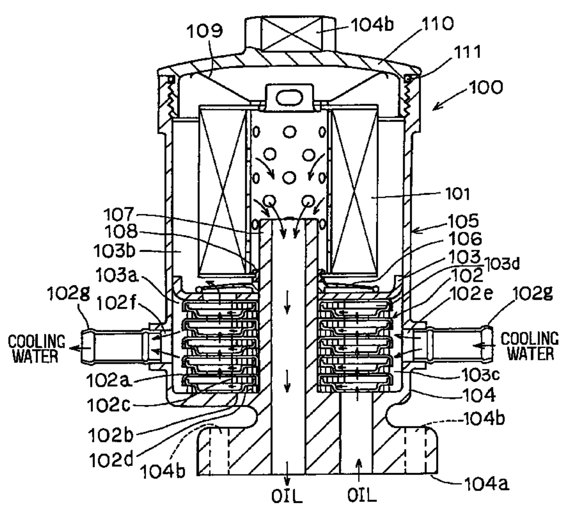
(54) Oil cooler with cooling water side fin and oil side fin

(57) An oil cooler has a tube (103d) disposed in a cooling water passage (103c) and defining an oil passage therein, an oil side inner (102c) fin brazed to an inside wall of the tube (103d) in the oil passage, and a water side inner fin (102d) brazed to an outside wall of the tube (103d) in the cooling water passage. The thickness Tw of the water side inner fin (102d) is thicker than the thickness To of the oil side inner fin (102c). The water side and oil side inner fins (102c, 102d) are corrugated fins.

FIG. 1



EP 0 919 780 A2

Description

[0001] This invention relates to an oil cooler for cooling engine oil circulating in a water-cooled engine, by exchanging heat between cooling water for the water-cooled engine and the engine oil.

[0002] Recently, a number of apparatuses such as an oil cooler which are installed in an engine room has increased. In such a tendency, clearances among the apparatuses in the engine room have been reduced to comply with the increase in number of the apparatuses and not to increase the size of the engine room. When the clearances among the apparatuses are reduced, however, installation performance (mountability) of the apparatuses deteriorates. This may cause increase in manufacturing cost of the vehicle. Because of this, the size reduction of each apparatus has been required.

[0003] The present invention has been made based on the above problem. An object of the present invention is to provide an automotive oil cooler with a small size.

[0004] According to the present invention, an oil cooler has a tube disposed in a cooling water passage and defining an oil passage therein, an oil side fin fixed to an inside wall of the tube, and a water side fin fixed to an outside wall of the tube and having a plate thickness thicker than that of the oil side fin. Preferably, the oil side and water side fins are corrugated fins. Accordingly, the oil side and water side fins can be formed to have small fin pitches, respectively, so that the size of the oil cooler is reduced. Further, each of the fins can have a high density and a large withstand pressure strength. Because the plate thickness of the water side fin is thicker than that of the oil side fin, a climbing rate of temperature of the water side fin is prevented from exceeding that of the oil side fin when they are brazed. As a result, brazing deficiencies caused by erosion of the water side fin can be prevented.

[0005] Preferably, the oil cooler further has a casing, a partition member integrally brazed to the casing and partitioning inside of the casing into the cooing water passage and a filter casing portion, and a filter disposed in the filter casing portion. Accordingly, there is no need to use O-rings for securing sealing property between the cooling water passage and the filter casing portion, resulting in decrease in number of parts for the oil cooler. This further results in manufacturing cost reduction of the oil cooler.

[0006] Other objects and features of the present invention will become more readily apparent from a better understanding of the preferred embodiments described below with reference to the following drawings.

FIG. 1 is a cross-sectional view showing an oil cooler in a first embodiment;
FIG. 2 is a perspective view showing a core portion of the oil cooler in the first embodiment;
FIG. 3 is a cross-sectional view showing an inner fin of the core portion in the first embodiment;
FIG. 4 is a graph showing a relationship between an oil side heat transfer coefficient and an inner fin height;
FIG. 5 is a graph showing a relationship between stress generated in the core plate and the thickness of the core plate;
FIG. 6 is a graph showing a relationship between an oil flow resistance and the thickness of the inner fin;
FIG. 7 is a graph showing relationships between stress generated in the inner fin and an inner fin pitch;
FIG. 8 is a graph showing relationships between stress generated in the core plate and the thickness of the core plate;
FIG. 9 is a graph showing a relationship between a thermal resistance and the thickness of the core plate;
FIG. 10 is a cross-sectional view showing an oil cooler in a second embodiment;
FIG. 11 is a cross-sectional view showing an oil cooler in a third embodiment;
FIG. 12 is a cross-sectional view showing an oil cooler in a fourth embodiment;
FIG. 13 is a perspective view showing a honeycomb structural member employed as a partition member in the fourth embodiment;
FIG. 14 is a cross-sectional view showing an oil cooler in a fifth embodiment;
FIG. 15 is a cross-sectional view showing an oil cooler in a sixth embodiment;
FIG. 16A is a front view showing an oil cooler in a seventh embodiment;
FIG. 16B is a right side view showing the oil cooler of FIG. 16A;
FIG. 16C is a bottom view showing the oil cooler of FIG. 16A;
FIG. 17A is a front view partially showing the oil cooler in the seventh embodiment;
FIG. 17B is a cross-sectional view taken along a XVIIB-XVIIB line in FIG. 17A;
FIG. 18 is a front view showing the oil cooler in the seventh embodiment;
FIG. 19 is an explanatory view showing an oil flow route in the oil cooler in the seventh embodiment;
FIG. 20 is a cross-sectional view taken along a XX-XX line in FIG. 19;
FIG. 21 is a cross-sectional view taken along a XXI-XXI line in FIG. 19;
FIG. 22A is a front view showing an oil cooler in an eighth embodiment;
FIG. 22B is a right side view of the oil cooler of FIG. 22A;
FIG. 23A is a front view partially showing an oil cooler in a ninth embodiment; and
FIG. 23B is a cross-sectional view taken along a

XXIIIB-XXIIIB in FIG. 23A.

(First Embodiment)

[0007] An oil cooler 100 shown in FIG. 1 of a first preferred embodiment is to be fixed to a wall of a water-cooled engine (herebelow referred to as an engine). The oil cooler 100 has a cylindrical filter element 101 (herebelow referred to as a filter) for filtering engine oil (herebelow referred to as oil) circulating in the engine so that foreign materials are removed from the oil. The oil cooler 100 further has an oil cooler core portion 102 (herebelow referred to as a core portion) for exchanging heat between engine cooling water (herebelow referred to as cooling water) and the oil.

[0008] The core portion 102 is composed of a plurality of core units which are laminated with and brazed to one another in a thickness direction thereof (see FIG. 2). Each of the core units has core plates 102a, 102b which are pressed to have specific shapes and a rectangular corrugated oil side inner fin 102c which is brazed to the core plates 102a, 102b therebetween. A cooling water passage 103c for flowing the cooling water therein and an oil passage (tube) 103d for flowing the oil therein are separated from one another by the core plates 102a, 102b. That is, the oil passage 103d defined by the core plates 102a, 102b is provided in the cooling water passage 103c. Each of the core units is laminated with adjacent one of the core units through a rectangular corrugated cooling water side inner fin 102d. The cooling water side inner fin 102d is brazed to the corresponding core plates 102a, 102b between the two adjacent core units. The thickness (fin thickness, plate thickness) Tw of the cooling water side inner fin 102d is thicker than the thickness (fin thickness, plate thickness) To of the oil side inner fin 102c.

[0009] Each of the inner fins 102c, 102d has as shown in FIG. 3 well-known louvers 103e which are formed by partially cutting and integrally bending up the inner fins 102c, 102d on the both surfaces thereof. The cooling water and the oil meander on the both surfaces of the respective inner fines 102c, 102d due to the louvers 103e. Incidentally, the core portion 102 is disposed in a filter bracket (casing) 105 composed of a bracket member 104 for being fixed to the engine and a partition member 103 brazed to the bracket member 104. The bracket member 104 and the partition member 103 are made of metal, specifically aluminum in this embodiment. The partition member 103 partitions inside the bracket member 104 into a core space 103a in which the core portion 102 is held and a filter casing portion (filter space) 103b in which the filter 101 is held.

[0010] The core space 103a accommodates the core portion 102 and constitutes part of the cooling water passage 103c. The core portion 102 is brazed to the inner wall of the filter bracket 105 (the partition member 103 and the bracket member 104). The filter bracket 105 has an inlet portion 102e for allowing the cooling water to flow into the core space 103a and an outlet portion 102f for allowing the cooling water, which has finished to exchange heat, to flow out from the core space 103a. Connection pipes 102g are connected to the inlet and outlet portions 102e, 102f by brazing for connecting external pipes (not shown).

[0011] When the core portion 102 and the filter bracket 105 are brazed, as shown in FIG. 1, each of the core plates 102a, 102b, the inner fines 102c, 102d respectively having front and back surfaces covered with brazing filler metal, and the partition member 103 are laminated with one another in a specific order in the filter bracket 105, and are brazed to one another in a state where an engine installation face 104a of the bracket member 104 is set on a lower side. The bracket member 104 is fixed to the engine through the engine installation face 104a. Accordingly, the core portion 102 can be securely brazed due to a gravitational force thereof.

[0012] Further, in the filter casing portion 103b, a check valve 106 made of rubber is provided to prevent the oil, which enters the filter casing portion 103b through the core portion 102, from flowing back toward the core portion side. The oil is filtered by the filter 101 and is returned toward the engine through a pipe portion 107 which extends from the central portion of the filter 101 and penetrates the central portion of the core portion 102. A seal member 108 made of rubber is disposed between the pipe portion 107 and the filter 101 to seal the gap between the pipe portion 107 and the filter 101.

[0013] The filter 101 is pushed against the partition member 103 by an elastic member 109 such as a disc spring, and the elastic member 109 is pushed by a lid 110 covering the opening of the filter casing portion 103b. The lid 110 is screwed to the bracket member 104 through an O-ring 111 to hermetically seal the filter casing portion 103b. The lid 110 has a bolt hole 104b for receiving a bolt (not shown) that fixes the filter bracket 105 (bracket member 104) to the engine. The bolt hole 104b is formed with width across flats to engage with a tool such as a spanner, which is used to rotate the lid 110. Incidentally, in the oil cooler 100 of this embodiment, the lid 110 is detached from the bracket member 104 when the filter 101 is exchanged.

[0014] Next, features and effects in this embodiment will be explained. First, because the inner fins 102c, 102d are formed into rectangular corrugated shapes, respectively, by a roller forming method as a corrugated fin for a heat exchanger such as a radiator or a condenser can be. Because of this, the inner fins 102c, 102d can have a fin pitch (see FIG. 3) smaller than that of an offset type fin that is formed by pressing. As a result, a withstand pressure strength (mechanical strength) of the tube (oil passage) 103d becomes large, and the density of the inner fins is increased so that the oil cooler 100 is miniaturized.

[0015] Incidentally, a conventional automotive oil cooler has, as disclosed in JP-B2-2-10357, a cooling water passage, an oil passage (tube) defined within the cooling water passage by core plates, and offset type fins brazed to both surfaces (in both passages) of each of the core plates. The inventors of the present invention first studied the offset type fins and tried to decrease the fin pitch and the height of the offset type fins so that the fins have high densities. However, it was difficult to control the fin pitch and the height of the offset type fins, because the offset type fins were formed by pressing. As opposed to this, in this embodiment, the fin pitch and the height of the inner fins 102c, 102d can be readily controlled.

[0016] Meanwhile, the engine oil circulates within the engine to lubricate movement of pistons, com shafts, and the like and to cool such parts. The increase in density of the inner fins can decrease pressure loss of the oil cooler. As a result, the engine oil may not be supplied to all over the engine and accordingly the engine may seize. To solve this problem, in this embodiment, the thickness To of the oil side inner fin 102c is decreased to prevent pressure loss from increasing within the tube 103d, without lowering the withstand pressure strength of the tube 103d.

[0017] Secondly, because the thickness Tw of the water side inner fin 102d is set to be larger than the thickness To of the oil side inner fins 102c, a climbing rate of temperature of the water side inner fin 102d is prevented from exceeding that of the oil side inner fin 102c when they are brazed. Accordingly, the erosion of the water side inner fin 102d is prevented to prevent brazing deficiencies. As described above, according to the first embodiment, the oil cooler 100 can be miniaturized without deteriorating qualities such as the brazing properties and the withstand pressure strength.

[0018] In addition, because the water side inner fin 102d always contacts the cooling water, the water side inner fin 102d is eroded more easily than the oil side inner fin 102c. Therefore, if the thicknesses of the inner fins 102c, 102d are equal to one another, the water side inner fin 102d is eroded more quickly than the oil side inner fin 102c. That is, the life-time of the oil cooler 100 is restricted by the life-time of the water side inner fin 102d. As opposed to this, according to this embodiment, because the thickness Tw of the water side inner fin 102d is thicker than the thickness To of the oil side inner fin 102c, the life-time of the water side inner fin 102d is lengthened, and consequently the life-time of the oil cooler 100 is lengthened.

[0019] Preferably, the thickness Tw of the water side inner fin 102d is more than 1.05 times as thick as the thickness To of the oil side inner fin 102c. More preferably, the thickness Tw of the water side inner fin 102d is more than 1.10 times as thick as the thickness To of the oil side inner fin 102c. Concerning the oil side inner fin 102c, referring again to FIG. 3, the fin height ho of is preferably in a range of 1 mm to 3 mm, the thickness To is preferably in a range of 0.05 mm to 0.3 mm, and the fin pitch fpo is preferably equal to or smaller than 4 mm. The plate thickness Tp of the tube 103 (core plate 102a or 102b) is preferably equal to or larger than 0.2 mm.

[0020] Concerning the water side inner fin 102d, likewise, the fin height hw is preferably in a range of 1mm to 3 mm, the plate thickness Tw is preferably in a range of 0.05 mm to 0.3 mm, and the fin pitch fpw is preferably equal to or smaller than 4 mm. These preferable dimensional ranges are determined by experimental results shown in FIGS. 4 through 9. For example, FIG. 4 shows a relationship between an oil side heat transfer coefficient α_0 and the height ho or ht of the inner fin 102c or 102d, when the thicknesses To, Tw of the inner fins 102c, 102d are 0.1 mm, respectively, and the thickness Tp of the tube 103d is 0.6 mm. This was examined to prevent the louvers 103e from being closed by the brazing filler metal. Incidentally, the lower limit (0.05 mm) of the thickness To, Tw of the inner fins 102c, 102d is determined so that the inner fins 102c, 102d can be securely brazed.

[0021] The core space 103a is filled with the cooling water, and the filter casing portion 103b is filled with the oil. Because the partition member 103 and the bracket member 104 are unified by brazing, it is not necessary that several O-rings are intervened between the core space 103a and the filer casing portion 103d to secure the sealing property therebetween as for example described in European Patent No. 631804A1 (January 4, 1995). This results in decrease in number of the parts of the oil cooler 100, and therefore results in manufacturing cost reduction and size reduction of the oil cooler 100. The mountability of the oil cooler 100 to the vehicle is improved due to the size reduction. In addition, the number of the O-rings that are consumable supplies is decreased, so that a burden to a user of the oil cooler is reduced after the user has purchased the oil cooler.

(Second Embodiment)

[0022] Referring to FIG. 10, an oil cooler 400 in a second preferred embodiment has around the filter 101 a cooling water passage 401 in which the cooling water flows. The cooling water passage 401 is provided between a partition member 1031 and the bracket member 104. Accordingly, an amount of heat exchange between the cooling water and the oil is increased, so that the temperature of the oil can be more decreased. This lengthens the life-time of the oil. Accordingly, the frequency for exchanging the oil is decreased so that the burden of the user is reduced. The other features and effects are the same as those in the first embodiment, and the same explanations are not reiterated.

[0023] In the embodiments described above, both of the inner fins 102c, 102d are formed into a rectangular corrugated shape, respectively. However, the shape of the fins are not limited to that and may be a sinwave like shape. Although the oil cooler 100 or 400 is an exterior type oil cooler having the core portion 102 disposed outside of the engine, the present invention can be applied to an interior type oil cooler having a core portion disposed in an engine water jacket (cooling water passage) within the engine.

(Third Embodiment)

[0024] In the first embodiment, the bracket member 104 of the filter bracket 105 has the filter casing portion 103b. As opposed to this, in an oil cooler 200 of a third preferred embodiment, as shown in FIG. 11, a filter casing 201 for accommodating the filter 101 therein is integrated with the filter 101. When the filter 101 is exchanged, the filter casing 102 is also exchanged together with the filter 101. In the third embodiment, the partition member 103 separates the core space 103a from the portion where the filter 101 and the filter casing 201 are disposed, and simultaneously serves as a fixing member for fixing the filter 101 and the filter casing 201. The other features and effects are the same as those in the first embodiment.

(Fourth Embodiment)

[0025] In the third embodiment, the partition member 103 is composed of an aluminum plate. As opposed to this, referring to FIG. 12, an oil cooler 300 of a fourth preferred embodiment has a partition member 1032, which is a honeycomb structural member (see FIG. 13) composed of an aluminum thin plate 1032c perpendicularly joined to two aluminum thin plates 1032a, 1032b therebetween. Accordingly, the partition member 1032 is lightened, resulting in lightening of the oil cooler 300. In addition, the rigidity of the partition member 1032 is improved. The other features and effects are the same as those in the third embodiment.

(Fifth Embodiment)

[0026] An oil cooler 500 in a fifth preferred embodiment is a modified one of the oil cooler 400 in the second embodiment. Referring to FIG. 14, the oil cooler 500 has a spiral first fin (first protruding member) 501 in the cooling water passage 401. The spiral fin 501 protrudes from the partition member 1031 toward the bracket member 104 in the cooling water passage 401. Accordingly, the heat exchange between the cooling water and the oil is facilitated in the cooling water passage 401, so that the temperature of the oil is further lowered. The other features and effects are the same as those in the second embodiment.

(Sixth Embodiment)

[0027] An oil cooler 600 in a sixth preferred embodiment is another modified one of the oil cooler 400 in the second embodiment. Referring to FIG. 15, the oil cooler 600 has a second fin (second protruding member) 601 protruding from the outside wall of the bracket member 104 of the filter bracket 105. This embodiment is explained based on the oil cooler 400 in the second embodiment; however, it may be applied not only to the oil cooler 400 but also to the oil cooler 500 in the fifth embodiment, or the oil cooler in which the cooing water passage 401 is not provided as in the first to third embodiments.

(Seventh Embodiment)

[0028] The oil coolers 100 - 600 in the first to sixth embodiments are exterior type oil coolers respectively including the core portion 102 which is positioned outside of the engine. As opposed to this, in a seventh preferred embodiment, the present invention is applied to an interior type oil cooler 700 including the core portion 102 positioned within the engine, specifically within a water jacket (cooling water passage) of the engine.

[0029] Referring to FIGS. 16A-16C, also in the oil cooler 700, the partition member 103 (plate member) and the bracket member 104 including bracket parts 104A-104D are integrally brazed to one another. The filter 101 is accommodated within a filter chamber 701 made of aluminum. The filter chamber 701 is brazed to the partition member 103 and the bracket member 104 after it is formed into a specific shape by pressing or by forging (see FIGS. 17A, 17B). In the oil cooler 700, the lid 110 is fixed to the filter chamber 701 by bolts 702.

[0030] As shown in FIG. 18, internal threaded holes 703, 704 are formed on upper and lower sides of the filter chamber 701, respectively, and bolts 706, 707 are inserted into the holes 703, 704 through flat washers 705 made of relatively soft metal such as copper. Therefore, when the filter 101 is exchanged, the oil pooling in the filter chamber 701 readily flows out by disengaging the bolts 706, 707. As a result, exchanging performance of the filter 101 can be improved.

[0031] Next, the flow route of the oil in the oil cooler 700 will be generally explained. As shown in FIG. 19, the oil discharged from the engine enters the inside of the oil cooler 700 from an engine side oil inlet 708 provided in the bracket part 104D of the bracket member 104, passes through an oil passage 709 provided in the bracket part 104D, and flows into the core portion 102 through a core side oil outlet 710 (see FIG. 20). Then, as shown in FIGS. 19, 21, the oil which has finished heat exchange in the core portion 102 flows into the filter chamber 701 through a core side oil inlet 711 formed in the bracket part 104A, is filtered by the filter 101, and returnee to the engine through a first engine side oil outlet 712 formed in the bracket part 104B. The bracket part 104D defines a reflux passage 713 for diverging the oil from the oil passage 709 to circulate it to the engine. A relief valve 714 is disposed in the reflux passage 713 for directly returning the oil, which is conducted through the engine side oil inlet 708, to bypass the oil cooler 700 when the pressure inside of the oil cooler 700 (the core portion 102 and the filter chamber 701) exceeds a specific magnitude. Incidentally, numeral 715 represents a hole for circulating part of the oil within the filter chamber 701 to an oil pan.

(Eighth Embodiment)

[0032] Referring to FIGS. 22A, 22B, an oil cooler 800 in an eighth preferred embodiment is a modified one of the oil cooler 700 in the seventh embodiment. Specifically, the oil cooler 800 has a fin (third protruding member) 801 protruding from the outside wall of the filter chamber 701 and the lid 110. Accordingly, the temperature of the oil can be lowered as in the fifth and sixth embodiments, and thereby the life-time of the oil is lengthened.

(Ninth Embodiment)

[0033] An oil cooler 900 in a ninth preferred embodiment is an interior type oil cooler as those in the seventh and eighth embodiments, and adopts a honeycomb structural member as shown in FIG. 13 as the partition member 1032. The partition member 1032 has bolt holes 104d into which bolts are inserted. In this case, as shown in FIGS. 23A, 23B, it is preferable that reinforcement collars 901 are brazed to the honeycomb partition member 1032 around the bolts holes 104d.

(The other embodiments)

[0034] In the fourth and ninth embodiments, the partition member 1032 is composed of a honeycomb structural member; however, the present invention is not limited to it. The entire filter bracket 105, the bracket member 104, or the filter chamber 701 may be composed of a honeycomb structural member.
[0035] In the first to sixth embodiments, although the core portion 102 is brazed to both of the partition member 103 and the bracket member 104, the core portion 102 may brazed to only one of the partition member 103 and the bracket member 104. In the second embodiment, although the cooling water passage 401 is defined by the partition member 1031 and the bracket member 104, the cooling water passage 401 can be defined by the other members.
[0036] While the present invention has been shown and described with reference to the foregoing preferred embodiments, it will be apparent to those skilled in the art that changes in form and detail may be made therein without departing from the scope of the invention as defined in the appended claims.

Claims

1. An oil cooler for cooling oil by exchanging heat between the oil and cooling water, the oil cooler comprising:

   a casing (105) defining a cooling water passage (103c) therein;
   a tube (103d) disposed in the cooling water passage and defining an oil passage therein;
   an oil side fin (102c) fixed to an inside wall of the tube (103d); and
   a water side fin (102d) fixed to an outside wall of the tube (103d) and having a plate thickness thicker than that of the oil side fin (102c).

2. The oil cooler of claim 1, wherein the oil side fin (102c) and the water side fin (102d) are corrugated fins.

3. The oil cooler of claim 1, wherein the plate thickness (Tw) of the water side fin (102d) is more than 1.05 times as thick as that of the oil side fin (102c).

4. The oil cooler of claim 3, wherein the plate thickness (Tw) of the water side fin (102d) is more than 1.1 times as thick as that of the oil side fin (102c).

5. The oil cooler of claim 1, wherein:

   the oil side fin (102c) has a plurality of louvers (103e) for meandering the oil on both surfaces thereof;
   a height (ho) of the oil side fin (102c) is in a range of 1 mm to 3 mm;
   a plate thickness (To) of the oil side fin (102c) is in a range of 0.05 mm to 0.3 mm;
   a fin pitch (fpo) of the oil side fin (102c) is less than 4 mm; and
   a plate thickness thickness (Tp) of the tube (103d) is more than 0.2 mm.

6. The oil cooler of claim 5, wherein:

   a height (hw) of the water side fin (102d) is in a range of 1 mm to 3 mm;
   the plate thickness (Tw) of the water side fin (102d) is in a range of 0.05 mm to 0.3 mm; and
   a fin pitch (fpw) of the water side fin (102d) is less than 4 mm.

7. The oil cooler of claim 1, further comprising:

   a partition member (103, 1031, 1032) partitioning inside of the casing (105) into the cooling water passage (103c) and a filter casing portion (103b) and forming part of the oil passage for introducing the oil from the tube (103d) into the filter casing portion (103b), the partition member (103, 1031, 1032) being made of metal and integrally brazed to the casing (105); and
   a filter (101) disposed in the filter casing portion (103b) of the casing (105), for filtering the oil.

8. The oil cooler of claim 7, wherein the filter (101) is surrounded by the cooling water passage (103c)

9. The oil cooler of claim 8, wherein the cooling water passage (103c) is defined between the casing (105) and the partition member (1031).

10. The oil cooler of claim 7, further comprising a first protruding member (501) disposed in the cooling water passage surrounding the filter (101) and protruding from a wall of the partition member (1031) toward an inside wall of the casing (105).

11. The oil cooler of claim 10, further comprising a second protruding member (601) protruding from the casing (105).

12. The oil cooler of claim 7, further comprising a second protruding member (601) protruding from the casing (105).

13. The oil cooler of claim 7, wherein the partition member (1032) has a honeycomb structure.

14. An oil cooler for cooling oil, comprising:

a core portion (102) having a tube (103d), in which the oil flows, for exchanging heat between the oil and cooling water flowing outside of the tube (103d), an oil side fin (102c) fixed to an inside wall of the tube (103d), and a water side fin (102d) fixed to an outside wall of the tube (103d) and having a plate thickness thicker than that of the oil side fin (102c);
a filter (10) for filtering the oil that is cooled in the core portion (102); and
a partition member (103, 1031, 1032) disposed between the core portion (102) and the filter (101) and separating a core space (103a) in which the core portion (102) is disposed from a filter casing space (103b) in which the filter (101) is disposed.

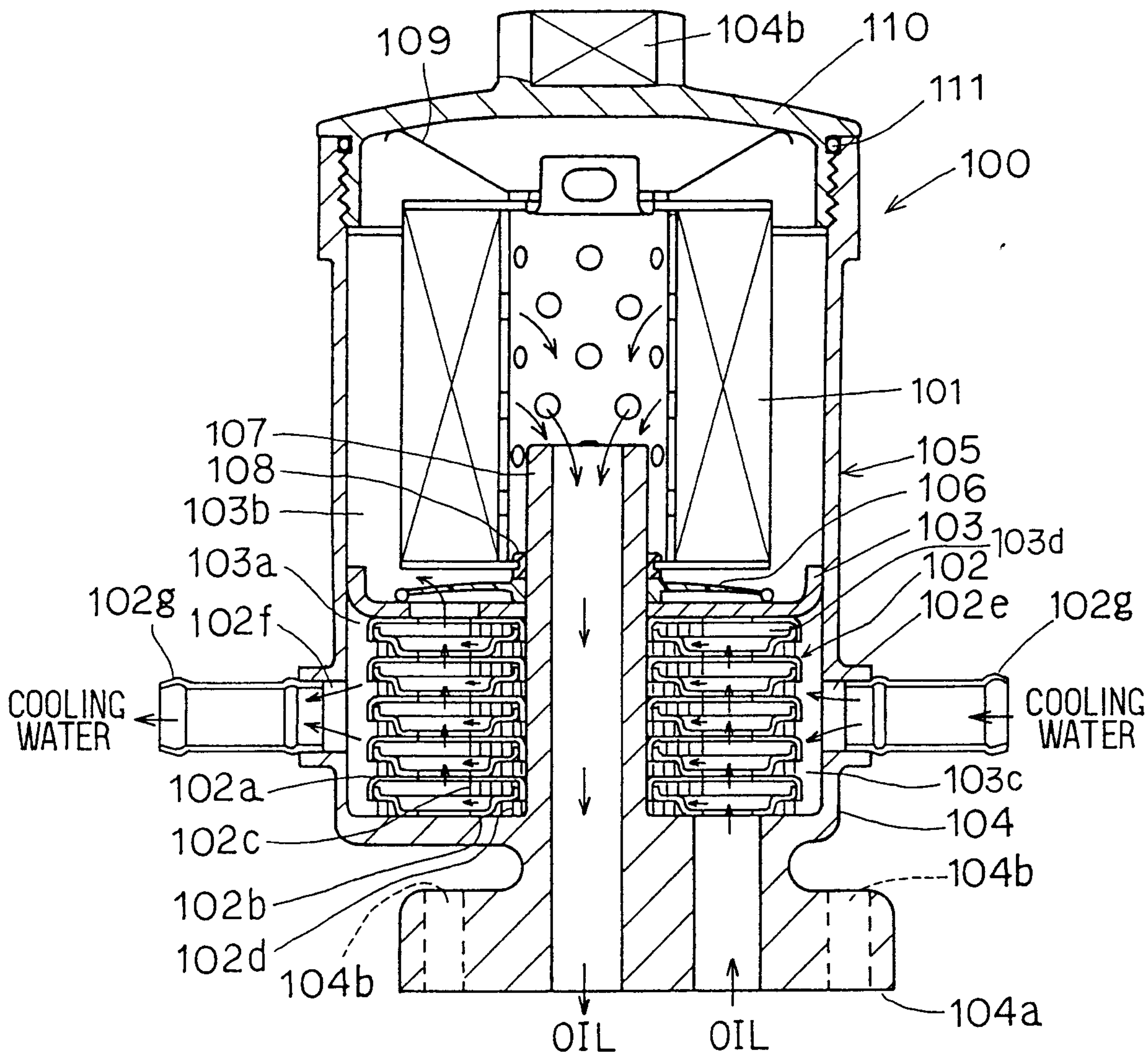
15. The oil cooler of claim 14, wherein the oil side fin (102c) and the water side fin (102d) are corrugated fins.

16. The oil cooler of claim 14, further comprising a casing (105) for accommodating the core portion (102) and the filter (101) therein,
wherein the partition member (103, 1031, 1032) is brazed to an inside wall of the casing (105) and partitions inside of the casing (105) into the core space (103a) and the filter casing space (103b).

17. The oil cooler of claim 14, wherein the core portion (102) is disposed in a cooling water passage of a water-cooled engine.

18. The oil cooler of claim 17, wherein further comprising a filter chamber (701) for accommodating the filter (101) therein, the filter chamber (701) having a protruding member (801) protruding from an outside wall thereof.

FIG. 1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104b
110
111
100
101
107
108
103b
105
106
103
103d
103a
102
102g
102f
102e
102g
COOLING WATER
COOLING WATER
102a
103c
102c
104
104b
102b
102d
104b
104a
OIL
OIL

FIG. 2

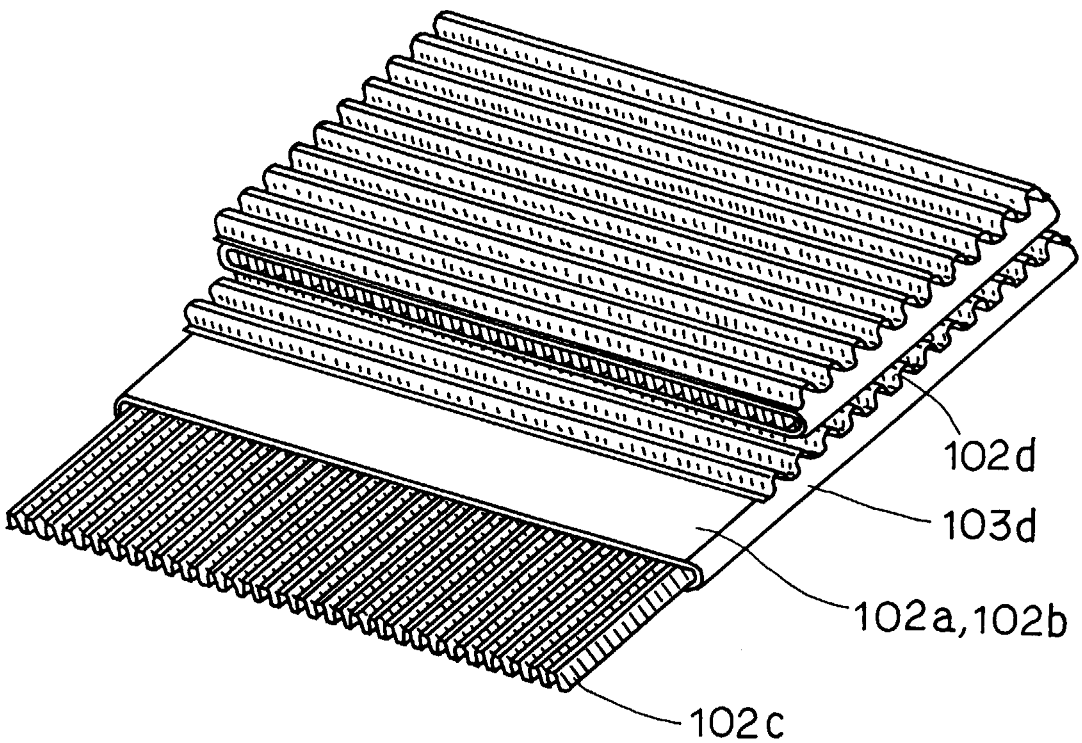

102d
103d
102a,102b
102c

FIG. 3

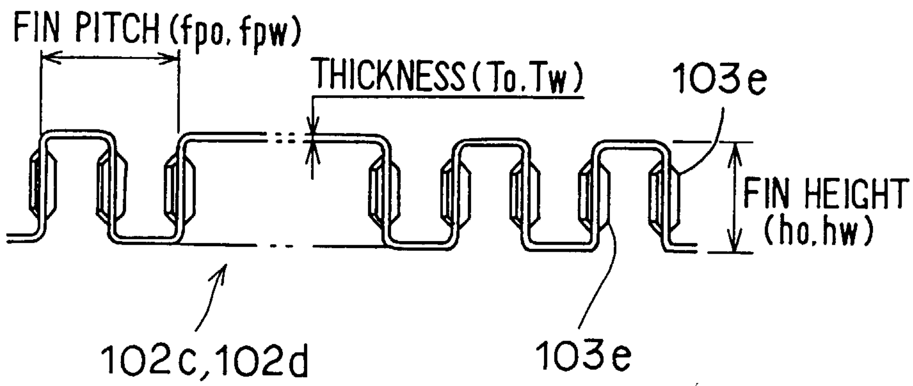

FIN PITCH (fpo, fpw)
THICKNESS (To, Tw)
103e
FIN HEIGHT
(ho, hw)
102c,102d
103e

FIG. 4

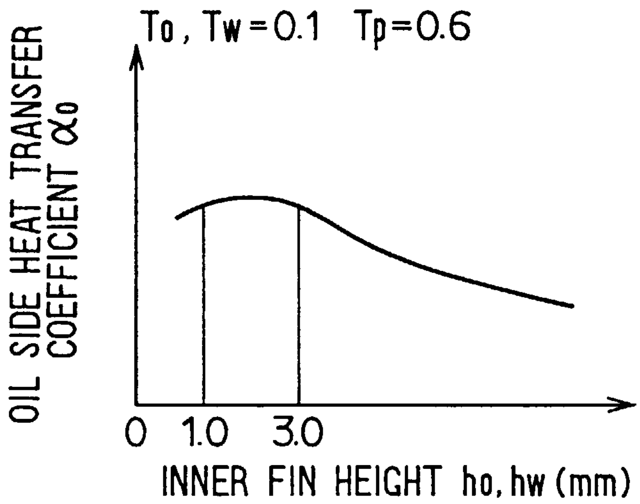


FIG. 5

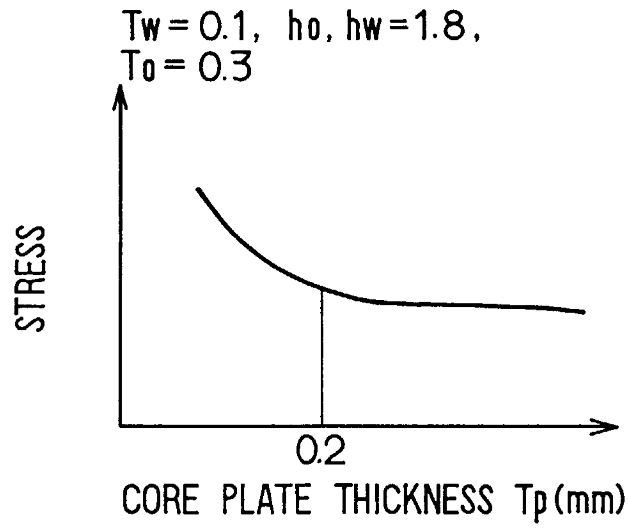


FIG. 6

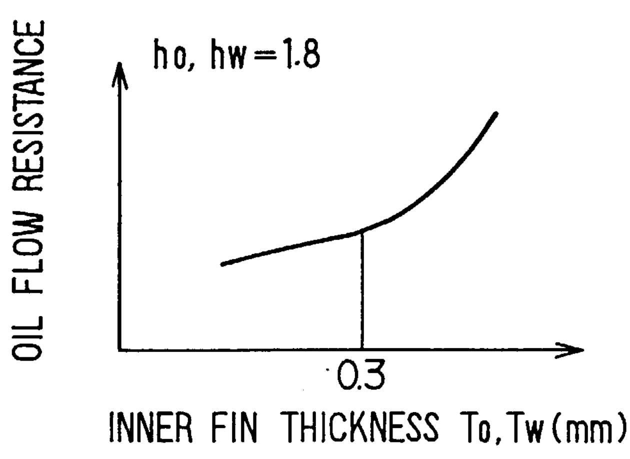


FIG. 7

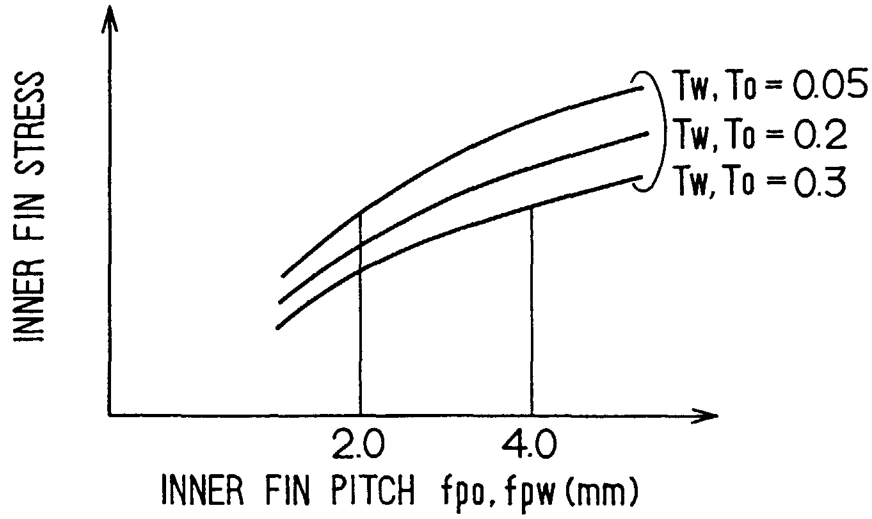


FIG. 8

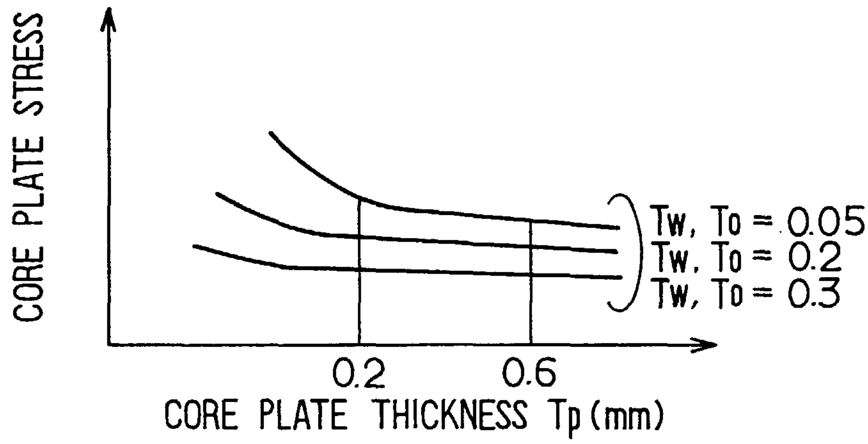


FIG. 9

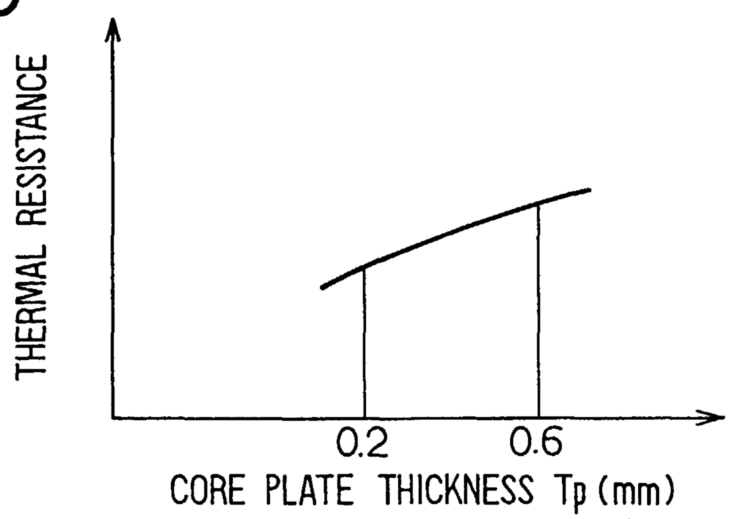


FIG. 10

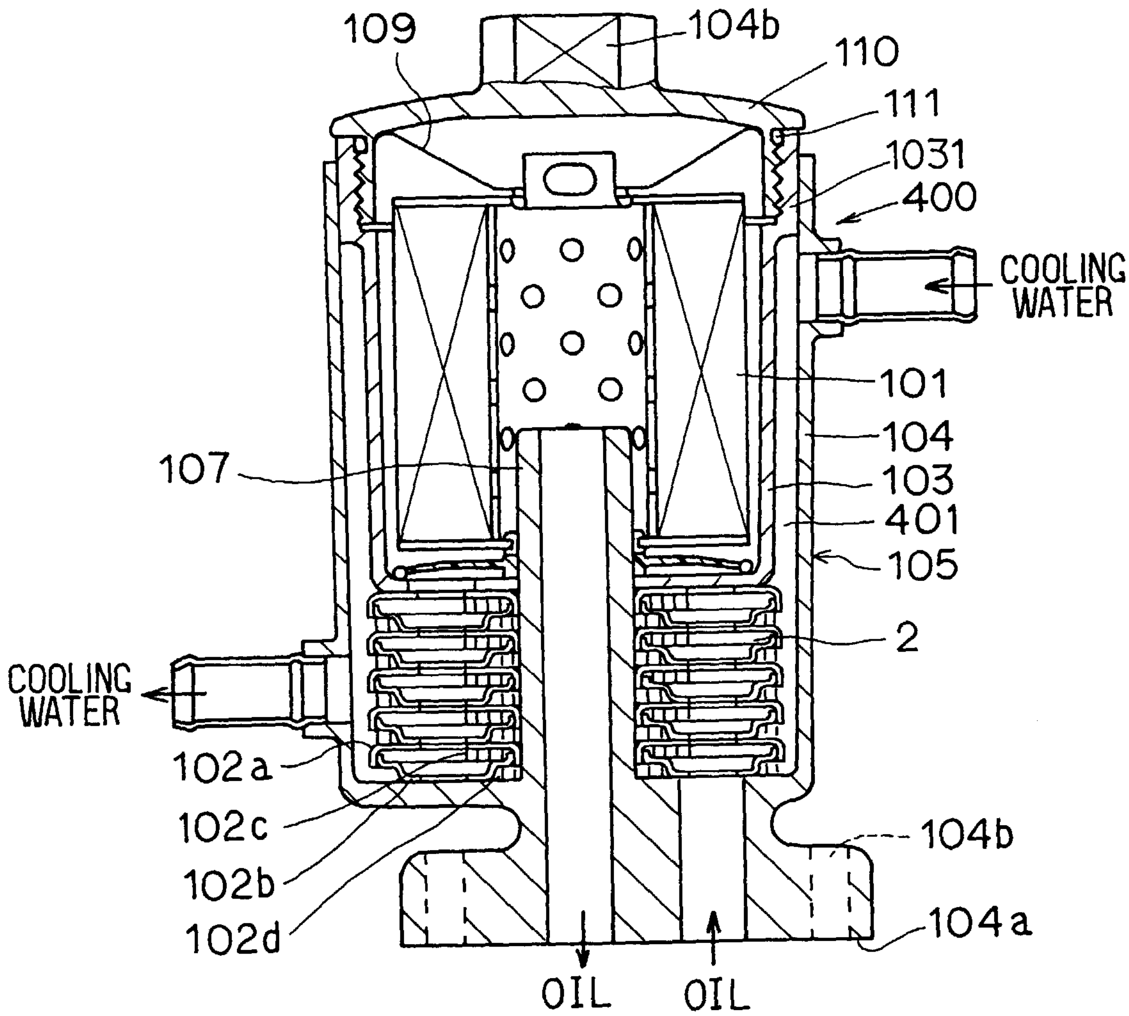

109
104b
110
111
1031
400
COOLING
WATER
101
104
107
103
401
105
2
COOLING
WATER
102a
102c
104b
102b
104a
102d
OIL
OIL

FIG. 11

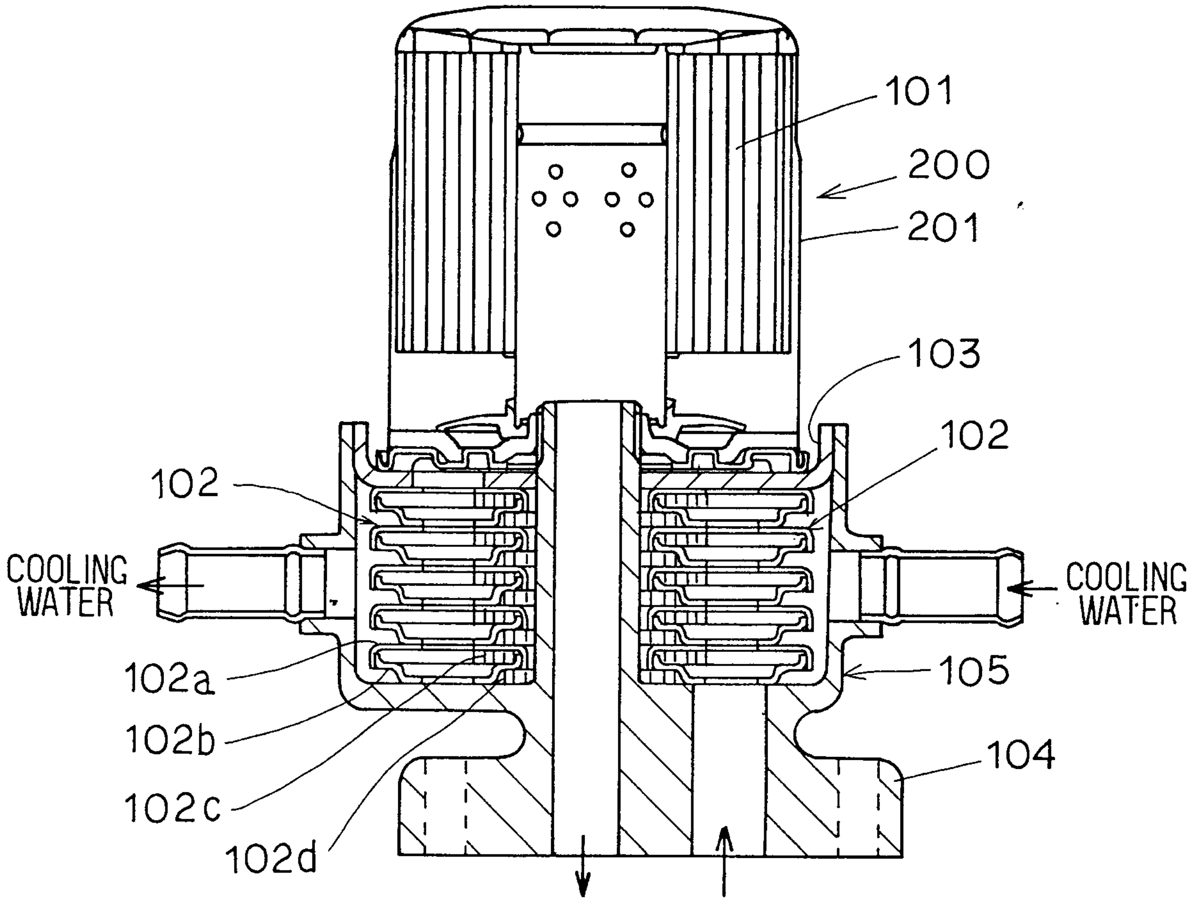

101
200
201
103
102
102
COOLING WATER
COOLING WATER
105
102a
102b
104
102c
102d

FIG. 12

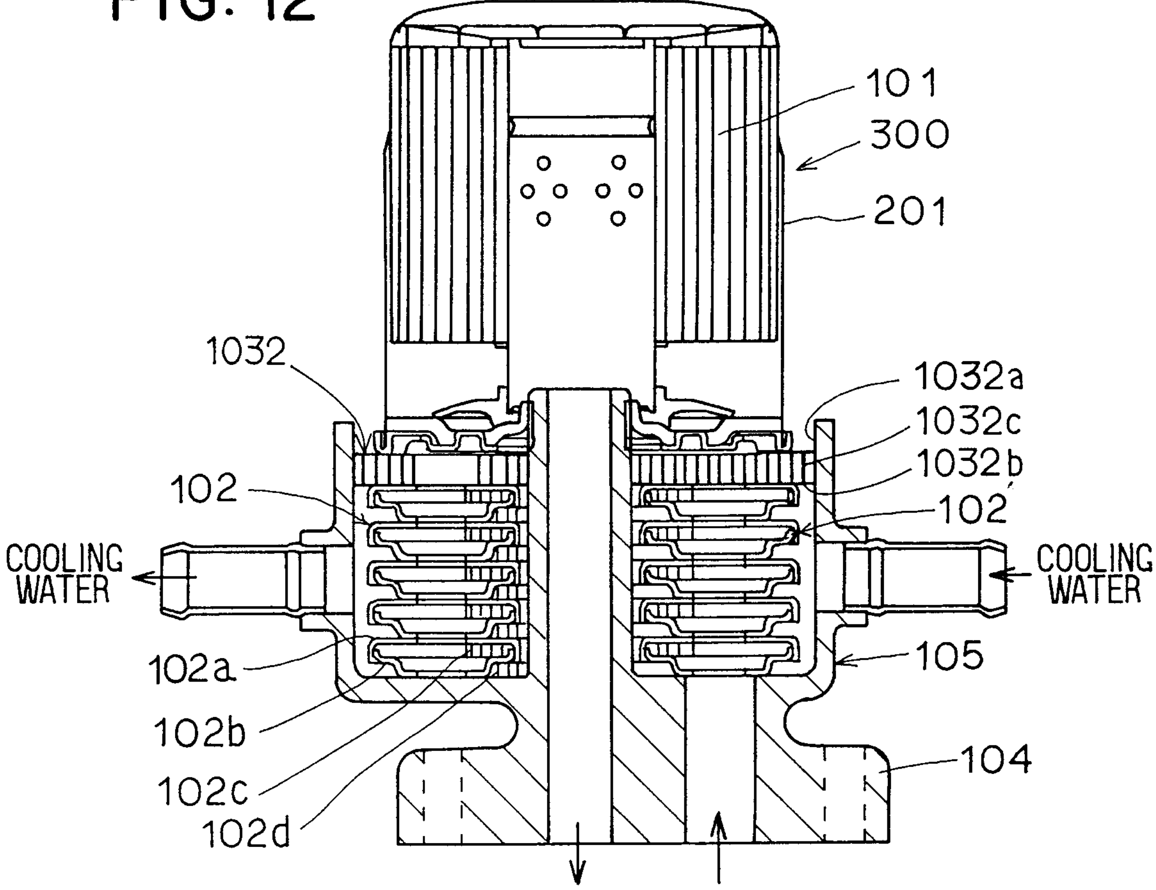

101
300
201
1032
1032a
1032c
1032b
102
102'
COOLING WATER
COOLING WATER
102a
105
102b
104
102c
102d

FIG. 13

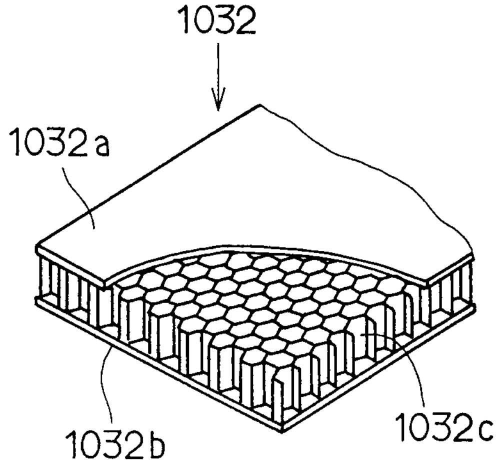

1032
1032a
1032b
1032c

FIG. 14

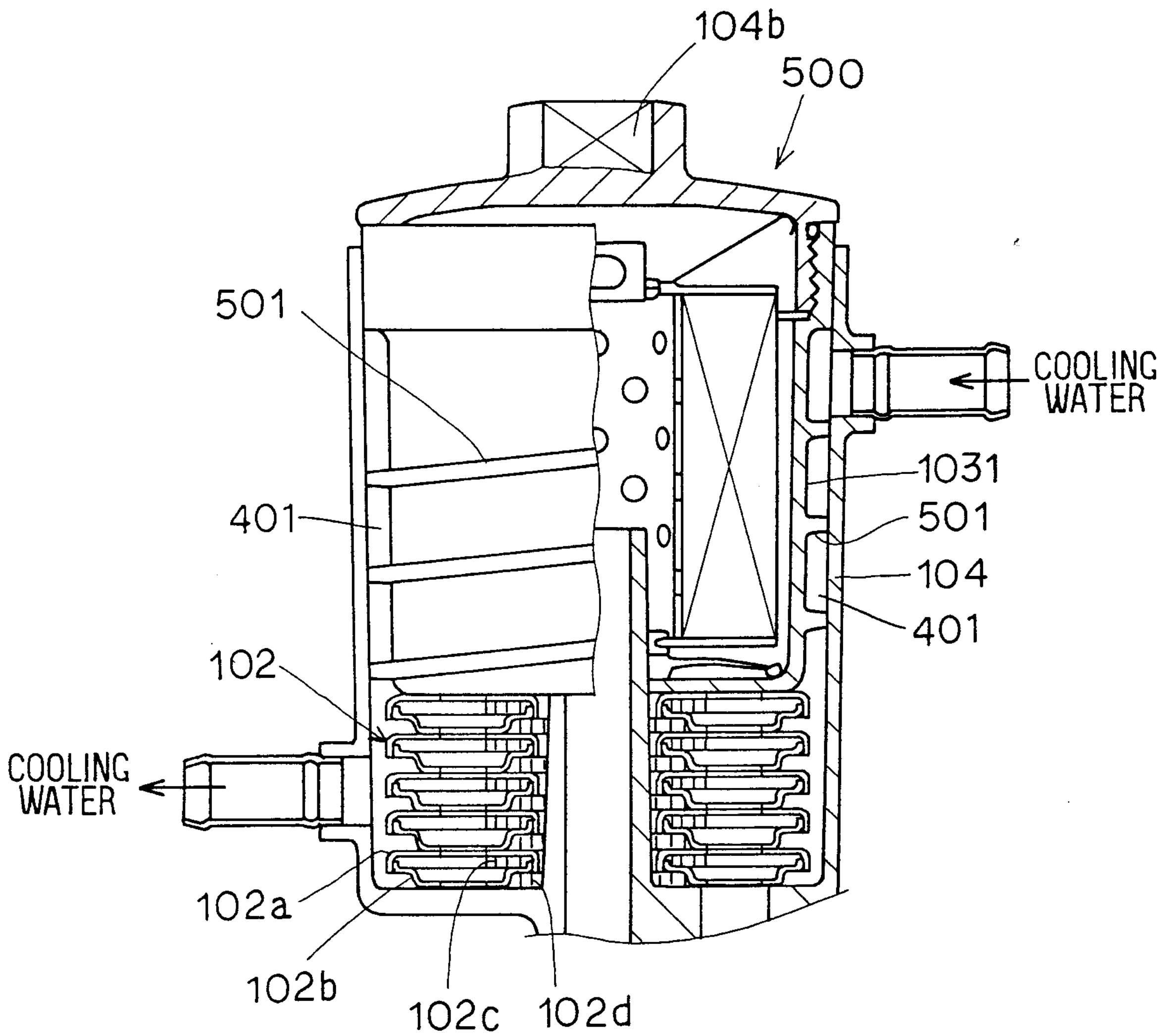
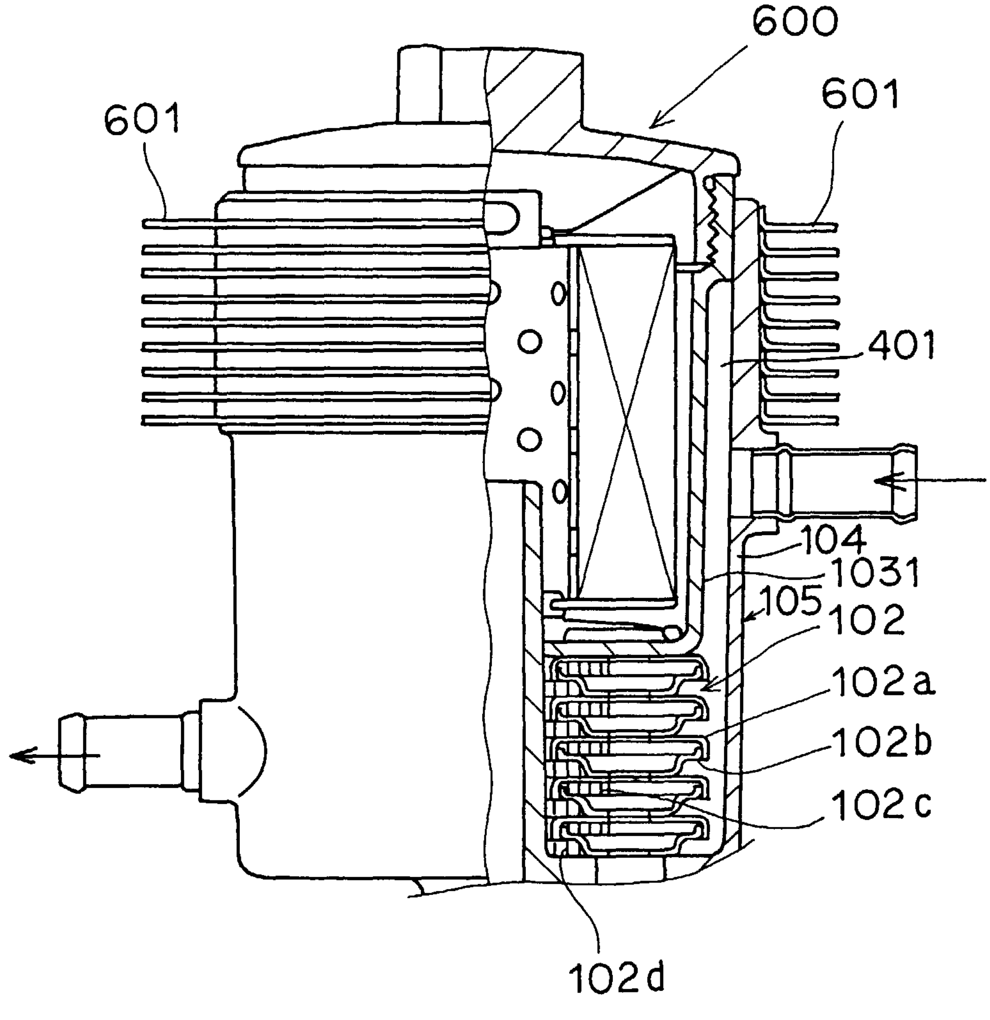

104b
500
501
COOLING WATER
1031
501
104
401
401
102
COOLING WATER
102a
102b
102c
102d

FIG. 15



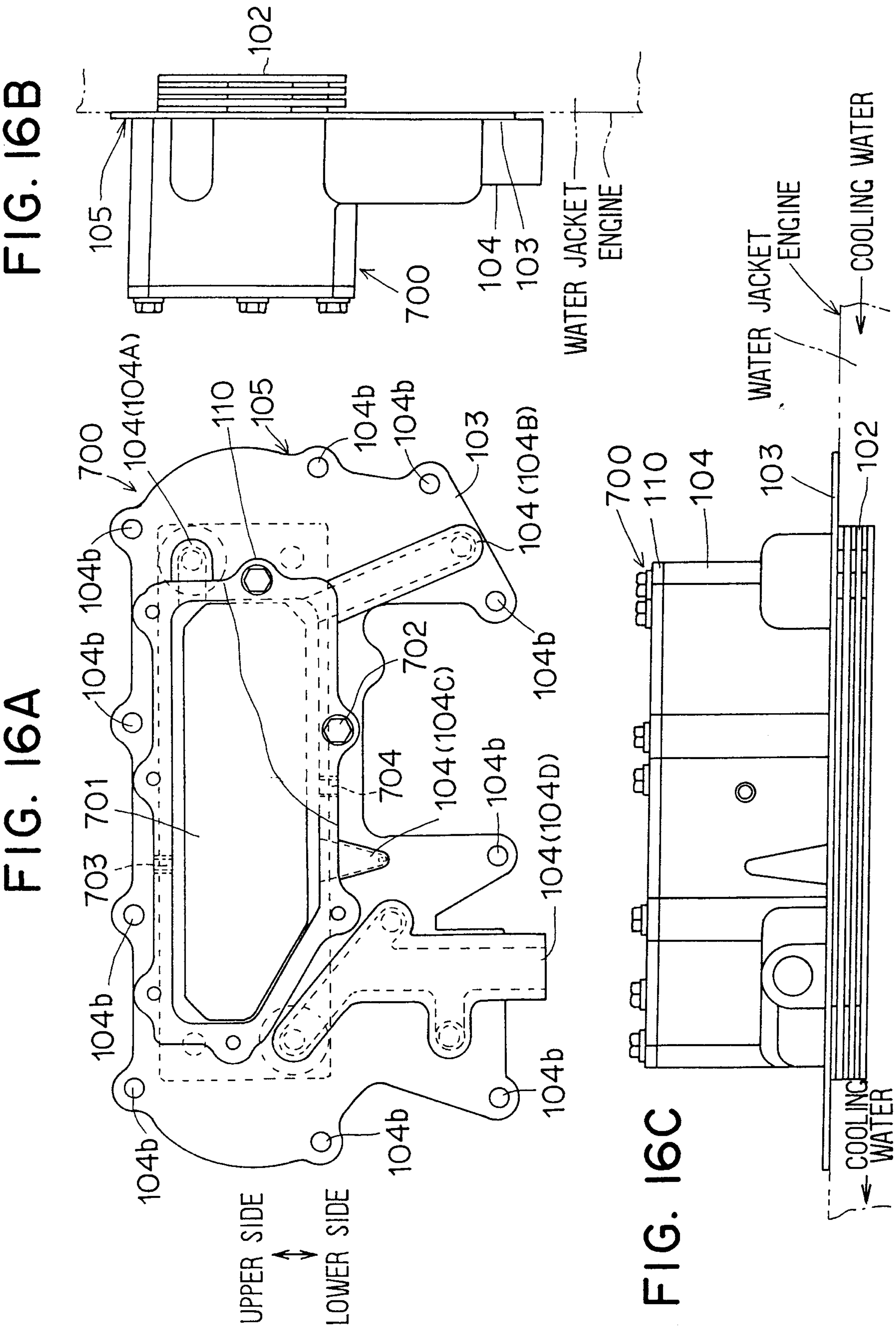


FIG. 16A
FIG. 16B
FIG. 16C
UPPER SIDE
LOWER SIDE
WATER JACKET
ENGINE
COOLING WATER
102
103
104
104(104A)
104(104B)
104(104C)
104(104D)
104b
105
110
700
701
702
703
704

FIG. 17A

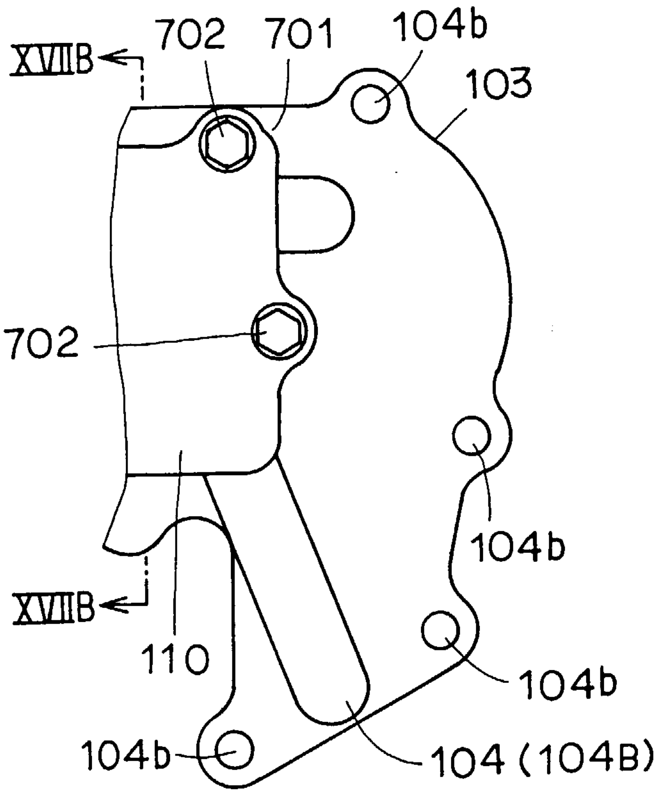


FIG. 17B

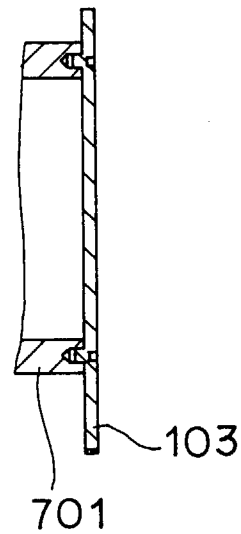


FIG. 18

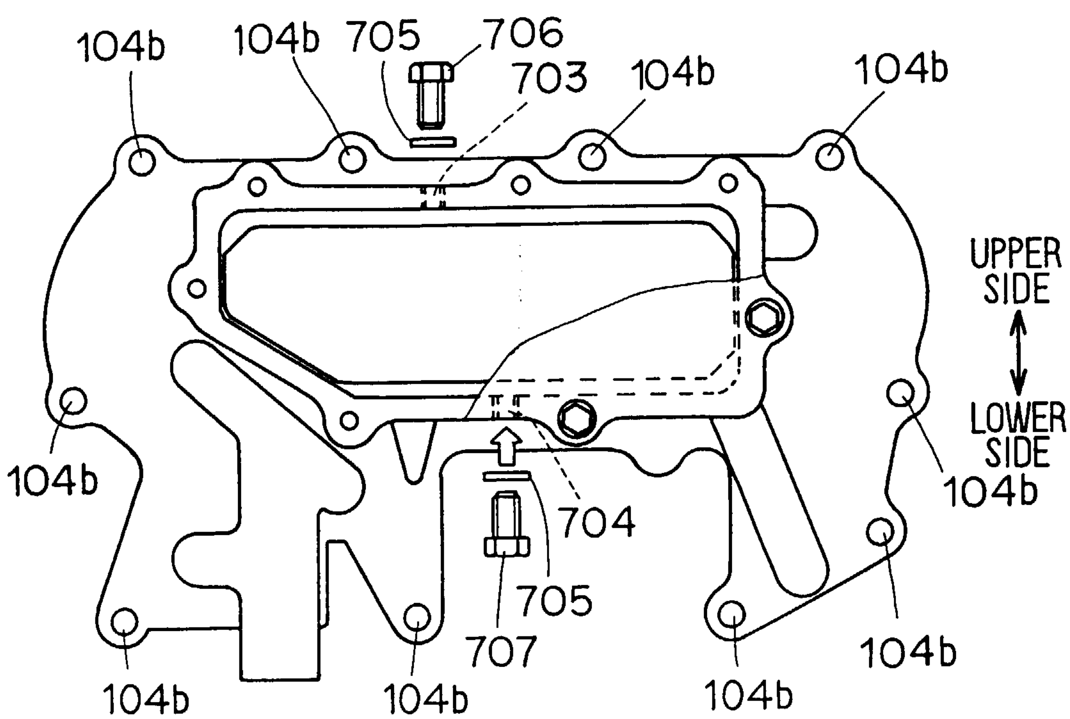


FIG. 19

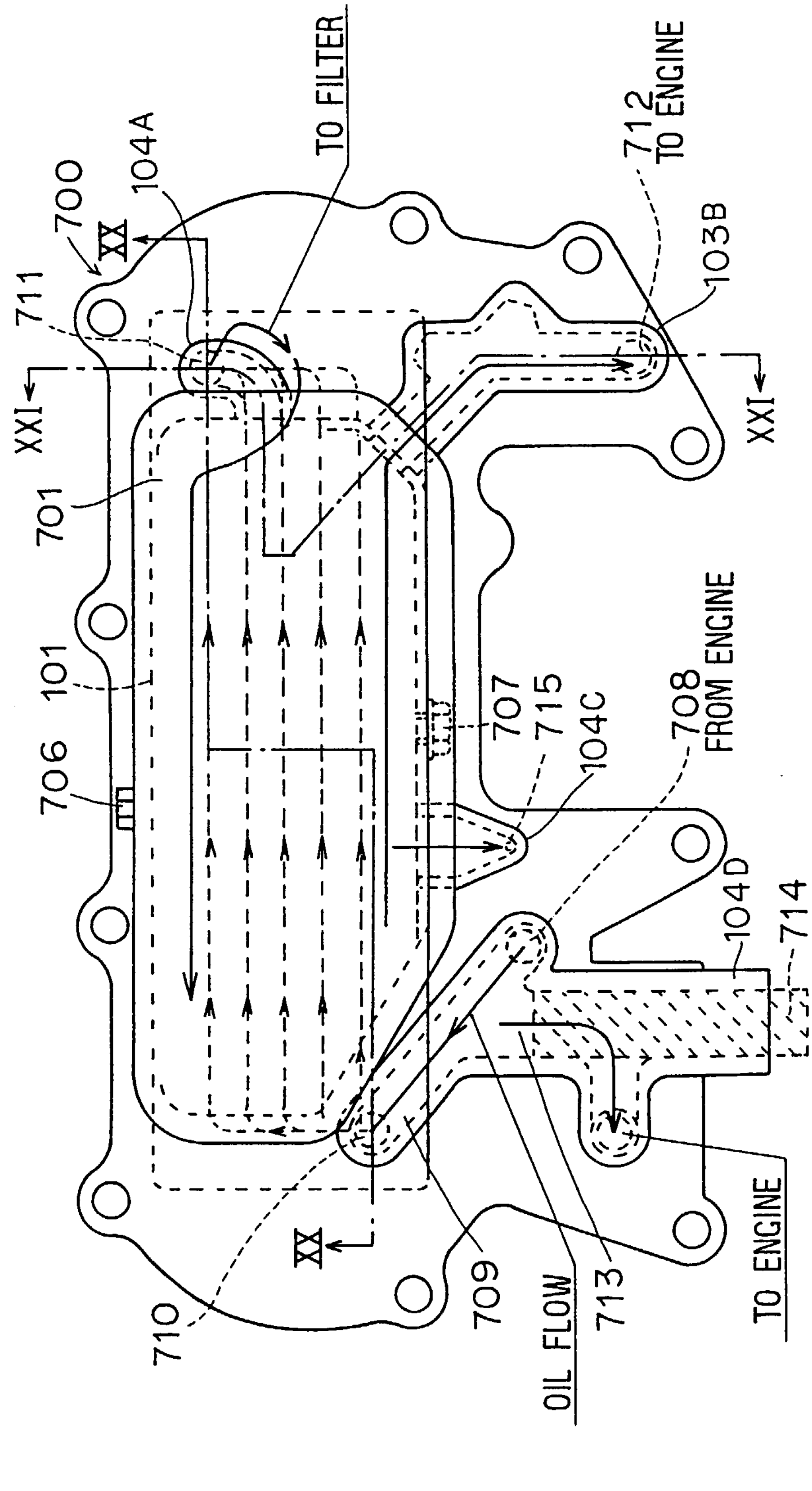

700
XX
104A
711
TO FILTER
712
TO ENGINE
103B
XXI
XXI
701
101
706
707
715
104C
708
FROM ENGINE
104D
714
710
XX
709
OIL FLOW
713
TO ENGINE

FIG. 20

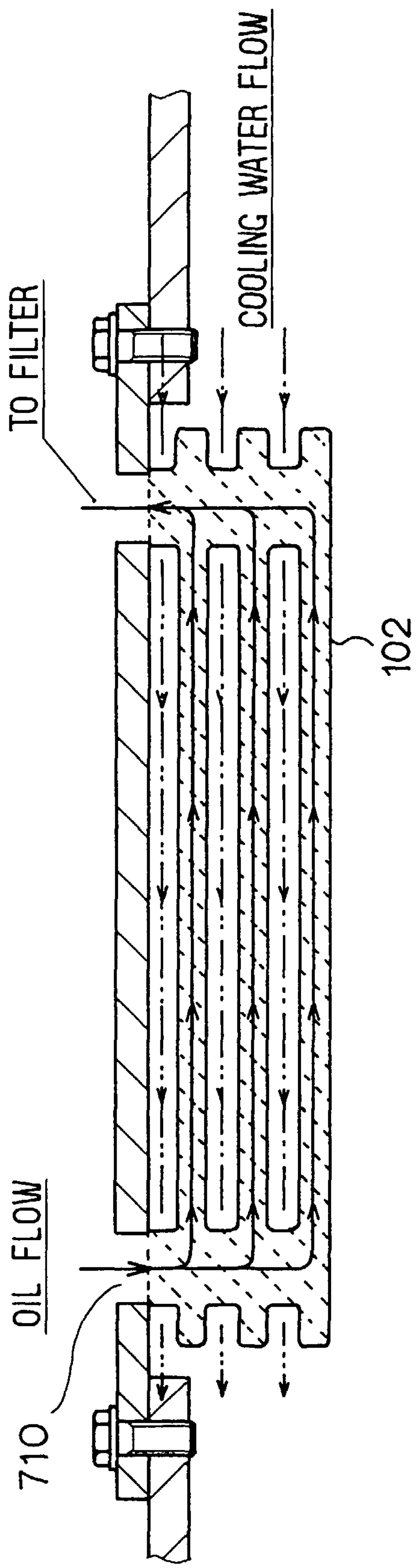


FIG. 21

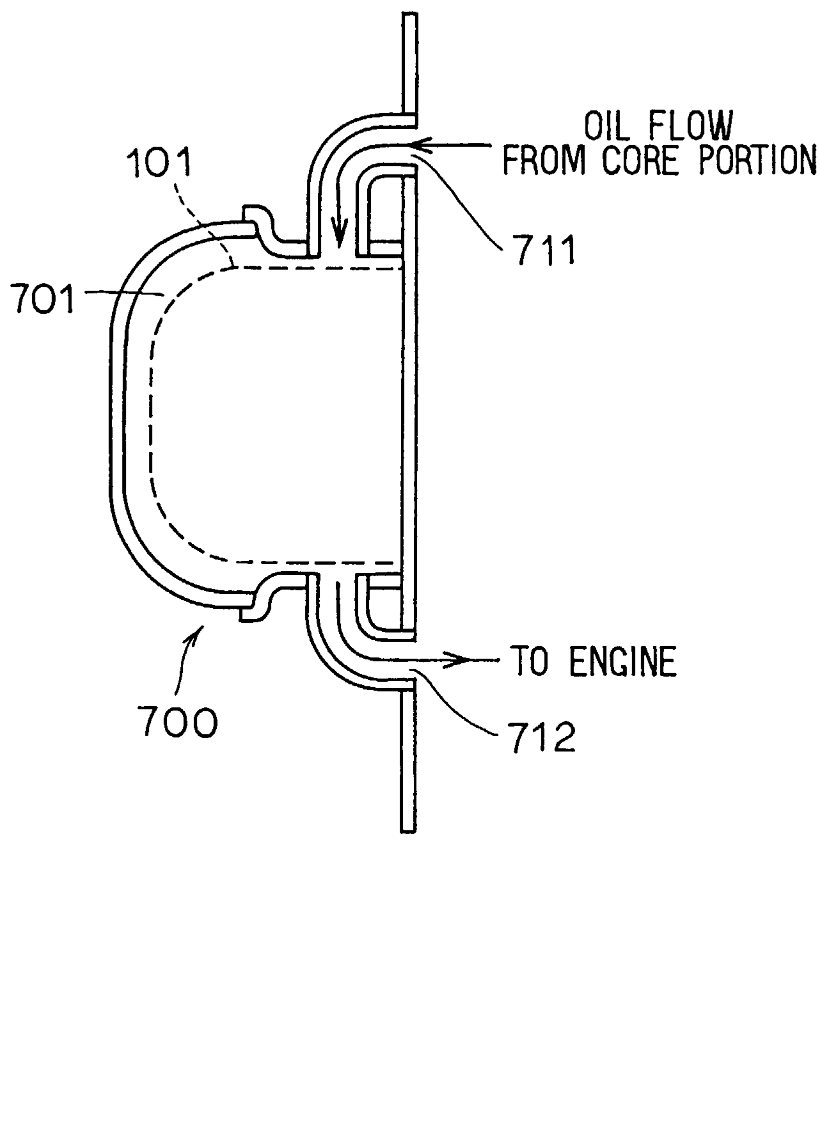


FIG. 22A

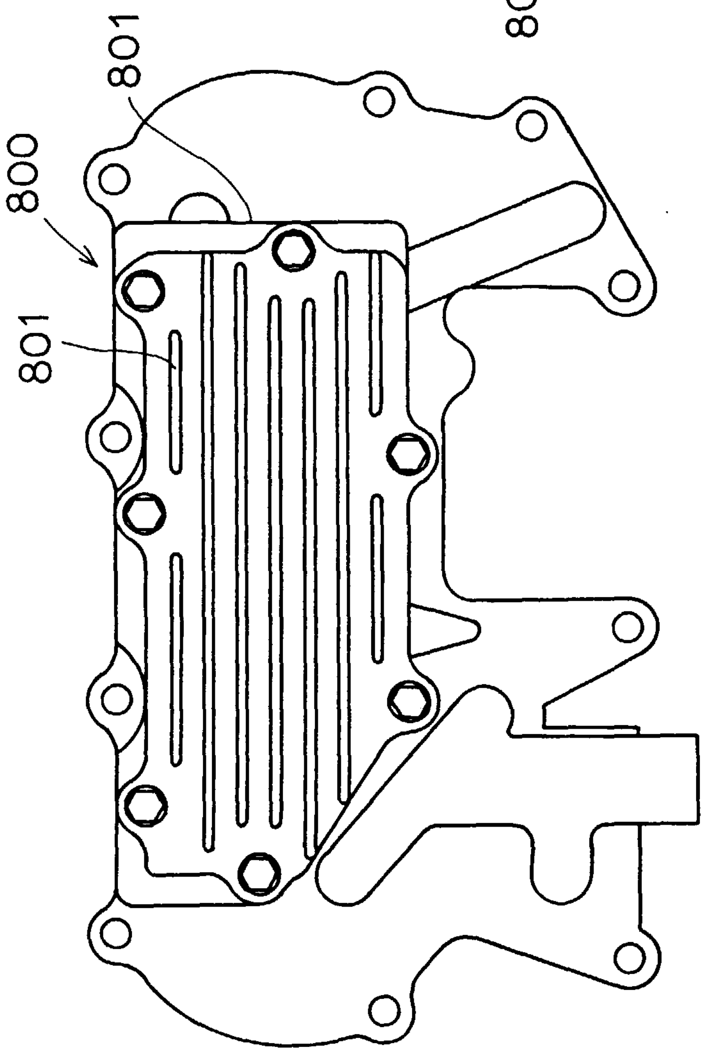


FIG. 22B

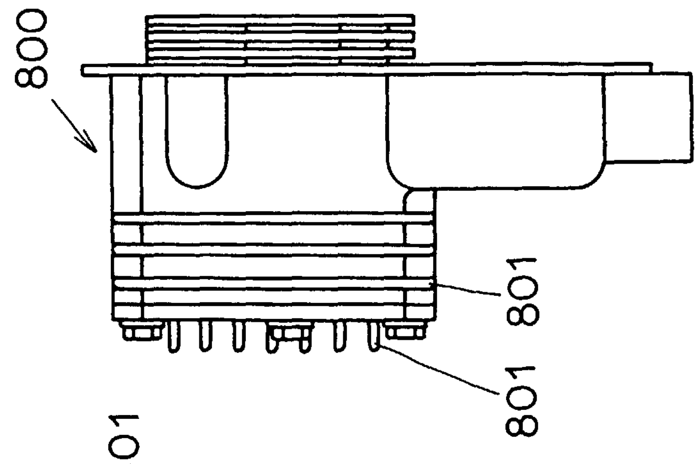


FIG. 23A

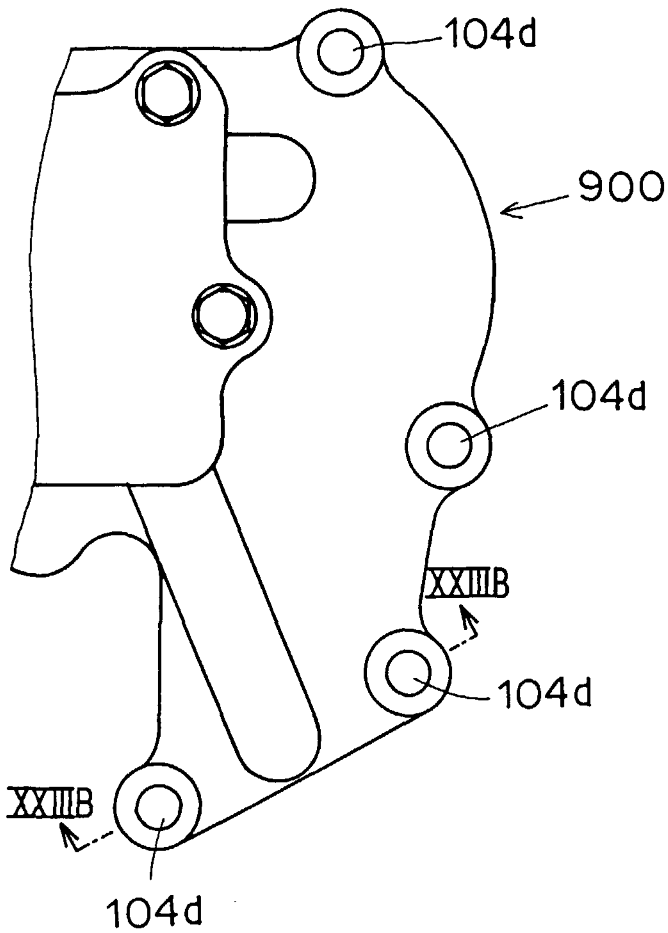


FIG. 23B