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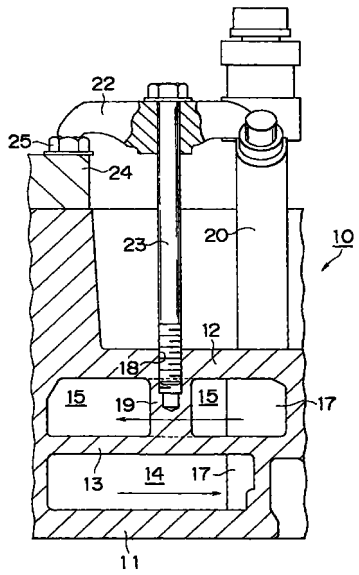
(54) Cylinder head of internal combustion engine

(57) A cylinder head (10) has two water jacket portions (14, 15) that are vertically divided by a middle deck (13). A clamp (22) extends over an upper portion of a fuel injector (22). The clamp (22) is fastened to the cylinder head (10) by a fastening bolt (23), so that the fuel injector (20) is fastened and secured to an upper portion of the cylinder head (10) while being urged downward. A fastening bolt boss portion (19) into which the fastening bolt (23) is screwed extends through the upper water jacket (15) and interconnects the middle deck (13) and a top deck (12), which form a lower partition and an upper partition of the upper water jacket (15), respectively.

FIG. 2



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a cylinder head of an internal combustion engine and, more particularly, to a construction of the cylinder head suitable for use in an in-cylinder direct injection type internal combustion engine.

2. Description of the Related Art

[0002] In a direct injection type diesel engine in which fuel injectors are disposed at sites in an upper portion of a cylinder head corresponding to upper central portions of combustion chambers, each fuel injector is disposed in a housing hole extending through the upper portion of the cylinder head. A conventional structure for fastening a fuel injector disposed in a housing hole to a cylinder head is described in, for example, Japanese Patent Application Laid-Open No. HEI 10-82355. In this fastening structure, a clamp is placed so as to extend from an upper portion of the fuel injector to an upper portion of the cylinder head. The clamp is pressed toward the upper portion of the cylinder head by a fastening bolt inserted through the clamp into the upper portion of the cylinder head from an upper face of the clamp. Adoption of this fastening structure makes it possible to firmly fasten fuel injectors to an upper portion of a cylinder head even if the fuel injectors are designed to inject high-pressure fuel into the corresponding cylinders as in a direct injection type diesel engine.

[0003] In a cooling structure of a cylinder head described in Japanese Patent Application Laid-Open No. SHOU 61-175217, a water jacket for circulating cooling water is divided into an upper portion and a lower portion in the cylinder head. In the cylinder head, cooling water is conducted through the lower water jacket portion and the upper water jacket portion in that order. Therefore, a portion of the cylinder head adjacent to the combustion chambers, that is, a lower portion of the cylinder head where the heat load is high, can be cooled with precedence over other portions of the cylinder head, so that the cylinder head cooling efficiency improves.

[0004] Although both the injector fastening structure of a direct injection type internal combustion engine and the cooling structure of the cylinder head to which fuel injectors are fastened as described above are excellent structures, a combination of the two structures will have an unignorable problem as described below.

[0005] Fig. 4 is a side sectional view of a portion of a cylinder head around a fuel injector, wherein the cylinder head has upper and lower water jacket divisions and incorporates an injector fastening structure as described above.

[0006] Referring to Fig. 4, upper and lower-stage water jackets 54a, 54b are formed between a bottom deck 51 that forms a bottom face of a cylinder head 50 and a top deck 52 that forms a top face of the cylinder head 50. The two water jackets 54a, 54b are separated by a middle deck 53.

[0007] The cylinder head 50 has injector housing holes 55 that extend through the bottom deck 51 and the top deck 52. A fuel injector 56 is disposed in each housing hole 55 in a manner as shown in Fig. 4. Disposed on top of the cylinder head 50 is a clamp 60 that extends from a protrusion formed in an upper portion of the cylinder head 50 to an upper portion of the fuel injector 56. A fastening bolt 61 is inserted through a central portion of the clamp 60. A distal end of the fastening bolt 61 is screwed into a fastening bolt boss 62 formed in the top deck 52 of the cylinder head 50.

[0008] By tightening the fastening bolt 61, the clamp 60 is forced to press the fuel injector 56 from above with a cylinder head-contacting portion of the clamp 60 serving as a fulcrum. As a result, the fuel injector 56 is fastened and secured to the cylinder head 50 while being urged downward.

[0009] In this structure, however, if the wall thickness of the top deck 52 is increased in order to increase the bolt-fastening force caused by the fastening bolt boss 62, there occurs a problem that the cylinder head 50 becomes large in size, or a problem that the sectional area of the upper water jacket 54a decreases. Therefore, an attempt to secure a sufficient tightening force of the fastening bolt 61 may result in upward deformation of a portion of the top deck 52 surrounding the boss 62. If such deformation occurs, the fastening force on the fuel injector 56 decreases so that the fuel injector 56 cannot be stably secured.

SUMMARY OF THE INVENTION

[0010] Accordingly, it is an object of the invention to provide an internal combustion engine cylinder head that makes it possible to stably secure fuel injectors even if the cylinder head is provided with a plurality of water jacket portions divided vertically by partitions.

[0011] This object is achieved by a cylinder head of an internal combustion engine comprising the features of claim 1. Further advantageously features are the subject-matters of the dependent claims.

[0012] In accordance with the invention, there is provided a cylinder head of an internal combustion engine comprising plurality of water jackets vertically divided by partitions, wherein a clamp extending over an upper portion of a fuel injector is fastened to an upper portion of the cylinder head by a fastening bolt. The cylinder head is characterized in that a fastening bolt boss portion into which the fastening bolt is screwed extends through an uppermost water jacket of the plurality of vertically divided water jackets and interconnects an

upper partition of the uppermost water jacket and a lower partition of the uppermost water jacket.

[0013] In this cylinder head, the upper partition and the lower partition of the uppermost water jacket are partially interconnected by the fastening bolt boss portion, so that those connected portions of the cylinder head have increased rigidities and, therefore, deformation of a portion near the fastening bolt boss portion can be suitably prevented. Therefore, even if the fuel injector is of a type that is designed to inject high-pressure fuel, such as a direct injection type or the like, the fuel injector can be firmly and stably fastened and secured to the cylinder head. Although the fastening bolt boss portion takes up a space in the uppermost water jacket, the fastening bolt boss portion does not block the passage of cooling water in the uppermost water jacket. Therefore, good cooling effect of the uppermost water jacket is maintained.

[0014] In the cylinder head of the invention, cooling water may be allowed to flow around the fastening bolt boss portion in the uppermost water jacket.

[0015] Therefore, although the interconnection of the upper and lower partitions by the fastening bolt boss portion provides a possibility of slightly impeding the flow of cooling water in the uppermost water jacket, cooling water is allowed to flow around the fastening bolt boss portion, so that the cooling effect on a portion surrounding the fastening bolt boss portion will not deteriorate.

[0016] In the above-described cylinder head, the fastening bolt boss portion may be formed downstream of the fuel injector in terms of a flowing direction of cooling water in the uppermost water jacket.

[0017] If the fastening bolt boss portion is positioned downstream of the fuel injector in terms of the flowing direction of cooling water, impediment of the flow of cooling water around the fuel injector caused by the fastening bolt boss portion is avoided. The above-described construction also avoids an undesired event that cooling water warmed by the heat from the fastening bolt boss portion directly flows to the fuel injector. Therefore, it becomes possible to enhance the fastening of the fuel injector and increase the rigidity of the cylinder head while maintaining high injector cooling performance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The foregoing and further objects, features and advantages of the present invention will become apparent from the following description of preferred embodiments with reference to the accompanying drawings, wherein like numerals are used to represent like elements and wherein:

Fig. 1 is a fragmental sectional view of an embodiment of the cylinder head of the invention, illustrating a side sectional construction thereof;

Fig. 2 is a fragmental sectional view of the cylinder head shown in Fig. 1, illustrating an injector fastening structure thereof;

Fig. 3 is a sectional view taken on line III-III in Fig. 1; and

Fig 4 is a fragmental sectional view of a conventional cylinder head, illustrating a side sectional construction around an injector fastening portion.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0019] A preferred embodiment in which the cylinder head of an internal combustion engine of the invention is embodied as a cylinder head of a direct injection type diesel engine will be described in detail below.

[0020] Fig. 1 shows a side sectional construction of a cylinder head according to the embodiment.

[0021] Referring to Fig. 1, a cylinder head 10 has a bottom deck 11 that forms a bottom face of the cylinder head 10 and a top deck 12 that forms a top face of the cylinder head 10. A water jacket 14, 15 for circulating cooling water is formed between the bottom deck 11 and the top deck 12. A middle deck 13 is formed between the bottom deck 11 and the top deck 12. The water jacket 14, 15 is formed by two layer portions divided vertically by the middle deck 13, that is, an upper-layer water jacket 15 and a lower-layer water jacket 14. Cooling water for cooling the cylinder head 10 is first conducted through the lower-layer water jacket 14, and then conducted into the upper-layer water jacket 15 in a returning manner. Thus, cooling water flows through the lower-layer water jacket 14 and the upper-layer water jacket 15 in opposite directions as indicated by arrows in Fig. 1.

[0022] In the cylinder head 10 of the embodiment, the water jacket is vertically divided into two stages, and cooling water is conducted through the lower-layer water jacket 14 and the upper-layer water jacket 15 in that order. In this manner, a portion of the cylinder head 10 adjacent to the combustion chambers, that is, a lower portion of the cylinder head 10 in which the heat load is relatively high, is cooled with precedence over other portions of the cylinder head 10, thereby improving the cooling efficiency.

[0023] The cylinder head 10 has a housing boss portion 17 in which a housing hole 16 for housing a fuel injector is formed. The housing boss portion 17 extends vertically through the lower-layer water jacket 14 and the upper-layer water jacket 15. The cylinder head 10 has a structure for fastening and securing a fuel injector disposed in the housing hole 16 to the cylinder head 10.

[0024] Fig. 2 shows a fragmental side sectional view of the cylinder head 10, illustrating the structure for securing a fuel injector to the cylinder head 10 and its surrounding structure.

[0025] In the cylinder head 10, a clamp 22 is placed so as to extend from an upper portion of a fuel injector

20 housed in the housing boss portion 17 to a head portion of a cam cap bolt 25 securing a cam cap 24, as shown in Fig. 2. The clamp 22 is secured to an upper portion of the cylinder head 10 by a fastening bolt 23 inserted through a central portion of the clamp 22.

[0026] The cylinder head 10 has a fastening bolt boss portion 19 having a bolt hole 18 into which the fastening bolt 23 is screwed. The fastening bolt boss portion 19 extends through the upper-layer water jacket 15 to interconnect the top deck 12, which forms an upper partition of the upper-layer water jacket 15, and the middle deck 13, which forms a lower partition of the upper-layer water jacket 15.

[0027] By screwing the fastening bolt 23 into the bolt hole 18 and tightening the fastening bolt 23, the clamp 22 is forced to press the fuel injector 20 from above while a portion of the clamp 22 contacting the head portion of the cam cap bolt 25 is serving as a fulcrum. As a result, the fuel injector 20 is fastened and secured in the housing hole 16 while being urged downward.

[0028] In this fastening structure, the fuel injector 20 is urged downward when fastened and secured as described. Therefore, the fastening bolt boss portion 19 coupled to the fastening bolt 23 is urged upward by the axial tension of the fastening bolt 23. In the cylinder head 10 of the embodiment, however, the top deck 12 and the middle deck 13 are partially interconnected by the fastening bolt boss portion 19 as described above, so that the rigidity of portions around the fastening bolt boss portion 19 of the cylinder head 10 is increased. Therefore, those portions of the cylinder head 10 of the embodiment are suitably prevented from being deformed by a force acting along an axis of the fastening bolt 23. As a result, it becomes possible to fasten and secure the fuel injector 20 more firmly and stably.

[0029] The rigidity of the entire cylinder head 10 can also be increased by the fastening bolt boss portion 19 connecting the top deck 12 and the middle deck 13.

[0030] Although the fastening bolt boss portion 19 takes up a space in the upper-layer water jacket 15, the fastening bolt boss portion 19 does not block the cooling water passage through the upper-layer water jacket 15. Therefore, good cooling effect of the upper-layer water jacket 15 is maintained.

[0031] The cooling structure of the cylinder head 10 of the embodiment and, more particularly, the cooling structure in the upper-layer water jacket 15 will be described below.

[0032] Fig. 3 is a plan sectional view of the cylinder head 10 taken on line III-III in Fig. 1, illustrating a horizontal sectional construction of the cylinder head 10 including that of the upper-layer water jacket 15. In Fig. 3, the flow of cooling water in the upper-layer water jacket 15 is indicated by arrows.

[0033] As shown in Fig. 3, the fastening bolt boss portion 19 of the cylinder head 10 of the embodiment is provided downstream of the housing boss portion 17 housing the fuel injector 20 in terms of the flowing direction of cooling water in the upper-layer water jacket 15. Therefore, the fastening bolt boss portion 19 does not impede the flow of cooling water near the housing boss portion 17, so that the provision of the fastening bolt boss portion 19 does not reduce the injector cooling efficiency.

[0034] Furthermore, since the fastening bolt boss portion 19 extends to interconnect the upper partition and the lower partition of the upper-layer water jacket 15, there is a possibility of slightly impeding the flow of cooling water in the upper-layer water jacket 15. However, cooling water is allowed to flow substantially freely near the fastening bolt boss portion 19, so that the cooling effect on the surroundings of the fastening bolt boss portion 19 will not deteriorate.

[0035] As can be understood from the above description, the cylinder head 10 of the embodiment achieves various excellent advantages as stated below.

[0036] Since the top deck 12 and the middle deck 13 are partially interconnected by the fastening bolt boss portion 19, those connected portions of the cylinder head 10 have increased rigidities, so that the portions are suitably prevented from being deformed by an axial force of the fastening bolt 23. Therefore, it becomes possible to fasten and secure the fuel injector 20 more firmly and stably. Even if the fuel injector 20 is of a type that is designed to inject high-pressure fuel, the fuel injector 20 can be firmly and stably fastened and secured to the cylinder head 10.

[0037] The connection of the top deck 12 and the middle deck 13 by the fastening bolt boss portion 19 also increases the rigidity of the entire cylinder head 10.

[0038] Furthermore, since the fastening bolt boss portion 19 is provided downstream of the housing boss portion 17 in terms of the flowing direction of cooling water, adverse effect of the provision of the fastening bolt boss portion 19 on the cooling of the fuel injector 20 is avoided.

[0039] Further, since the fastening bolt boss portion 19 extends to interconnect the upper partition and the lower partition of the upper-layer water jacket 15, there is a possibility of slightly impeding the flow of cooling water in the upper-layer water jacket 15. However, cooling water is allowed to flow substantially freely near the fastening bolt boss portion 19, so that the cooling effect on the surroundings of the fastening bolt boss portion 19 will not deteriorate.

[0040] The invention is not limited to the foregoing embodiment, but may also be embodied in various other manners, for example, in manners modified from the foregoing embodiment as described below.

[0041] In the foregoing embodiment, the fastening bolt boss portion 19 is provided downstream of the housing boss portion 17 in terms of the flowing direction of cooling water, at such a position that cooling water sufficiently flows around the housing boss portion 17. However, the position of the fastening bolt boss portion

19 can be arbitrarily determined. An advantage is that the provision of the fastening bolt boss portion 19 extending through the upper-layer water jacket 15 to interconnect the top deck 12 and the middle deck 13 enhances the fastening of a fuel injector while increasing the rigidity of the water jacket structure even if the water jacket structure is divided into upper and lower portions.

[0042] Although in the aforementioned embodiment, the invention is applied to the cylinder head having the upper and lower water jacket divisions 14, 15, the invention may also be applied to a cylinder head having more than two vertically divided water jacket portions, in a manner similar to the foregoing embodiment. If a fastening bolt boss portion is formed so as to extend through the uppermost water jacket portion and interconnect decks corresponding to the upper and lower partitions of the uppermost water jacket portion, it is possible to achieve advantages similar to those achieved by the foregoing embodiment.

[0043] Still further, although in the foregoing embodiment, the invention is applied to the direct injection type diesel engine cylinder head, the invention may also be applied to cylinder heads of other types of internal combustion engines, for example, a cylinder head of an in-cylinder direct fuel injection type gasoline engine, or the like, in a manner similar to the foregoing embodiment. The invention is applicable to any cylinder head as long as the cylinder head has a construction in which a water jacket is formed by a plurality of water jacket portions vertically divided by partitions and a fuel injector is fastened and secured to an upper portion of the cylinder by using a clamp and a fastening bolt. The invention can be effectively applied to a case where the fuel injector is of an in-cylinder direct fuel injection type. However, according to the invention, the fuel injector may also be of a type other than the in-cylinder direct injection type.

[0044] A cylinder head 10 has two water jacket portions 14, 15 that are vertically divided by a middle deck 13. A clamp 22 extends over an upper portion of a fuel injector 22. The clamp 22 is fastened to the cylinder head 10 by a fastening bolt 23, so that the fuel injector 20 is fastened and secured to an upper portion of the cylinder head 10 while being urged downward. A fastening bolt boss portion 19 into which the fastening bolt 23 is screwed extends through the upper water jacket 15 and interconnects the middle deck 13 and a top deck 12, which form a lower partition and an upper partition of the upper water jacket 15, respectively.

[0045] A cylinder head (10) has two water jacket portions (14, 15) that are vertically divided by a middle deck (13). A clamp (22) extends over an upper portion of a fuel injector (22). The clamp (22) is fastened to the cylinder head (10) by a fastening bolt (23), so that the fuel injector (20) is fastened and secured to an upper portion of the cylinder head (10) while being urged downward. A fastening bolt boss portion (19) into which the fastening bolt (23) is screwed extends through the upper water jacket (15) and interconnects the middle deck (13) and a top deck (12), which form a lower partition and an upper partition of the upper water jacket (15), respectively.

[0046] Selected drawing: Fig. 2

Claims

1. A cylinder head (10) of an internal combustion engine comprising a plurality of water jackets (14, 15) vertically divided by partitions, wherein a clamp (22) extending over an upper portion of a fuel injector (20) is fastened to an upper portion of the cylinder head (10) by a fastening bolt (23),

   the cylinder head (10) being characterized in that a fastening bolt boss portion (19) into which the fastening bolt (23) is screwed extends through an uppermost water jacket (15) of the plurality of vertically divided water jackets and interconnects an upper partition (12) of the uppermost water jacket (15) and at least a lower partition (13) of the uppermost water jacket.

2. A cylinder head of an internal combustion engine according to claim 1, characterized in that in the uppermost water jacket (15), the fastening bolt boss portion (19) is arranged such that the cooling water is allowed to flow around the fastening bolt boss portion (19).

3. A cylinder head of an internal combustion engine according to claim 2, characterized in that the fuel injector (20) extends through the uppermost water jacket (15) and is secured to the cylinder head (10).

4. A cylinder head of an internal combustion engine according to claim 3, characterized in that the fastening bolt boss portion (19) is formed downstream of the fuel injector (20) in terms of a flowing direction of cooling water in the uppermost water jacket (15).

5. A cylinder head of an internal combustion engine according to claim 1, characterized in that the internal combustion engine is an in-cylinder direct injection type internal combustion engine.

FIG. 1

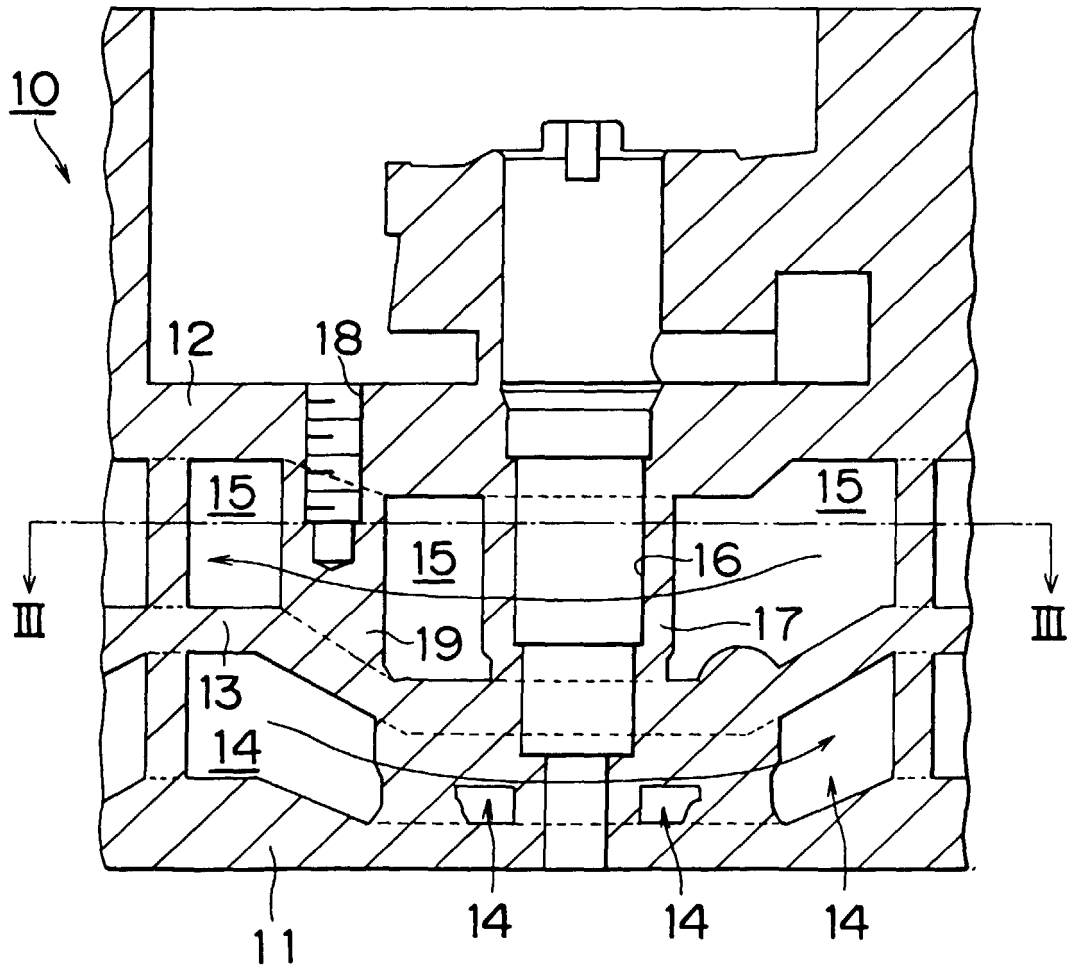

FIG. 2

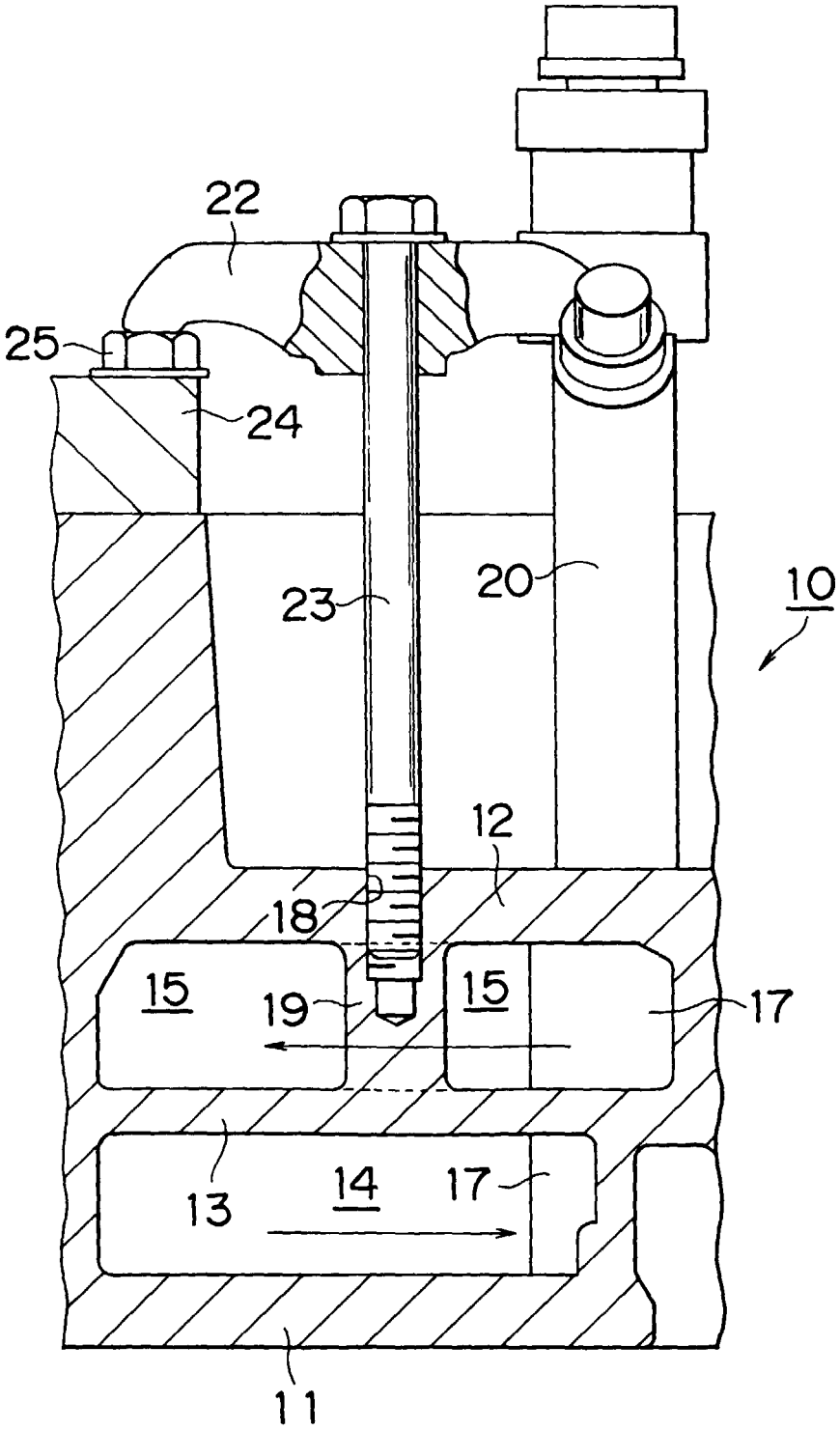

FIG. 3

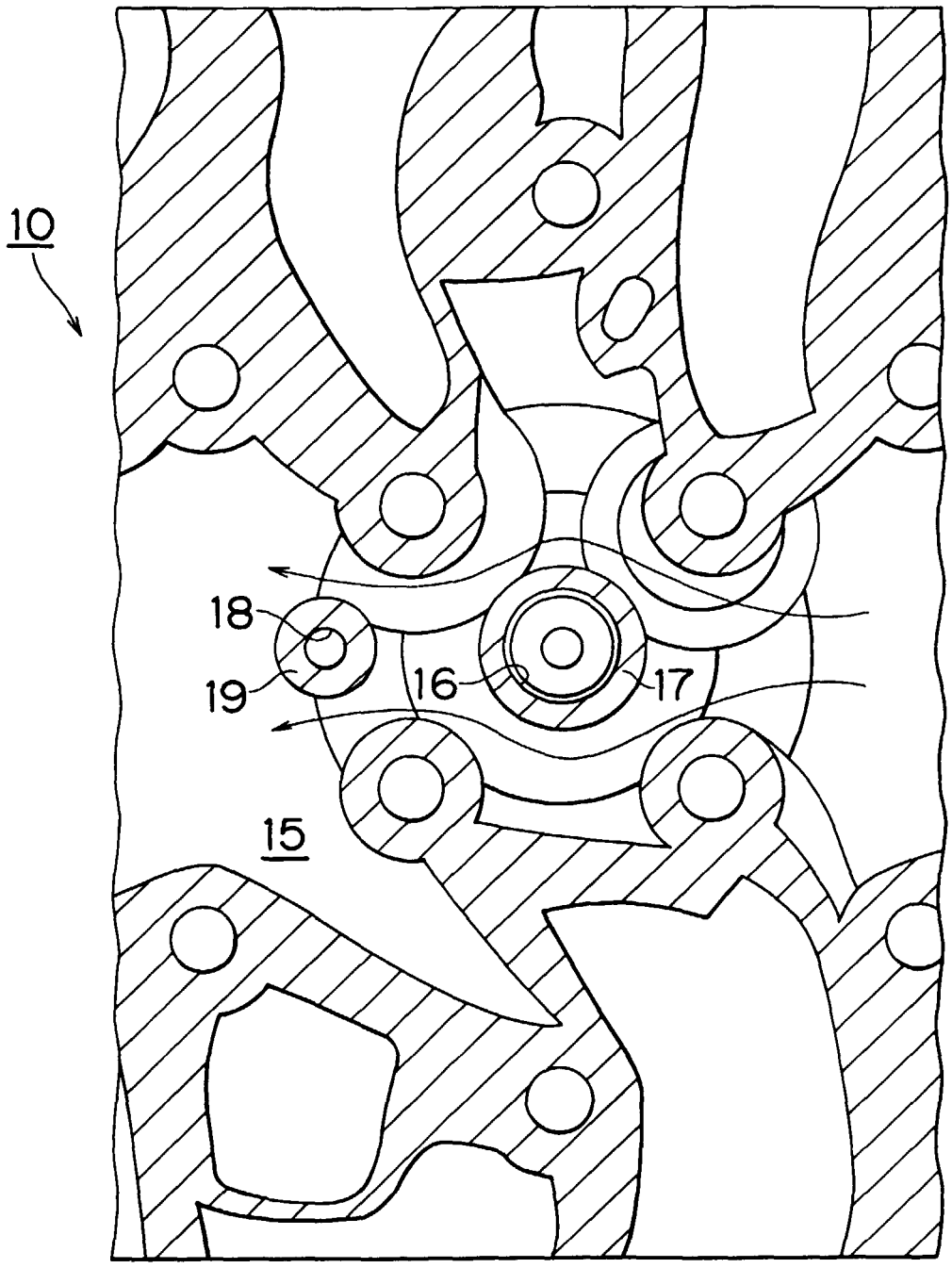

FIG. 4

RELATED ART