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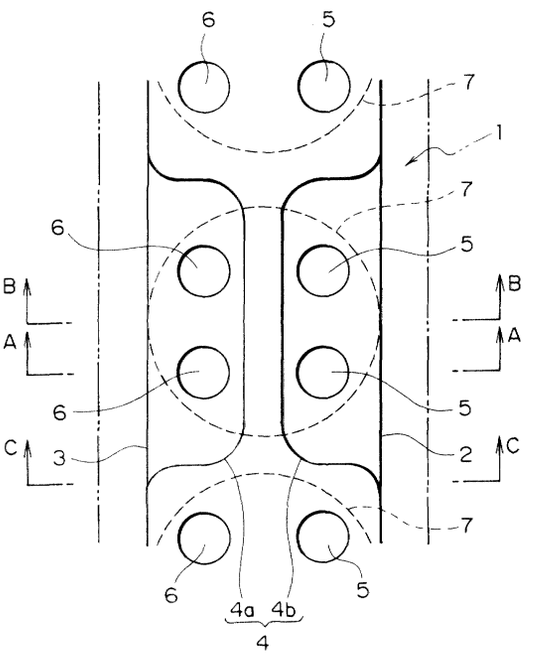
(54) Cooling water channel structure of a cylinder head and method of manufacturing a cylinder head

(57) A cooling water channel of a cylinder head (1) has two parallel channels: an intake side channel (2) extending along the periphery of an intake port (5) in a longitudinal direction and an exhaust side channel (3) extending along the periphery of an exhaust port (6) in a longitudinal direction. Furthermore, a central channel (4) defined between the intake port (5) and the exhaust port (6) is divided into upper and lower sides, and the central channel (4a) on the upper side is communicated with the exhaust side channel (3), and the central channel (4b) on the lower side is communicated with the intake side channel (2).

FIG. 1



EP 1 143 135 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a cooling water channel structure of a cylinder head used in an engine in which a plurality of cylinders are arranged in series, and a method of manufacturing the cylinder head.

2. Description of the Related Art

[0002] Conventionally, as disclosed in, for example, Japanese Utility Model Application Laid-open No. Hei 7-35741, it is well-known that a cooling water channel provided in a cylinder head is formed so as to be separated into an intake side channel and an exhaust side channel.

[0003] When the cooling water channel is separated into an intake side channel and an exhaust side channel so that cooling water flows in parallel, a distance of each channel is shortened compared with the case where a cooling water channel is continuously disposed. In this case, there are advantages that a pressure loss is reduced, and a cooling water pump to be used can be miniaturized. A cylinder head having a cooling water channel with the above-mentioned structure is described in, for example, Japanese Patent Application Laid-open No. Hei 9-203346 and Japanese Utility Model Application Laid-open No. Hei 7-35741.

[0004] A cooling water channel formed in a cylinder head is designed in such a manner as to cool, in particular, the periphery of ports. FIG. 15 is a cross-sectional view showing a general cooling water channel structure in the periphery of ports. As shown in this figure, in most cases, the cooling water channel of a cylinder head 50 includes three channels: an intake side channel 53 extending around an intake port 51, an exhaust side channel 54 extending around an exhaust port 52, and a central channel 55 extending through a central portion (central upper portion of a combustion chamber) between the intake port 51 and the exhaust port 52.

[0005] In general, the central channel 55 extending betweeh the ports have a substantially inverse triangle shape, as shown in FIG. 15. In the case of a channel structure having the intake side channel 53 and the exhaust side channel 54 so as to allow cooling water to flow in parallel, the central channel 55 is communicated with either one of the intake side channel 53 or the exhaust side channel 54.

[0006] In the case of cooling the cylinder head 50, a lower end portion 56 between the ports, where the intake port 51 and the exhaust port 52 are disposed closest to each other, has a thin wall as well as is thermally influenced. Therefore, this portion is likely to be cracked due to thermal fatigue. Accordingly, this portion needs cooling the most.

[0007] However, in the case of the above-mentioned cooling water channel structure, the cross-section of the central channel 55 is prescribed to be an inverse triangle shape. Therefore, the amount of flowing cooling water is varied between an upper side U and a lower side L, irrespective of the flow rate. More specifically, the upper side U allows cooling water to flow easily, whereas the lower side L does not allow cooling water to flow easily. Therefore, cooling water stagnates or its flow becomes slow in the lower end portion 56 (which needs cooling most) between the intake port 51 and the exhaust port 52. Consequently, it is difficult to obtain a sufficient cooling efficiency.

SUMMARY OF THE INVENTION

[0008] Therefore, with the foregoing in mind, it is an object of the present invention to provide a cooling water channel structure of a cylinder head effective for enhancing a cooling efficiency particularly in a wall portion between an intake port and an exhaust port in an engine having a plurality of cylinders arranged in series, and a method of manufacturing the cylinder head.

[0009] The cooling water channel structure of a cylinder head according to the present invention is used for an engine in which a plurality of cylinders are arranged in series, and includes: an intake side channel extending along a periphery of an intake port in a longitudinal direction; an exhaust side channel extending along a periphery of an exhaust port in a longitudinal direction; and a central channel extending between the intake port and the exhaust port, in which the central channel is divided into the two upper and lower sides.

[0010] The method of manufacturing a cylinder head according to the present invention by molding a cylinder head for an engine in which a plurality of cylinders are arranged in series, using a mold having a predetermined shape, includes the steps of: disposing an intake side channel forming core having a substantially L-shaped cross-section, for forming an intake side channel extending along a periphery of an intake port in a longitudinal direction and having a central channel extending between the intake port and an exhaust port, and an exhaust side channel forming core having a substantially L-shaped cross-section, for forming an exhaust side channel extending along a periphery of the exhaust port in a longitudinal direction and having the central channel extending between the intake port and the exhaust port, in such a manner that the respective central channels are overlapped with each other in a vertical direction; and injecting molten metal into the mold.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is a diagram schematically illustrating the outline of a cooling water channel structure of an

embodiment according to the present invention;
FIG. 2 is a plan view of a cylinder head seen from the upper surface thereof;
FIG. 3 is a bottom plan view of a cylinder head seen from the lower surface thereof;
FIG. 4 is a cross-sectional view taken along a line A-A in FIGS. 1 and 2;
FIG. 5 is a cross-sectional view taken along a line B-B in FIGS. 1 and 2;
FIG. 6 is a cross-sectional view taken along a line C-C in FIGS. 1 and 2;
FIG. 7 is a plan view of a cylinder head gasket;
FIG. 8 is a perspective view of an intake side channel forming core;
FIG. 9 is a perspective view of an exhaust side channel forming core;
FIG. 10 is a perspective view showing a state where the intake side channel forming core is combined with the exhaust side channel forming core;
FIG. 11 is a schematic front view showing a state where the intake side channel forming core is combined with the exhaust side channel forming core;
FIG. 12 is a perspective view showing a state where the forming cores are cut from a portion corresponding to the cross-sectional view in FIG. 4;
FIG. 13 is a perspective view showing a state where the forming cores are cut from a portion corresponding to the cross-sectional view in FIG. 5;
FIG. 14 is a perspective view showing a state where the forming cores are cut from a portion corresponding to the cross-sectional view in FIG. 6; and
FIG. 15 is a cross-sectional view showing a conventional cooling water channel structure in the periphery of ports.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] Hereinafter, the present invention will be described by way of an illustrative embodiment with reference to the drawings. The present embodiment is applied to a diesel 4-valve DI (direct injection) engine having a cylinder serial arrangement in which a plurality of cylinders are arranged in series, and two intake valves and two exhaust valves are provided in one cylinder. With reference to the schematic diagram of FIG. 1, an outline of a cooling water channel structure of the present embodiment will be described. FIG. 1 shows only one cylinder (combustion chamber).

[0013] The cooling water channel formed in a cylinder head 1 includes an intake side channel 2 extending along intake ports 5 in a longitudinal direction, an exhaust side channel 3 extending along exhaust ports 6 in a longitudinal direction, and a central channel 4 extending between the intake port 5 and the exhaust port 6, i.e., in an upper central portion of each cylinder 7 (hereinafter, also referred to as "combustion chamber"). The central channel 4 is separated into two upper and lower channels. One (lower) central channel 4b is communicated with the intake side channel 2, and the other (upper) central channel 4a is communicated with the exhaust side channel 3. Thus, the cooling water channel of the cylinder head 1 is separated into two independent channels: the intake side channel 2 having the central channel 4b on the lower side, and the exhaust side channel 3 having the central channel 4a on the upper side. Furthermore, in order to distribute an appropriate amount of cooling water into the intake side channel 2 and the exhaust side channel 3, the respective channel entrance areas are defined.

[0014] Cooling water sent from a water pump (not shown) passes through the cooling water channel of a cylinder block and is divided to the intake side channel 2 and the exhaust side channel 3 of the cylinder head 1. After flowing from the intake side channel 2 and the exhaust side channel 3, the cooling water is combined to be sent to a radiator. Because of the above-mentioned constitution, even when the cross-sectional area of a certain portion of the cooling water channel is decreased, a resultant increase in a pressure loss is not so large as that in the case of a serial channel in which the intake side channel and the exhaust side channel are continuously formed, and a small water pump can be used for supplying cooling water.

[0015] In the diesel 4-valve DI engine having a cylinder serial arrangement, when intake valves 11 and exhaust valves 12 are disposed as shown in FIG. 3, the thickness of a wall in a valve gap portion 13 interposed between both the intake valve 11 and the exhaust valve 12 is difficult to be rendered thick. The valve gap portion 13 is most likely to be thermally influenced. Since the valve gap portion 13 is a part which receives most thermal influence, the valve gap portion 13 is likely to be cracked due to thermal fatigue. Thus, it is desirable that the valve gap portion 13 is intensively cooled with cooling water.

[0016] In the present embodiment, in order to satisfy the above-mentioned demand, as described above, the cooling water channel of the cylinder head 1 is separated into two independent parallel channels: the intake side channel 2 having the central channel 4a and the exhaust side channel 3 having the central channel 4b, and the central channel 4 is divided into the upper and lower channels.

[0017] Hereinafter, a specific structure of the above-mentioned cooling water channel will be described with reference to FIGS. 2 to 7. FIG. 2 is a plan view of a cylinder head seen from the upper surface. FIG. 3 is a bottom plan view of a cylinder head seen from the lower surface. FIGS. 4 to 6 are cross-sectional views showing a cooling water channel. FIG. 4 is a cross-sectional view taken along a line A-A in FIGS. 1 and 2. FIG. 5 is a cross-sectional view taken along a line B-B in FIGS. 1 and 2. FIG. 6 is a cross-sectional view taken along a line C-C in FIGS. 1 and 2. FIG. 7 is a plan view of a cylinder head gasket.

[0018] The cooling water sent from a channel inside the cylinder block (not shown) flows into the intake side channel 2 and the exhaust side channel 3 of the cylinder head 1 in parallel through communication holes 21 and 22 of a gasket 8 as shown in FIG. 7. The communication holes 21 and 22 on the intake and exhaust sides are formed so that an appropriate amount of cooling water is distributed to the intake side channel 2 and the exhaust side channel 3.

[0019] The intake side channel 2 extending along an outside of the intake ports 5 in a longitudinal direction and the central channel 4b on the intake side (lower side) are separated from each other in a portion corresponding to the intake port 5 and between the adjacent intake ports 5 in one cylinder 7, as shown in FIGS. 4 and 5. However, they are combined with each other between the intake ports 5 in the adjacent cylinders 7, as shown in FIG. 6.

[0020] On the other hand, the exhaust side channel 3 extending along an outside of the exhaust port 6 is separated into two (upper and lower) ports with the exhaust port 6 interposed therebetween in a portion corresponding to the exhaust port 6 and between the adjacent exhaust ports 6 in one cylinder 7, as shown in FIGS. 4 and 5. Furthermore, the central channel 4a on the exhaust side (upper side) is defined between the exhaust port 6 and the intake port 5 in a portion corresponding to the exhaust port 6, as shown in FIG. 4. The central channel 4a is communicated with the upper channel of the exhaust side channel 3 in the adjacent exhaust ports 6, as shown in FIG. 6.

[0021] Furthermore, the exhaust side channel 3 and the central channel 4a are combined (into one channel) between the exhaust' ports 6 in the adjacent cylinders 7, as shown in FIG. 6.

[0022] The central channel 4b on the intake side and the central channel 4a on the exhaust side are disposed so as to be overlapped with each other, as shown in FIG. 4. Because of this, a partition wall 9 separating the central channel 4b on the intake side from the central channel 4a on the exhaust side connects the wall on the intake port 5 side to the wall on the exhaust port 6 side. Furthermore, the central channel 4b on the intake side and the central channel 4a on the exhaust side are designed so as to have substantially the same cross-sectional area.

[0023] Thus, in the present embodiment, the central channel 4 defined between the intake port 5 and the exhaust port 6 is divided into the upper and lower channels. Because of this, the flow rate of cooling water is not likely to be varied between the central channel 4a on the upper side and the central channel 4b on the lower side.

[0024] Therefore, if the same amount of cooling water as that of a central channel 55 composed of one conventional channel as described above is allowed to flow through the upper and lower central channels 4a and 4b, it becomes possible to increase the amount of cooling water flowing through the central channel 4b on the lower side, compared with the amount of cooling water flowing through the lower side of the conventional central channel 55. Consequently, it becomes possible to enhance a cooling efficiency in a lower end portion between the ports in the cylinder head 1, i.e., in the valve gap portion 13 interposed between the intake valve 11 and the exhaust valve 12 shown in FIG. 3. This is effective for preventing the valve gap portion 13 from being damaged by thermal fatigue.

[0025] When it is desired to increase the flow rate of cooling water flowing through the central channels 4a and 4b in such a case, the cross-sectional areas of the intake side channel 2 and the exhaust side channel 3 outside of the ports can be set smaller than those of the central channels 4a and 4b. This setting increases a pressure loss. However, if the cooling water channel is separated into the intake side channel 2 and the exhaust side channel 3 so as to allow the cooling water to flow in parallel as in the present embodiment, an increase in a pressure loss will not be so large as that in the serial channel structure in which the intake side channel and the exhaust side channel are continuously arranged.

[0026] In the present embodiment, the central channel 4 is divided into the upper and lower channels, whereby port walls are connected to each other via the plate-shaped partition wall 9 between the upper and lower channels 4a and 4b. Consequently, stiffness between the ports can be enhanced.

[0027] The cylinder head 1 having a cooling water channel structure obtained as described above is produced by setting cores in a mold formed into a predetermined shape, and injecting molten metal into the mold. More specifically, the cylinder head 1 is produced by molding, during which the cooling water channel is produced by using cores as shown in FIGS. 8 to 14.

[0028] FIG. 8 is a perspective view of an intake side channel forming core. FIG. 9 is a perspective view of an exhaust side channel forming core. FIG. 10 is a perspective view showing a state in which the intake side channel forming core is combined with the exhaust side channel forming core. FIG. 11 is a schematic front view showing a state in which the intake side channel forming core is combined with the exhaust side channel forming core. Furthermore, FIG. 12 is a perspective view showing a state where the forming cores are cut from a portion corresponding to the cross-sectional view in FIG. 4. FIG. 13 is a perspective view showing a state where the forming cores are cut from a site corresponding to the cross-sectional view in FIG. 5. FIG. 14 is a perspective view showing a state where the forming cores are cut from a portion corresponding to the cross-sectional view in FIG. 6.

[0029] As shown in FIG. 8, an intake side channel forming core 31 includes a portion 31a for forming an intake side channel and a portion 31b for forming a central channel, and has a substantially L-shaped cross-section. On the other hand, as shown in FIG. 9, an ex-

haust side channel forming core 32 includes a portion 32a for forming an exhaust side channel and a portion 32b for forming a central channel, and has a substantially L-shaped cross-section.

[0030] The cores 31 and 32 formed as described above are placed in a mold under the condition that the portions 31b and 32b for forming a central channel are disposed so as to be superimposed on top of the other with a predetermined interval, as shown in FIGS. 10 and 14.

[0031] Thus, a substantially N-shaped gap S is formed between opposed surfaces of the intake side channel forming core 31 and the exhaust side channel forming core 32 disposed as described above. As a result, in the cylinder head 1 after molding, a stepped wall is defined between the intake side channel 2 and the exhaust side channel 3. In other words, the stepped wall is considered as a structure in which two vertical ribs separated with a predetermined interval are disposed between the intake port 5 and the exhaust port 6. Because of this rib structure, the stiffness of the cylinder head 1 in the vertical direction can be enhanced without decreasing a channel cross-sectional area for cooling water. Furthermore, due to the production of the cylinder head 1 by molding, only two cores are required for forming a cooling channel, and handling thereof is easy.

[0032] The present invention is not limited to the above-mentioned embodiments, and alterations can be made appropriately without departing from the spirit of the invention.

[0033] For example, the central channels 4a and 4b may be formed so as to be completely independent from the intake side channel 2 and the exhaust side channel 3. More specifically, the cooling water channel may have a 4-division structure in which the intake side channel 2, the exhaust side channel 3, and the upper and lower central channels 4a and 4b are disposed in parallel with each other. When such a structure is adopted, a wide choice can be made for setting a cross-sectional area so that an appropriate amount of cooling water is distributed into each channel.

[0034] Furthermore, the cooling water may be flowed into the intake side channel 2 and the exhaust side channel 3 via a pipe or the like, in place of the communication holes 21 and 22 provided in the gasket 8.

[0035] As described above, according to the present invention, in an engine in which a plurality of cylinders are arranged in series, cooling can be efficiently conducted, particularly, in a wall portion between an intake port and an exhaust port.

[0036] A cooling water channel of a cylinder head (1) has two parallel channels: an intake side channel (2) extending along the periphery of an intake port (5) in a longitudinal direction and an exhaust side channel (3) extending along the periphery of an exhaust port (6) in a longitudinal direction. Furthermore, a central channel (4) defined between the intake port (5) and the exhaust port (6) is divided into upper and lower sides, and the central channel (4a) on the upper side is communicated with the exhaust side channel (3), and the central channel (4b) on the lower side is communicated with the intake side channel (2).

Claims

1. A cooling water channel structure of a cylinder head for an engine in which a plurality of cylinders are arranged in series, comprising:

   an intake side channel extending along a periphery of an intake port in a longitudinal direction;
   an exhaust side channel extending along a periphery of an exhaust port in a longitudinal direction; and
   a central channel extending between the intake port and the exhaust port,

   characterized in that the central channel is divided into the two upper and lower sides.

2. A cooling water channel structure of a cylinder head according to claim 1, **characterized in that** one of the upper and lower sides of the central channel is communicated with the intake side channel, and the other side is communicated with the exhaust side channel.

3. A cooling water channel structure of a cylinder head according to claim 1, **characterized in that** the upper and lower sides of the central channel are respectively provided so as to be independent from the intake side channel and the exhaust side channel.

4. A method of manufacturing a cylinder head by molding a cylinder head for an engine in which a plurality of cylinders are arranged in series, using a mold having a predetermined shape, **characterized by** comprising the steps of:

   disposing an intake side channel forming core having a substantially L-shaped cross-section, for forming an intake side channel extending along a periphery of an intake port in a longitudinal direction and having a central channel extending between the intake port and an exhaust port and an exhaust side channel forming core having a substantially L-shaped cross-section, for forming an exhaust side channel extending along a periphery of the exhaust port in a longitudinal direction and having the central channel extending between the intake port and the exhaust port, in such a manner that the respective central channels are overlapped with each

other in a vertical direction; and
injecting molten metal into the mold.

FIG. 1

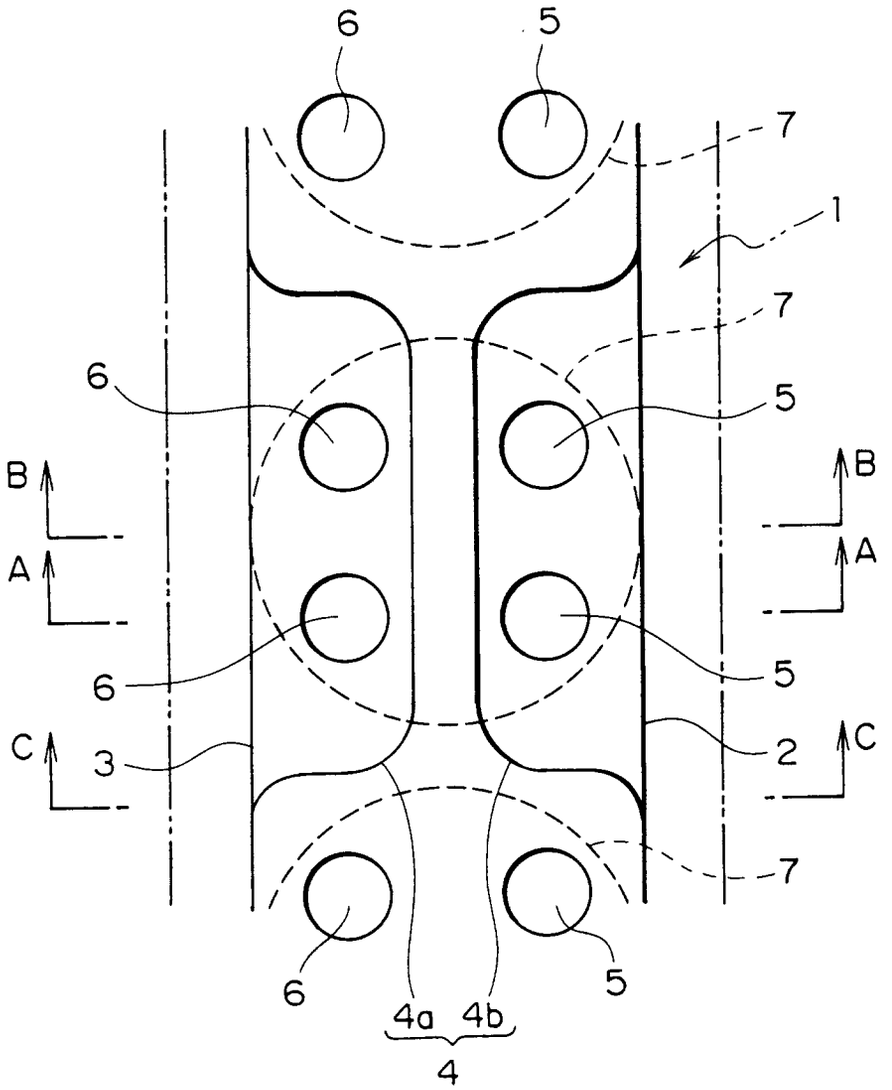


FIG. 2

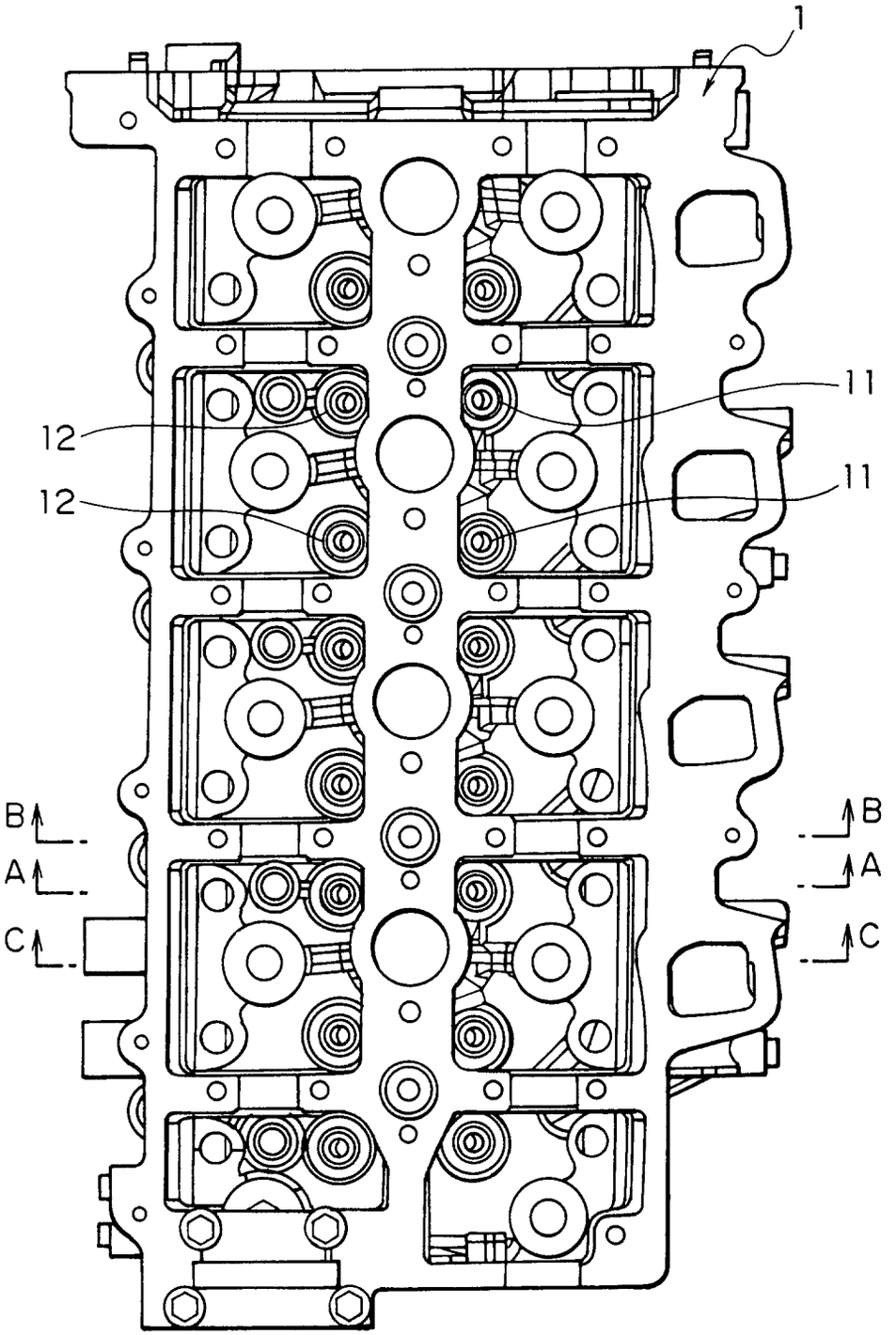


FIG. 3

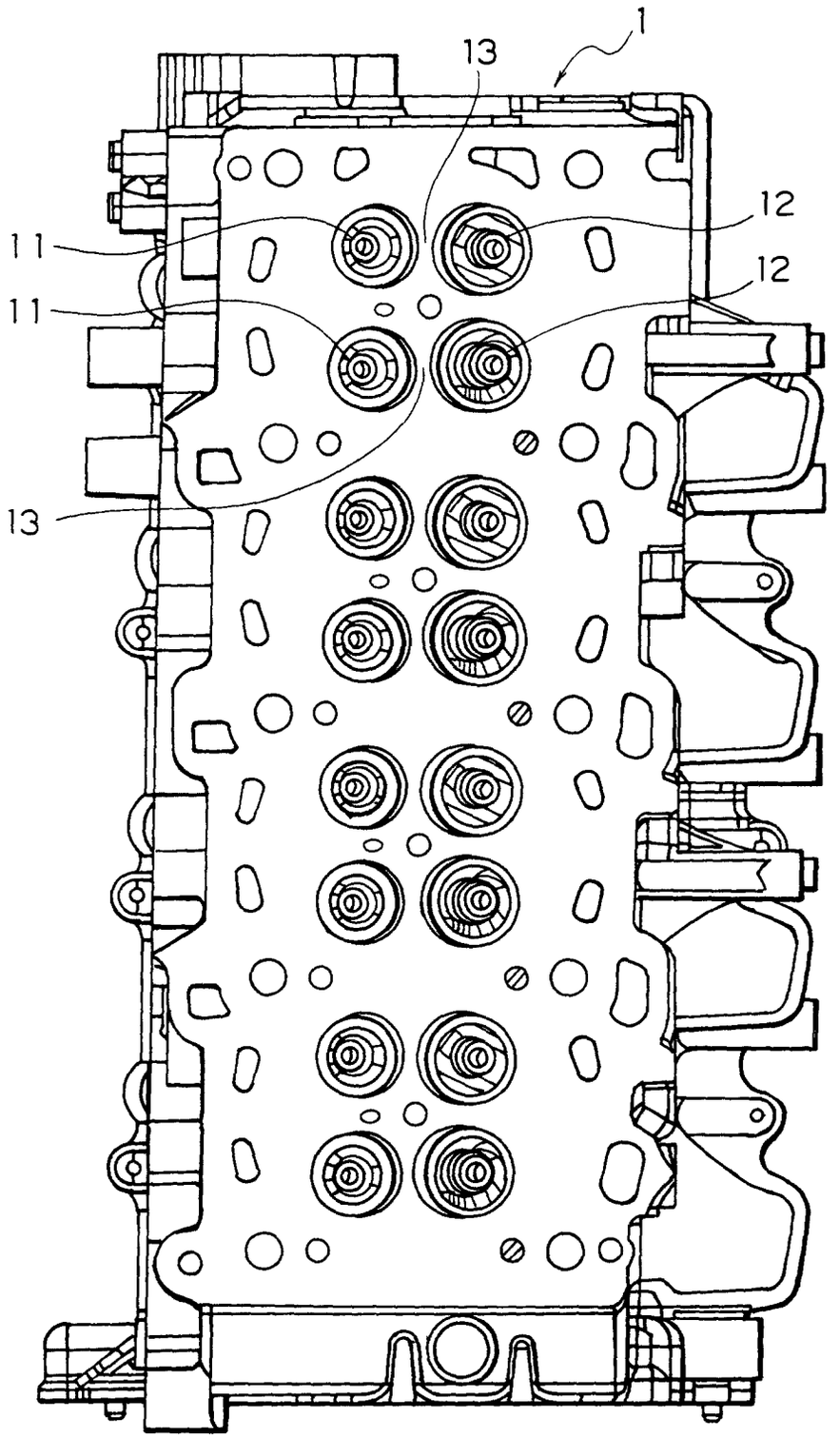


FIG. 4

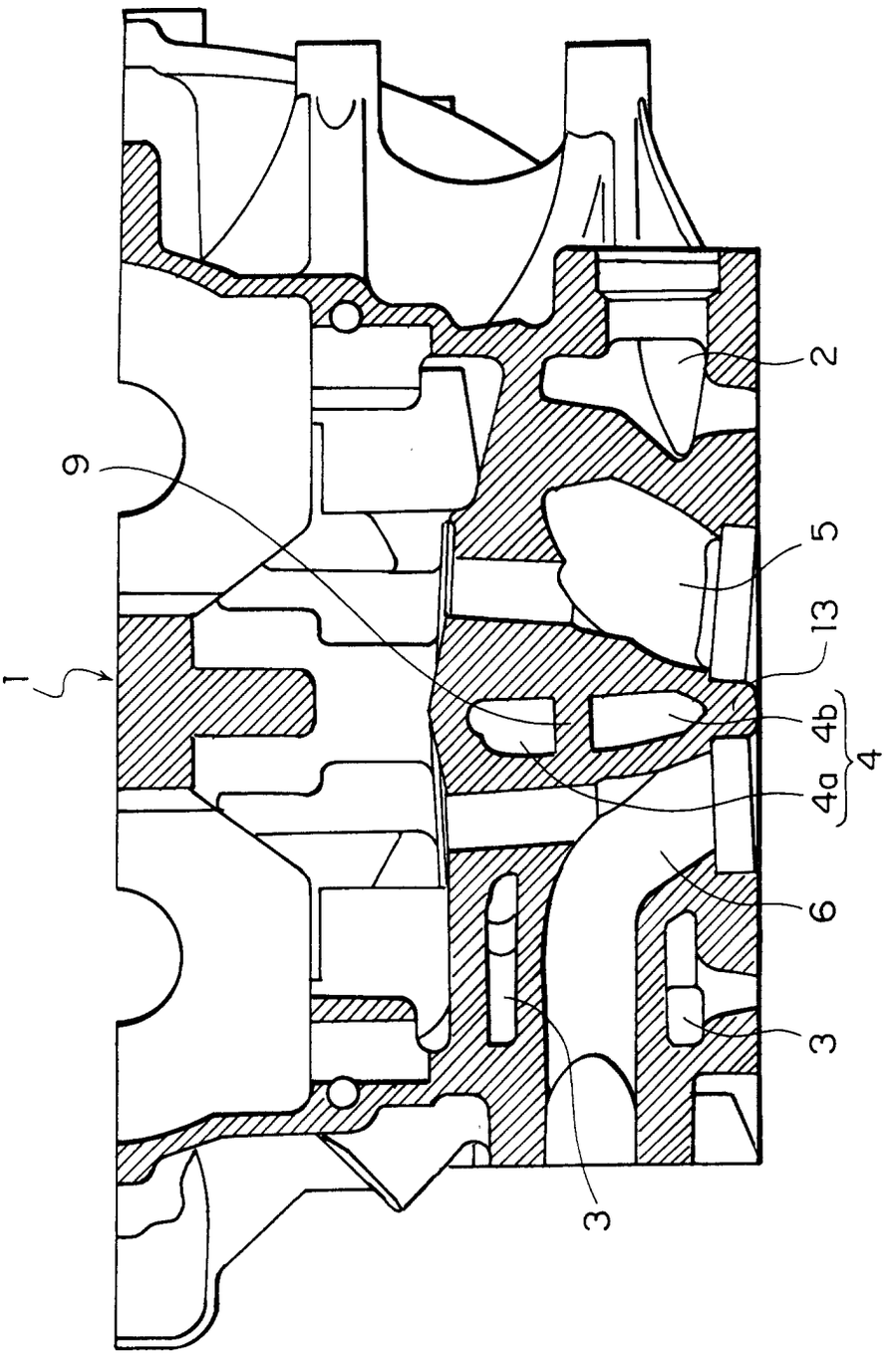


FIG. 5

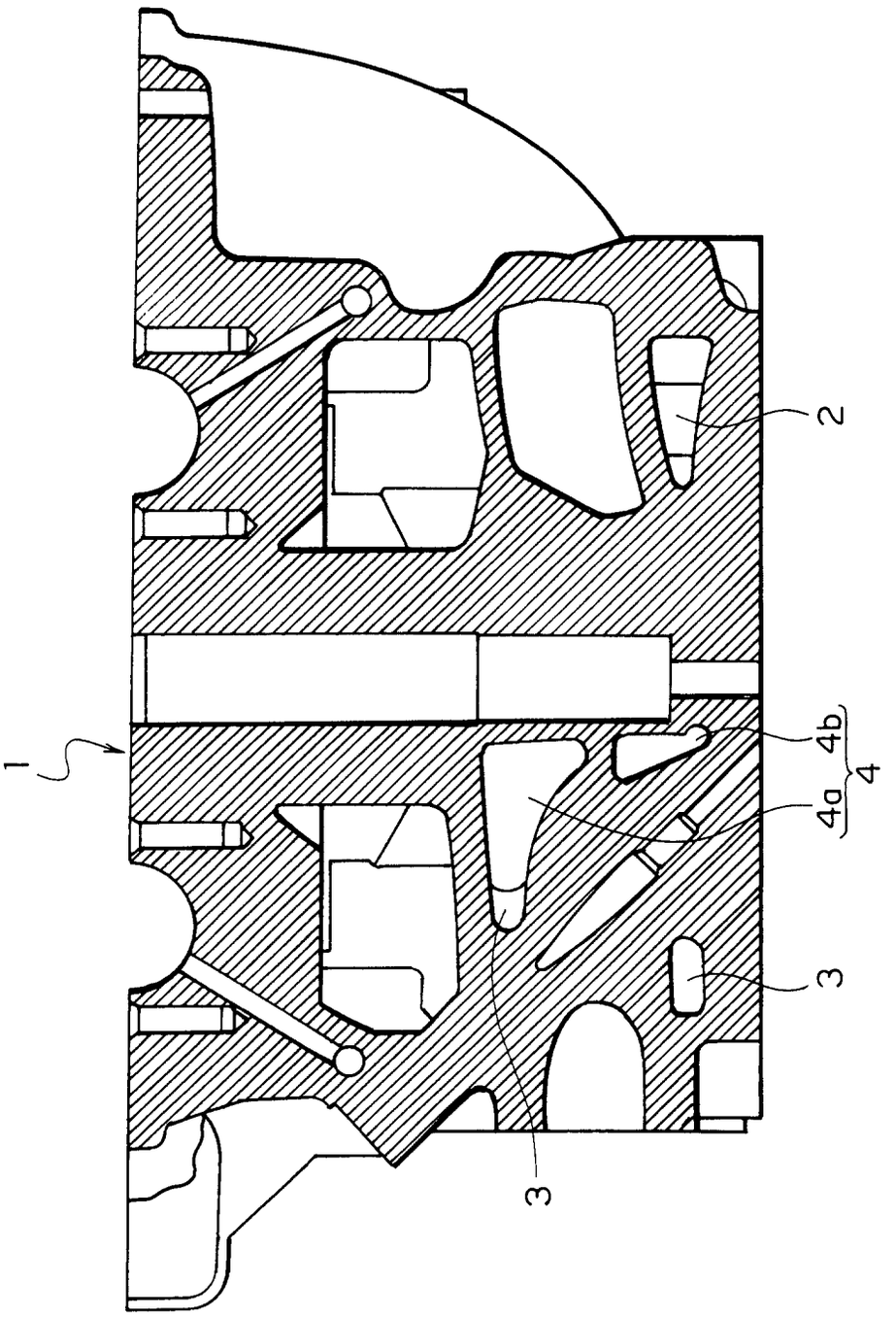


FIG. 6

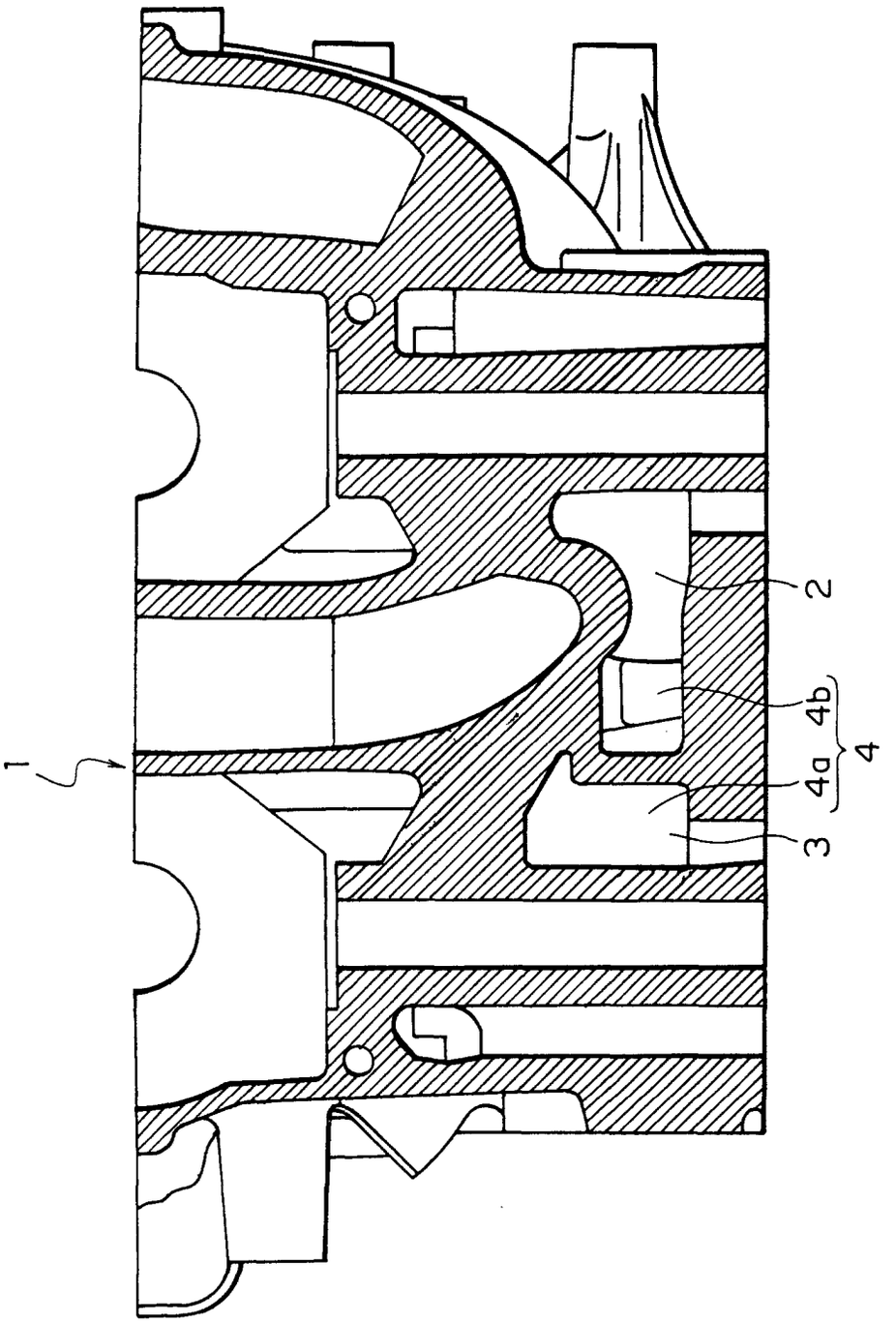


FIG. 7

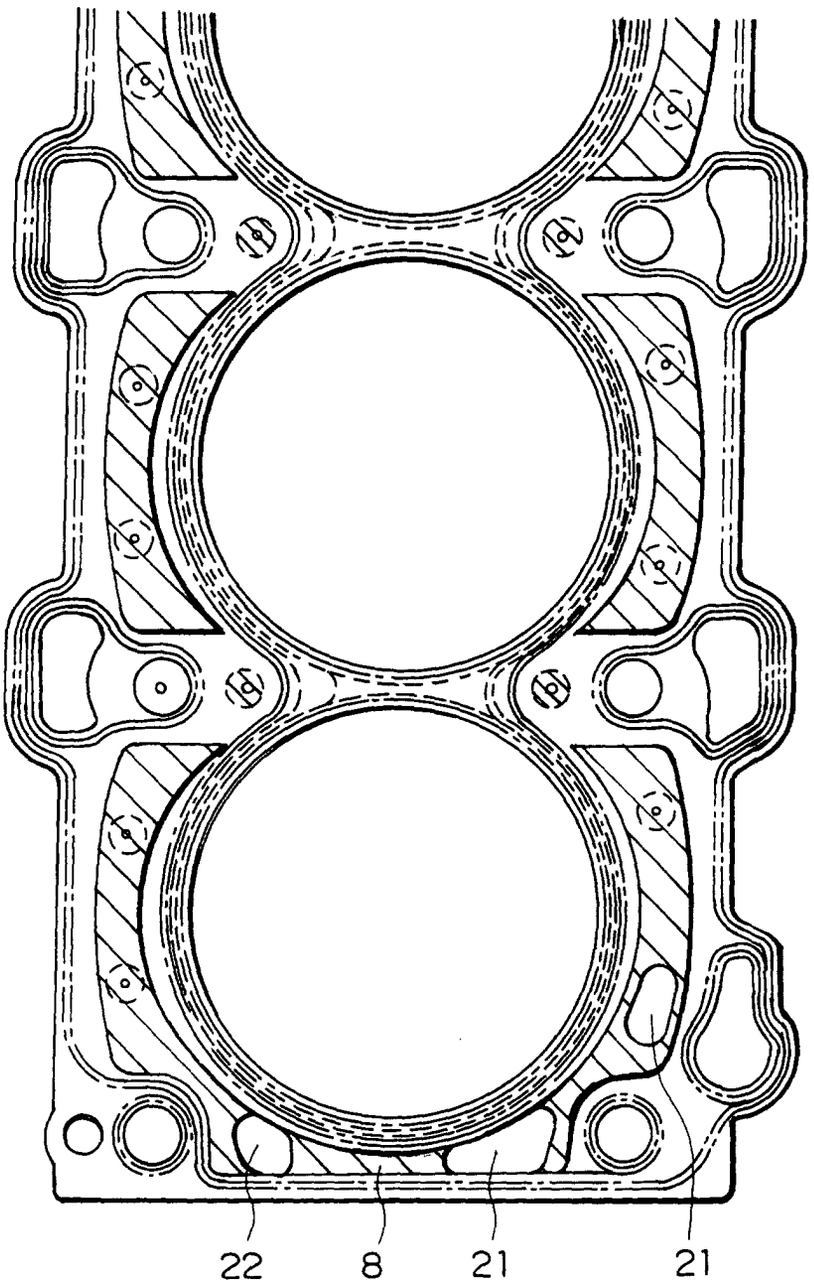


FIG. 8

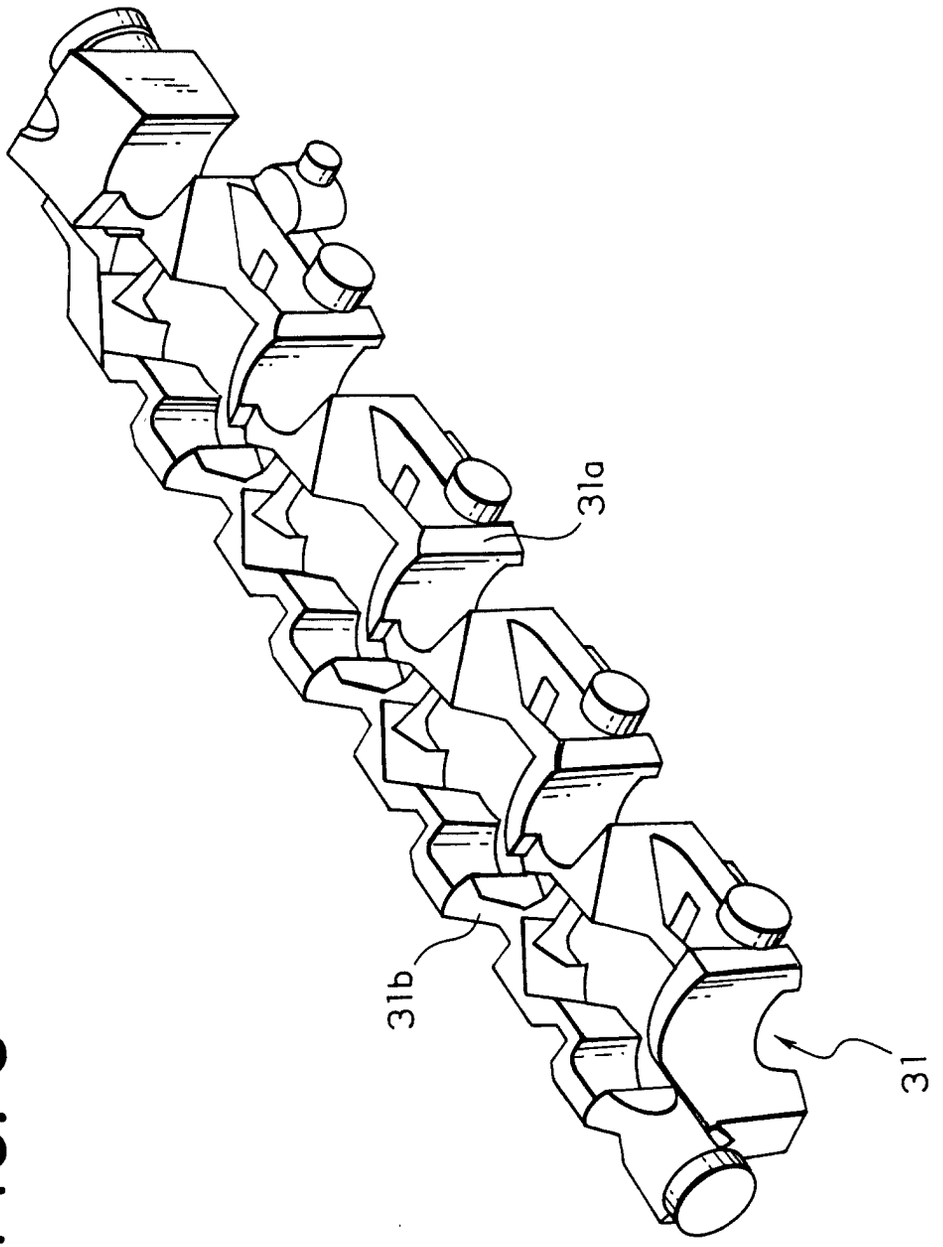


FIG. 9

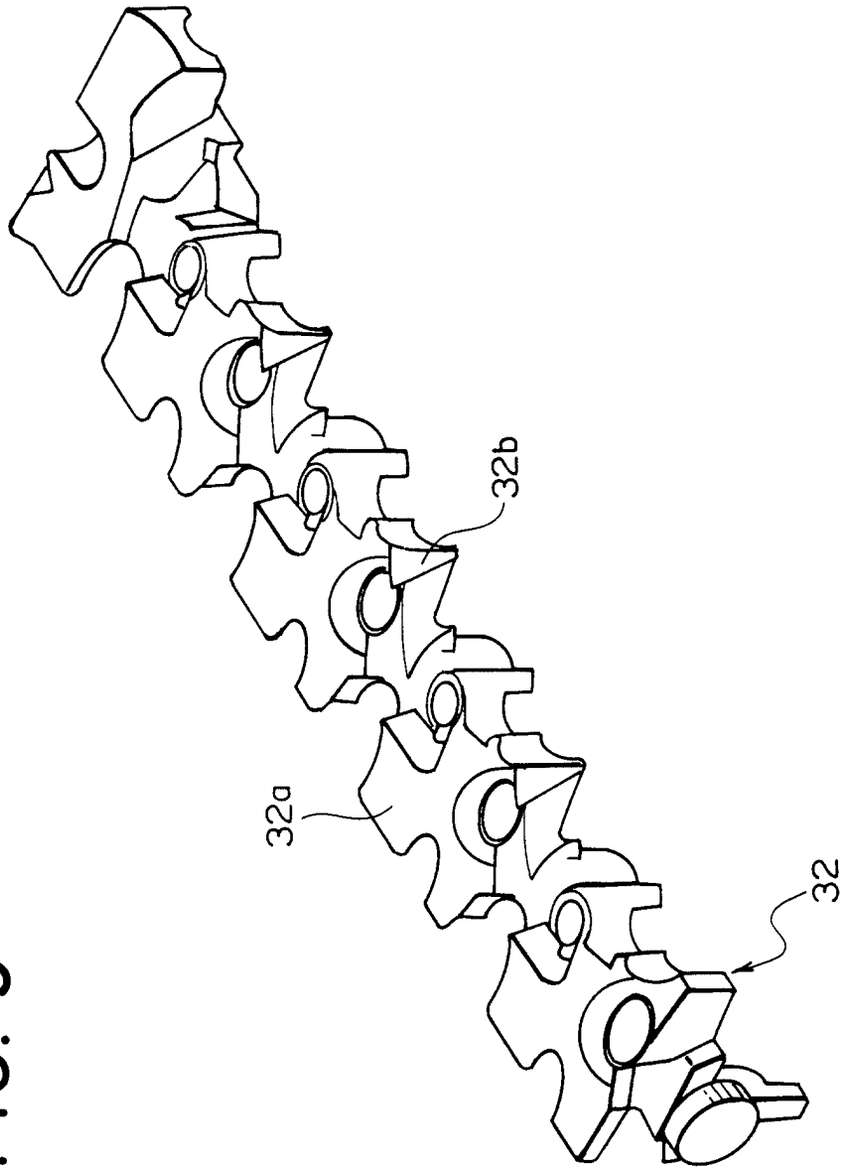


FIG. 10

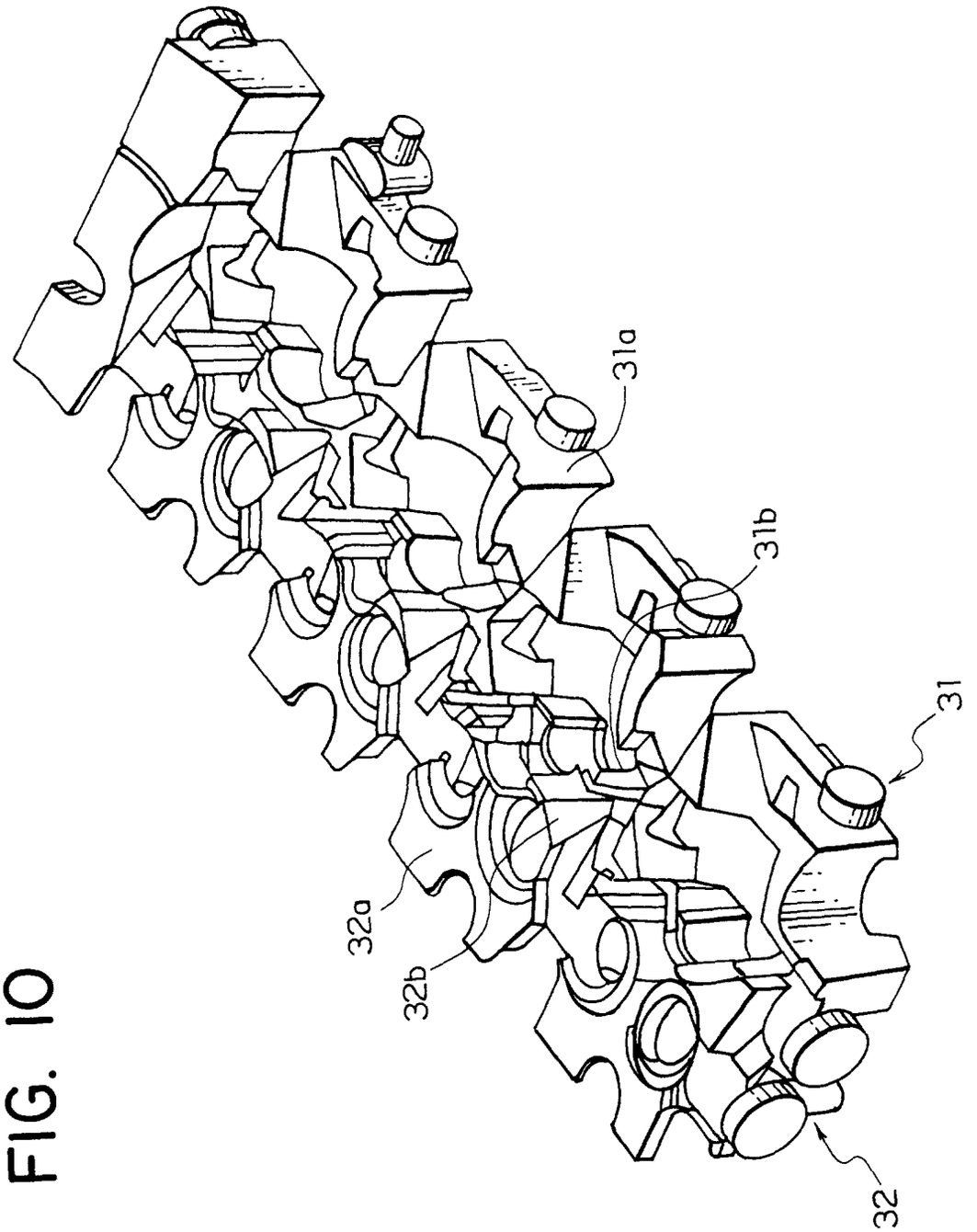


FIG. 11

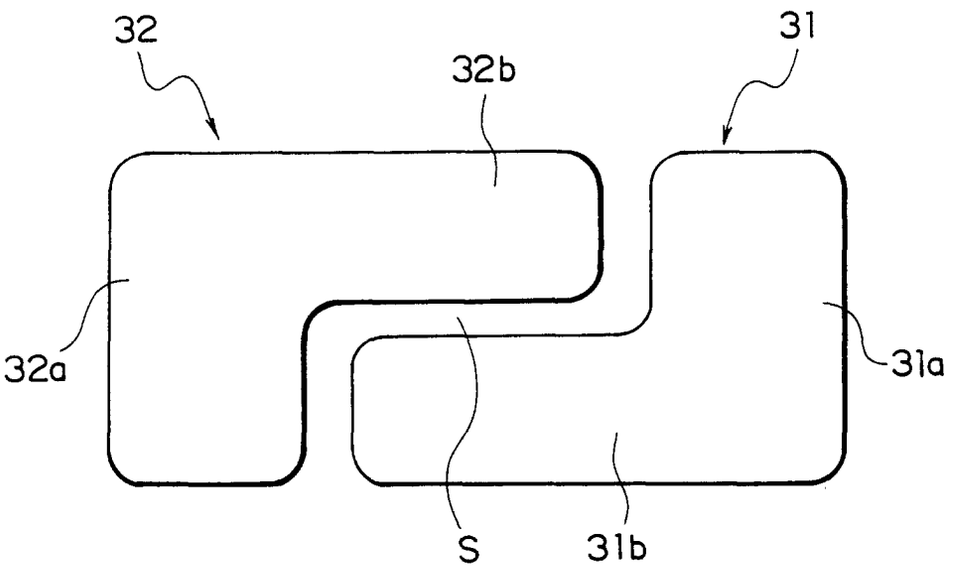


FIG. 12

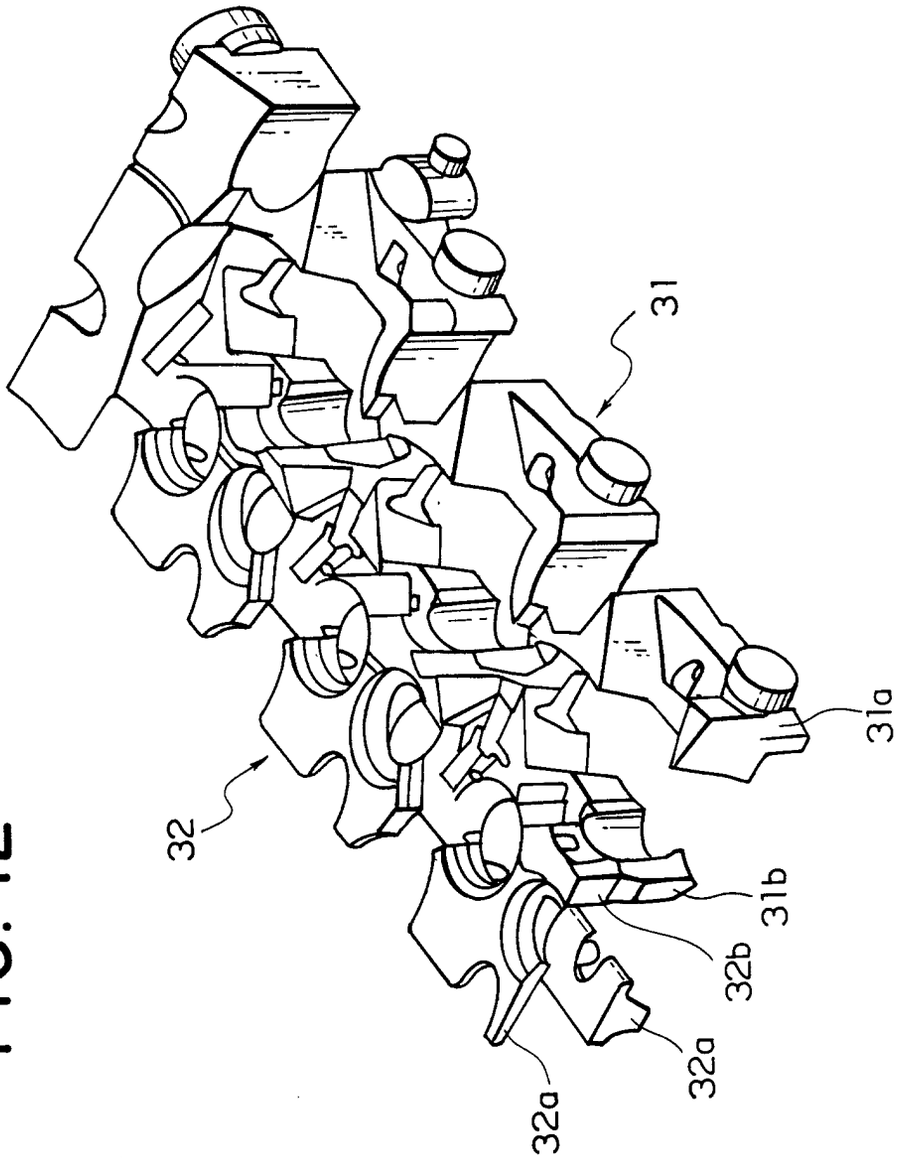


FIG. 13

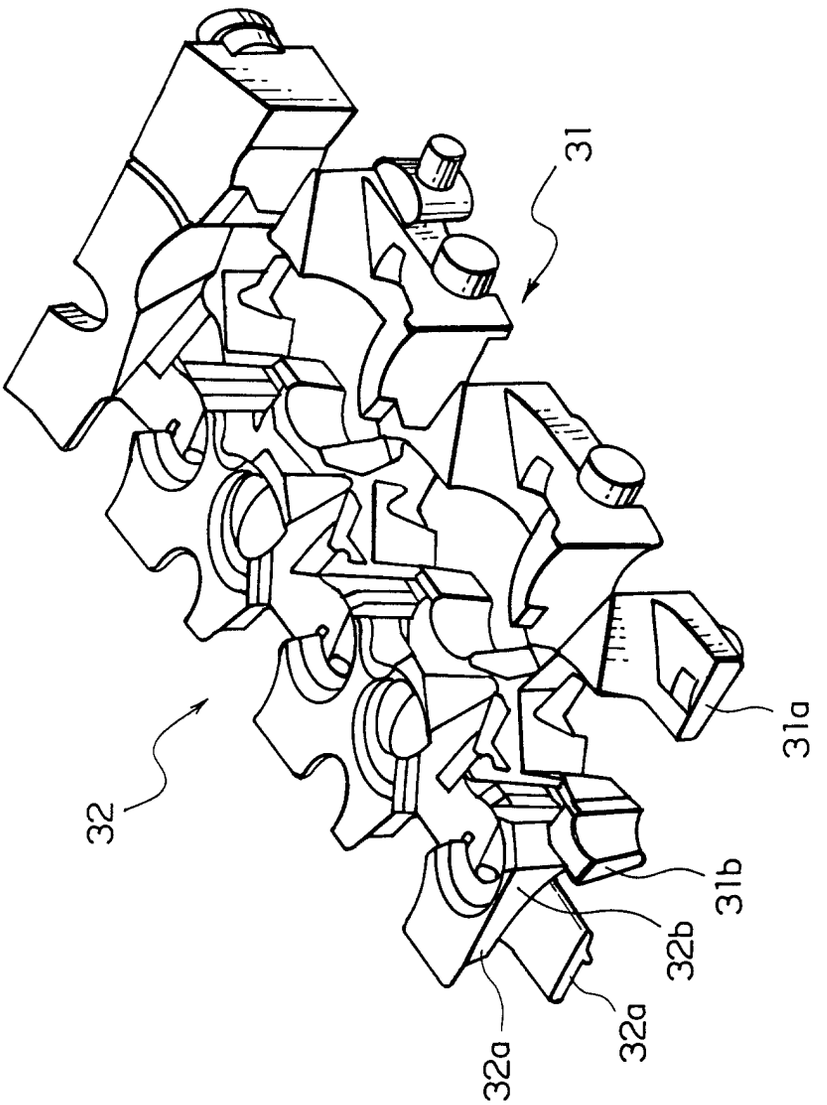


FIG. 14

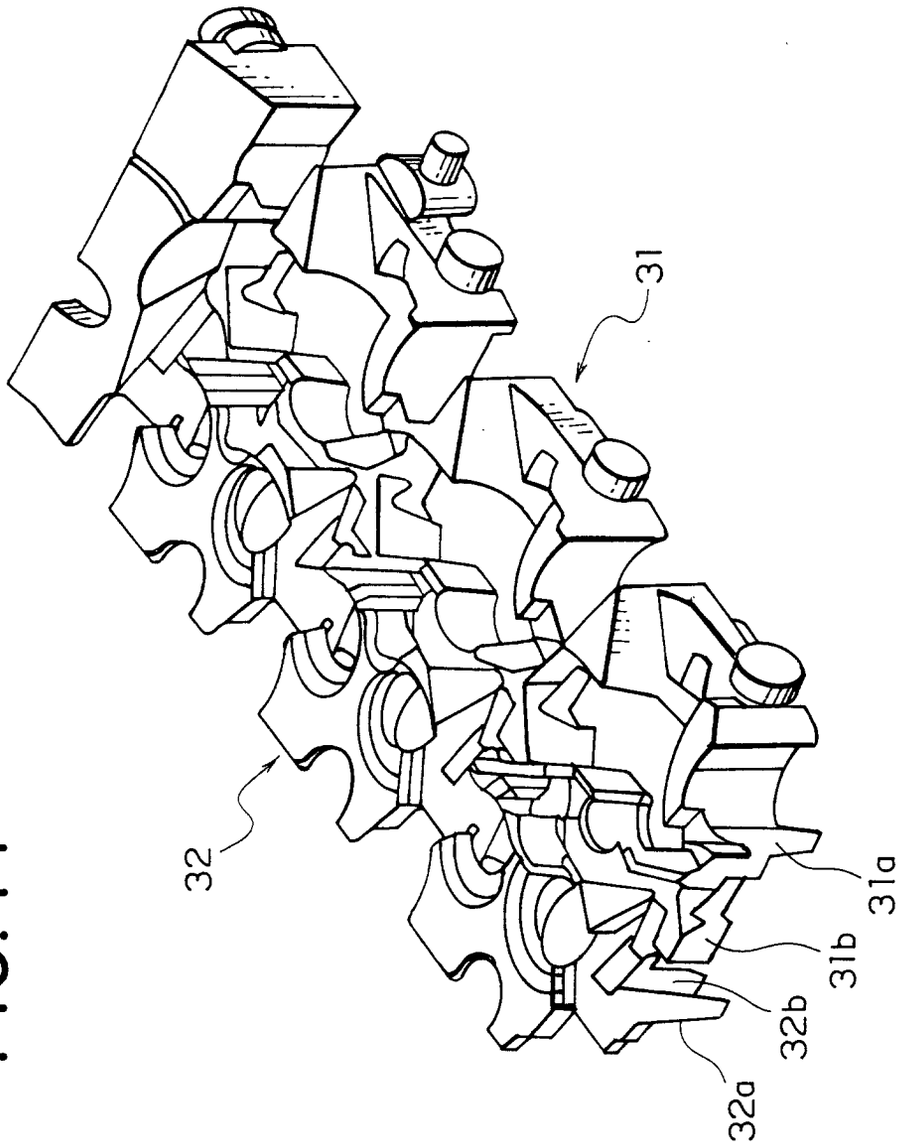


FIG. 15